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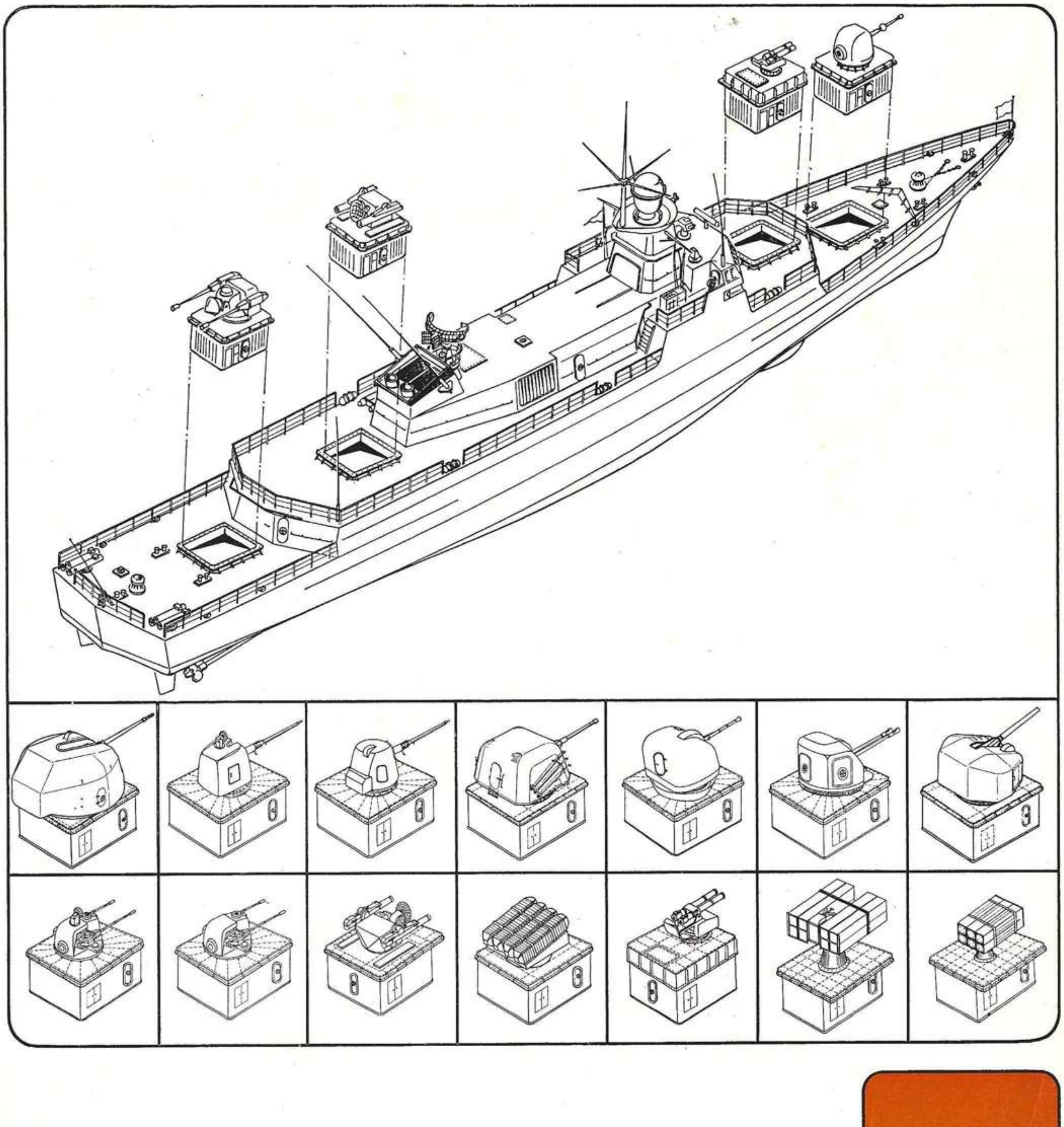

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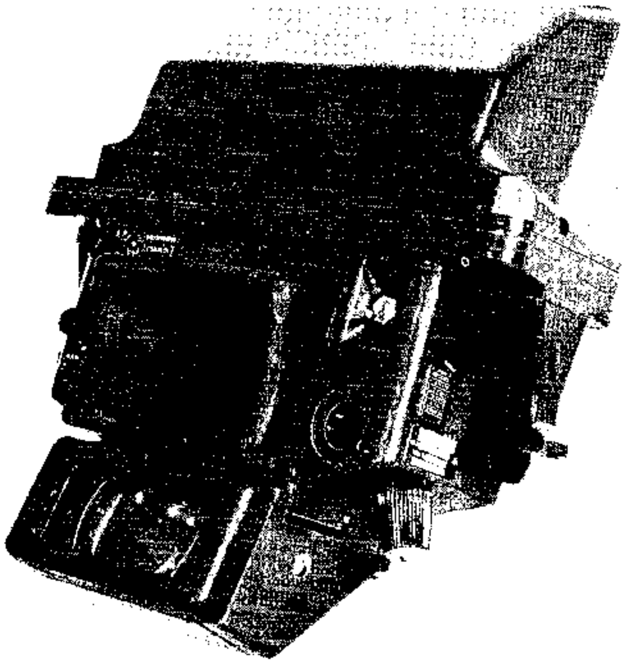

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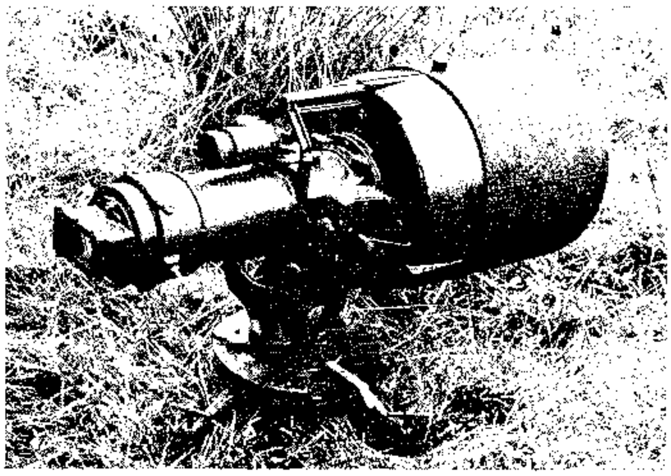

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Edited by **R. T. Pretty**
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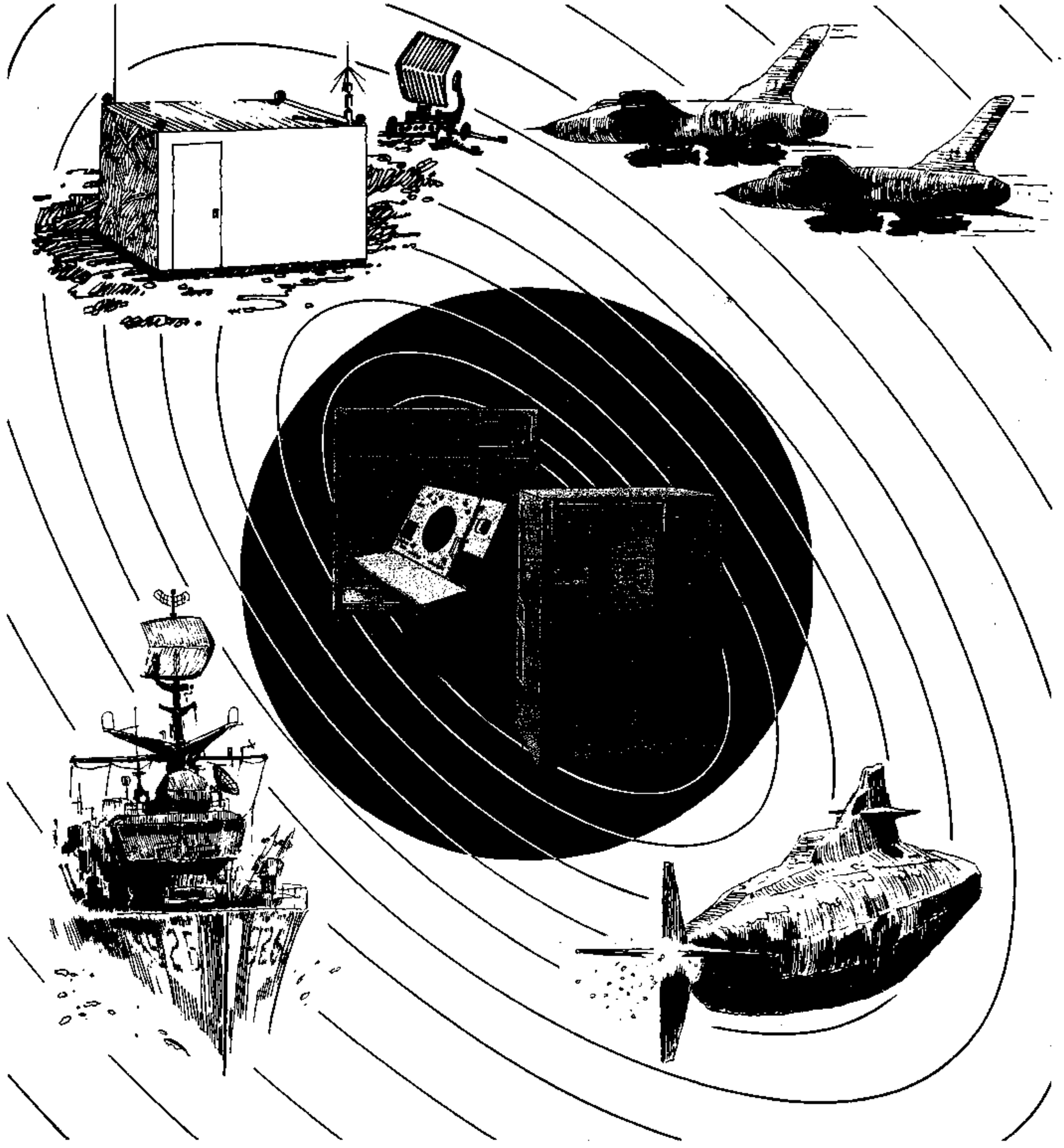

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S12. SUBMARINES AND SYSTEMS
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ALBATROS SYSTEM LENDS A NEW DIMENSION TO NAVAL DEFENCE.
Combined use of both missiles and guns ensures effective all-weather defence against all types
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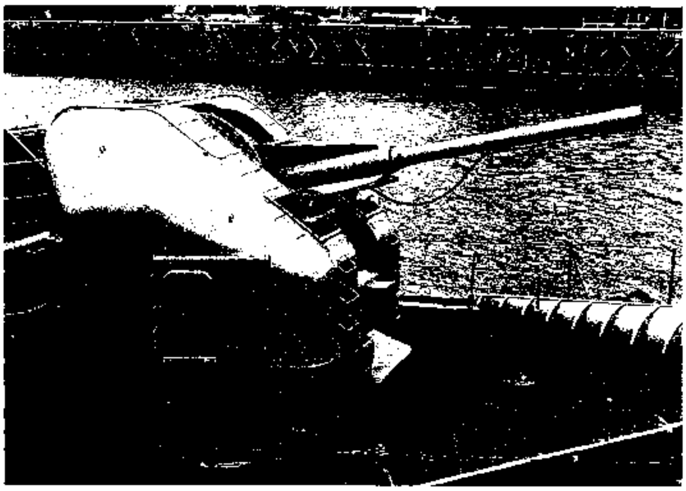
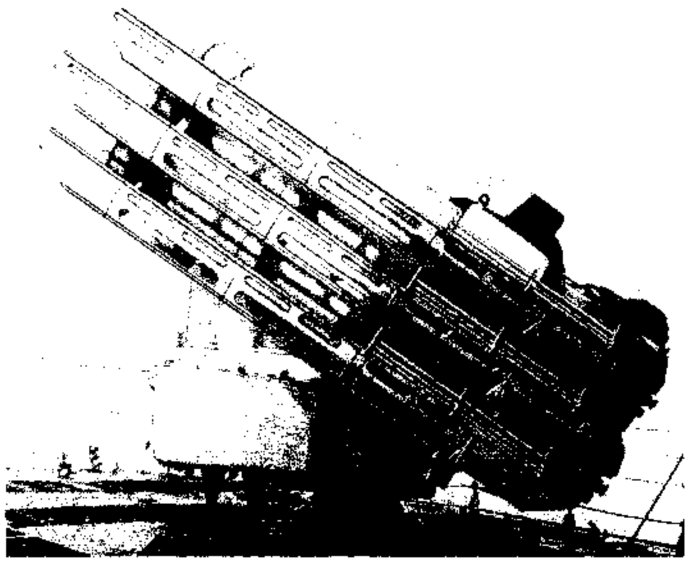


A.C.A. 100 mm turret



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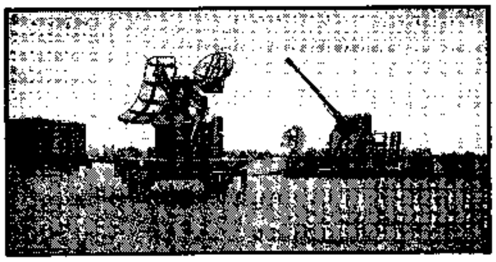
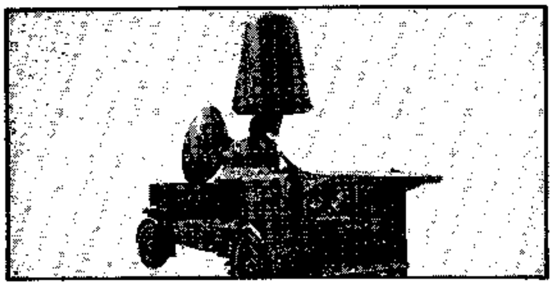
Flycatcher. Signaal's fourth novel system against low-flying aircraft.



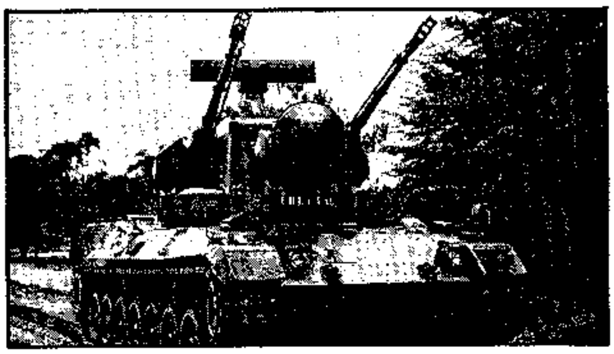
1955

L4/3 combined search and automatic tracking radar on one platform



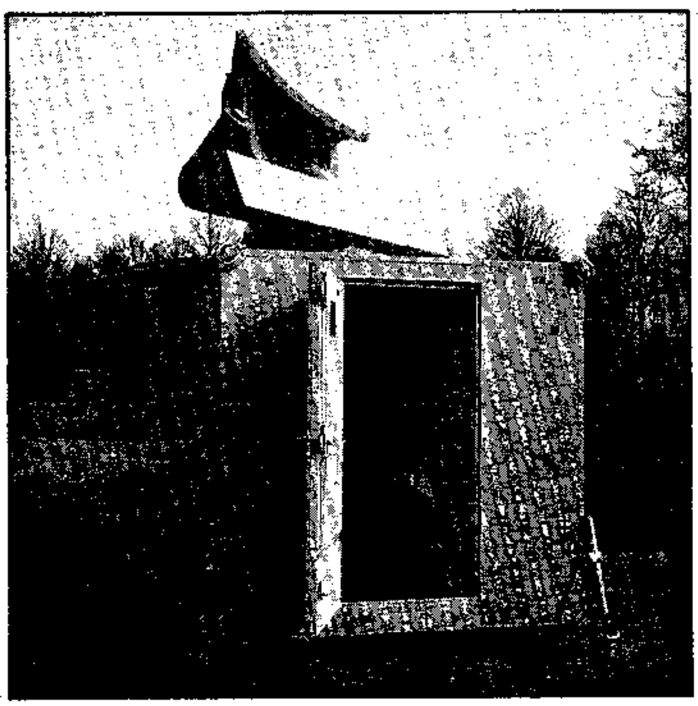
1964

L4/5 special purpose digital computer - search while track by using an integrated radar system



1971

A-A Tank. Miniaturised integrated radar system for use in selfpropelled vehicles
- special 'anti-image' radar



1973

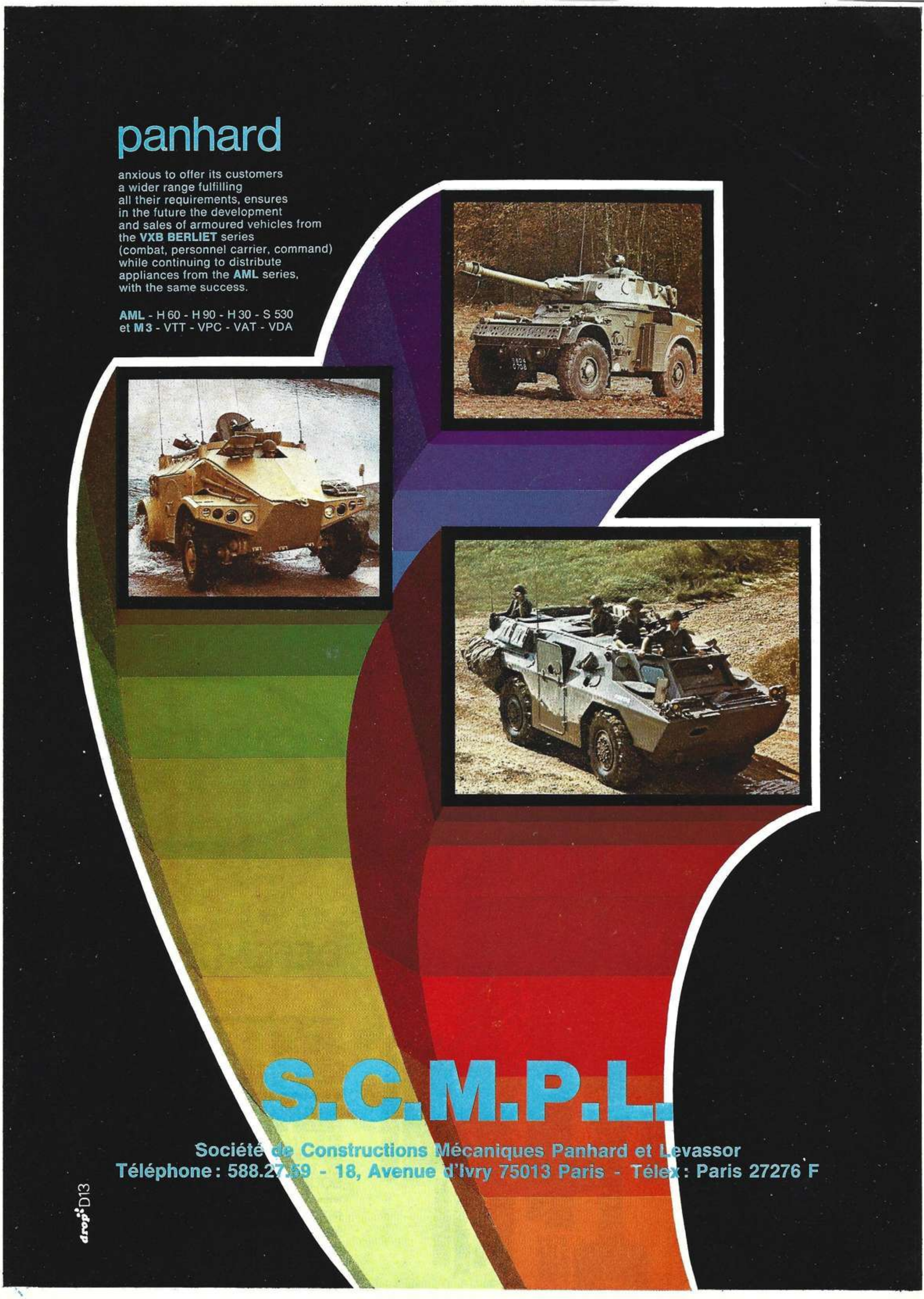
Flycatcher, another first combines all proven qualities of its predecessors, adding:
- self-contained weapon control cell for guns and/or missiles
- general purpose micromin computer
- digital gun-data transmission
- mobile and air-transportable.

Hollandse Signaalapparaten BV-Hengelo - The Netherlands. Radar, weapon control, data handling and air traffic control systems.

it catches all that flies

SIGNAAL

S 13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anxious to offer its customers a wider range fulfilling all their requirements, ensures in the future the development and sales of armoured vehicles from the VXB BERLIET series (combat, personnel carrier, command) while continuing to distribute appliances from the AML series, with the same success.
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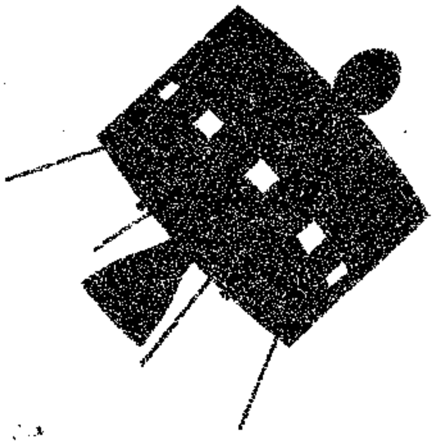

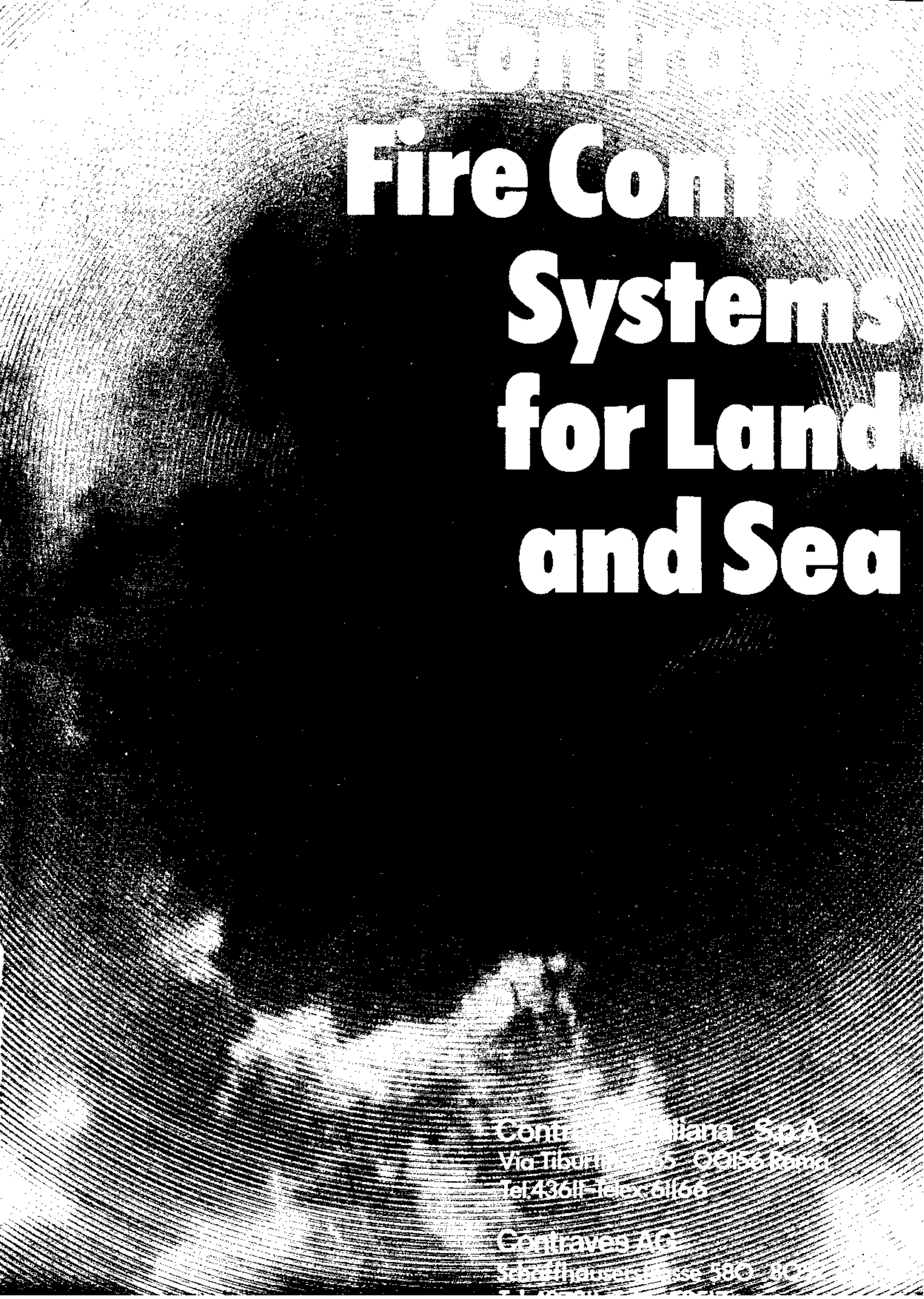
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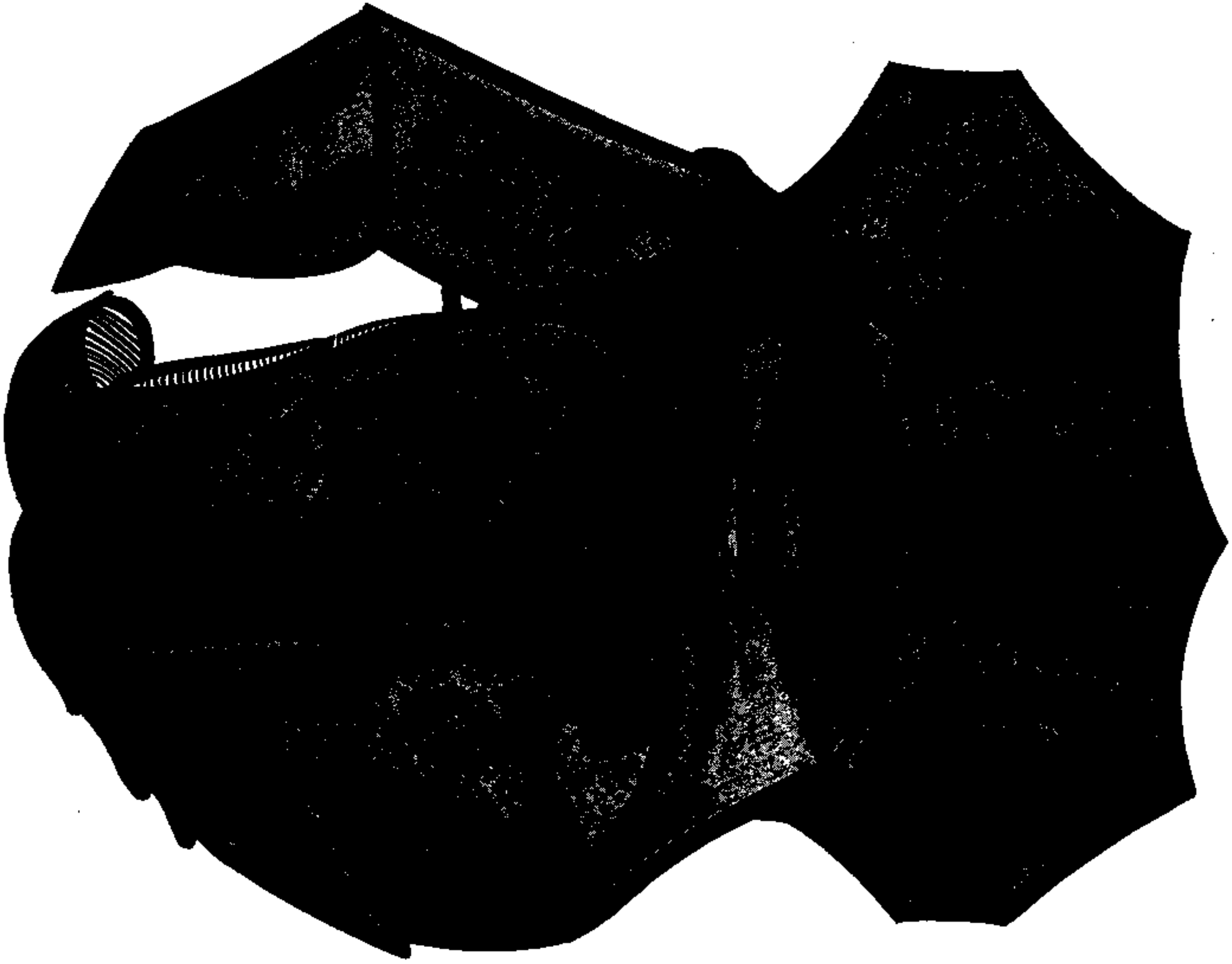

STRENGTH IN DEFENCE

Sperry Gyroscope is a major Defence contractor and supplies numerous systems and instruments to the navies, armies and air forces of the world.

Typical equipment supplied includes:

- ☐ **Aircraft instruments, nav/attack platforms and data recorders.**
- ☐ **Naval compasses, SINS, lightweight fire control and mine counter measures.**
- ☐ **Omega automatic navigation for ships and aircraft.**
- ☐ **Missile and torpedo guidance and control, safety and arming systems.**
- ☐ **Digital computers, memory storage and message switching systems.**
- ☐ **Navigation and gunfire control systems for fighting vehicles.**

Contact Director of Marketing for information.

SPERRY
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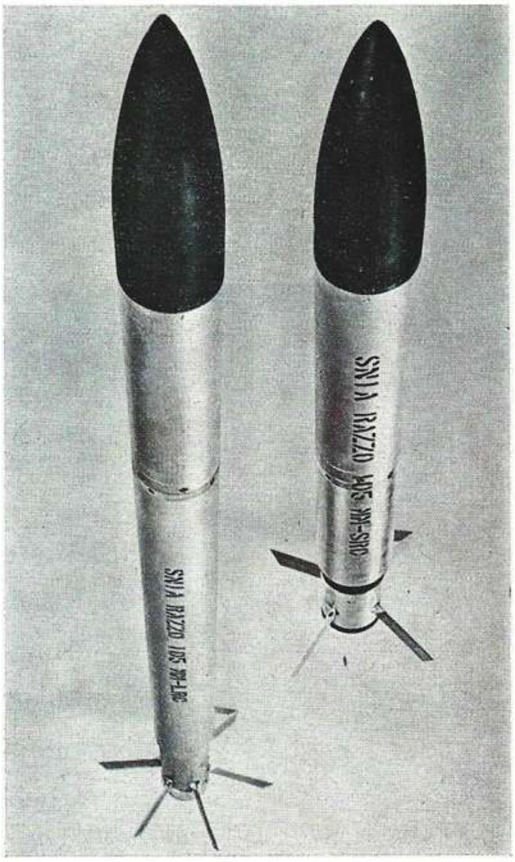
TELEPHONE: BRACKNELL 3222

SCLAR



SHIPBORNE MULTI-ROLE ROCKETS LAUNCHING SYSTEM

THE SCLAR SYSTEM IS THE LATEST DEVELOPMENT IN THE FIELD OF ROCKET SYSTEM, SPONSORED BY THE ITALIAN NAVY, BEING THE RESULT OF A LENGTHY AND PRODUCTIVE COOPERATION BETWEEN ELETTRONICA SAN GIORGIO - ELSAG, BREDA MECCANICA BRESCIANA AND SNIA VISCOSA.
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ELSAG S.p.A.
Weapon Control Systems Department
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Telex 27660 ELSAG

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25100 BRESCIA ITALY
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Defence and Aerospace Division
00187 ROMA ITALY
v. Lombardia 31
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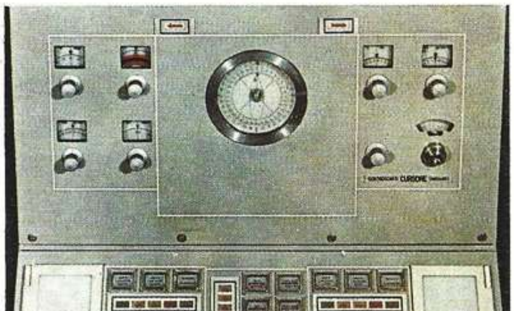

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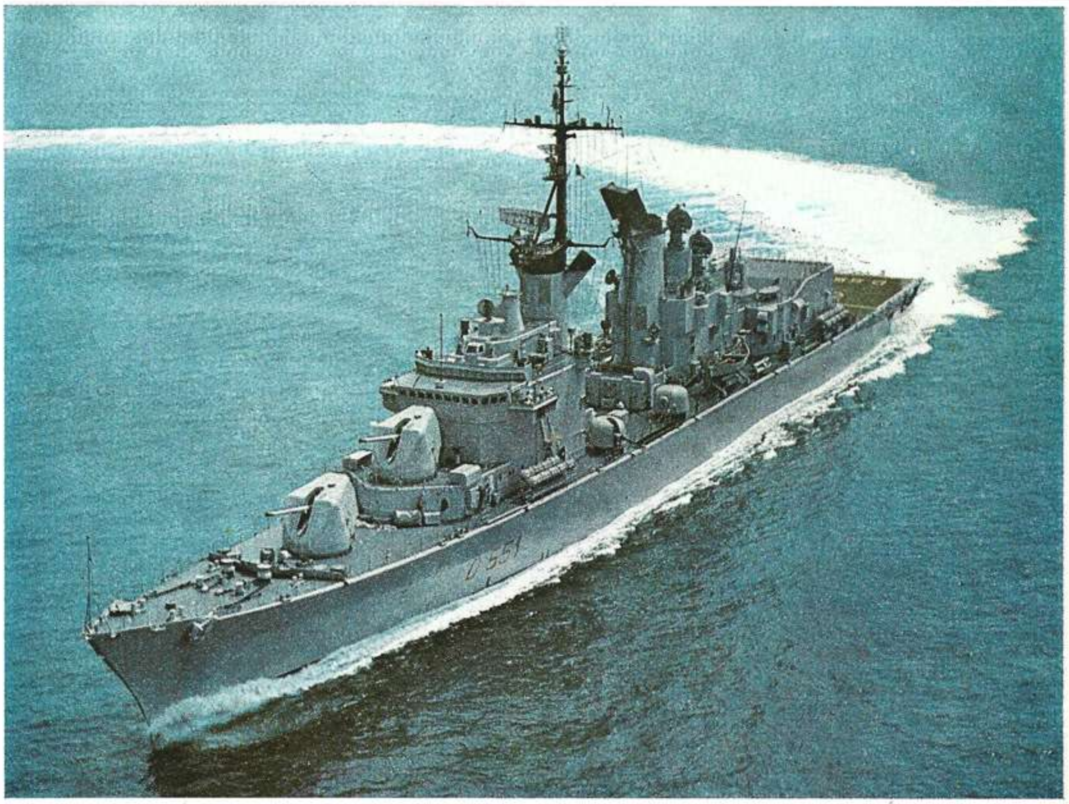

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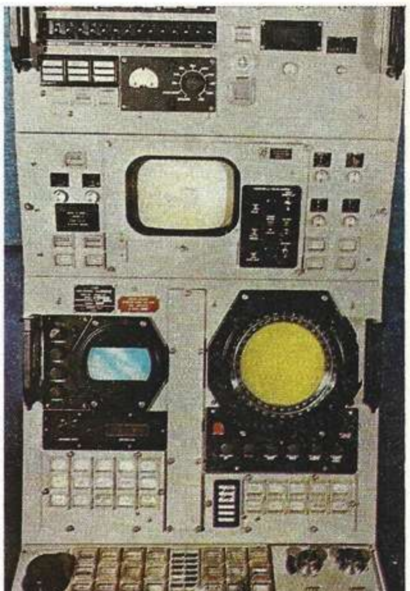

COMBAT SYSTEM ENGINEERING AND SHIPBORNE WEAPON CONTROL SYSTEMS

SINCE 1928 ONE OF THE MOST PROMINENT AND NOW THE LEADING ITALIAN FIRM IN THE FIELD OF DESIGN AND PRODUCTION OF NAVAL FIRE CONTROL SYSTEMS.

MAIN SUPPLIERS OF FIRE CONTROL SYSTEMS TO THE ITALIAN NAVY AND TO A NUMBER OF FOREIGN NAVIES, POSSESSING A SOUND EXPERIENCE IN COMBAT SYSTEM INSTALLATION AND REFITTING.

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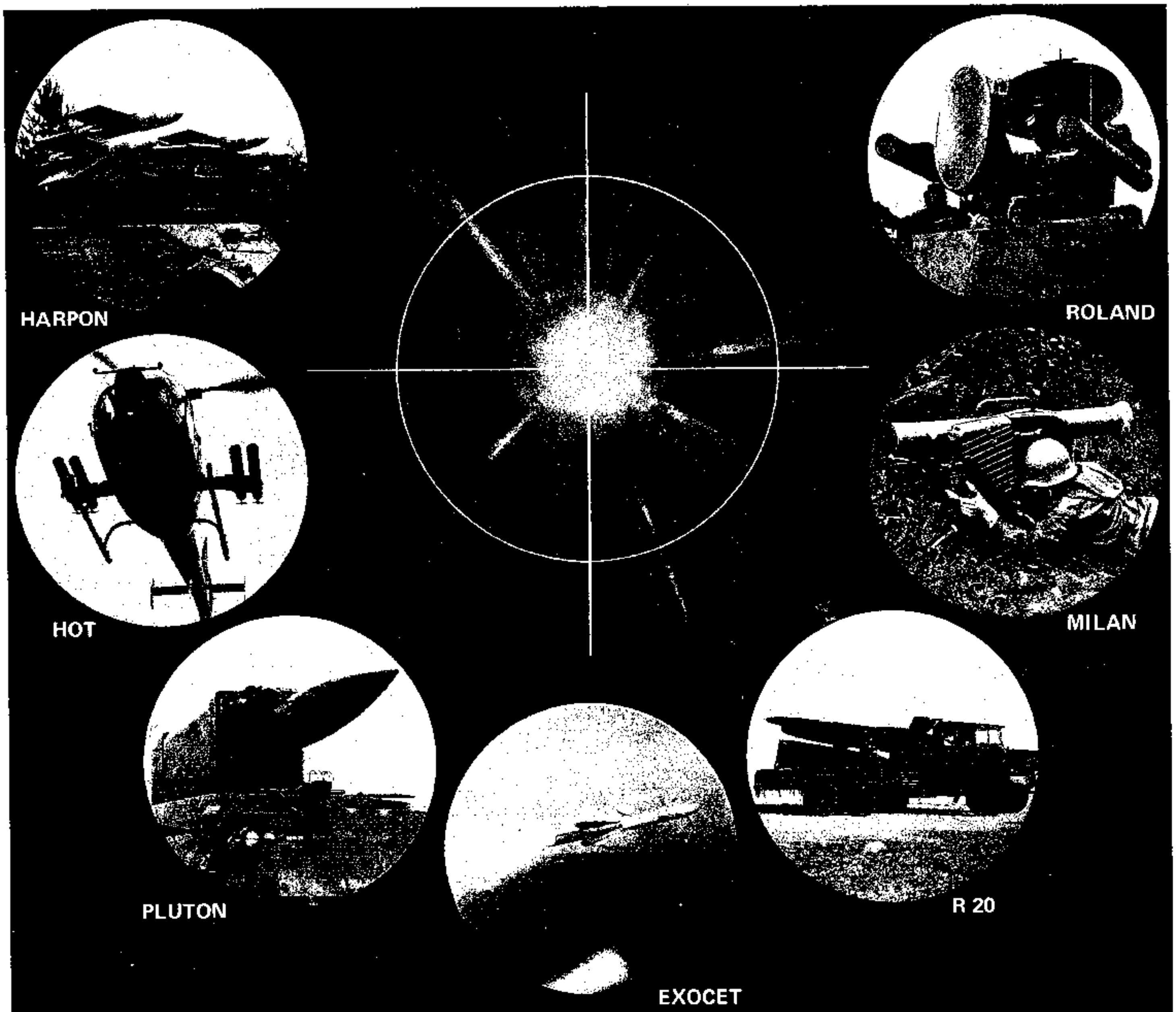

AEROSPATIALE's Tactical Missile Division has designed, developed and delivered more than 350,000 weapon systems, over half of them for export.

First generation, manually guided missiles: ENTAC, SS 11, SS 12M, AS 12, AS 20, AS 30.

Second generation missiles with automatic command to line-of-sight, both simple to operate and highly accurate:

HARPON, AS 30 IR,

ROLAND (surface-to-air), MILAN and HOT (anti-tank), developed jointly with MBB Germany in the EUROMISSILE organization.

EXOCET, surface-to-surface weapon system to arm naval craft of all sizes, from fast patrol boats to cruisers, as well as airplanes and helicopters (tests now underway).

Studies of the submarine-launched EXOCET are going ahead and a coastal defence version is also planned (fixed and mobile missile batteries).

EXOCET has been ordered by the French Navy and many others.

PLUTON, surface-to-surface tactical nuclear missile.

CT 20 target drones and derived systems, used as standard equipment for the testing of surface-to-air missiles.

R 20, battlefield reconnaissance drone (by day and by night).

aerospatiale

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The BL 755 Cluster Bomb is highly effective against tanks and other armoured vehicles, aircraft, transport, patrol boats and personnel. It weighs a nominal 273 kg (600 lb), needs only a simple sighting system and can be delivered from tree top level.

• RETARDED BOMBS

Complementary to the cluster weapon No. 117 and 118 Retarding Tails can be fitted to a range of 245-454 kg (500-1000 lb) HE bombs to achieve very low-level attacks against the larger target where concentrated HE is required.

The photograph above shows BL 755 Cluster Bombs and 454 kg (1000 lb) Retarded Bombs on the HS Harrier.

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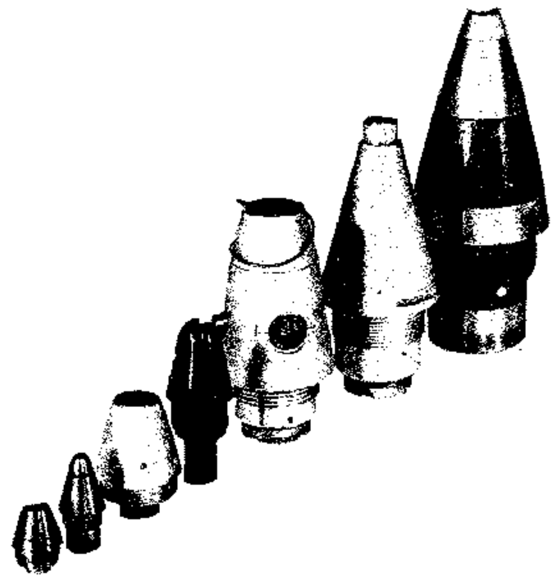

The Borletti Company established in 1896 to manufacture high precision mechanical products, has since 1914 co-operated with the Italian Military Authorities in the development of a number of clock devices for military purposes. Its Ordnance Division has subsequently developed and manufactured timing devices and a wide range of percussion, time and proximity fuses for artillery shells, rockets, land and sea mines, airborne bombs and demolition charges. Design and development facilities are also available to undertake studies on new fuses or timing devices. The Company in past years has been assigned some of the most important fuse contracts under the U.S. Off Shore Procurement programme.

Most NATO and SEATO Services are equipped with Borletti fuses and timing devices.

Manufacturing facilities include up-dated high precision machinery, automatic assembly machines, and full X-Ray services for inspection requirements.

Italian Army Inspection Teams are permanently stationed at the Borletti Ordnance Plants.

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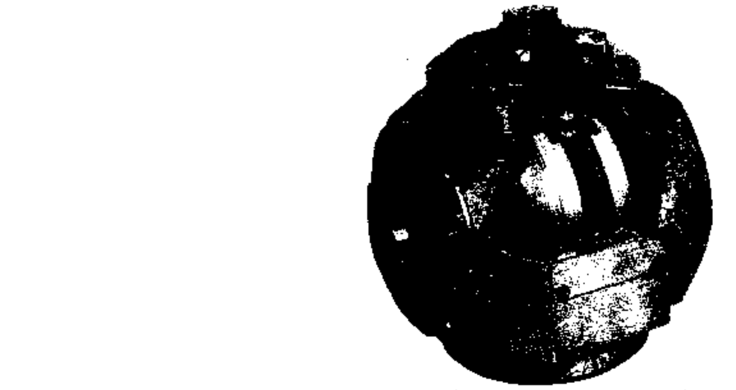


for ships heading and vertical reference systems

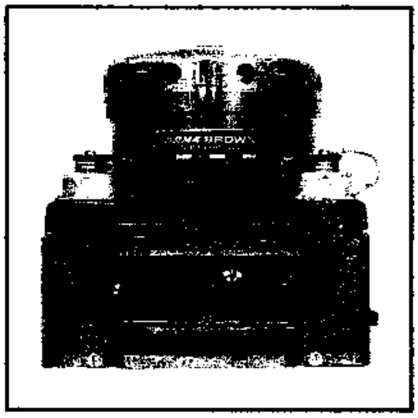
with a proven MTBF in excess of 50,000 hours

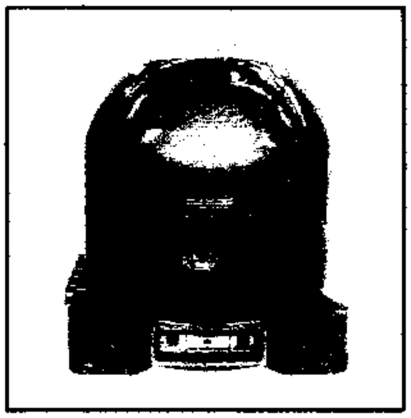
Combined navigation and fire control stabilisation

The Arma-Brown Sensitive Element (also selected for the N.C.S.I.) is used in both the azimuth and vertical reference systems. Integrating the two provides a relatively inexpensive, accurate reference for fire control stabilisation. The compass can function independently to avoid duplication of services.

Arma Brown Gyro Compass MK.1 MOD.5

With remote control unit allowing directional gyro mode to be selected at extreme latitudes and during high speed manoeuvres and Coarse/Fine synchro outputs equally suited for feeding Navigational or Stabilisation systems.



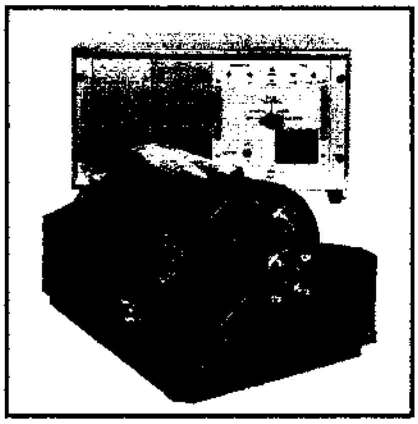


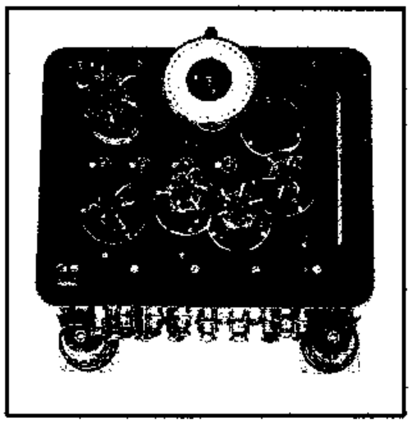
Arma Brown Gyro Compass MK.7

This compass is basically a MK.1 Mod.5 unit in a vertically stabilised gimbal mount offering the same North Seeking/Directional Gyro capability with improved performance in vessels subject to heavy pitch and roll characteristics.

Vertical Reference Gyro

The reference consists of a single gyroscopic element slaved to the vertical by two pendulums with computer corrected errors due to ships motion and earths rotation giving a basic accuracy of ± 3 mins of arc.





Coarse/Fine Retransmission Units

Available with various input configurations and outputs tailored to individual requirements; interfacing with Autopilot, Radar, Sonar, Direction Finder, Roll and Pitch stabilisers and Fire Control systems. Self Alignment ensures maximum state of equipment readiness.

For further information contact the Marketing Manager.

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à grande portée : 25 km.
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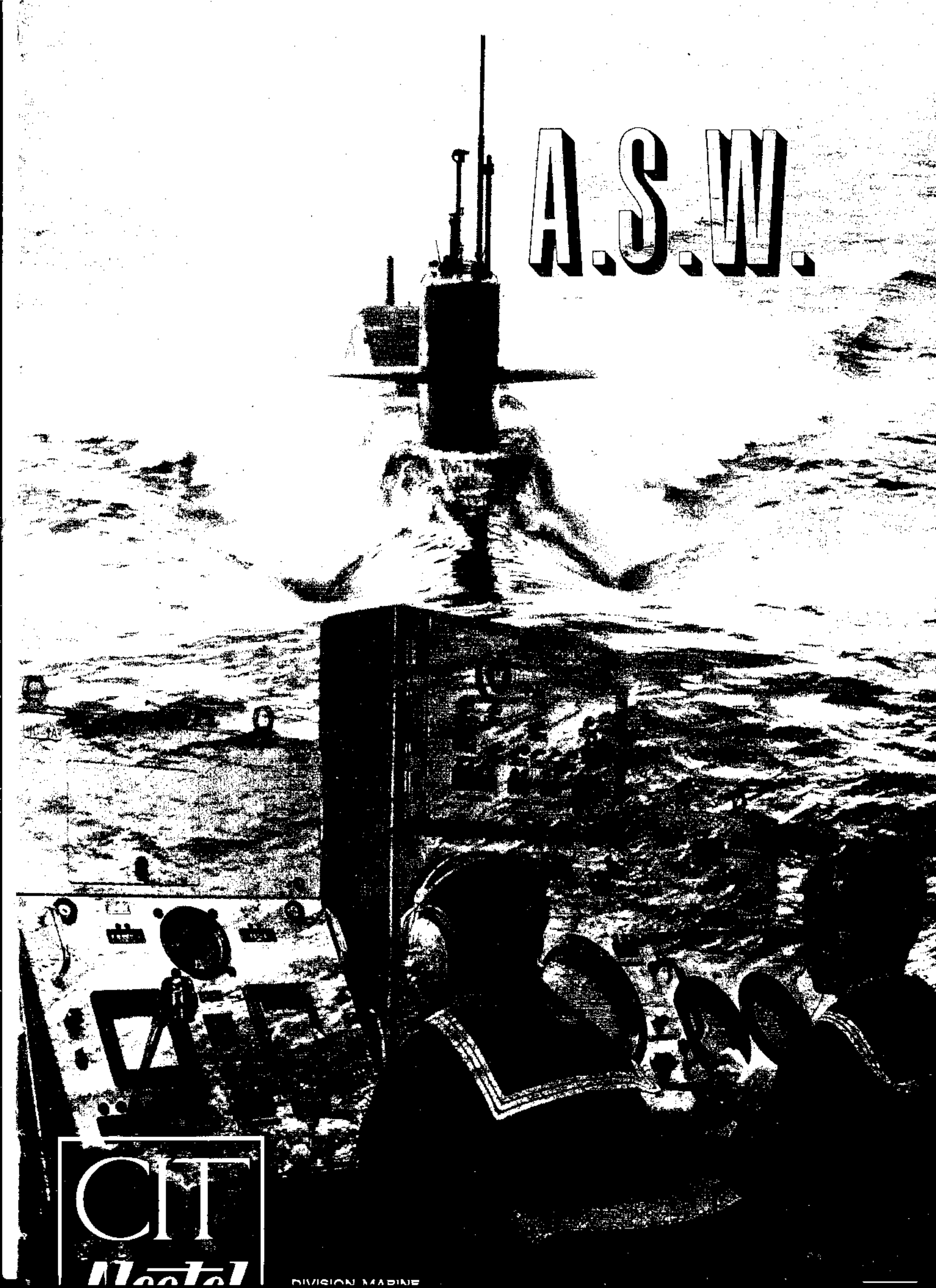
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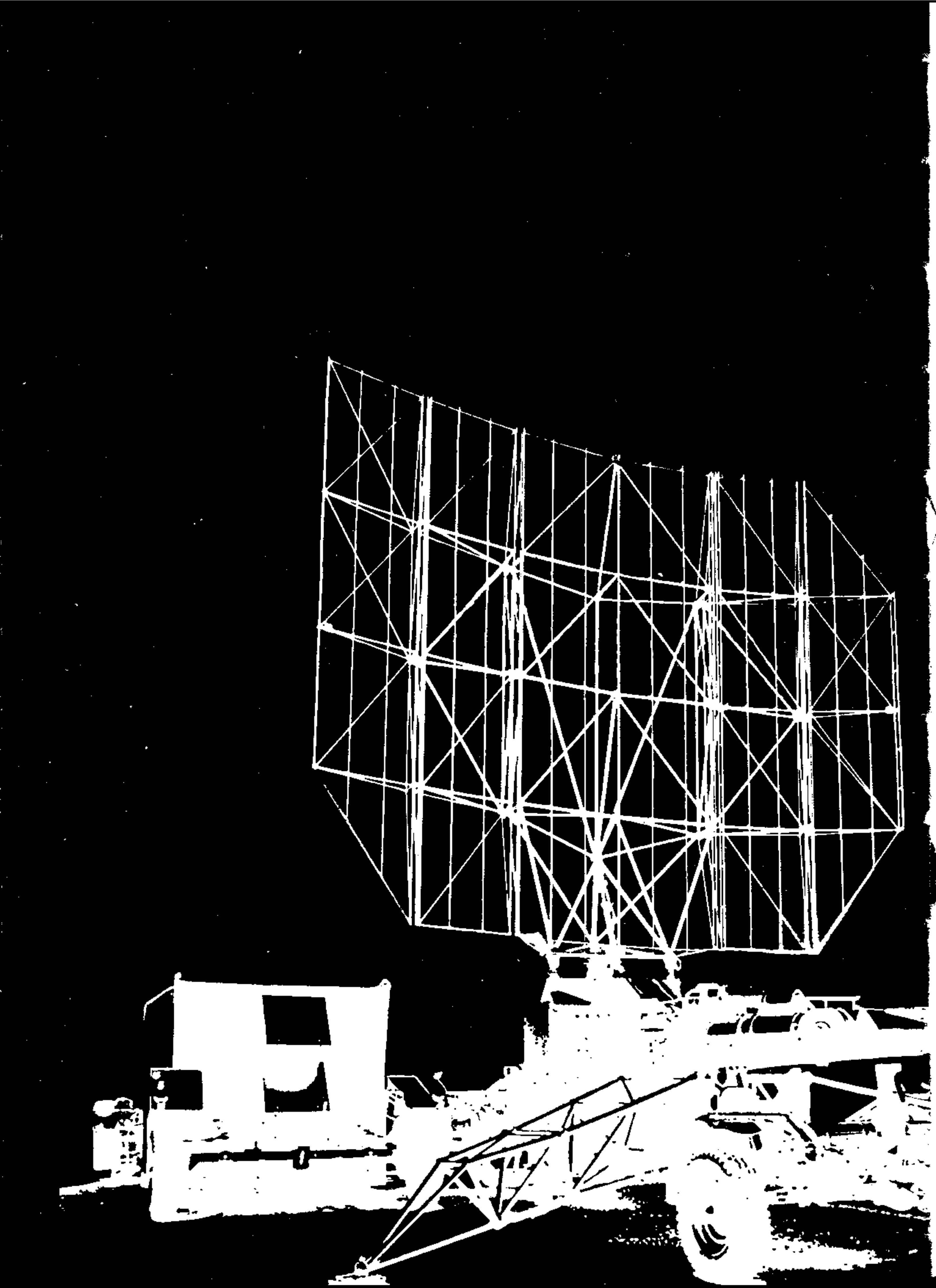
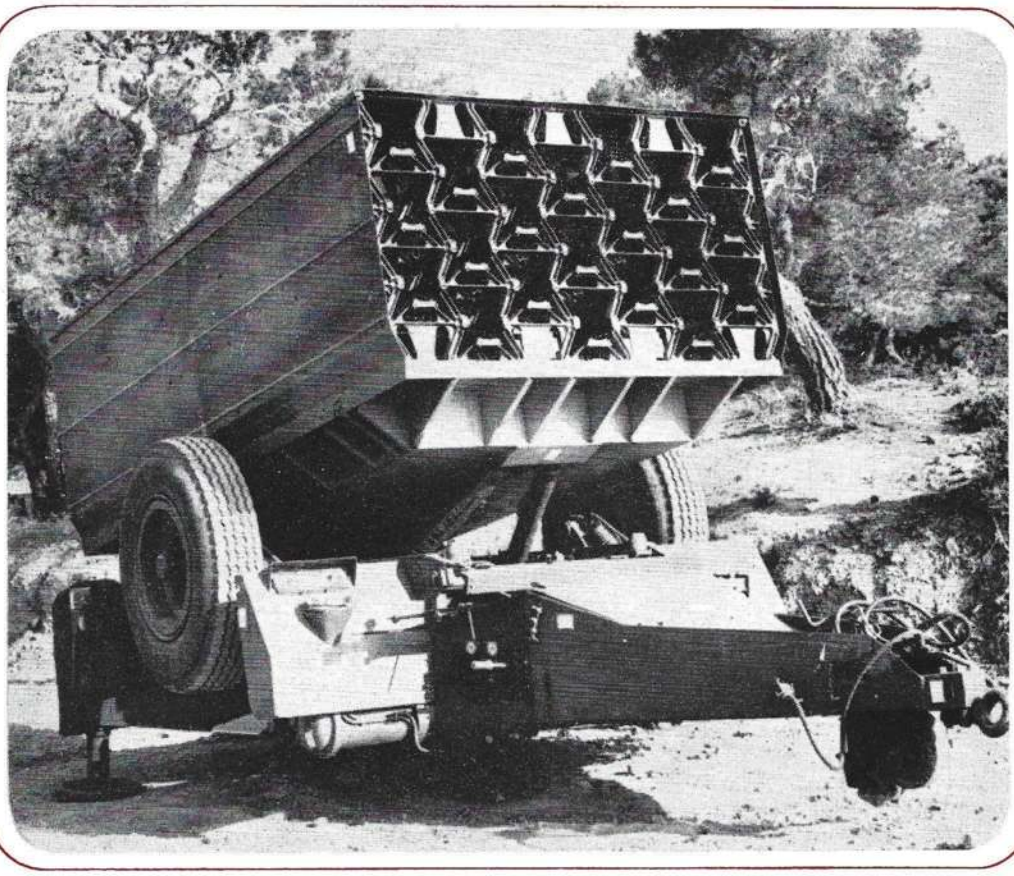


fire power, accuracy,
rapidity and simplicity of use characterize the

RAP. 14

multiple rocket launcher.



Instantaneously into action on a fixed, towed,
vehicle carried or self propelled mounting,
it beats effectively a 25 acre zone with a single

21 round salvo.

It is, therefore, capable of undertaking a large variety
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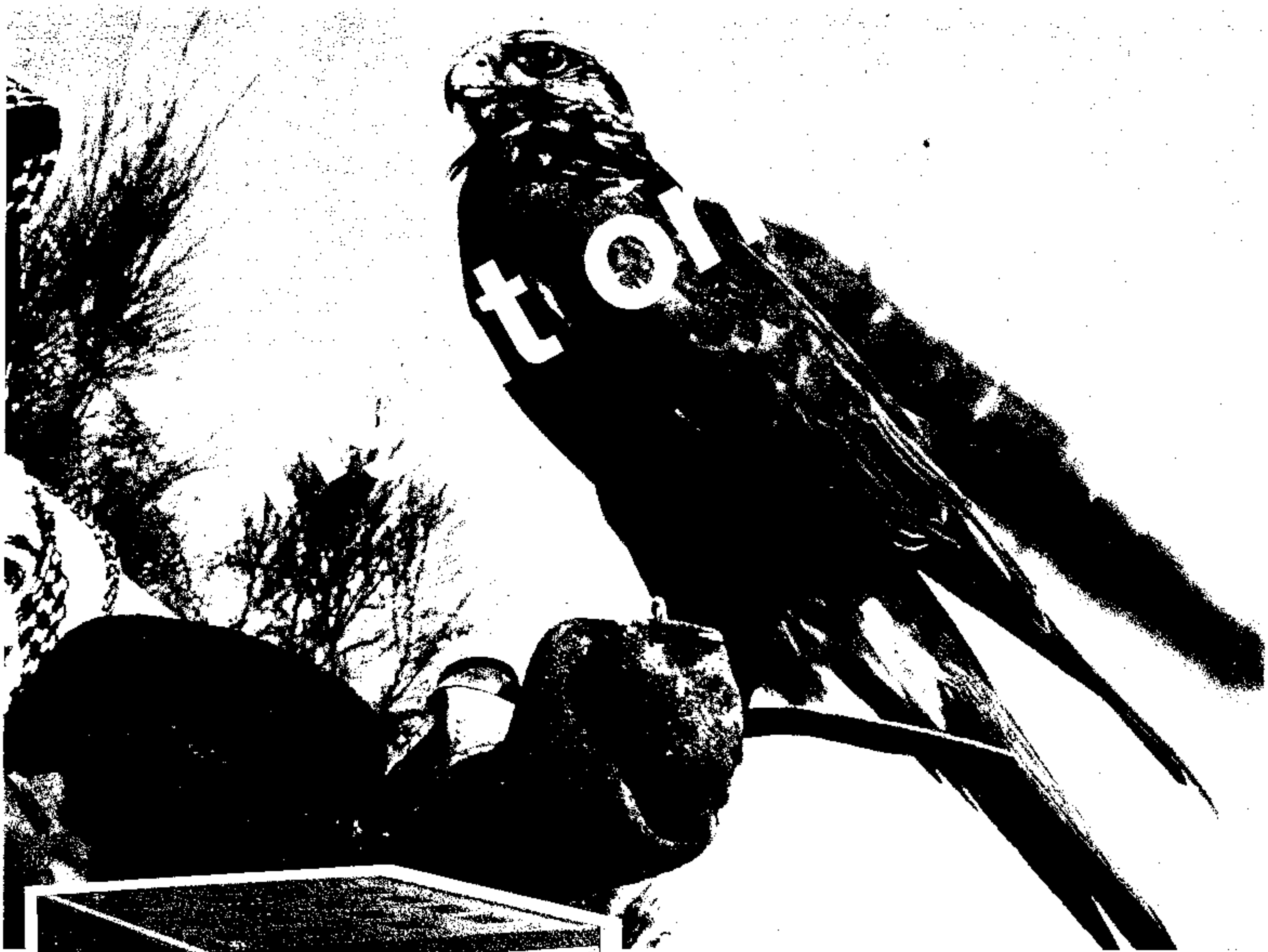

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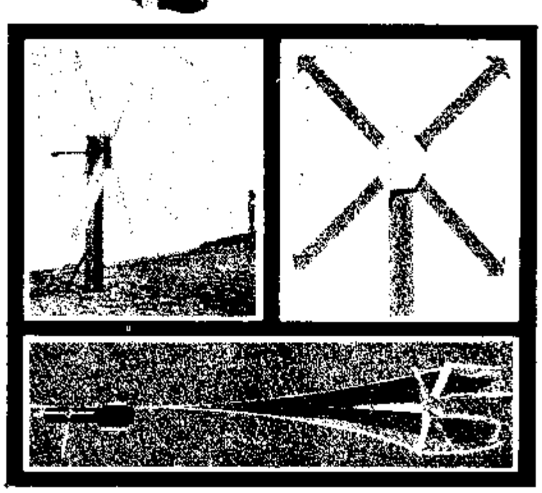

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Immediate display of the number of hits scored

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SIXTH EDITION

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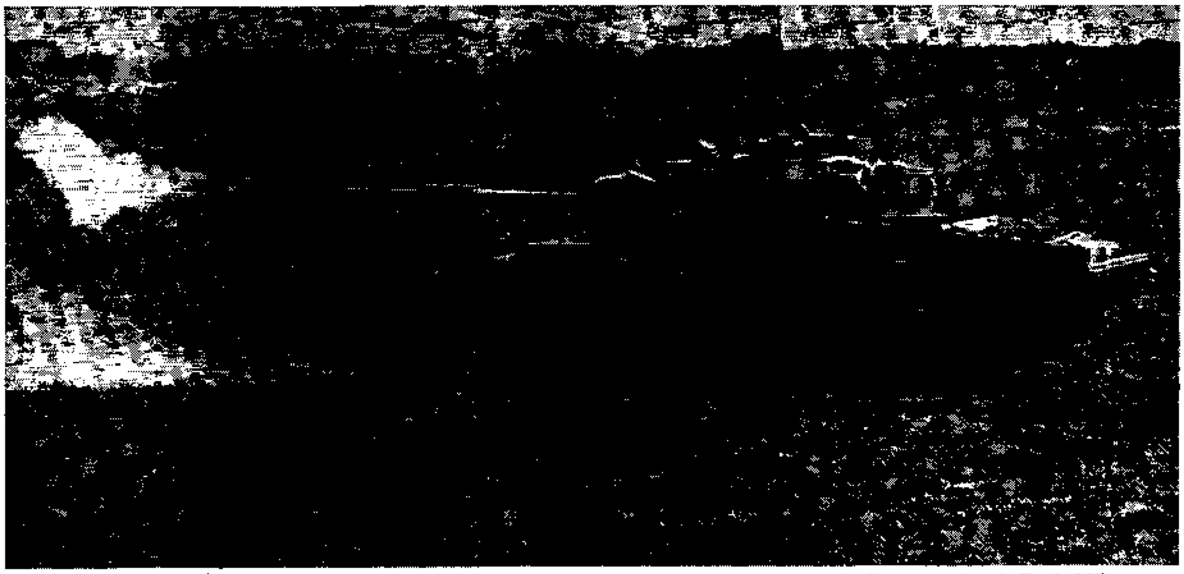

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Vickers experience is unrivalled in the design and manufacture of armoured fighting vehicles.

In their respective roles these vehicles are unequalled in performance and are designed for use in any part of the world.

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JANE'S WEAPON SYSTEMS 1974-75

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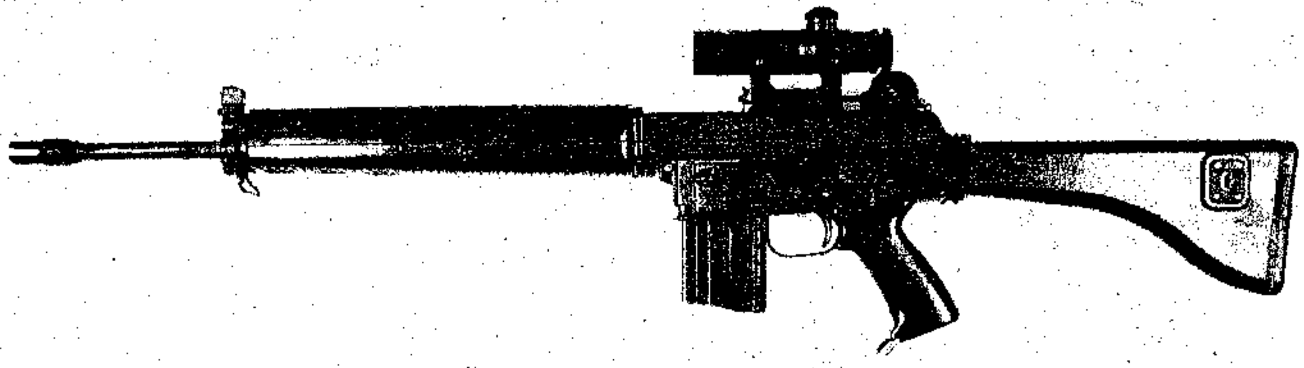
SUB MACHINE GUNS
POLICE CARBINES
AUTOMATIC RIFLES

STERLING SUB MACHINE GUN 9 mm MARK 4 (L2A3)

The standard sub machine guns with the British Forces and in service in over 80 countries in the world. Continues to function in the most adverse conditions of mud, sand, snow and ice. Exceptionally accurate and of renowned reliability. Illustrated with optional bayonet. Also available as a police carbine, i.e. semi-automatic fire only.

STERLING PATCHETT SUB MACHINE GUN 9 mm MARK 5 (L34A1)

Developed to meet a requirement for a fully silenced weapon. It retains all the other features of the Mark 4 and uses standard 9mm Parabellum ammunition. The bullet is slowed to sub-sonic speeds by the silencing arrangements giving a truly silent weapon. There is nothing to wear out in the built in silencer and thousands of rounds can be fired without attention except normal cleaning. Also available as a police carbine.



STERLING AR 18 5·56 mm COMBAT RIFLE

(Shown with immediately detachable 3x telescopic sight)

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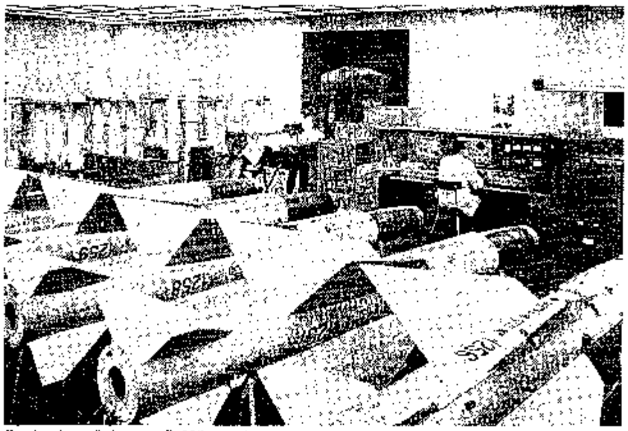
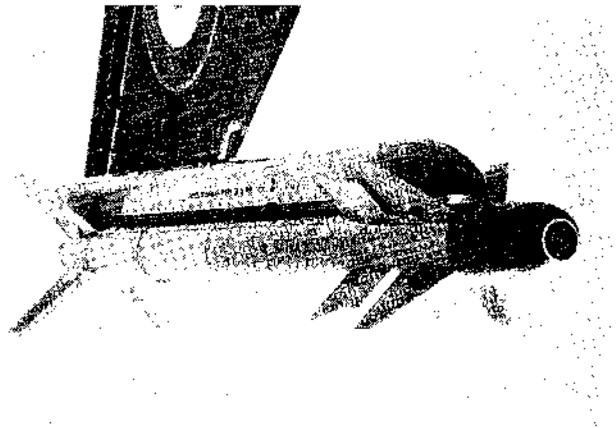

Production of air-to-air R 530 missile.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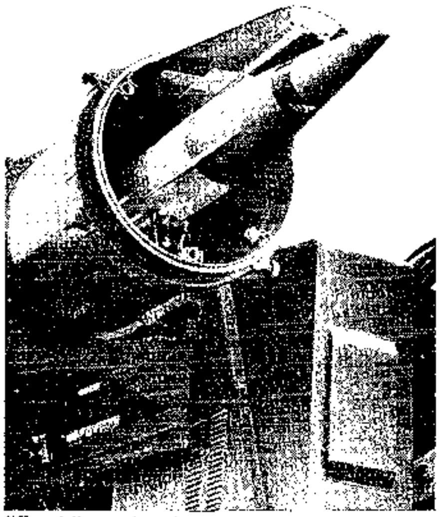
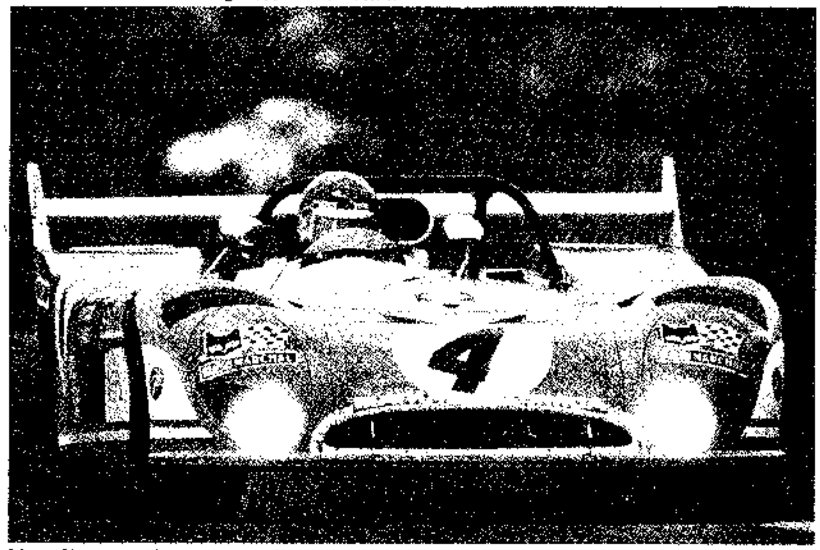

"Crotale" ground-to-air missile.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FOREWORD

Much has happened, but little has been achieved, in the world since we wrote the Foreword to the fifth edition of this book. In both military and political contexts (where these are separable) there have been momentous events, many of which created new problems that remain unresolved as we contemplate a new foreword over twelve months later.

Within this short time-span, the government of the UK has been removed from Conservative hands to Socialist and the latter party has won a second mandate only months after ousting their opponents. America, in the same period, underwent the trauma of a Presidential resignation induced by the Watergate scandal. The French President, M. Pompidou, died; while West Germany's Willy Brandt resigned; and surrounding these central changes have been more changes of government—accompanied by varying degrees of violence—in other countries than at any other comparable period that we can recall.

As if these political upheavals alone were not enough to seriously threaten what stability there is, another bloody round has been fought in the Arab/Israeli conflict; there has been war in Cyprus, the Ulster sub-war continues, as does the Vietnamese struggle, and the general level of lawless violence has been sustained by much the same mixture of terrorist-type activities as in the preceeding years.

In the face of such widespread and varied evidence of prevailing instability, it would take an unusually skilled and bold clairvoyant to make a confident prediction of the effect of all this on East-West relations over the next few years.

While feeling that the almost conventional East-versus-West view of world affairs is rapidly becoming too narrow to serve for much longer as the principal fulcrum for debates on world affairs, we are unable to advance proposals for a more suitable approach at this time.

Despite the multiplicity of images crowding our crystal ball, and the limited visibility therein, as it has been our custom to produce some kind of assessment of the present state and likely future trend of international military affairs, we feel we should again attempt this task in order that the reader may relate those hardware developments recorded in this volume to their operational context. We approach this annual venture with more trepidation than usual, and in entreating the indulgence of those more informed than ourselves on this subject we would reiterate that military systems and equipment are the major preoccupation both of ourselves and of this book. More profound or detailed politico-military discussion should be sought elsewhere.

To begin our summary with a glimpse of the obvious, it is evident that there has been no slackening of the arms race between the USA and the Soviet Union; nor is there any sign of a reduction in the Chinese armament effort. It seems apposite to interpose at this point the observation that these efforts—and the armament programmes of other nations, large and small—are being pursued in the face of savage world-wide inflation which seems to defy all efforts to find a cure. Some nations and types of government may be better able than others at forcing through military equipment programmes and projects in the face of inflationary conditions; which injects another parameter to be considered by those attempting to predict the future balance between individual nations or groups of nations.

Returning to the nuclear super-powers, it could indeed be argued that a major outcome of the strategic arms agreements between them has been a considerable increase in the effort devoted to weapon development programmes aimed at circumventing the agreements; and little is now heard of the Pugwash argument, that the development of anti-ballistic missile systems is "de-stabilising", in that it encourages the development of more sophisticated offensive missiles. It is evident that the drive towards greater sophistication is independent of any such encouragement. Details of the new Soviet ICBMs, information on American warhead development and new strategic missile projects which appear in this edition, illustrate the point.

Writing more than two years ago about the 1972 Moscow agreements, we observed that they amounted to little more than a reflection of what both parties had intended to do anyway; and that "little more" could best be summarised as a public declaration that neither dare launch a major nuclear attack on the other, nor create a situation where the other was left with no choice but to launch such an attack.

Much the same, we are sure, is true of the 1974 agreements: the two parties now appear to be content with not much more than a token ABM missile system (and both are almost certainly working on other [cheaper?] defensive techniques); and are now more interested in small-to-middling nuclear warheads than in multi-megaton devices—and in providing these payloads with a better probability of reaching their precise destination; the drive towards improved nuclear missile performance is probably primarily that of maintaining the relative capabilities of the two powers somewhere near the alleged point of balance.

Somewhat further down the scale of nuclear affairs, it is our view that a more dispassionate appraisal of nuclear weapon testing and nuclear weapon proliferation is to be desired. The

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continuation of French tests in the Pacific and the detonation of an Indian nuclear device, during the past twelve months have predictably evinced responses of a different nature. It is hard to deny that the world as a whole would be better off without more nuclear explosions—as indeed it would without many other human malpractices—but in a year in which Britain, China, France, India, Russia and the USA all detonated nuclear devices of some kind—(and Israel declared that nuclear arms were well within her scientific and industrial abilities) it seems less than rational to lambast but two of these nations. Perhaps this really demonstrates either the strength of various nations' predjudices or the relative efficacy of the nuclear nations' respective PR arrangements.

Perhaps the French authorities were a little tactless in their approach to the matter. Perhaps they could have arranged things differently. It seems probable, however, that the reactions of other countries were based to some extent on simple francophobia which in turn probably stems largely from envy of French military independence. The ability of French forces—nuclear and non-nuclear—to deter a potential aggressor can be debated at length; but the fact that France has such forces wholly under her control, backed by an industry which is capable of continuously upgrading them, makes her unique among Western European nations. The British submarine nuclear force is still potentially independent (operationally) and at the present time considerably more potent than the French force; but whereas France has a continuing programme of both submarine and weapon development, the British—although not lacking in either technological manpower or engineering facilities—have a variety of political and psychological obstacles to surmount before they can seriously consider the engineering implications of upgrading the Polaris force.

Again, the British airborne nuclear force—to whatever undisclosed extent it still exists—is also potentially independent; but a modernisation programme would encounter similar obstacles. So far as static and land-mobile missiles are concerned, however, the British forces are dependent—as are all other NATO forces—on American-controlled weapons for their nuclear fire-power.

Many military commentators contend that this is as it should be—that small independent nuclear forces have no rational place in the modern military arena. Hitherto much has been said in favour of the parallel argument that nuclear proliferation is a danger that the world should earnestly seek to avoid. However in the present international situation and having regard to the present and likely future state of weapon development, both arguments seem to us to be of diminishing validity.

In the early days of the NATO alliance there was, on the one hand, a reasonable degree of unanimity among the allies, regarding both the objectives of the alliance as such and the long-term desires of the member nations and, on the other hand, a powerful incentive for the United States to co-operate with Western Europe—the possibility of containing any future conflagration within Europe or at least keeping it away from North America. Today, however, there is little sign of unanimity among the allies—as their reactions to the 1973 Arab-Israeli war, the oil crisis and the Cyprus tragedy have clearly demonstrated; Russian aircraft, submarines and missile developments have caused many responsible Americans to advocate an American withdrawal from Europe. While NATO has an important continuing role in Western defence, as also have many other alliances around the world, no member nation can place absolute reliance on the support of others if its integrity should be threatened.

In these circumstances the arguments in favour of a measure of military self-sufficiency are persuasive.

Short of military intervention there is no way of preventing a nation from arming itself with whatever weapons it is willing and able to beg, borrow, buy or build. If the Indian Government, for example, is determined to make India a nuclear power, can obtain the necessary raw materials and can persuade the Indian electorate to support it, there is very little in practical terms that the rest of the world can do to change the course of events. To argue, as some have, that India cannot afford such a development (or ought not to try to afford it) is futile; the question of a country's "affording" any such activity arises only to the extent to which external purchases are involved: internally, the question is simply one of tailoring the national organisation and standard of living to the fulfilment of national military aspirations. If Britain, for example chooses to seek an improved standard of living while maintaining four times as many men and women in national and local government service as it does in its armed forces, it may well be difficult for the nation to spare much money for defence; but few other countries regard so lavish a bureaucracy as either necessary or desirable, and many have to make do with living standards lower than that which the British have already achieved.

In the Middle East, full scale war broke out again so soon after the foreword to the last edition was written—indeed our speculation upon an oil crisis and its effects appeared in print just as the crisis occurred—that any comments that we might now make on the 1973 Arab-Israeli war would be unlikely to add much of value to the many columns of comment that have already been published.

Much information on Russian weapons emerged from that conflict and has been incorporated in the main text of this edition. So far as the general political scene is concerned,

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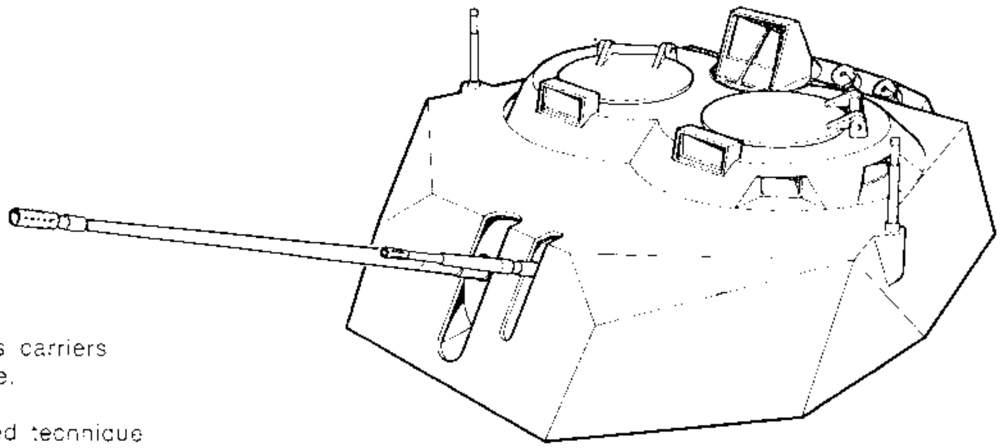

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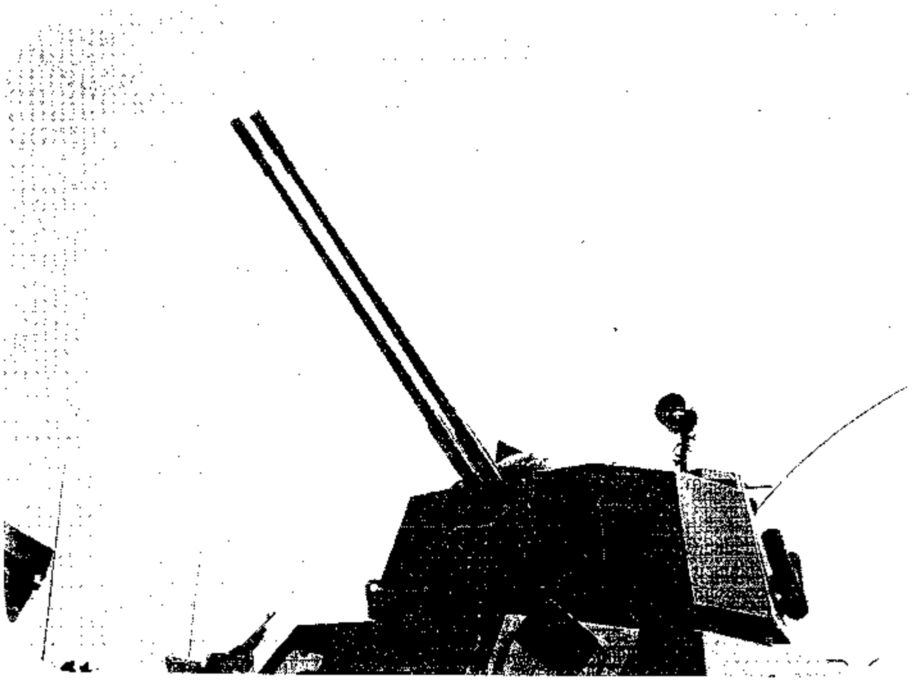

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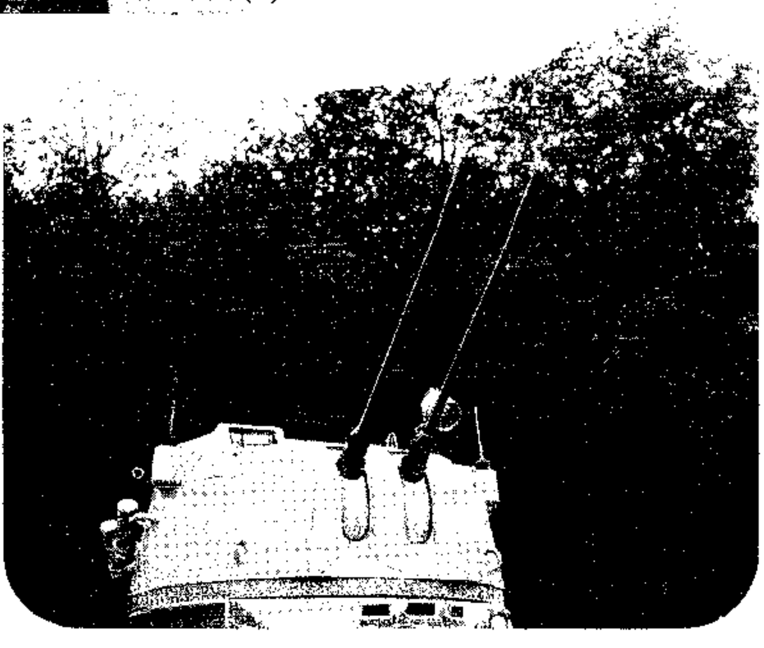

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the observations that we made two years ago are reasonably representative of our current views. The replacement of President Nixon by President Ford in the United States may well lead to modification of American Middle East policy at some time in the future, but any major change appears unlikely while Dr. Kissinger remains in the role of the "Flying Doctor/Arbitrator". This said, it must be recorded with regret, that more than a year after this latest and mostly costly renewal of Arab-Israeli fighting, a lasting solution seems less likely than a further resort to arms.

Before moving on from the Yom Kippur war of 1973, we feel that comment should be made briefly upon one aspect of this conflict which has not been stressed in any of the analyses presented to us. In short, our concern is to draw attention to the severe equipment attrition rates which both sides suffered. The actual figures for tanks, artillery, aircraft, transport and so on are still contested in the columns of military journals, but that these figures were extremely high is not disputed. In addition to losses of equipment, there is some evidence to suggest that the consumption of expendable stores—ammunition and guided weapons, especially—was also at a high level. This in turn prompts us to offer for consideration the proposition that the extraordinary rapidity of hardware depletion suffered by the combatants, and the uncertainties of resupply by their respective armament suppliers, frightened both sides into a more ready acceptance of a ceasefire than purely political or military consideration would have dictated. We presume that the lessons of this feature of the Yom Kippur war will not pass unnoticed by the military authorities of other nations.

It is perhaps too naïve, or too simplistic (in the newer jargon), but one is drawn to ponder the question, "What with soaring attrition rates, and inflation worldwide, who can *afford* a war?" In reply to this rhetorical question we are forced reluctantly to observe that there is no record of a war having been cancelled purely on grounds of cost. And which nation, large or small, denies its citizens the best defence forces and equipment which can be obtained at a cost to the exchequer which is broadly acceptable to the populace? Here we have to admit that some styles of government are better than others at influencing the level of acceptability, but the net result is the same.

If, for the sake of argument, we accept the idealistic concept that in global terms all expenditure on arms represents a waste of the world's resources, until Man changes his nature dramatically it is likely to continue. However, it is our view (and that of others more eminent and more directly involved) that in NATO—and probably elsewhere—our methods of procurement are in themselves wasteful; and while it may not be feasible to halt the grand-scale wastage, we can and should tackle the lesser problem of inefficient equipment procurement.

One trouble is that while NATO arrives at most of its decisions internationally, most operative decisions relating to specific hardware are taken at a national level by individual governments. Discussions leading to the latter decisions are sometimes conducted with incomplete or erroneous ideas of the true circumstances. For example, one can read in the defence debates of various NATO governments, views relating to the various shares of the overall NATO burden shouldered by individual nations—mostly to the effect that 'they' don't do enough and 'we' are doing more than our share.

Most of this argument is sterile, if not actual political humbug; national debate can determine that nation's contribution to NATO but has no mandate in respect of any other nation. Conversely, each NATO member-nation has to live with the decisions of its partners. If this were more widely realised and accepted, in our view NATO would regain some of its earlier strength and unity of purpose. The situation is admirably summarised by the Norwegian Minister of Defence, Alv Jakob Fostervoll, in an article which appeared in the *NATO Review*: "I have often thought that much of the pressure for US troop reductions (in Europe), which the present US Administration has so far successfully resisted, has been the result of lack of information. This picture is based on two fundamental misconceptions—that the US presence in Europe is solely for the benefit of Europe and that the European contribution to defence is negligible." Hastening to add that the US Administration does not share those misconceptions, the Minister went on to quote the Congressional (Randall) Committee of 1972: "It should not be forgotten that the nations of the NATO Alliance constitute the principal world market for US industry outside the United States. In co-operating to ensure the success of NATO, we are, among other things, providing a security for crucially important American interests."

He later cites statistics given by Dr Schlesinger in his Annual Defense report for 1974/75, when the US Secretary of Defense stated, "Of the peacetime forces deployed in the European area, our allies contribute approximately 90 per cent of NATO's ground forces, 80 per cent of the ships and 75 per cent of the aircraft." To supplement this information, Mr Alv Fostervoll wrote, "On a global basis the US and Canada have some 2.2 million men under arms compared with NATO Europe's 3.3 million, in each case one per cent of the population. Moreover, the UK maintains some 17 per cent of its forces outside its national boundaries, and Belgium as much as 33 per cent compared with 11 per cent of US Forces stationed in and around the continent of Europe. There has also been a noticeable shift in the sharing of the defence burden over the last ten years. The Europeans are now providing a greater share of NATO's total defence spending than they were in 1963—and let us remember in this connection that you get more soldiers for any given sum of money in Europe than you would for the same amount in the US."

As we have already said, these figures do not tell the whole story and we have not repeated them here for the simple effect of comparison. Rather, it is our aim to suggest that it is pointless to attempt to make simple comparisons between the constituent parts of what is, or should be, a united entity. In a later issue of *NATO Review* the Deputy Director of the Institute for International Affairs in Rome, Sgr Stefano Silvestri, outlined the impossibility of making such direct comparisons, with some more figures. He wrote, "Everyone knows that defence is also a problem of resources, these vary greatly from country to country. The US Defence Budget (1973-74) provides for an expenditure of 85.2 billion dollars, almost double Holland's GNP, and more than half Britain's GNP. The USA alone supplies about two-thirds of the Alliance's total defence budget (about 126 billion dollars, between Europeans and Americans). These impressive figures deserve careful consideration: there can be no possible comparison between the contribution the Americans can make and the contribution of each single European country. The only acceptable comparison would be between the American budget and the budget of the European countries as a whole. However, while the former is a reality, the latter is still a statistical fiction.

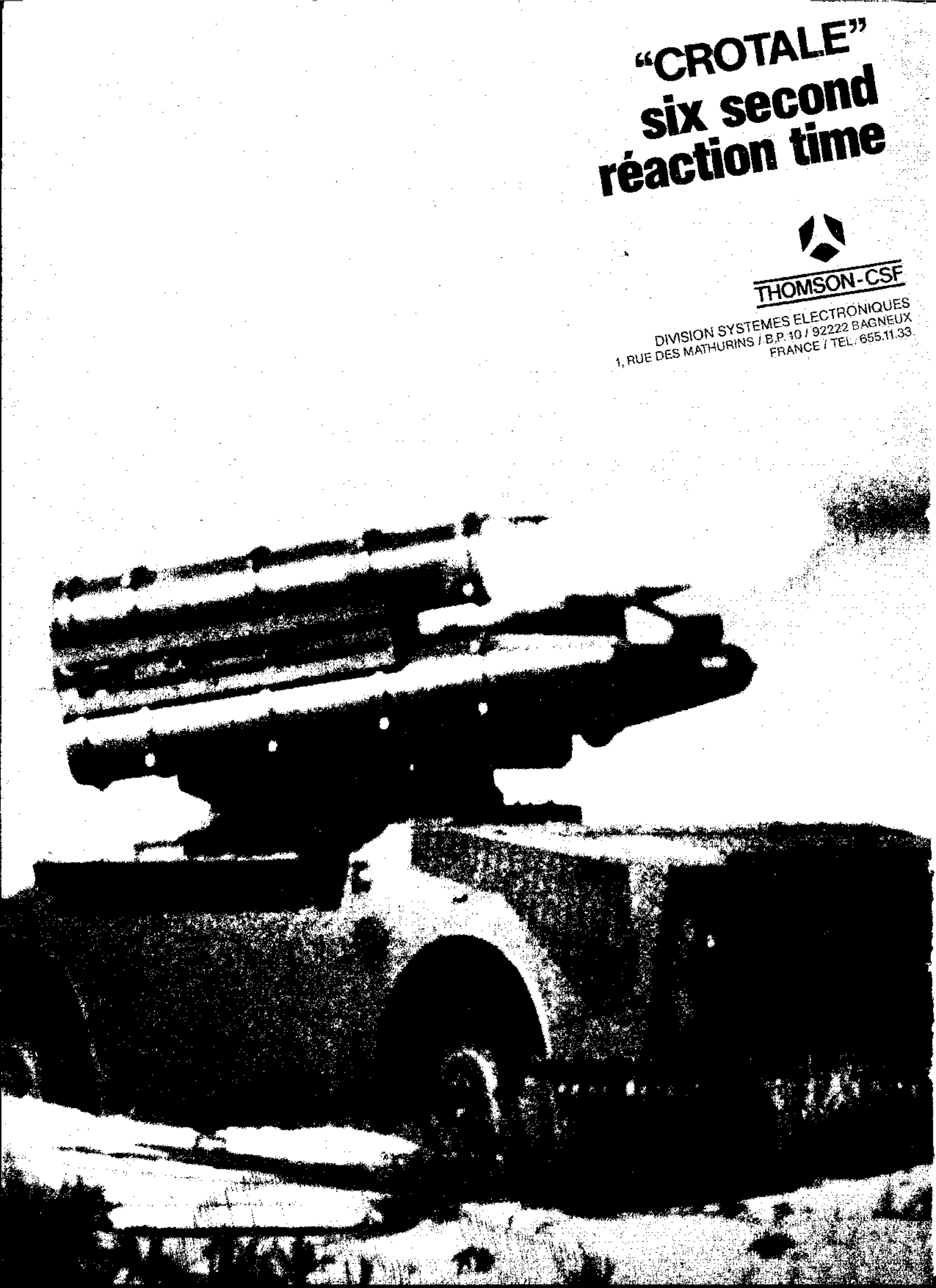
"Concealed behind these European figures there are in fact very different realities." Among them are the numbers of men under arms, the sums spent on equipment, and so on, but defence budgets are not the only elements that divide the allies. One of the most significant other factors is the non-standardisation of armaments—and readers of *Jane's Weapon Systems* will soon be able to call to mind their own favourite example(s) of this feature of life in NATO.

After describing the difficulties of reconciling differences between industry, the Armed Forces, Government, and between partner nations, as affecting the attempts to bring about a greater measure of commonality in defence equipment procurement, Sgr. Silvestri goes on to write:

"The Atlantic Alliance, given its very nature, has to take these national divergences into account. NATO and the various specialised Committees of the Atlantic Alliance which deal with these questions are strictly inter-governmental and they cannot therefore oblige or propose choices that go beyond the limits dictated by the single national policies. The integration of the armed forces is therefore bound to remain more theoretical than real, existing only at the level of the High Commands, (whose function is to plan in peacetime and who would only become operational in wartime) whilst logistics remain a national responsibility. The absence of common policy on defence budgets impedes the overcoming of these limitations. . . . It is not likely that the solution of these problems can ignore certain choices. The existence of a conflict, at times open and at times latent, between the establishment of an actual European weapons industry (and therefore also a certain degree of protectionism) and the interests of the vast American industry, is, for example, evident. Short term costs and efficiency favour the great American industry and bilateral agreements between single European national industries and American corporations. Such a choice, however, condemns NATO to a continuation of the present troubles since it contrasts with a rationalisation at the European level. . . . Until now, the Alliance has not dealt with these questions explicitly. Thus, for example, there has been no official or unofficial reaction to the proposals of rationalisation and concentration of European industries, such as in the case of computers and aeronautics advanced recently by the Commission of the European Economic Community. The Commission's proposals were absurdly limited only to 'civilian sectors' of the industries considered, as if it were really possible to separate the civilian and military sectors when dealing with problems such as the dimensions of an industry, while the organisation in charge of the military sector, that is, NATO, avoids taking a stand or advancing suggestions because of political sensitivity.

"In the near future these problems will become increasingly urgent. From the armed forces' point of view, we are approaching the threshold of amazing technological changes. The enormous developments in electronics and missiles, the development of 'smart' weapons, the progressive relative decline of systems such as the main battle tank or the fighter bomber, the growing electronic warfare environment in which weapons systems must survive to carry out their missions, the appearance of semi-automatic battlefields, of new bomblets and minelets anti-tank systems, etc., signal a real tactical and possibly even strategic revolution. Armed forces that wish to maintain their conventional credibility cannot ignore these developments."

R. T. Pretty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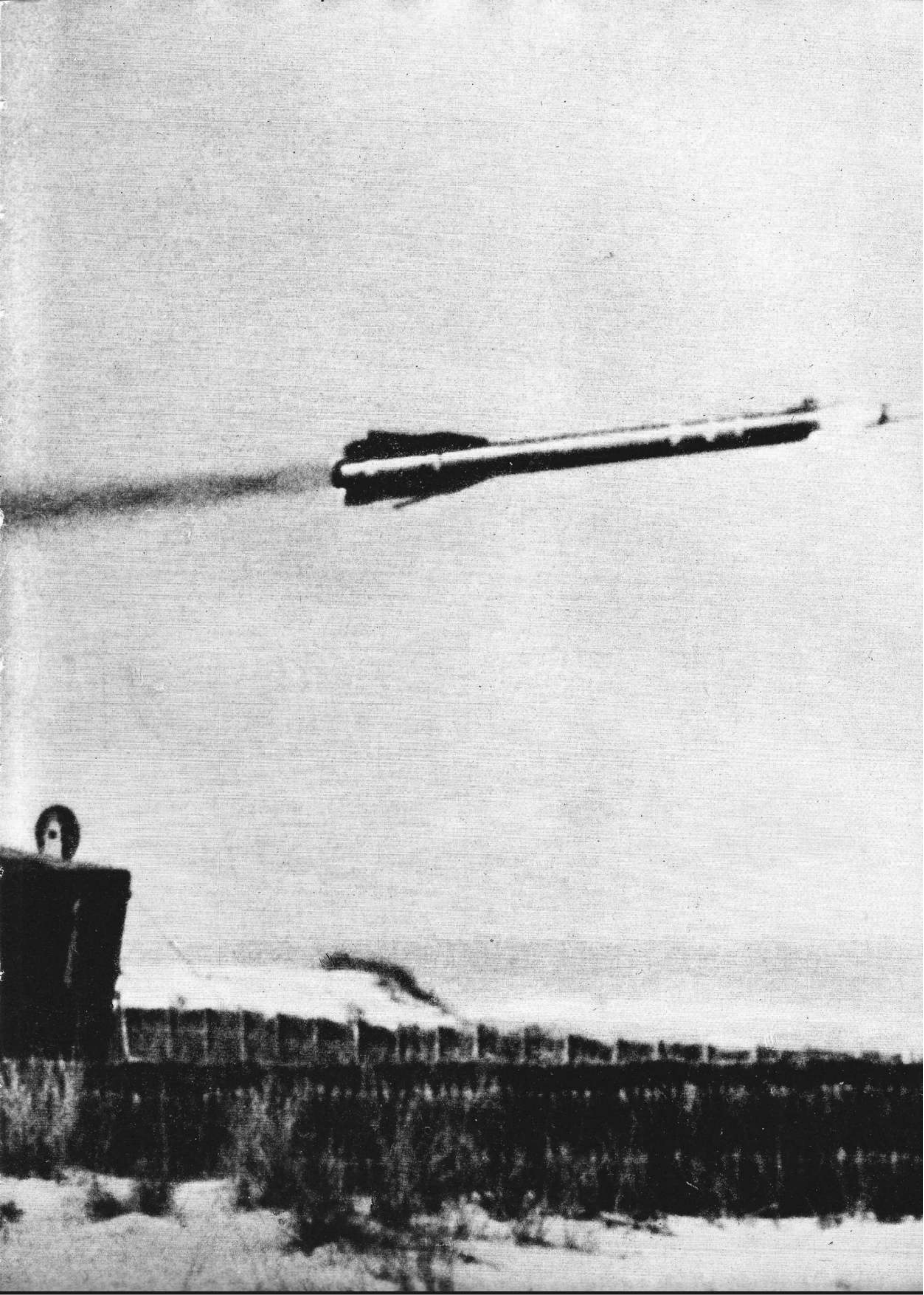

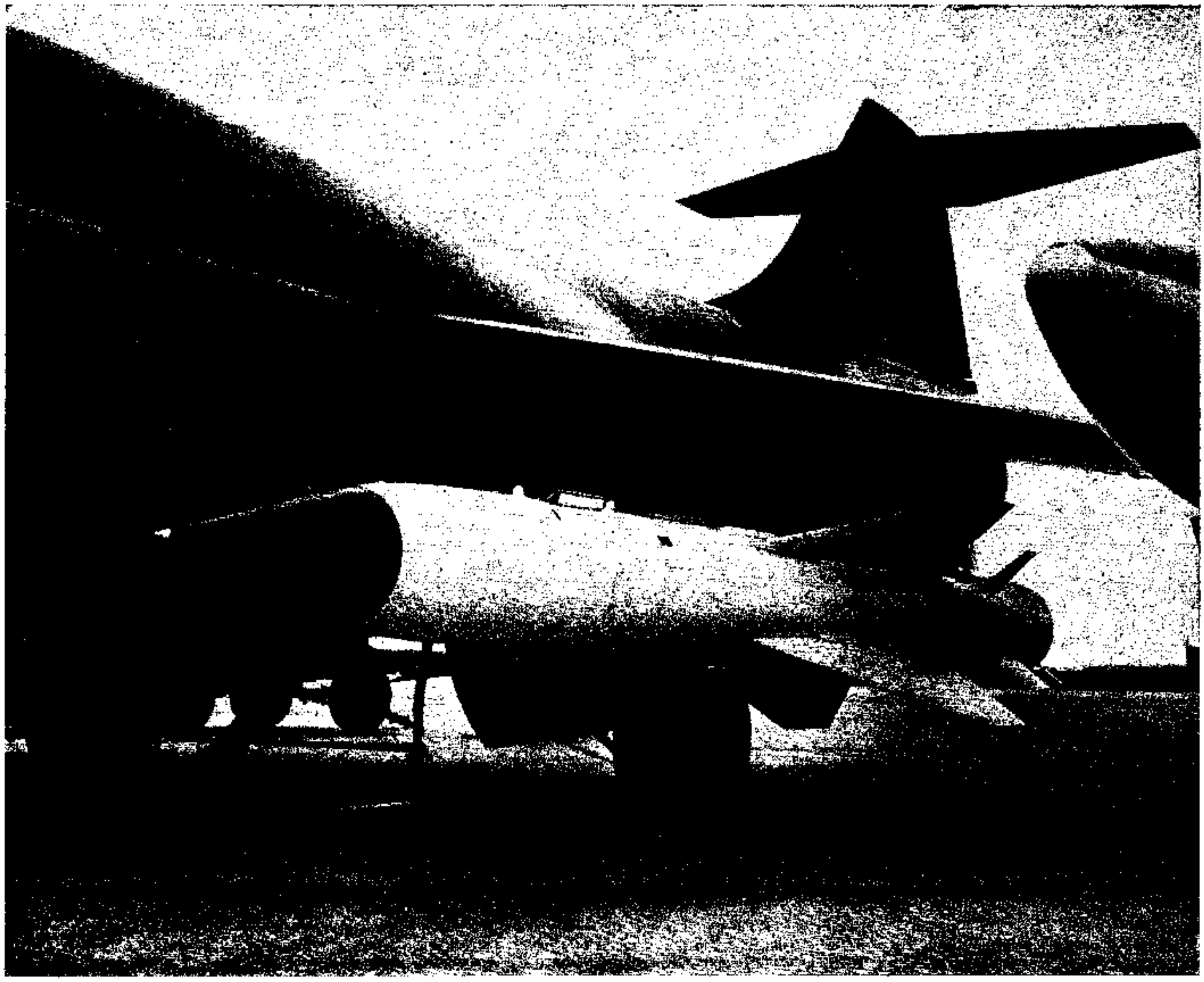

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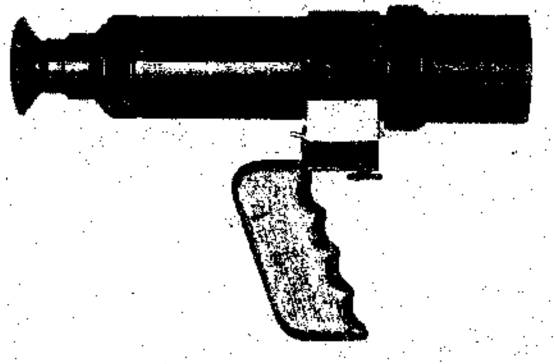

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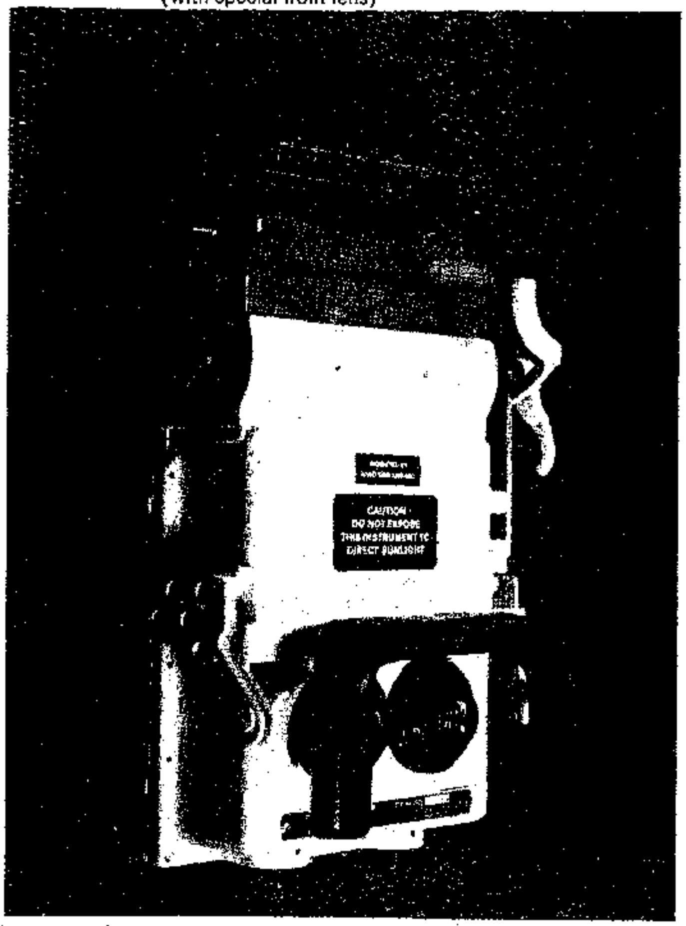

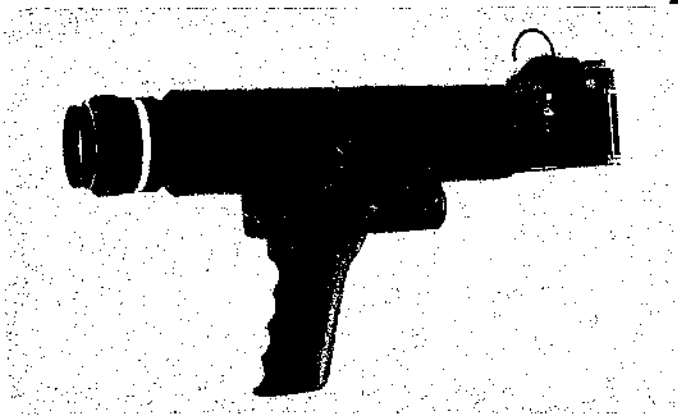

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SECTION ONE – SYSTEMS

MISSILE SYSTEMS

DATA ACQUISITION & COUNTERMEASURE SYSTEMS

STRATEGIC SURFACE-TO-SURFACE MISSILES

2200.111

INTRODUCTION:

This section is concerned with current and proposed land-based strategic missile systems. Only five nations have so far seriously attempted the construction of such systems; and one, the United Kingdom, abandoned the attempt at an early stage. Of the others, the USA and the USSR have developed and are developing many different systems and possess large numbers of several different types of operational missile; in France a single land-based strategic missile system has been developed and a version of it with a more powerful warhead is in hand; and in the Chinese People's Republic missile systems are certainly being developed, but little information is available.

It is worth noting that such information as has been published concerning the Chinese missile programme has come from official sources in the USA as does most of the information on Russian missiles. Of the four national strategic missile programmes, therefore, the only one on which significant information is available from sources other than the USA is the French, and even in this case little has been said by the French authorities. While it is only reasonable to expect the information freely available from American or French sources to be less than the total that is in the possession of the authorities concerned, it should be remembered that the information on, say, Minuteman that is withheld for security reasons is not necessarily of the same kind as that which could be, but is not, published concerning, say, the Russian SS-9 missile.

All performance figures quoted for these weapons should, therefore, be treated with some reserve. For the major intercontinental missiles the stated maximum ranges are probably reasonably close to the true values; because if the true performance were markedly less, the missiles would not have the deterrent capability that appears to be accepted as real by those against whom it is directed. With the reconnaissance and related facilities available nowadays to such powers as the USA and the USSR it seems most unlikely that a major deception in this respect could be maintained for long. On the other hand, it may be assumed with some confidence that the published information on developments in multiple warheads and in devices for overcoming or confusing anti-missile defences falls far short of the whole truth.

Although the distinction between "strategic" and "tactical" weapons is commonly encountered in North American and Western European descriptions and discussions of nuclear armaments, it is worth remembering that the distinction, in this form, is essentially American in origin. In the USSR a distinction is made between strategic and other *forces*; and it happens that the Russian strategic rocket forces are primarily equipped with what the USA and its allies now call strategic *weapons*; but the inclusion of some of the smaller Russian missiles in the "strategic" category and the exclusion of some quite large other missiles is essentially arbitrary.

While some well-known missile systems, such as Minuteman and Scarp, can obviously be properly described as strategic surface-to-surface weapons, defining the boundaries of any such classification must to some extent be an arbitrary process. For purposes of selection for inclusion in this section, a strategic surface-to-surface missile has been defined as one that satisfies three criteria. First, its destructive power must be such as to pose a threat either to the strategic missile installations of a potential enemy or to his major population centres. In practical terms, of course, this means that it must carry a nuclear warhead rated in excess of 100 kilotons. Warheads of this order of destructive power are, however, also carried by some of the larger "tactical" nuclear weapons.

Secondly, the operational range of the missile coupled with that of any vehicle from which it can be launched must be such that the missile can be used to threaten a potential enemy's installations or population from a point outside the periphery of the enemy's territory. For a land-based missile the range capability that will enable it to satisfy this criterion obviously depends on the geographical situation; some Russian missiles of quite modest range performance, but capable of carrying large nuclear warheads, are included in this section because they could be used strategically against any of the countries that border the USSR. The third criterion is that the weapon must have been designed for use in such a strategic role.

The terms **intercontinental ballistic missile** (ICBM), **medium-range ballistic missile** (MRBM) and **intermediate range ballistic missile** (IRBM) are used fairly indiscriminately in the literature to describe missiles that are – almost invariably – strategic missiles. It has been suggested that the MRBM description covers missiles with a range capability of up to about 2,500 km. (and we have arbitrarily selected a bottom limit of 1,000 km, thus excluding the American Pershing missile and the Russian Scaleboard – both of which are generally regarded as tactical missiles although they could be said to meet the strategic criteria) the ICBM those capable of travelling more than 6,000 km and the IRBM those in between; but different interpretations are often encountered. Probably the nearest approach to consistency in terminology is the description as an ICBM of any missile capable of covering the distance between the USA and the USSR – and latterly China – in either direction.

For some years these three categories have covered all the surface-launched strategic missiles in operational service in the world. Earlier, a fourth category, the **strategic cruise missile** figured in the US armoury (and the USSR still deploys cruise missiles with nuclear warheads and ranges of several hundreds of kilometres, but they are classed as tactical weapons) but these were withdrawn from service when ICBM deployment in the USA had reached an advanced stage. Cruise missiles have the disadvantage, relative to ballistic missiles, of being easier to intercept and destroy: on the other hand they require much less elaborate launch facilities.

Recently, for reasons which are set out in the discussion of the SALT agreements below, there has been a revival of interest in cruise missiles in the USA. The proposals under consideration at present relate to submarine-launched and air-launched missiles but it is by no means impossible that a land-based version should be added.

Two abbreviations commonly used in strategic-weapons literature are MIRV and MRV – standing for Multiple Independently Targeted Re-entry Vehicle and Multiple Re-entry Vehicle respectively. A missile with an MRV warhead arrangement houses in its final stage a number of warheads which separate before re-entry and reach the ground some distance apart from each other: the pattern of these impacts cannot readily be varied, however, and the extent to which it can be varied at all is strictly limited. With an MIRV system, on the other hand, the multiple warheads contained in the final stage of the missile can be separated out at times and in ways that give not only a wide range of choice of impact pattern but also the opportunity to vary this choice with little difficulty. In principle, MRV and MIRV techniques can be applied to almost any reasonably large missile: in practice, however, since the separate packaging of the individual warheads involves considerable loss of total explosive power, use of the techniques is restricted to the larger land-based missiles and to submarine-launched ballistic missiles.

A third abbreviation – less well-established than the first two but gaining currency – is MARV. This stands for Manoeuvrable Re-Entry Vehicle and is used to denote a re-entry vehicle equipped with means of propulsion and a navigation system which together enable the vehicle to execute limited manoeuvres, after re-entry, to improve system accuracy.

SALT

On 26th May, 1972, three documents were signed, in Moscow, representing the first formal agreements in the Strategic Arms Limitation Talks (SALT) which had been in progress between the USA and the USSR since November 1969. One of these documents was a treaty limiting anti-ballistic missile (ABM) systems: the effects of this are noted later in this section of the book: the second and third documents were respectively an interim agreement on offensive strategic missiles and a protocol defining the effect of this agreement on submarine-launched missiles. These documents are not the only ones that are currently relevant to the strategic balance or imbalance between the two powers: and the dialogue between them continues; at the present time, however, and for the purposes of this introduction, it is sufficient to consider the general effect of the interim agreement and protocol.

Although this section is concerned with land-based strategic missiles, it is necessary in summarising the effect of the Moscow agreement to make reference also to submarine-launched ballistic missiles (SLBM) because the two are treated in the documents as being to some extent interchangeable. The interim agreement, which is intended to remain in force for five years, requires that the total of ICBM and SLBM *launchers* for each country shall be based on the numbers operational or in course of construction on 26th May, 1972, for SLBM, and 1st July, 1972, for ICBM. Beyond the totals at the latter date no further large

Shown in public for the first time in the Moscow parade on November 7th 1973, these large missile containers are believed to be for the new generation of Russian intercontinental ballistic missiles (Novosti) modern ICBM (by which is understood missiles of the size of the Russian SS-9 missile described in entry number **2962.111** below) are to be deployed; but subject to this reservation modernisation and replacement of missiles, launchers and submarines is not restricted. Furthermore, ICBM launchers and launchers on older submarines may be exchanged for an equal number of new SLBM launchers.

The protocol, which has the same duration as the agreement, interprets part of the agreement as meaning that the USA may have not more than 710 SLBM launchers and not more than 44 modern ballistic missile submarines and that the comparable figures for the USSR are 950 launchers and 62 submarines. The distinction between 'older' and 'modern' submarines is not, however, very precise.

Generally, it appears that the effect of the two documents is to permit the USA to maintain a force of 1,710 strategic missile launchers distributed at will in the ranges 1,000 to 1,054 ICBM, 656 to 710 SLBM and 41 to 44 ballistic missile submarines. Similarly the USSR may select options for a total of 2,358 launchers within the ranges 1,408 to 1,618 ICBM, 740 to 950 SLBM and 56 to 62 missile submarines.

Various attempts have been made to translate these options into figures of merit that demonstrate the relative actual and potential strengths of the two forces. Such an assessment, however, borders on the impossible: apart from the options implicit in the figures just given, each country has a wide choice of actual missile types that may be deployed without contravening the agreement: subject to the limitation on the large missiles each may replace its less effective missiles with more modern types. These choices are further complicated by MRV and MIRV possibilities which may be further elaborated at will: on the other hand the effect of maintenance requirements on all types of missiles and the impossibility of keeping all missile submarines permanently on station must be taken into account. Finally, in the total strategic analysis, it has to be remembered that the SALT agreements have not so far covered airborne nuclear missiles at all.

All the avenues of further strategic missile development left open by the agreements are currently being explored by the US authorities and all available evidence suggests that the same is true of the USSR. If anything the level of activity seems to have risen since the agreements were signed. So far as land-based missiles are concerned, available information on these developments is set out in the pages immediately following this introduction: mention should also be made here, however, of the revived US interest in cruise missiles noted above and of suggestions for the air-launching of large ballistic missiles – a technique which, like that of using cruise missiles, is not prohibited by the SALT agreements.

CHINA (PEOPLE'S REPUBLIC)

2048.111
CHINESE ICBM

There is no available detailed information on Chinese intercontinental ballistic missiles. That they have made substantial progress towards the creation of an ICBM force, however, is evidenced by the seriousness with which the US authorities are viewing this development. At a press conference in February 1970 the US Director of Defence Research and Engineering, Dr John S. Foster, reported that during the preceding year the Chinese had been rebuilding their ICBM launching installations and appeared to have reached the point where they were ready to conduct ICBM launches.

Earlier reports had suggested that the whole Chinese missile programme had been delayed – particularly between 1966 and 1968 – possibly because of political harassment of the small group of scientists engaged on the programme. Nevertheless, the US Secretary of Defence, Melvin R. Laird, in his statement on the 1971 defence programme to the House Armed Services Committee in March 1970, said that the start of ICBM flight testing was expected during 1970; and that, although at least three years must almost certainly elapse before such a system could become operational, the Chinese might have as many as 10-25 intercontinental ballistic missiles, with a range of around 10,000 km, in 1975.

These figures were based on the assumption that the Chinese would continue with the development of missiles with liquid-fuelled motors. Although the construction of a solid-propellant manufacturing establishment had been completed it was thought that a solid-propellant ICBM would not be ready for deployment before 1975.

In his statement on the 1972 programme, a year later, Mr Laird told the Committee that the pace of Chinese ICBM development appeared to have been slightly retarded by a shift of emphasis towards the development of IRBMs or MRBMs and nuclear-armed aircraft. Nevertheless he still regarded 10-25 missiles by 1975 as possible with maximum effort. As a part of the programme, it appeared that there had been a limited-range (c. 3,000 km) ICBM shot within China (from north-west Manchuria to western Sinkiang) late in 1970. More recent information, however, suggests that an ICBM test firing could scarcely have occurred as early as this, and that the shot is more likely to have been an IRBM – possibly the second of the two types described in **2049.111** below.

By the Spring of 1973 the US authorities were making some fairly definite pronouncements on the ICBM programme. These may be summarised thus:

(a) A test firing of a missile with a range of some 6,500 km was expected during 1973. The missile would be fired from Lop Nor in Sinkiang.
(b) In its final form this liquid-fuelled missile was expected to have three or four stages, a thermonuclear 3MT warhead and a range of about 11,000 km. Storable liquid propellants would be used and the missile would be a large one – perhaps even longer than the Russian SS-9 (**2962.111**).
(c) Missile deployment was expected to start in 1974/75 and to reach a total of 20 missiles on launchers by 1975/76.
(d) A second-generation solid-propellant ICBM was believed to be in development. This could be deployed in hardened silos towards the end of the 1970s.

The range of 11,000 km suggested in this forecast would make it possible for the weapons to be targeted on cities in the USA. At present, however, it seems that the driving force behind the Chinese ballistic missile programme is the desire to get on terms with the Russian nuclear striking force.

In this connection it is worth noting that, according to reports from the USA, a very large phased-array radar antenna has been constructed in Western China. It is thought that this would provide notice of an attack from about nine-tenths of the Russian ICBM/IRBM force. The purpose of such warning is fairly evidently retaliatory – as was the American BMEWS – and there has as yet been no suggestion that the Chinese are building an ABM system.

Since the American forecast set out above was made there has been little in the way of definite information on Chinese ICBM progress; and American statements have suggested that the programme may have slipped again – possibly by as much as a year. On the other hand if the Chinese have indeed developed a large phased array radar it can reasonably be inferred that they have made substantial progress in military electronics development – notably in high-speed computers and integrated circuits. They may therefore be further advanced technologically than earlier estimates – which put them five years behind the Russians and ten behind the Americans – had suggested. All forecasts of Chinese development progress should therefore be treated with reserve.

2049.111
CHINESE IRBM

Although the Chinese IRBM and MRBM programmes have been subject to delays similar to those that appear to have affected their ICBM programme, it seems fairly clear that there has been a small-scale (15-20) deployment in China of a single-stage IRBM using a storable liquid propellant. This missile is understood to be similar to the first stage of the rocket which launched the first Chinese satellite in April, 1970 and its range has been estimated as lying between 2,500 and 4,000 km. A multi-stage IRBM, also using storable liquid propellants, is said to be in development and may have been deployed: its range is expected to be about 5,500 km – which would enable it to reach Moscow.

Thermonuclear warheads are believed to be carried by some of these MRBM and it is thought that their destructive power is in the region of 2-3MT.

2010.111
CHINESE MRBM

Liquid-fuelled medium-range ballistic missiles similar to the Russian SS-4 MRBM (**2952.111**) have been operational in north-eastern and north-western China since 1970. Like the SS-4, these missiles have a range of about 1,800 km; and it is understood that some 50 are currently deployed – possibly rising to 100 by 1975. The first operational warheads are believed to be smaller than those carried by the Russian missile; a figure of 20 KT has been suggested; but a larger warhead may be fitted to some: in particular it is probable that those which have been most recently deployed carry thermonuclear warheads similar to those carried by the IRBM.

At one time it was thought that this missile would either be deployed in large members or be replaced by solid-fuel missiles. It now seems rather more likely, however, that the Chinese will put the majority of their effort into the ICBM and IRBM programmes; and restrict the MRBM deployment to the minimum consistent with posing a significant threat to Russia while the other missiles are being deployed.

FRANCE

2145.111
SSBS INTERMEDIATE-RANGE BALLISTIC MISSILE TYPE S-2

DESCRIPTION:

SSBS (Sol-Sol-Balistique-Stratégique) is a medium-range two-stage solid-propellant missile, with nuclear warhead, which is stored in and launched from an underground silo. It is maintained in a state of readiness, and preparation for firing and firing are automatic without human intervention in the launch area. Shortly after the firing order is given the silo door is ejected, permitting launching of the missile.

Launch areas are dispersed and hardened to reduce the effects of an enemy attack. Each includes the silo in which the missile is maintained in operational readiness and an annexe housing the automatic launching equipment and servo mechanisms.

DEVELOPMENT:

The government agency concerned is the Direction Techniques des Engins, and the main contractor is the Division Systèmes Balistiques et Spatiaux of Aérospatiale (SNIAS).

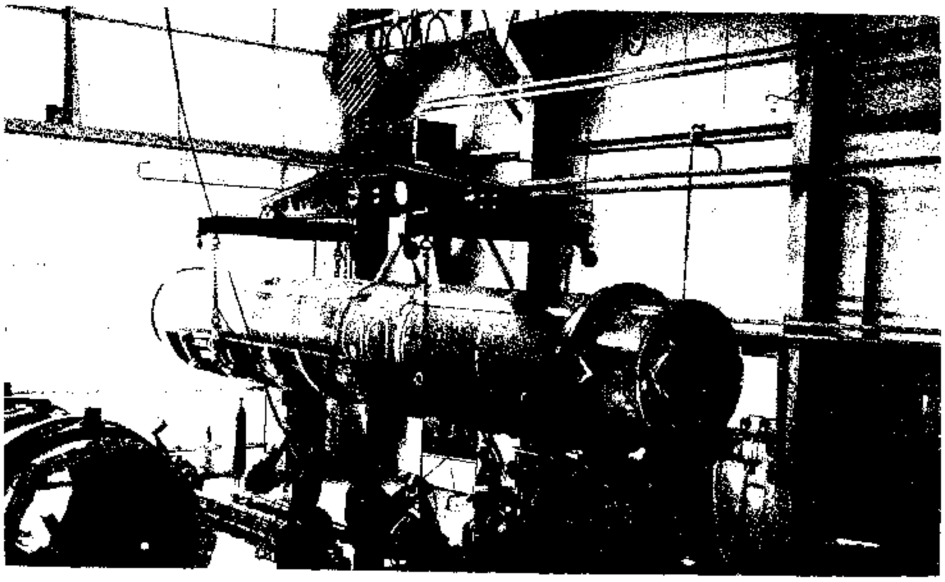
The present production version of the missile is known as the S-2 and is the culmination of study research and development programmes that can be traced back to 1959, first experimental launches having taken place in 1965/66.

STATUS:

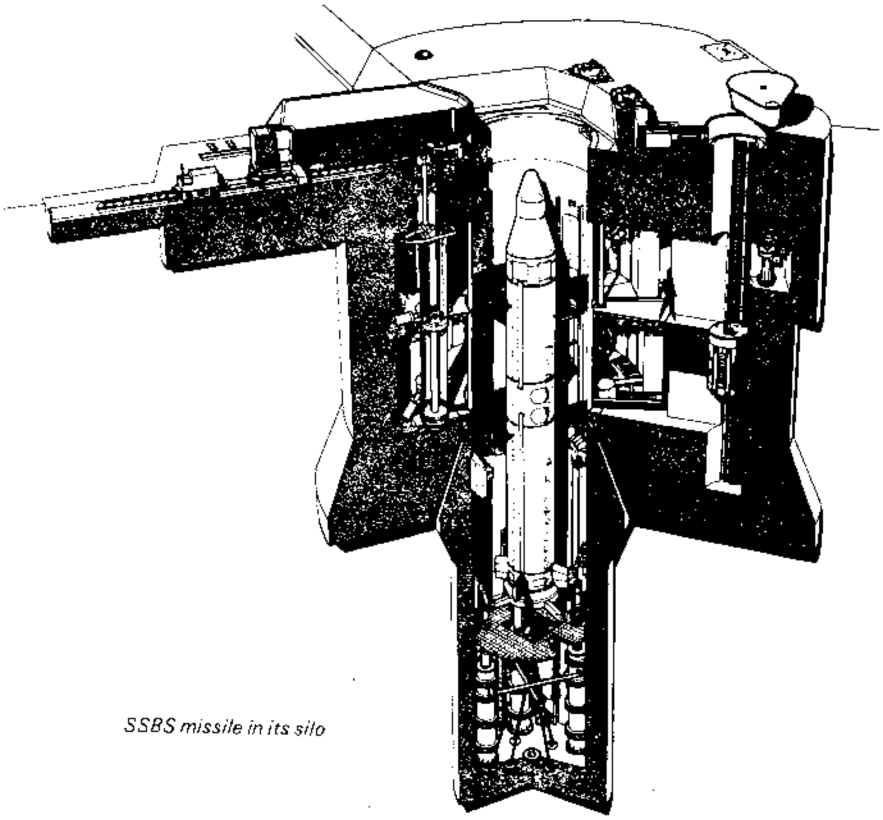
Two groups of nine launch areas have now been established on the Plateau d'Albion. Each group is commanded by a heavily protected, subterranean Central Fire Control Room. These are linked to Strategic Air Force Headquarters by attack proof communications networks. The first of these groups became operational in the summer of 1971 and the second in 1972.

The St Christol Air Base provides the necessary logistical support facilities: emergency and routine repairs, training centre, vector and warhead assembly and storage, etc.

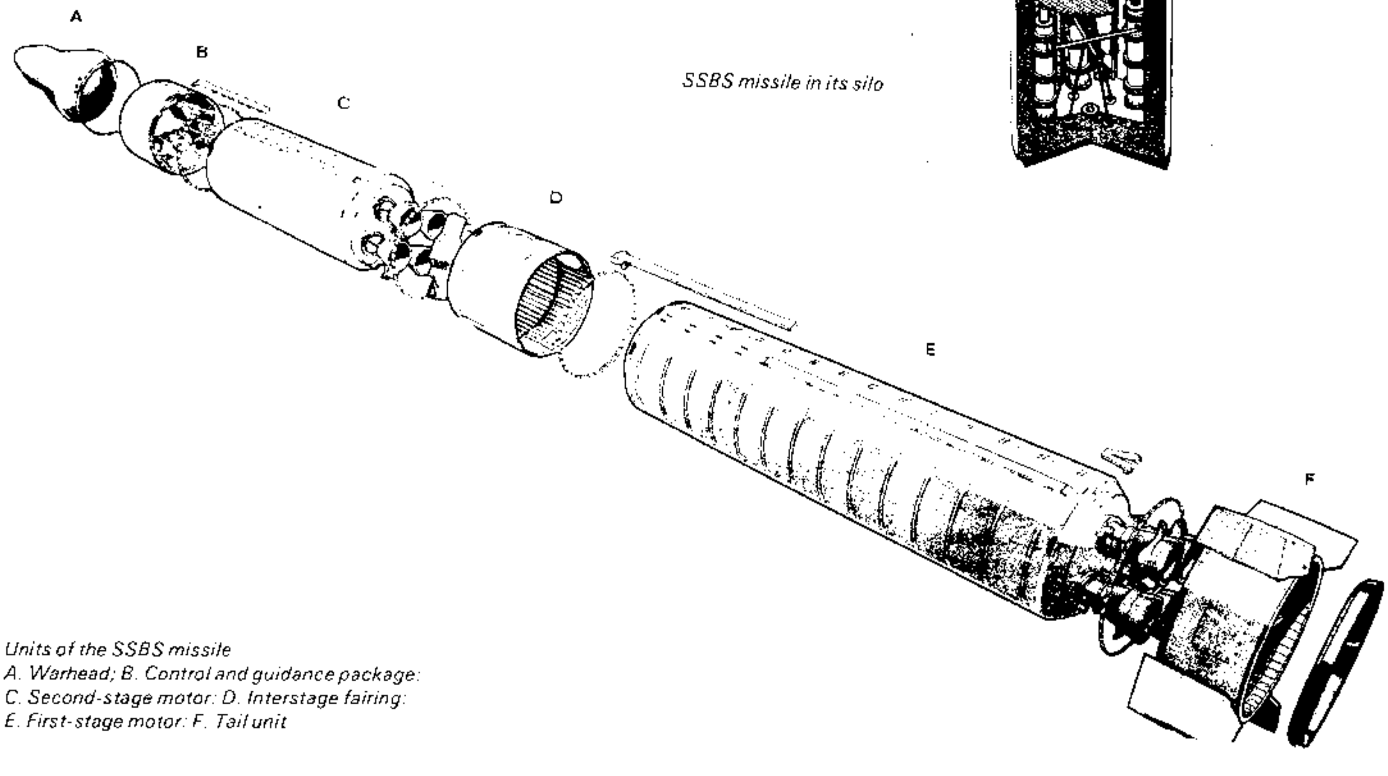
The operational sites cannot be used for experiments and trials. These take place from the Centre d'Essais des Landes near Biscarrosse towards a target area in the Azores.



Assembly of S-2 SSBS missile



SSBS missile in its silo



Units of the SSBS missile
A. Warhead; B. Control and guidance package; C. Second-stage motor; D. Interstage fairing; E. First-stage motor; F. Tail unit

CHARACTERISTICS:

Type: Intermediate-range, silo-launched ballistic missile

Guidance: Inertial

Propulsion:

First Stage: SEP Type 902 motor in maraging metal rolled and welded casing containing 16 metric tons of solid propellant. Four gimballed nozzles for control. Thrust about 55,000 kg.

Second Stage: SEP Type 903 motor with flow-turned Vascojet 1,000 casing containing 10 metric tons of solid propellant. Four gimballed nozzles for control. Thrust about 45,000 kg.

Warhead: Nuclear. 150 kilotons

Dimensions: Length: 14.80 metres
Diameter: 1.50 metres

Launch Weight: approximately 30 metric tons

Range: Approx 1,700 nm (c. 2,750 km)

MANUFACTURERS:

Missile:

Structures —Aérospatiale
—SNECMA
Cases —Aérospatiale
Motors —G2P
Equipment —SAGEM
—SFENA
—Crouzet
—SOGEA
—Souriau
—Air-Equipement
—Wonder
—Aérospatiale

Warhead:

Re-Entry Body —Aérospatiale
Nuclear Charge —Commisariat à l'Energie Atomique

Missile System Integration:
—Aérospatiale

Environment:

Electronic —CII
—CETT
—SINTRA
—Thomson-CSF
—SECRE
—CSEE
Electric —CGEE
—SGE
Mechanical —SFAC
—Berliet
—SILAT/ECAN
Civil —Ballot
—Drouard & Le Francois
Integration —Aérospatiale

S-2 SSBS missile launch

2163.111
SSBS INTERMEDIATE RANGE BALLISTIC MISSILE TYPE S-3

DESCRIPTION:

In 1973 a new French IRBM programme was initiated to develop the second-generation SSBS S-3 Weapon Systems. This programme entails the deployment of the new missile in a third group of 9 silos, which are to be operational by the end of the decade, and the renovation of the first two groups of S-2 silos (**2145.111**).

The S-3 missile will have a higher performance than the S-2 and will be equipped with a megaton-range thermonuclear warhead and penetration aids.

Improvements to the silos will include both equipment modernisation and system modifications to increase reliability and reduce maintenance costs.

CHARACTERISTICS:

Type: Intermediate-range silo-launched, ballistic missile

Guidance: Inertial

Propulsion:

1st Stage: SEP Type 902 motor (same as S 2)

2nd stage: SEP RITA II motor in wound fibreglass casing containing 6 metric tons of solid propellants. Thrust c. 30,000 kg. Thrust vector control by 4 freon injectors into a single fixed nozzle

Warhead: Thermonuclear (c. 1 MT)

Dimensions: Length: 14 m
Diameter: 1.5 m

Range: c. 1,850 nm (c. 3,000 km)

MANUFACTURERS:

Missile:

Structures —Aérospatiale
Equipment Bay —Aérospatiale
Motors: —G2P
Equipment —EMD
—SAGEM
—LCT
—Crouzet
—Aérospatiale
—Air Equipment
—Souriau
—SOGEA
—Wonder

Warhead:

Re-entry Vehicle —Aérospatiale
Nuclear Charge —Commisariat à l'Energie Atomique
Integration —Aérospatiale

Environment:

Integration is handled by Aérospatiale. Negotiations are under way for the selection of subcontractors for this important part of the system and final decisions are believed to be imminent.

THE UNITED STATES OF AMERICA

2709.111
ABRES-ADVANCED BALLISTIC RE- ENTRY SYSTEMS

DESCRIPTION:

ABRES is the acronym describing a continuing programme of work on advanced systems sponsored by the USAF's Space and Missile Systems Organisation on behalf of all three US Services. The programme was initiated in 1962 but absorbed some relevant projects that had been started before then.

Obviously the work carried out on the programme is part of a coherent system of investigations planned by the sponsoring body. Equally obviously, the detail of this plan has not been made public; and the information that has seeped out does not present the complete picture – or indeed indicate to which picture some of the pieces belong.

Broadly speaking, however, it can be said that within the total framework of possible operations in the post-ballistic phases of the trajectory of an offensive exo-atmospheric missile there are five main areas of interest:

(a) *Concealment techniques.* Techniques designed to delay detection of the re-entry vehicle by the defence forces by reducing radar cross-section or by using depressed trajectory attack.

(b) *Confusion techniques.* Techniques designed to make it difficult for the defence forces to locate or identify the significant elements of the attacking force. They include radar blackout and saturation devices, such as chaff, and force saturation devices such as decoys. Active ECM may also be included under this heading.

(c) *Evasion techniques.* Techniques designed to make it difficult for the defenders to intercept an incoming warhead even when it has been correctly located and identified. The principal technique here is a form of manoeuvre that invalidates the defence's computation of future position to an extent that makes it difficult, if not impossible, for an ABM missile to be vectored onto a successful intercept course.

(d) *Re-entry techniques*. Constructional techniques aimed at increasing the speed of penetration without loss of accuracy or impairment of function and at increasing the accuracy of the penetration trajectory.

(e) *Target-seeking techniques*. Techniques of manoeuvre during and after re-entry that enable the incoming warhead either to improve its overall accuracy or to regain accuracy after evasive manoeuvres.

The first four groups are generally classified under the heading of "penetration aids" (or "penaids"). Work on such aids has been going on for a long time and operational systems have been deployed in both ICBMs and SLBMs. The ABRES programme, therefore, has not embraced all the work in this field but some of the work forms part of the ABRES programme.

It should also be noted that the work on multiple re-entry vehicles (MRV and MIRV) necessarily involves consideration of some of these techniques. Such work is by no means exclusively concerned with re-entry and post-re-entry manoeuvres, however; indeed a large part of the process of separating and guiding a multiplicity of warheads necessarily occurs during the exo-atmospheric phase of a missile's flight. Although there is some overlap, therefore, the ABRES programmes are not entirely mutually dependent.

It will be evident that there is a close relationship between the third and fifth groups of techniques. Any manoeuvre carried out during the re-entry phase of a missile's flight necessarily introduces possibilities of unforeseeable departures from the planned trajectory resulting from random variations in atmospheric density, winds or turbulence. These random possibilities exist in any case, of course, and, together with imperfections in geodetic surveying, constitute an important source of missile inaccuracy: if the missile is caused to manoeuvre, however, the effects are likely to be accentuated. Not much has been said about the ways in which these difficulties can be overcome: clearly some form of homing technique is required; but equally clearly the simple forms of homing guidance lend themselves too readily to countermeasures. Some discussion of known techniques will be found in the MARV entry below (**2719.111**).

PROJECTS:

Available information on the general nature of some of the component projects and groups of projects of the ABRES programme is listed below, together with names of manufacturers concerned where these are known. Reference should also be made to re-entry vehicle data in entries **2708.111** and **2719.111** below.

A-ball One of the projects taken over by ABRES in 1962 and subsequently renamed BGRV.

ABC Advanced Ballistic Concepts. General title covering several re-entry vehicle projects.

ACE Advanced Control Equipment. USAF project, involving McDonnell Douglas, on manoeuvrable re-entry vehicles. At least two test flights have taken place.

BGRV Hypersonic Boost Glide Re-entry Vehicle. Formerly known as A-ball, this is an early manoeuvrable re-entry vehicle project by McDonnell Douglas, believed to have been first tested in 1967.

DRADS Degradation of Radar Defence Systems. An active ECM homing and jamming project. Raytheon and TRW.

ECM Projects. Numerous active and passive ECM techniques have been covered and have involved Philco-Ford, Raytheon, RCA, Sanders Associates, Sperry Rand and TRW. One Sperry project reported has been the development of noise jamming techniques suitable for use against the Dog House (**2864.153**) central discrimination and handling radars of the Moscow ABM defences (**2945.181**).

FATE Fusing, Arming, Test and Evaluation. A programme co-ordinated by Philco-Ford's Space and Re-entry Systems Division and Stanford Research Institute and covering the functions specified for each new type of re-entry vehicle.

Lapdog An early re-entry vehicle project subsequently re-named MBRV.

LORV Low Observable Re-entry Vehicle. Reduced radar cross-section project by Avco Corporation.

MBRV Manoeuvrable Ballistic Re-entry Vehicle. One of the earlier re-entry vehicle projects undertaken by General Electric. Formerly known as Lapdog it is believed to have been roughly contemporary with A-ball/BGRV.

Optical Countermeasures. Various techniques aimed at altering or camouflaging the signatures of re-entry vehicles.

Re-entry Vehicles. So far as is known, no complete operational re-entry vehicle has been developed under the ABRES umbrella. Major contributions have, however, been made to the Mk 11, 11A, 11B, 11C and 12 re-entry vehicles and some contribution has also been made to the Mk 3 (300 ?) vehicle. Available details of these vehicles are set out in entry **2708.111** below.

REST Re-entry Environment and Systems Technology. Investigations concerning fluid mechanics, flow fields round re-entry vehicles, stability and advanced heat shields. Avco Corporation.

SEE Small Evader Experiment: A recent manoeuvrable re-entry vehicle project by General Electric. Believed to be the latest in this sequence of projects.

MANUFACTURERS:

Twenty-three manufacturers were involved in the ABRES programme when it was first set up but over the years the number has increased to fifty-six. Among these, AVCO, Bendix, Chrysler, General Dynamics, General Electric, General Precision, Hughes, McDonnell Douglas, MIT, Philco-Ford, Raytheon, RCA, Sanders Associates, Sperry Rand, Stanford Research Institute and TRW are known to have been involved in various projects.

2708.111
BALLISTIC MISSILE RE-ENTRY VEHICLES

DESCRIPTION:

Although details of some ballistic missile re-entry vehicles (RV) are given in the entries describing the missiles in which they are used, the following annotated list – although not exhaustive – may be helpful.

Mk 3 See Mk 300 below.

Mk 5 Single-warhead RV with single target capability and yield reported as 1 MT. No penetration aids (penaids). Used on Minuteman I, LGM-30A (**2710.111**).

Mk 6 Large RV with single multi-megaton warhead and three-target selection capability and elaborate penaids. Made by General Electric and used on Titan II (**2826.111**).

Mk 11 Single-warhead RV with two-target capability and yield of about 1 MT. No penaids. Made by AVCO and used on Minuteman I, LGM-30B (**2715.111**).

Mk 11A Single-warhead RV similar to Mk 11 but may differ in warhead yield. Use as Mk 11.

Mk 11B Single-warhead RV with 1-2 MT yield and eight-target selection capability. Incorporates penaid canister, made by Tracor, designated Mk 1 or Mk 1A – difference not known but penaid believed to be mainly if not entirely chaff ("window") and Mk 1A may reflect improvements in dispensing techniques. RV is made by Avco and used on Minuteman II (**2716.111**).

Mk 11C Single-warhead RV similar to Mk 11B but improved and hardened against nuclear weapon effects.

Mk 12 Three-warhead MIRV with yield of 200 KT for each warhead. Complete system including penaids contracted to General Electric and used on Minuteman III (**2717.111**). Post-boost propulsion and control by Bell Aerosystems package.

Mk 12A Currently proposed modified version of Mk 12. Improvements are understood to be aimed at improved capability against hardened targets for Minuteman III (**2717.111**). RV improvements generally will presumably be the responsibility of General Electric; there will also be work for the Atomic Energy Commission in upgrading the nuclear warheads.

Mk 17 Large multimegaton RV with a high degree of accuracy. Cancelled because of funding clash with Mk 12 but also because its evident first-strike potential was out of keeping with the US strategic posture at the time. Originally planned for Poseidon (**1132.411**) as well as Minuteman III (**2717.111**).

Mk 18 RV with multiple unguided RVs for super-saturation. Stemmed from Avco and General Electric/Atomic Energy Commission research and the CRESS (Combined Re-entry Effort in Small Systems) programme. In its early stages the project was known as SWARMS. Project cancelled in favour of Mk 12 and the RV for the Poseidon missile (**1132.411** and see Mk 300 below).

Mk 19 High-yield, high accuracy system first proposed in 1972 but rejected as inconsistent with the spirit of SALT as a result of public and Congressional pressure. Now believed to be on the point of reinstatement because of the increasingly evident need for a hard-target capability in the ICBM force.

Mk 20 High-yield warhead intended ultimately to replace the Mk 12/Mk 12A warheads. For use with Minuteman III it will probably have the same number of warheads as the earlier RVs but will have an improved yield/weight ratio. Not yet in development.

(Mk 100 ?) RV for Polaris A-1 and/or A-2 (**1130.411**). Single thermonuclear warhead with a yield of some 800 KT.

(Mk 200 ?) RV for later model of Polaris A-3 missile (**1131.411**). Three 200 KT MRV thermonuclear warheads.

(Mk 300 ?) Usually referred to as Mk 3 but apparently in separate series from, e.g. Mk 11. RV for Poseidon missile (**1132.411**). Capacity for 14 RVs with or without warheads: currently deployed with 10 MIRV 50 KT thermonuclear warheads plus penaids. Essentially a resurrection of the SWARMS concept with guidance: to some extent based on the Lockheed Agena reconnaissance satellite programme using the restart capability of the Bell Model 8048 engine and using vernier jets for altitude adjustment.

Mk 400 Ballistic RV being developed by Lockheed for the MIRV system of the Trident missile (**2840.411**).

Mk 500 Manoeuvrable RV (MARV) being developed by General Electric for the Trident missile programme.

STATUS:

As indicated for each RV in the above list. In addition to the entry references noted above the ABRES (**2709.111**) and MARV (**2719.111**) entries may also be found useful.

MANUFACTURERS:

Some contractors are named above. Many other companies have played important parts in the specification, development and testing of these vehicles.

2719.111
MARV (MANOEUVRABLE RE-ENTRY VEHICLE) SYSTEMS

INTRODUCTION:

Work on manoeuvrable re-entry vehicles (MARV) for ballistic missiles has been in progress for some time in the USA. Some of this work has been done as part of the general ABRES programme (**2709.111**); but there is also a separate MARV programme for the Mk 500 re-entry vehicle for the US Navy's Trident missile (**2840.411** and see also **2708.111**). Of the two programmes, that associated with ABRES is the more fundamental, since it is concerned with the general problems of RV manoeuvres, whereas the Trident programme is aimed at providing a specific capability for a specific missile.

MARV systems can be used for two quite distinct purposes. On the one hand they can introduce an unpredictable element into the movement of the RV, thus making it more difficult for the defence system to make a successful interception, alternatively they can be used to improve the overall effectiveness of the missile system by providing a terminal guidance function. The two purposes are in one sense mutually opposed, since evasive manoeuvres will tend to diminish system accuracy; but this tendency can be corrected – provided sufficient time and power are available – by following the evasion phase of the re-entry by a terminal guidance phase.

In the recent past MARV development emphasis has been more on evasion techniques for improved penetration than on terminal guidance. The reason for this is that terminal guidance has maximum relevance to attacks on hard targets – "counterforce" operations – whereas during the relevant period the US strategic policy has been one of "assured destruction" and the ICBM force has been assigned to a "countervalue" role and targeted mainly on soft targets. In line with this policy it has been felt that the development of systems that might enable US missiles to destroy Russian missiles in their silos would be dangerously provocative – "destabilising" as the jargon has it. Although some suitable techniques have been known for a decade, therefore, little effort had been applied to using them before the Autumn of 1973.

This situation has now changed. Presumably because of the evident intention of the Russian authorities to press ahead with ICBM/MIRV developments, the US Defence Department included in its FY1975 budget proposals an item for "advanced development of a terminally guided MARV for possible retrofit into both ICBMs and SLBMs" and proposed the allocation of $20 million, to start this programme, out of a total of $120 million for ABRES ($30 million more than the FY1974 total).

DESCRIPTION:

A MARV differs from a non-manoeuvring re-entry vehicle in the provision of a propulsion system, some form of guidance or navigation system and the mechanical wherewithal to convert the commands of the guidance/navigation system into actual RV movements.

It is important to distinguish between the various propulsion systems which may now be incorporated in an advanced ICBM. Minuteman III (**2717.111**), for example, has three solid-propellant rocket stages whose function is to accelerate the payload to the required velocity and place it accurately, using the missile-borne inertial navigation system, on the required trajectory. In that payload, which is a MIRV system, there is a fourth propulsion stage, comprising a main propulsion motor and several peripheral attitude control motors; this system is controlled by a complete guidance package and causes the payload "bus" to make excursions from its initial ballistic trajectory so that the independently targeted warhead RVs can be set on their separate ballistic trajectories. If one or more of these RVs is a MARV then each such MARV will require a further propulsion and guidance system – a fifth stage of propulsion and a third guidance system.

It will readily be apparent that since the MIRV guidance package is referenced to the trajectory established by the main vehicle propulsion and guidance system any inaccuracies introduced by the two guidance systems will be additive; so that – quality for quality – a MIRV system is intrinsically less accurate than a single warhead system. Similarly, a MARV system which executes only evasive manoeuvres and does not incorporate terminal guidance is also intrinsically less accurate than a non-manoeuvring warhead.

Inaccuracies in the main propulsion process and subsequent MIRV operation and evasive manoeuvring can be corrected only by a guidance system which is referenced to something other than a trajectory established in an earlier phase of the missile's flight; and in practical military terms the only suitable type of reference will be some invariant characteristic of the target or its surroundings – some physical feature which cannot readily be altered, disguised or simulated by the enemy. One characteristic which is likely to be suitable in many instances is the physical configuration of the terrain over which the RV must pass on its way to the target.

TERCOM – Terrain Contour Matching

A system which is capable of using physical features in the required manner is known as TERCOM. This is an altitude comparison and pattern recognition system which is used to apply corrections to the inertial navigation system which is carried by the RV and which has otherwise been referenced to the other missile navigation systems as described above.

In TERCOM a radio altimeter is used to measure the true height of the RV above ground level and a pressure altimeter is used to measure pressure altitude. The difference between these two readings gives a measure – though not necessarily an accurate one – of the height of the ground surveyed above some datum level such as sea level. The reading obtained is an average one for a defined area of land beneath the RV. A typical area is a square of side 400 ft (122 m) but larger or smaller areas can be used.

Starting at a point determined by the inertial navigation system, readings for a considerable number – typically 64 – of consecutive contiguous areas of equal size are taken by the system and stored in the system's memory. This chain of readings is then compared with a rectangular matrix of readings for a much larger area of terrain which should include the planned track of the RV and any likely departures from that track. By correlating the measured track with all possible similar tracks in the matrix a track giving the best fit can be discovered and the along-track and cross-track navigation errors can be measured and corrections applied. A single comparison of this type, of course, cannot be expected to give good results but repeated measurements and corrections offer the possibility of satisfactorily accurate navigation.

Since the correlation process is in terms of variations in terrain height above datum rather than absolute height, neither altimeter need be exactly calibrated and the system is substantially independent of variations in barometric pressure. What is important, however, is the preparation of the comparison matrix, this must be prepared beforehand by reconnaissance and in some circumstances this could be difficult.

MAGCOM

TERCOM and systems using similar principles are unusable over long stretches of water (whether liquid or frozen) and may be unsatisfactory over large desert areas. An alternative system, called MAGCOM, uses techniques similar to those of TERCOM but using the contours of the earth's magnetic field for comparison instead of the physical contours of the terrain. Prior reconnaissance for this system is likely to be even more difficult than for TERCOM, but otherwise there seems to be no reason why the system should not function satisfactorily. For the Submarine-Launched Cruise Missile, however, it is understood that the intention is to rely on inertial navigation over water and TERCOM over land – presumably because the whole flight over water will be a single operation controlled by one navigation system the inaccuracy at landfall should not be greater than can be handled by the TERCOM system.

STATUS & MANUFACTURERS:

Development work on TERCOM and MAGCOM has largely been carried out by E-Systems Inc who did some early work on TERCOM-like systems back in the 1960s. It is understood, however, that Boeing, General Dynamics/Electronics and McDonnell Douglas have worked on similar systems more recently. As noted above a TERCOM-type system has been specified for the Submarine-Launched Cruise Missile.

Early studies by Lockheed Missiles & Space recommended a mixed payload for the MIRV of the US Navy's Trident missile (**2840.111**) – consisting partly of non-manoeuvring RVs and partly of MARVs. The two RVs are known as the Mk 400 which is being developed by Lockheed and the Mk 500 – the MARV – which is being developed by General Electric. The future of the latter RV was somewhat uncertain until recently, but it now seems fairly clear that it will be put into service in due course.

Thirdly, as part of the ABRES programme (**2709.111**) McDonnell Douglas have a MARV development in hand. Unlike the other two developments this project is not directly related to a specific missile and its funding, too, has been in some doubt. For the reasons stated in the introductory paragraphs above, however, its future now seems assured – assuming, that is, that the work so far done will be taken as the basis for the MARV development for which provision was made in the FY1975 budget proposals.

2710.111
MINUTEMAN INTERCONTINENTAL BALLISTIC MISSILES

DESCRIPTION:

Minuteman is the general name of a family of a silo-launched solid-propellant intercontinental ballistic missiles now extensively deployed in the USA. Of the four versions of Minuteman that have so far been constructed, three are currently operational with the USAF – Minuteman I (LGM-30B), Minuteman II and Minuteman III. A force modernisation programme which has been in operation since 1964, however, is progressively eliminating Minuteman I, and the 1,000-missile force will, when this programme is complete, consist only of Minuteman II and III 450 of the former and 550 of the latter.

MINUTEMAN I – LGM-30A (**2715.111**) is the original version operational in 1963 but no longer in service

MINUTEMAN I – LGM-30B (**2715.111**) was used to equip the next four wings. It is somewhat longer than the LGM-30A and has a greater range but is otherwise generally similar in design and performance.

MINUTEMAN II – LGM-30F (**2716.111**) became operational with the sixth wing in 1966. This is a more sophisticated weapon with a greater range and more flexible targeting capability than the Minuteman I. It can deliver a heavier payload with greater accuracy. Tracor Mk 1A penetration aids are part of the payload.

MINUTEMAN III – LGM-30G (**2717.111**) incorporates all the Minuteman II improvements and has an improved third stage. It carries the advanced Mk 12 multiple independently targetable re-entry vehicle (MIRV) warhead.

DEVELOPMENT:

Invitations to tender for the original Minuteman contracts were issued early in 1958, and out of fourteen bids made, that of Boeing was accepted in October of that year. In February 1961 the first Minuteman surface launch took place successfully at Cape Kennedy and later in the year the first silo launch was attempted. This was unsuccessful – the missile exploded after first-stage ignition – but the second attempt on November 17th was a success.

Minuteman's production line started to roll in 1962 and the first two flights (20 missiles) were declared operational in Malmstrom AFB, Montana, in December of that year. This base was equipped with its full complement of three squadrons of missiles (total 150) by July 1963 – these missiles being of the LGM-30A pattern – meanwhile deliveries of the LGM-30B version to other bases had begun. These were deployed at four bases at Ellsworth, South Dakota, Minot, North Dakota, Whiteman, Missouri, and Warren, Wyoming. The first of these four AFBs was declared operational in July 1963 and Wing V at Warren was completed in June 1965. Wing V was equipped with 200 missiles and the others with 150, making a total of 800 missiles in all. Meanwhile, in September 1964, the first launch of a Minuteman II missile was made successfully from Cape Kennedy.

Assembly and check-out of Wing VI, the first Minuteman II base, was begun in 1965 and the wing became operational in December 1966. An additional squadron of 50 Minuteman II missiles was deployed adjacent to Wing I by April 1967, bringing the total number in the strategic alert to 1,000. By October of that year, as part of the force modernisation programme, the 150 Minuteman I missiles at Wing IV, Whiteman AFB, had been replaced by Minuteman II missiles. Two months later the first flight of 10 missiles at Wing J had been modernised.

Development of Minuteman III was authorised in the spring of 1966, and the first successful launch was made from Cape Kennedy on August 16, 1968. Initial planning called for Minuteman III to be operational in July 1969, but funding limitations caused a slippage of approximately one year.

Installation of the first squadron of 50 began at Minot AFB, North Dakota, on 18 April 1970, and the first flight of 10 missiles became operational two months later. The first squadron became operational on 8 January 1971 when the fifth flight was handed over to the Strategic Air Command.

Since then the force modernisation programme has been proceeding on the revised schedule and the planned deployment of 550 missiles should be completed in 1975.

Presumably in an attempt to redress the USA/USSR strategic missile balance, however, the USAF are currently pressing for a further extension of MIRV deployment aimed at equipping all 1,000 missiles with triple MIRV warheads. Since at the time we go to press the total number so equipped is probably between 350 and 400, it would seem that such a programme could scarcely be completed before the end of 1978.

OPERATIONAL OORGANISATION:

Missiles are organised in flights of 10 launchers, each flight having its own launch control centre. Five such flights make a squadron and three or more squadrons make a wing.

Geographical dispersion is over very wide areas. Wing I for example is spread over an area of 18,000 square miles in Montana. Missiles are stored ready for launch in individual hardened launch sites each having a surface area of two to three acres. The individual launch silo is nearly 25 metres deep and nearly four metres in diameter with two underground equipment rooms around the silo casing extending more than eight metres below the surface. The flight-launch control centre is buried some 15 metres underground and is a blast-resistant shock-mounted capsule operated by two officers of Strategic Air Command.

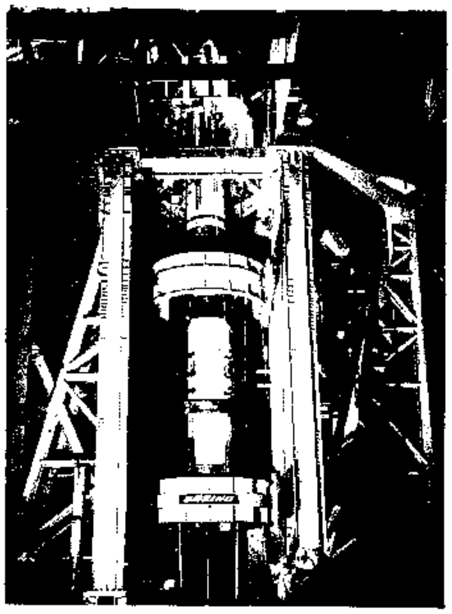
The missile launch sites are unmanned in their normal operating mode of Strategic Alert. In this condition the missile guidance equipment power is on continuously and the missile's own internal computer regularly performs routine checks relating to the missile's readiness for launch. Each site is so deployed that it is at least 5½ kilometres from a launch control centre and at least 9 kilometres from any other launch site.

Although primarily concerned with the control of a flight of missiles, each launch control centre has the capability of controlling a squadron. In each squadron two of these centres are designated as command centres having the capability and responsibility of controlling the entire squadron should the other three centres be incapacitated, and all five are redundantly interconnected so that any one can assume total control of the squadron if necessary. To minimise the effects of human error, launch command is programmed to take place normally as the result of a co-operative team effort by two control centres: in addition any one centre in an entire missile wing can nullify a launch command generated by an individual centre acting independently of the squadrons.

It was announced in January 1966 that Boeing's Missile and Information Systems Division was then designing an airborne launch control system for Minuteman as an alternative to launch control from their underground centres. The qualification testing programme of this system, designed for installation in KC-135 airborne command post aircraft, was completed successfully in the autumn of the same year.

Recently, the US authorities were worried by the possibility of disruption of the command and control system from the airborne command post by EMP (electro-magnetic pulse) interference resulting from nuclear explosions. Guidance hardening modifications have therefore been made and an improved command post arrangement was devised and is known as AABNCP (advanced airborne national command post). Equipment for this system is installed in Boeing 747 aircraft, from which launch commands for Minuteman can be given if necessary.

Another recently-introduced improvement is the Command Data Buffer System. Details of the functioning of this system have not been released, but its purpose is to increase the speed of remote re-targeting of the missiles. It has been reported that the system will enable the command to switch a missile to a new target in 20 minutes – whereas previously it could take up to 36 hours

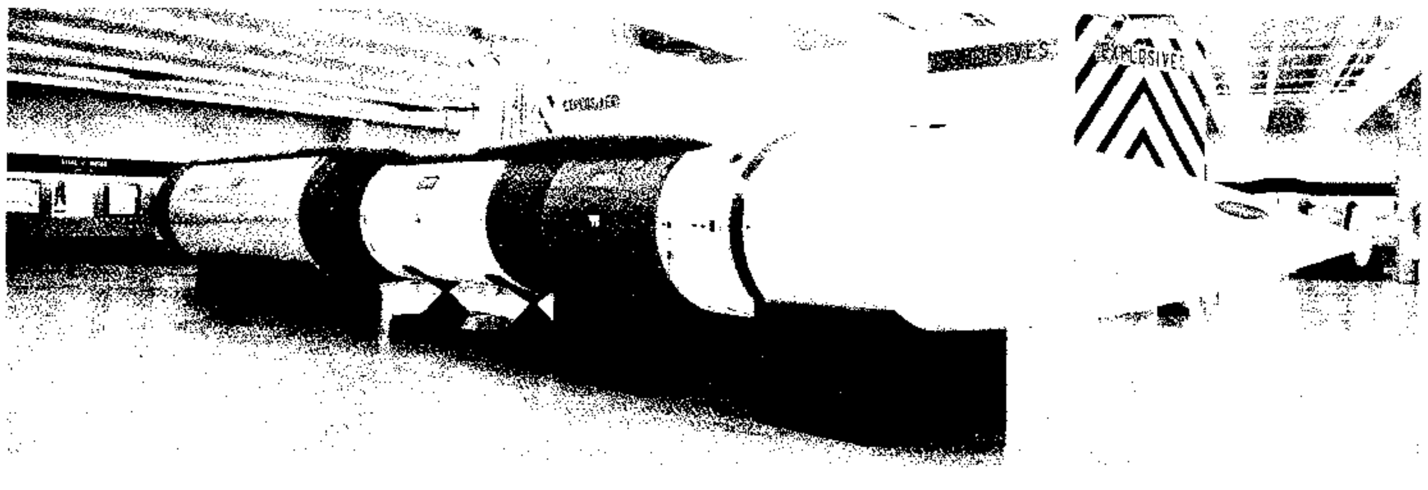


A 700-ton "earthquake machine", developed by Boeing to simulate the effects of nearby nuclear explosions, for testing Minuteman III suspensions

MANUFACTURERS:

Assembly, test and installation of the Minuteman system is the responsibility of the Boeing Aerospace Company, Seattle, Washington, 98124, with TRW Systems providing systems engineering and technical direction. Contractors for control and guidance equipment are the Autonetics Division of Rockwell International. Ground electronics system is by Sylvania.

Thiokol first-stage motors are used on all three missiles as also are Aerojet-General second stage motors. Third-stage motors for Minuteman I and Minuteman II are by Hercules Inc. and that for Minuteman III is by Aerojet-General and Thiokol. Avco ablative-type re-entry vehicles are used on the first two missiles and those for Minuteman III are by General Electric, with Bell Aerosystems as associate contractor for the post-boost propulsion system in the fourth stage.



LGM-30G Minuteman III ICBM

2715.111
MINUTEMAN I INTERCONTINENTAL BALLISTIC MISSILE

DESCRIPTION:

As noted in the general entry on Minuteman missiles (**2710.111**), two versions of this first member of the series were produced and deployed. The earlier version, designated LGM-30A, is no longer operational, having been replaced by later versions, and the following description relates only to the second, slightly larger, version – LGM-30B.

Minuteman I is a three-stage ICBM powered by solid-propellant motors and carrying a single thermonuclear warhead. It is inertially guided but the guidance accuracy is – naturally – not disclosed; all that can be said on this subject is that the combination of its CEP and warhead yield is generally regarded to be insufficient for the missile to be effective against a fully-hardened missile silo in enemy territory.

CHARACTERISTICS:

Service Designation: LGM-30B
Type: 3-stage, solid-propellant, intercontinental ballistic missile
Guidance: Inertial – Rockwell International Autonetics
Propulsion: First stage – Thiokol TU-122 (M-55) approx 91,000 kg st.; Second stage – Aerojet, thrust unknown but probably around 20,000 kg; Third stage – Hercules, thrust approx 16,000 kg. Thrust vector control by four gimballed nozzles is used on all three stages
Re-entry Vehicle: Various types have been used. Currently operational missiles are believed to carry Avco Type 11 and 11A vehicles
Warhead: Thermonuclear single warhead with a yield unofficially reported to be 1 MT
Dimensions: Length 17.0 m; diameter approx 180 cm at the first stage interstage
Launch Weight: Approx 29,400 kg
Speed: More than 24,000 km/h at burn-out
Range: Approx 10,000 km

STATUS:

Operational, but replacement by Minuteman III missiles is expected to be complete not later than 1975.

MANUFACTURERS:

Assembly, test and installation: Boeing Aerospace Company, Seattle, Washington 98124.

Systems engineering: TRW Systems Group, 1 Space Park CR, Redondo Beach, California 90278.

Guidance: Rockwell International Autonetics, 161 Brick St., Princeton, West Virginia 24740.

Propulsion: Aerojet-General Corporation, 9400 E. Flair Drive, El Monte, California 91734; Hercules Inc., 910 Market St, Wilmington, Delaware 19899; Thiokol Chemical Corporation, Bristol Pennsylvania 19007.

Re-entry Vehicle: Avco Systems Division, 201 Lowell St., Wilmington, Massachusetts 01887.

2716.111
MINUTEMAN II INTERCONTINENTAL BALLISTIC MISSILE

DESCRIPTION:

Minuteman II was introduced as a considerably improved version of Minuteman I (**2715.111**). The improvements, however, took the form of an upgrading of the missile's capabilities rather than a radically new departure – as, in some respects, is Minuteman III (**2717.111**). Like Minuteman I it is a three-stage ICBM carrying a single thermonuclear warhead, but it has increased range and azimuth, providing greater targeting coverage, while carrying a larger payload. A more sophisticated guidance system is capable of pre-storing the locations of a larger number of alternative targets and the over-all accuracy of the missile system is greater than for Minuteman I. The increased payload capability enables the missile to carry a larger thermonuclear warhead together with a number of penetration aids.

The first-stage and third-stage motors of Minuteman II are believed to be the same as those and on Minuteman I but the second-stage motor is new.

CHARACTERISTICS:

Service Designation: LGM-30F
Type: 3-stage, solid-propellant, intercontinental ballistic missile
Guidance: Inertial – Rockwell International Autonetics
Propulsion: First stage – Thiokol TU-122 (M-55), approx 91,000 kg st; Second stage – Aerojet SR19-AJ-1, approx 27,500 kg st; Third stage – Hercules, thrust approx 16,000 kg. Thrust vector control on first and third stage motors by four movable nozzles. Second-stage motor has a single nozzle with secondary liquid injection for thrust vector control.
Re-entry Vehicle: Avco Type 11B and 11C with Mark 1 and 1A penetration aids – the latter being supplied by Tracor Inc.
Warhead: Thermonuclear single warhead of a yield unofficially reported as around 2 MT
Dimensions: Length 18.2 m; diameter approx 180 cm at the first stage interstage
Launch Weight: Approx 31,750 kg
Speed: More than 24,000 km/h at burn-out
Range: More than 11,250 km

STATUS:

Operational. According to firm plans at the time of writing, 450 Minuteman II missiles will be kept on the active strength for some years to come. There is, however, pressure from some quarters to replace these missiles by Minuteman IIIs.

MANUFACTURERS:

Assembly, test and installations: Boeing Aerospace Company, Seattle, Washington 98124.

Systems engineering: TRW Systems Group, 1 Space Park CR, Redondo Beach, California 90278.

Guidance: Rockwell International Autonetics, 161 Brick St., Princeton, West Virginia 24740.

Propulsion: Aerojet-General Corporation, 9100 E. Flair Drive, El Monte, California 91734; Hercules Inc., 910 Market St., Wilmington, Delaware 19899; Thiokol Chemical Corporation, Bristol, Pennsylvania 19007.

Re-entry Vehicles: Avco Systems Division, 201 Lovell St., Wilmington, Massachusetts 01887.

Penetration Aids: Tracor Inc., 6500 Tracor Lane, Austin, Texas 78721.

2717.111
MINUTEMAN III INTERCONTINENTAL BALLISTIC MISSILE

DESCRIPTION:

Minuteman III is the most potent weapon in the land-based armoury of the United States. Like Minuteman I and Minuteman II it is basically a three-stage ICBM powered by solid-propellant rocket motors, but it incorporates several features which make it more than a simple improvement on the two earlier members of the series.

Most of the special features relate to the final stage and re-entry system and the most significant, operationally, is the introduction of a MIRV system of three warheads. This MIRV head is essentially a fourth stage of the missile and is powered by a 135 kg thrust motor and manoeuvred by six small pitch and yaw motors and four smaller roll motors. These motors are controlled by the fourth-stage guidance package which also organises the release of the warheads, chaff and decoys from the General Electric re-entry vehicle. The third stage of the missile has also been considerably improved by the introduction of a new motor using fluid-injection thrust-vector control – which gives a finer control of movement than the earlier arrangement of four movable nozzles and which, with improved guidance, enables the missile to carry its large payload over a greater range and at the same time reduce the missile's CEP to about 400 metres.

CHARACTERISTICS:

Service Designation: LGM-30G
Type: 3-stage, solid-propellant, intercontinental ballistic missile
Guidance: Inertial – Rockwell International Autonetics
Propulsion: First stage – Thiokol TV-122 (M-55) approx 91,000 kg st; Second stage – Aerojet SR19-AJ-1, approx 27,500 kg st; Third stage – SR73-AJ-1 Aerojet and Thiokol, approx 15,500 kg st; Post-boost propulsion system — Bell Aerosystems package comprising 135 kg st bi-propellant (nitrogen tetroside/MMH) engine for fore-and-aft control, six 10 kg st engines for pitch and yaw control and four skin-mounted 8 kg st motors for roll control. Propellant tanks are welded shut for long-term silo storage. All motors commanded by fourth-stage guidance package
Re-entry Vehicle: General Electric Mk 12. Normal Minuteman III payload is three MIRV warheads plus chaff and decoys
Warheads: Thermonuclear, approx 200 KT each
Dimensions: Length 18.2 m; diameter 185 cm at first stage interstage
Launch Weight: Approx 24,500 kg
Speed: More than 24,000 km/h at burn-out
Range: More than 13,000 km
CEP: Less than 400 m

STATUS:

Operational. Current programme calls for replacement of all Minuteman I and some Minuteman II missiles by Minuteman III to a total of 550 by the end of 1975. Deployment beyond that point is possible since it is felt in some quarters that the USA should equip all its 1000-missile Minuteman force with MIRV warheads to counter the large Russian strategic missile force.

MANUFACTURERS:

Assembly, test and installation: Boeing Aerospace Company, Seattle, Washington 98124.

Systems engineering: TRW Systems Group, 1 Space Park CR, Redondo Beach, California 90278.

Guidance: Rockwell International Autonetics, 161 Brick St., Princeton, West Virginia 24740.

Propulsion: Aerojet-General Corporation, 9100 E. Flair Drive, El Monte, California 91734;

Minuteman III launch (US Air Force Picture)

Thiokol Chemical Corporation, Bristol, Pennsylvania 19007.

Post-boost Propulsion System: Bell Aerospace Co., Division of Textron Inc., PO Box 1, Buffalo, New York 14240.

Re-entry Vehicle: General Electric Co., 570 Lexington Avenue, New York, NY 10022.

2720.111
MINUTEMAN IV INTERCONTINENTAL BALLISTIC MISSILE

DESCRIPTION:

A range of improvements to the basic Minuteman III ICBM (**2717.111**) has been proposed by the US authorities. It is believed that the intention is to introduce these improvements sequentially, rather than as a complete improvement package; but in either case the effect will be – if the proposals are carried out – to produce a missile which is superior in performance to Minuteman III and operational earlier than the new MX ICBM (**2718.111**). The name "Minuteman IV" has no official status and is introduced here solely for editorial convenience.

The following improvements are believed to be proposed:

1. *Improved propulsion system* involving redesign of the second-stage and third stage motors.
2. *Improved guidance.* An improved system is being developed by the Autonetics Division of Rockwell International and involves major software and minor hardware changes. Aim is to reduce the missile CEP from about 400 m to a little over 200 m. Total cost has been estimated at $120 million with $30 million to be spent in FY 1975.
3. *Improved re-entry vehicles.* First improvement will be the introduction of the Mk 12A RV (**2708.111**), total development cost of which is believed to be in the order of $150 million including about $60 million for improved warheads. Subsequent improvements will probably include the Mk 20 RV (**2708.111**) at a cost of some $400 million and may involve the MARV (**2719.111**) or Pave Pepper (**2839.111**) re-entry projects.
4. *Improved silos.* This aspect of the improvement programme can be separated from the other three, since these improvements are generally applicable to all Minuteman missiles. The general intention is to reduce the susceptibility of the silos to damage resulting from enemy attack by, for example, improving suspension systems.
5. *Operational testing.* Another separable aspect of the programme is the proposal to carry out some Minuteman trials from operational silos as distinct from the test launch sites from which all launches have hitherto been made. In this respect the US authorities consider themselves to be at a disadvantage relative to the USSR where frequent launches are made from operational bases. Information gained from such launches would be a valuable input to the improvement programme.

STATUS:

Generally as indicated in the foregoing notes, subject to the reservations that many of these proposals are, at the time of writing, encountering considerable opposition in Congress.

2718.111
MISSILE-X INTERCONTINENTAL BALLISTIC MISSILE

DESCRIPTION:

Missile-X or MX is the current provisional designation for a new intercontinental ballistic missile which has been under consideration for some time in the USA and which is envisaged as a replacement for – or possibly a supplement to – the Minuteman series of missiles (**2710.111** and **2715-7.111**).

The combined effects of the restrictions imposed by the SALT agreements in 1972 (see **2200.111**) and of the evident determination of the USSR to develop its strategic missile forces at least to the limits permitted by those agreements have concentrated thinking on the new missile; and while, at the time of writing, the final intentions are not clear, it seems likely that the following considerations will influence the final specification.

1. SALT agreements so far do not cover air-launched nuclear weapons: the final version of MX is therefore likely to be suitable for air-launching. Boeing have put forward a proposal for a system based on their 747 aircraft – which could carry four missiles of around 50 tonnes or eight of around 25 tonnes. Alternatively, a new aircraft could be developed. In either case the air-launch technique calls for exceptionally accurate initial navigation references: these are considered to be within the present state of the art – but their reliability under nuclear warfare conditions needs to be considered.
2. Although SALT is taken by the US authorities to restrict deployment of land-mobile strategic missiles there is currently no objection to their development. Since mobile missiles have the advantage of presenting a potential enemy with additional targeting problems it is likely that the possibility of a mobile arrangement will be borne in mind when the MX is finally specified. There were earlier proposals for a mobile Minuteman, but so far as is known no hardware was built.
3. A payload significantly larger than that of Minuteman III is regarded as important by the US authorities. Since SALT prohibits the creation of new silos for larger missiles it is almost certain that the MX will be developed to make maximum use of the existing Minuteman silos. One way of doing this is to use a cold-launch technique – one in which the missile is ejected from the silo by cold gases and first-stage ignition does not occur until after the missile is clear of the silo. This technique makes it possible to dispense with the protective shielding which has to be used in hot-launch silos and thus increase the usual diameter of the Minuteman silo to about 3 metres. A cold-launch technique is already used for launching submarine-born ballistic missiles.
4. Improved re-entry systems are already being studied and developed both for Minuteman and for the US Navy's Trident programme (**2840.411**). Much of this work, some of which is described elsewhere in this section (**2708/9.111** & **2719.111**), will also be applicable to the MX.
5. Much the same is true of propulsion systems. It is believed that a system similar to that developed by Thiokol for the Trident programme is likely to be selected for the MX.

STATUS:

MX is a research project at the time of writing, but the US Defence Department has requested an appropriation for FY 1975 which is nearly ten times as great as that for FY 1974. No programme details are known.

MANUFACTURERS:

Most of the major manufacturers who have been concerned with other US strategic missile systems are either involved in or likely to be involved in the MX programme. In the absence of firmly-designated contractors it would be invidious to select names for mention here.

2839.111
PAVE PEPPER RE-ENTRY PROJECT

DESCRIPTION:

One of several programmes aimed at increasing the effectiveness and operational versatility of US nuclear weapon systems, Pave Pepper is scheduled to start in US Fiscal Year 1975.

The aim of the programme is understood to be the development of small low-yield re-entry vehicles for use with both strategic and tactical missiles and each re-entry vehicle being assigned a specific target. A three-year development programme is envisaged.

Details of missiles with which these re-entry vehicles might be associated have not been released up to the time of writing, nor have the names of any manufacturers concerned been disclosed. The reported relevance of the programme to both strategic and tactical missiles, however, suggests that there may be two sub-programmes involved in the development, with some common features such as the physical configurations and basic construction of the re-entry vehicles. For the tactical application it is possible to imagine an arrangement whereby a Lance (**2682.111**) or Penking (**2765.111**) missile would be required to take out specific targets using, perhaps TGSM dispensing techniques similar to those described in entry **2838.111**, designation and homing systems analogous to the Paveway series (**1533.311**) and miniature nuclear warheads like those described in entry **2725.103**. The Paveway techniques would scarcely be applicable to the strategic use of the system, however: nor would the TGSM dispensing technique in its present form. To design a different dispensing mechanism would presumably present few problems; but the target designation and guidance would appear to require a command system of some kind on the parent missile.

All this is speculation, however, and it may well be wide of the mark.

STATUS:

Project. It is reported that expenditure of $21 million, $38 million and $22 million are envisaged for FY 1975, FY 1976 and FY 1977 respectively.

2826.111
TITAN II INTERCONTINENTAL BALLISTIC MISSILE

DESCRIPTION:

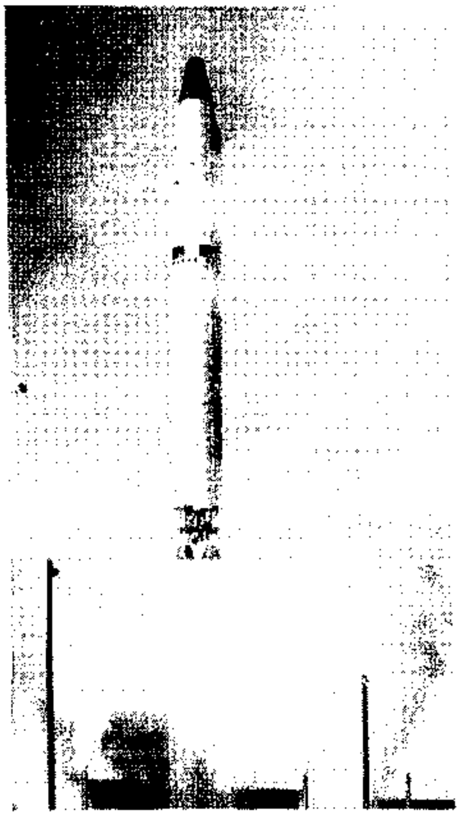
The LGM-25C Titan II is an improved version of the earlier HGM-25A Titan I intercontinental ballistic missile. It carries the largest of all US ICBM payloads and has a launch reaction time of one minute from its fully hardened underground silo.

Titan has been operational with the Strategic Air Command since 1963 and is deployed in three wings of 18 missiles each at Davis-Monthan AFB, Arizona; McConnell AFB, Kansas, and Little Rock AFB, Arkansas. In the statement of the US Secretary of Defence on the 1970-74 Defence Programme and 1970 Defence Budget, however, the following comment was made:

"Although the Titan II, with its large warhead, will still be useful against undefended large soft targets, its importance will decline greatly when large numbers of Minuteman IIIs and Poseidons enter the forces. Accordingly, we believe that after FY 1973 we can safely permit the Titan force to decline as the missiles on land continue to be used for follow-on operational reliability testing without replacement".

The general situation regarding US ICBMs has of course been modified by the SALT agreements. The most recent official US pronouncements available at the time of writing give no clear guidance regarding Titan's future, other than that there will still be 54 in the strategic alert up to mid-1975 at least. The available options would appear to be (1) to run the force down, "replacing" them by SLBM as permitted in the SALT Interim Agreement; (2) to maintain the 54-strong force by purchasing a small additional quantity to cover wastage; (3) developing a new heavy missile for the 54 silos; and (4) developing such a new missile as in (3) but increasing the number of silos by either disregarding the SALT agreement or waiting for its expiry. While (1) and (2) are probably the most and least likely courses respectively, the value of a very heavy missile in the inventory cannot be disregarded, so (3) followed by (4) could be the choice.

CHARACTERISTICS:
Designation: LCM-25C
Type: Land-based intercontinental ballistic missile
Guidance: Inertial
Propulsion: Two stage liquid propellant rocket motors. Stage 1: 195,000 kg st; Stage 2: 45,000 kg st
Warhead: Nuclear. Believed 5+ megatons
Re-entry Vehicle: General Electric Mk 6
Missile Length: Stage 1: 21.3 metres; Stage 2: 6.1 metres; Re-entry Vehicle: 4.3 metres. Total: 31.3 metres
Missile Diameter: 3 metres
Launch Weight: Stage 1: 117,000 kg; Stage 2: 29,000 kg; Re-entry Vehicle: 3,700 kg. Total 149,700 kg
Speed: More than 24,000 km/h
Ceiling: About 1,500 km
Range: About 15,000 km
MANUFACTURER:
Prime contractor was the Martin Marietta Corporation, Denver, Colorado.



Titan II launch

2707.111
TRIAD STRATEGIC DETERRENCE COMBINATION
DESCRIPTION:

Triad is the name given in the USA to the combination of its land-based, airborne and submarine strategic deterrence forces. The component parts of this combination are described in this section, in the section dealing with air-to-surface strategic missiles and in that dealing with sub-surface-to-surface weapon systems.

Details of strategic forces on alert are naturally not published by the US authorities, but an interesting pointer was given by General George S. Brown, USAF Chief of Staff, in his testimony before the US House of Representatives Armed Services Committee on the Fiscal 1975 defence budget. He said:

"The ICBM force today consists of 1,000 Minuteman and 54 Titan missiles. The alert rate of these weapons continues to be nearly 100%. The Minuteman and Titan missiles constitute over half of the megatonnage and about two-thirds of the delivery vehicles on alert to support the Single Integrated Operational Plan (SIOP), our general nuclear war plan. Minuteman III, the most modern of the ICBM force, provides weapons on alert at lower operating cost than any other Triad element."

At the time when this statement was made, the Minuteman force probably consisted of about 400 Mark III, 500 Mark II and 100 Mark I missiles which would give a total megatonnage of about 1100 MT, to which must be added between 300 and 500 MT for the 54 Titan missiles – say 1500 MT in all. The SLBM force at the same time consisted of a 656-missile mix of Poseidon, Polaris A-3 and Polaris A-2 missiles in a ratio of about 4:2:1 corresponding to an average of about 575 KT per missile or about 377 MT in all. However, only about 60% of the SSBN force is on station at any one time, so that the effective SLBM megatonnage on alert is only about 230 MT.

Interpreting General Brown's remarks on megatonnage conservatively, therefore, it seems reasonable to assume that the airborne weapon element in the strategic alert accounts for somewhere in the region of 1,000 MT.

Turning now to his remarks on delivery vehicles, it is evident that he must have been referring, so far as land-based or submarine forces are concerned, to complete missiles rather than warheads: the Minuteman/Vulcan force at the time could muster no more than 1900 warheads and the minimum number of SLBM warheads in SSBN on station must at that time have been at least 1200 and probably more like 1600; so that the land-based missiles would account for nearer one-half than two-thirds of the deliverable warheads. In terms of missiles, however, the land forces account for 1054 and the SSBN on station for about 400; so that the General's two-thirds approximation would be satisfied by adding 100-200 strategic bombers – figures which are reasonably consistent with a bomb/missile load of 1,000 MT or so. The total US intercontinental bomber inventory, however, is known to be nearly 500.

These calculations with respect to delivery vehicles are somewhat conjectural. The calculation of total megatonnage, however, is not: taking General Brown's statement at its face value it appears that the US strategic forces on alert have the capacity to deliver some 3,000 MT of thermonuclear warheads on an enemy.

THE UNION OF SOVIET SOCIALIST REPUBLICS

2900.111
INTRODUCTION

In the year that has elapsed since this introduction was written for the fifth edition, extensive changes in Russian strategic missile developments have been revealed – changes both in the numbers of different missiles that have been or are being developed and in the degree of missile system sophistication which has been attained.

From what has now been disclosed by the American authorities, it is evident that MIRV development in the Soviet Union was much further advanced – as indeed we suggested at the time that it probably was – than was generally acknowledged a year ago. MIRV tests for at least three different kinds of land-based strategic missile are now reported to have been carried out, arguing a considerable measure of confidence in the basic system design.

While our scepticism regarding the assessment of Russian progress and prospects in re-entry vehicle technology, declared by the US authorities at the time of SALT I and reiterated for some time thereafter, would appear to have been justified, however, it is important to note that the recently disclosed Russian achievements do not of themselves indicate that the American technological lead in this field has been extinguished. According to the information now available there are still no *operational* land-based strategic missiles with MIRV warheads in the Soviet Union; and even if this information should prove to be yet another understatement of the Russian achievement it is evident that the long US experience of designing and manufacturing both land-based and submarine-launched MIRV missile systems, coupled with the long and continuing programme of re-entry vehicle research and development must represent a substantial lead over their competitors. Nevertheless, since whatever barriers were previously impeding Russian MIRV advances (miniature on-board computers, probably, and possibly small but accurate inertial navigation devices) have now been breached, the Americans will have to work hard to maintain their advantage.

New Missiles

Four "new" Russian land-based strategic missiles have been described by the US authorities and assigned numbers in the US alphanumeric code. According to these descriptions, three of the missiles are significantly different from the earlier missiles; the fourth, known as the SSX-16 appears to be simply an improved version of the SS-13 (Savage) missile.

No NATO code-names for the new missiles have reached us; and because this means that there are now no such names for five of the missiles described in this section we think that readers will find it helpful if we list all the missiles in numerical order of the US code instead of alphabetically in NATO code order as before.

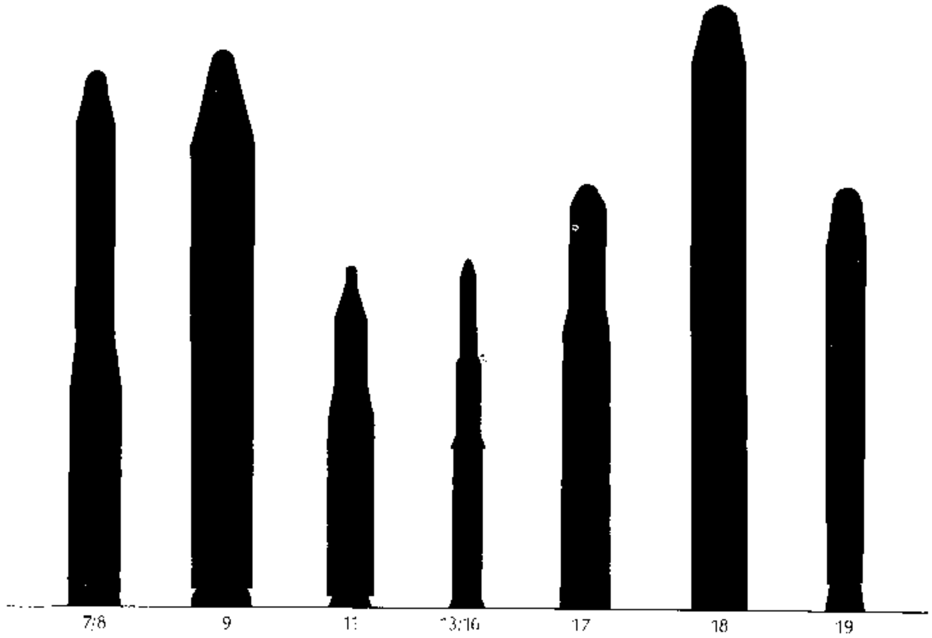
Not surprisingly, since the information on the new missiles which is available from open sources consists at best of occasional samples from what must be an extremely energetic continuing intelligence-gathering operation, inconsistencies abound; and it is not possible to give more than a general indication of the nature of the new deveiopments in the individual entries below. It is, however, instructive to compare the new range with the more important of the older missiles and an attempt at such a comparison has been made in the accompanying diagram – about which, however, the only thing that can be said with absolute confidence is that it is not accurate. It is based on a mixture of old and new information and has been simplified, not so much for the sake of clarity as for the purpose of not seeming to convey precise information on a still necessarily speculative subject. In particular, although data from American sources indicate some slight differences of size and shape between the old SS-13 and the new SSX-16 missiles we have not attempted to depict such differences here.

Older Missiles

There still remain some unresolved problems concerning the older missiles. Hardly had we consigned to the printers last year's introductory observations on the SS-11 and SS-13 missiles than we received from the USA an official document which contradicted much that we had said on the subject. This new information – together with some more recent and slightly different information – is incorporated in the accompanying diagram; and it will be seen that the SS-11 is disputed as being similar in length to the SS-13 but otherwise as quite different in shape.

However, this is not quite the end of the story. Accompanying the US Military Posture Statement for FY 1974 by Admiral Moorer (Chairman, US Joint Chiefs of Staff) was a diagram in which was shown a silhouette of the SS-7 missile as well as silhouettes of the SS-9, SS-11 and SS-13 missiles. The SS-7, which is generally associated with the NATO code-name "Saddler", was shown as a large missile only a little shorter (though significantly thinner) than the SS-9 and substantially larger than the other two. For some time, however, it has been generally accepted that "Saddler" is broadly similar to another of the older Russian ICBMs which is known as "Sasin" and usually associated with the US code SS-8.

This view received apparent confirmation in Admiral Moorer's posture statement for FY 1975, in which virtually the same four missile silhouettes were published, by a change of labelling which described the first missile as "SS-7/SS-8" – as is the first silhouette in our diagram. The problem that arises, however, is that neither in shape nor in length does the missile often seen in Moscow parades and generally identified as SS-8 or Sasin resemble this silhouette. In shape, as can be seen in the photograph accompanying entry



Silhouettes indicative of the relative sizes and general shapes of the more important operational Russian intercontinental ballistic missiles (SS-7, 8, 9, 11 & 13) and of the new generation of missiles (SSX-16, 17, 18 & 19). Silhouettes show, on the left, the SS-7 and possibly also the SS-8 (see text), the SS-9 and the SS-11; in the centre is a silhouette which is believed to be equally representative of both the SS-13 and the SSX-16; then follow the SSX-17, SSX-18 and SSX-19

2956.111 below, this missile more nearly resembles the SS-11 silhouette but it appears to be about 25% longer than that silhouette suggests.

It cannot therefore be said that the SS-11 identification problem has been satisfactorily resolved and there is now some uncertainty regarding the identification of the SS-7/SS-8 missiles. Pending receipt of further information, however, we have this year repeated the identifications which we have used before for the older missiles – except, of course, that we have brought the SS-11 description into line with the most recent data.

Deployment

If the USSR adheres to the terms of the SALT I Interim Agreement on ICBMs the maximum number of silo-launched missiles that they can deploy is 1,618. Current US estimates for mid-1974 are a total land-based static ICBM deployment of 1,587 and it is thought that, although there may be a slight increase resulting from deployment by mid-1975 of 25 SSX-18 missiles in the large silos which were under construction at the time of SALT I the total is likely to decline to a little over 1,400 by 1980, because the US authorities think that the Russians will probably exercise their option to "replace" most of their 209 old-type ICBMs by SLBMs.

Apart from these 209 missiles (SS-7 and SS-8) the remainder of the mid-1974 estimate of 1,587 is made up of 288 SS-9, 1,030 SS-11 and 60 SS-13.

Further Outlook

According to a recent US estimate, the Soviet Union may develop and test a further 12 new ICBMs, in addition to the SSX-16-19, by 1983. We report this statement because of its obvious interest and because presumably the US authorities had what seemed to them to be good reasons for making it. We find it difficult to imagine what reason the Soviet Union would have for such a lavish programme, however, and are inclined to view it with some scepticism.

2977.111
SS-3 (SHYSTER) MRBM

DESCRIPTION:

Almost certainly no longer in operational service in the USSR, although a few may still survive in relatively unimportant areas, the SS-3 missile – whose NATO code-name is believed to be Shyster – is a first-generation low medium-range ballistic missile developed in Russia from the German V-2 bombardment missile through two earlier stages known to NATO as Scunner (virtually a Russian-built copy of the V-2) and Sibling.

As can be seen in the illustration, the SS-3 exhibited a marked departure from the squat configuration of the V-2 and set the pattern for the succeeding SS-4 and SS-5 MRBMs. It is powered by a single-stage liquid-propellant rocket motor originally using LOX/alcohol fuel but subsequently converted to LOX/kerosene.

Estimates of the range of this missile exhibit wide variations – possibly because of the change of fuel.

CHARACTERISTICS:

Type: First-generation low medium-range ballistic missile
Guidance Principle: Radio command
Guidance Method: Control of guidance vanes in efflux nozzles
Propulsion: Single-stage liquid-propellant sustainer
Missile length: 21 metres
Missile diameter: 1.6 metres
Launch Weight: About 26,000 kg
Range: 800-1,200 km

STATUS:

Probably obsolete.

2952.111
SS-4 (SANDAL) MRBM

DESCRIPTION:

Known also by the NATO code-name "Sandal", the SS-4 is a low medium-range ballistic missile which is a developed version of the SS 3 (Shyster) – itself an improved version of the German V2 rocket used in the Second World War.

SS-4 was first shown in public in 1961 and became a standard MRBM in the Soviet armed forces. It was also the missile that lay at the root of the Cuban crisis in 1962: depending on the weight of the warhead the missile has a range of between 1,500 and 1,800 km, which would have enabled missiles launched from Cuba to reach the southern states of the USA.

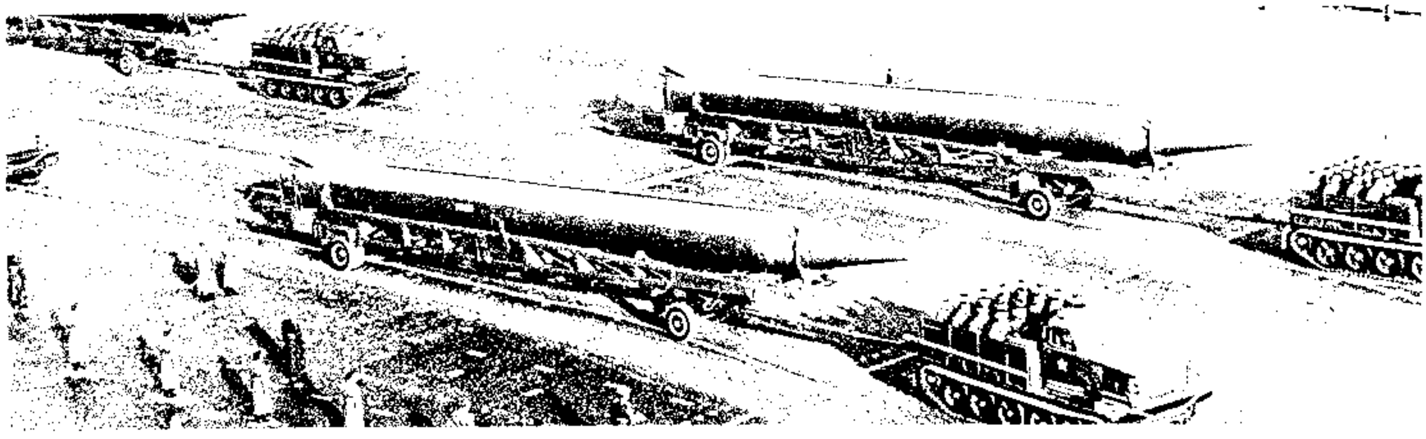
The complete weapon system comprises about twelve tractor vehicles with special trailers. Some twenty men are required to erect and launch the missile. The guidance system employed was originally radio command - operating on guidance vanes in the efflux nozzles – but it was observed at the time of the Cuban crisis that a changeover to inertial guidance had taken place.

STATUS.

SS-4 is now reported to be extensively deployed in the Central Asian region of the Soviet Union. Of some 600 MRBM and IRBM believed to be deployed in the USSR about 500 are probably SS-4s; and it is believed that a substantial number of these are targeted on installations in the People's Republic of China.

CHARACTERISTICS:

Type: Medium-range ballistic missile
Guidance Principle: Now inertial. Formerly radio command
Guidance Method: By control of elevators and of guidance vanes in efflux nozzles
Propulsion: One liquid propellant sustainer
Warhead: Optional nuclear (1 Megaton) or high-explosive
Missile Length: About 21 metres
Missile Diameter: About 160 cm
Launch Weight: About 27,000 kg
Speed at Burn-out: Mach 6 7
Range: About 1,800 km



Sandal Medium Range Ballistic Missile

2981.111
SS-5(SKEAN) IRBM

DESCRIPTION:

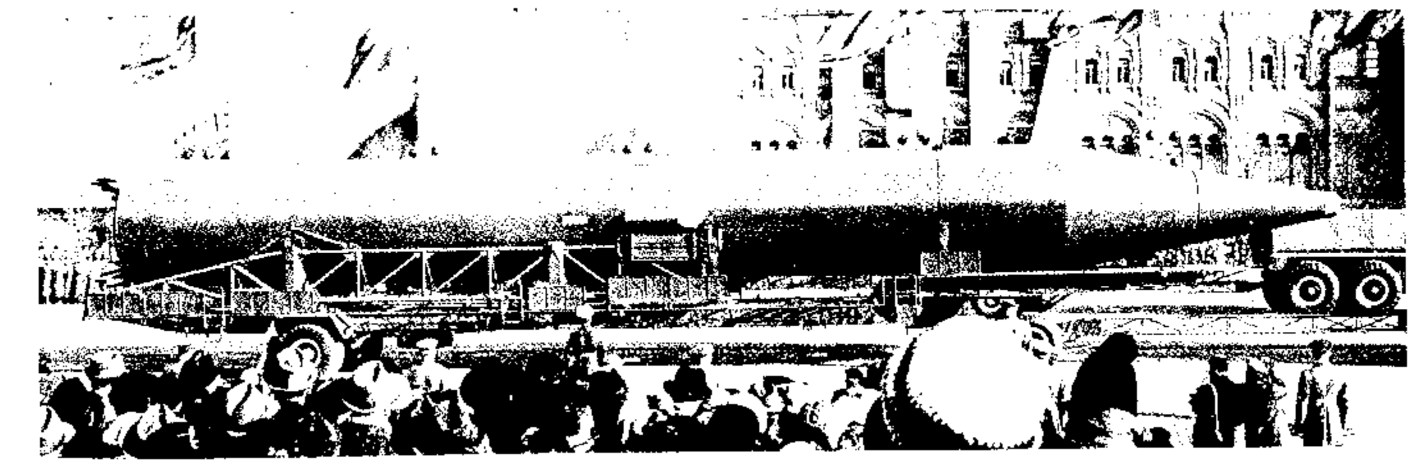
Successor to the Shyster and Sandal liquid propellant MRBM weapons, the SS-5 is an intermediate range missile also known by the NATO code-name "Skean". Although similar in general configuration to its predecessors it can be identified by the absence of tail fins and its blunted nose cone. It is carried on a different trailer, towed by the latest type of heavy tractor vehicle and has been shown inside silo underground launch facilities in official Soviet films. The missile was first displayed in 1964.

CHARACTERISTICS:

Type: Intermediate-range ballistic missile
Guidance Principle: Probably inertial
Propulsion: Single-stage liquid-propellant sustainer
Warhead: Nuclear, believed 1 MT
Missile Length: About 25 metres
Missile Diameter: About 2 4 metres
Range: Estimated 3,500 km

STATUS

Operational. About 100 of these missiles are believed to be deployed in IRBM fields.



Skean liquid propellant MRBM

2982.111
SS-7 (SADDLER) ICBM

DESCRIPTION.

SS 7, known also by the NATO code-name "Saddler" is the oldest ICBM still believed to be in the Russian operational inventory.

Despite its age, however, very little has ever been said about it in official or unofficial documents and it seems never to have found its way into any of the Moscow parades. The few references that have been made to it have almost invariably bracketed it with the SS-8 missile (**2956.111**).

As noted in entry **2900.111** above, however, the last two US Military Posture statements (for FY 1974 and 1975) have included a drawing of the SS-7 similar to the one accompanying **2900.111** which shows it to be a large missile – considerably larger than that illustrated in the SS 8 entry below – of two or possibly three stages. The data set out below summarise the generally-accepted performance data together with what can be inferred from this one published drawing.

CHARACTERISTICS:

Type: Intercontinental ballistic missile
Guidance Principle: Not known, but probably initially radio command. May have been updated to inertial
Propulsion: Probably two stages. Liquid propellant
Warhead: Nuclear, reputedly about 5 megatons
Missile Length: About 30-35 metres
Maximum Diameter: About 3 metres. Upper stage significantly less
Range: Said to be about 11,000 km

STATUS:

Operational, but obsolescent and likely to be "replaced" by SLBM under the terms of the SALT I Interim Agreement. 209 assorted SS-7 and SS-8 missiles are said to be deployed in the USSR. First deployment is said to have been as early as 1961.

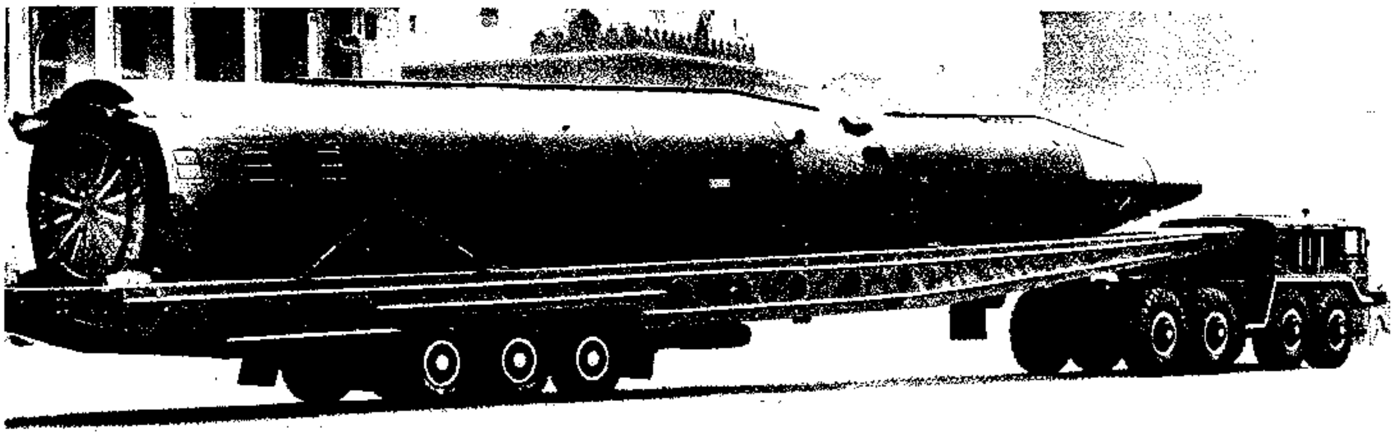
2956.111
SS-8 (SASIN) ICBM
DESCRIPTION:

Known also by the NATO code name "Sasin" the missile which has for some time been identified with the US code number SS-8 is a two-stage storable liquid-propellant long-range rocket first publicly shown in Moscow in 1964. It has not been seen in the most recent parades, but like the SS-7 (**2982.111**) it is still believed to be operational, but likely to be phased out in the fairly near future – possibly being "replaced" by SLBM in accordance with the SALT I Interim Agreement.

A little doubt has been cast on the identification of this missile (and hence on the characteristics quoted here) by the publication, in an official US document of a diagram purporting to represent both the SS-7 and SS-8 missiles (see **2900.111** and **2982.111**). Subject to this reservation, however the SS-8 appears to be some 28 metres in length, with a maximum body diameter not much under 3 metres and has an estimated range performance in the region of 10,000 km if used as a ballistic missile.

CHARACTERISTICS
Type: intercontinental ballistic missile
Guidance: Probably inertial
Propulsion: Two stage storable liquid rocket motors
Warhead: Nuclear, about 5 megatons
Missile Length: About 25 metres
Maximum Diameter: About 2.75 metres
Range: About 10,000 km
STATUS:

Operational but probably obsolescent as stated above. First deployed 1963.



Sasin liquid-propellant intercontinental missile

2962.111
SS-9 (SCARP) ICBM Mods 1 & 2
DESCRIPTION:

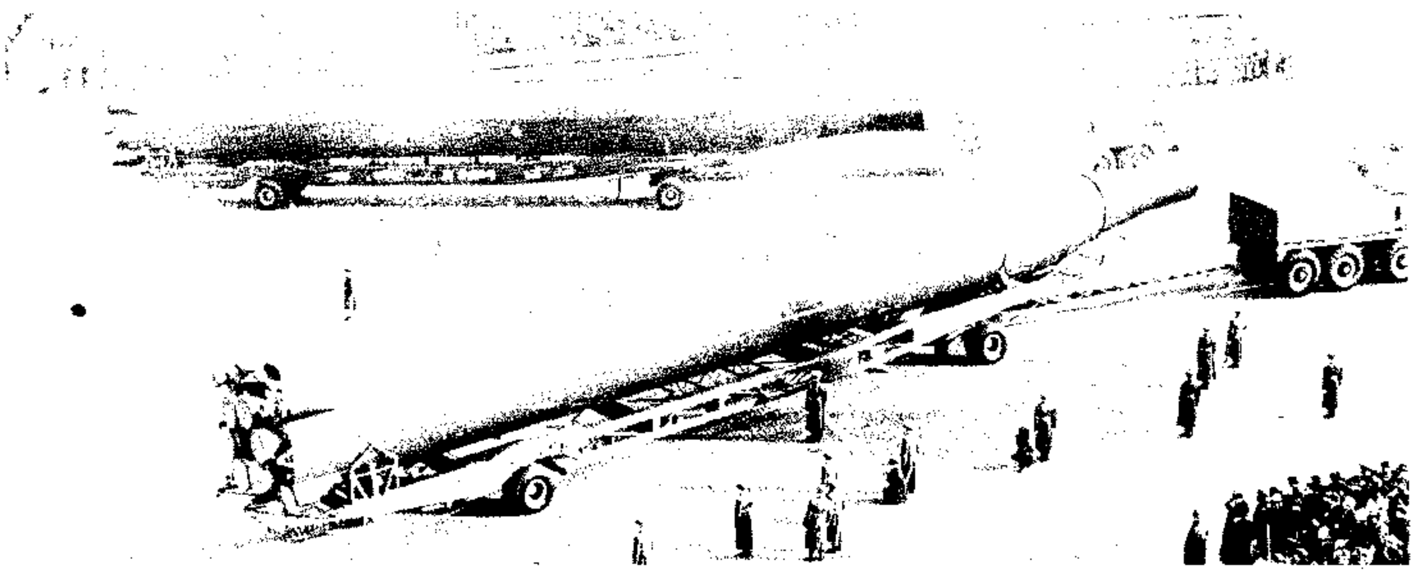
Probably the best known of all the ballistic missiles in the armoury of the USSR, the SS-9 (NATO code-name Scarp) is a three-stage liquid-propellant ICBM which was first shown in public in Moscow on 7 November 1967. The missile is some 35 metres long and 3 metres in diameter; and apart from the fact that the first stage propulsion system has six nozzles and four vernier nozzles little information is available from open sources concerning the detailed design of the weapon.

Much more is known and quite a lot has been published concerning its operational capabilities and deployment. Four significantly different versions of the missile have been identified by US intelligence and the following details apply mainly to the first two. It appears that installation started in 1965 and that by the spring of 1968 about 225 missiles had been deployed. There was then a nine-month period of apparent inactivity, after which installation was recommenced, and it is currently stated by the US authorities that there are 288 of these missiles in an operational condition.

It is believed that the rocket is capable of carrying a warhead weighing between 5,000 and 7,000 kg over a distance of some 12,000 km. In both the Mod 1 and the Mod 2 versions the payload is a single large warhead – that of the Mod 1 having a greater yield than that of the Mod 2. The larger warhead is generally believed to have a yield of 20-25 MT

CHARACTERISTICS:
Type: Intercontinental Ballistic Missile
Guidance: Inertial
Propulsion: 3-stage liquid-propellant motor
Warhead: Single nuclear warhead of 20-25 MT for Mod 1. Less for Mod 2
Missile Length: About 35 metres
Max Diameter: 3 metres
Range: 12,000 km as ballistic missile. Unlimited as FOBS
STATUS:

Operational. 288 are deployed in hardened silos. Most of these are Mod 1



The SS-9 Scarp ICBM on show in Moscow

2978.111
SS-9 Mod 3 ICBM
DESCRIPTION

SS-9 Mod 3 is the US code assigned to a version of the basic SS 9 missile (**2962.111**) which is reported to have been tested both in a depressed trajectory mode and as a Fractional Orbital Bombardment System. Some confusion regarding the meaning of these terms has been apparent in the literature and the following notes may be helpful.

Depressed Trajectory

A body moving solely under the influence of the Earth's gravitational attraction and having insufficient energy to escape from that attraction moves in an approximately elliptical (or, in special cases, circular) path. For an ICBM, assuming that all the available propulsive energy is supplied to it at the moment of launch, the trajectory will be an ellipse which intersects the circumference of the Earth at the points of launch and impact (neglecting the effects of the atmosphere). For any such pair of points there is an infinitely large number of possible elliptical trajectories but one of them is unique – the one for which the least propulsive energy is required. Looking at it in another way – for any given amount of propulsive energy there is a unique elliptical trajectory which gives the maximum range: all other trajectories, whether higher or lower than this unique trajectory will give less range from launch to impact.

It follows, therefore, that if the available propulsive energy is more than is required to transport the missile to the required destination on the minimum-energy trajectory, a set of other trajectories is available for selection by the user: the upper and lower bounds being determined by the amount of surplus energy available. It will be noted, however, that for this choice to be available the distance to be travelled by the missile must be less than its maximum range on a minimum-energy trajectory.

By selecting a trajectory which has an apogee lower than that of the minimum-energy path the missile will be better shielded from radar detection because it will cover a greater distance before appearing above the radar horizon. It will thus give the defences less time to launch an interceptor missile.

The foregoing argument is, of course, greatly simplified and neglects the complications of the effects of the atmosphere on the trajectory and the fact that the total propulsive energy cannot be supplied to an ICBM at the instant of launch. The general idea, however, should be sufficiently apparent.

SS-9 Mod 3 has, according to the US authorities, been tested in such a depressed trajectory mode – but not since 1971. It may be that now that reconnaissance satellites are so extensively used for ICBM detections the Russians feel that the sacrifice of range (or payload) is too dear a price to pay for the small advantage that may yet be gained.

FOBS

This description is misleading because, as is implicit in the foregoing discussion, the post-boost exo-atmospheric trajectory of any long-range missile is in fact a fraction of an orbit about the centre of the Earth – an orbit which would continue if the Earth's atmosphere and surface did not get in the way.

A slightly better description of what is now called FOBS would be "interrupted orbit" bombardment system; because the FOBS principle involves putting a missile into some kind of orbit (not necessarily one that is completely clear of the Earth's surface) and then – at a predetermined time – decelerating the missile so as to bring it back to the surface on a new trajectory. The principle is, of course, one that has been firmly established in space-flight programmes.

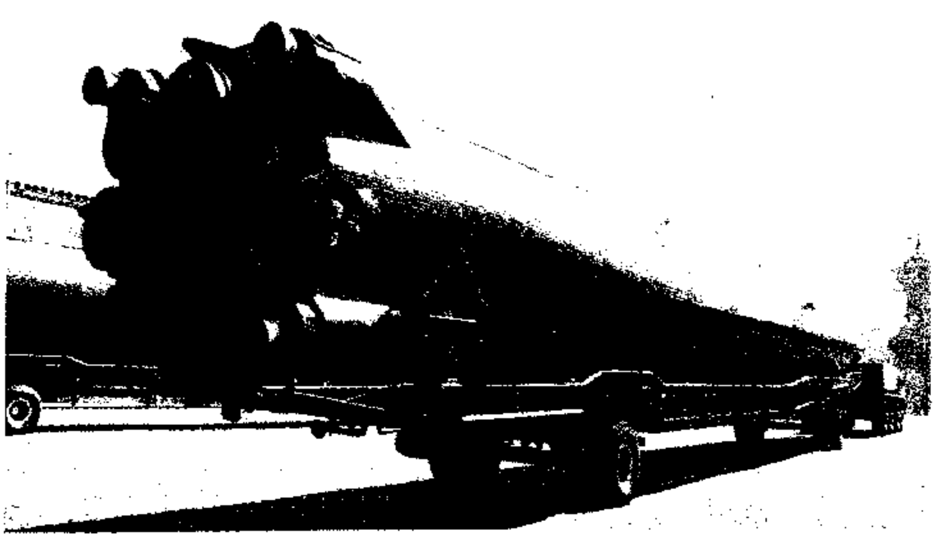
The main advantage of the technique is that, without foreknowledge of the timing and nature of the decelerations the point of impact cannot be predicted from observations of the original trajectory: predictions can only usefully be attempted when the missile is on its final trajectory, and the warning time thus available may be very short. If a full elliptical orbit can be used as the basis of the exercise an added advantage is that of being able to launch the attack from any direction.

Disadvantages are, first, that the complication of the deceleration process, possibly coupled with an exceptionally long flight, tends to reduce system accuracy unless some form of terminal guidance can be made available; and, secondly, that more energy is required to execute the FOBS sequence than is needed to put the same missile on the same target by way of a minimum energy trajectory. In practical terms this difficulty will generally be reflected in a reduction of payload.

STATUS:

According to US reports early in 1974, the SS-9 Mod 3 had not been tested for more than two years and was believed not to be deployed in any of the operational SS-9 silo complexes (presumably, since the basic missile is substantially the same as that of Mods 1 and 2, it is difficult to be sure of this).

This does not necessarily mean, however, that the depressed trajectory and FOBS techniques have been abandoned. The Russian missile development teams have obviously been very busy and the cessation of tests of the SS-9 Mod 3 may simply reflect a reduced priority for this version of the missile.



Rear view of Scarp missile, showing the six first-stage nozzles and the four verniers (Tass, 1968)

2979.111
SS-9 Mod 4 ICBM

DESCRIPTION:

This version of the SS-9 ICBM was an important element in progress towards the incorporation of MIRV systems in Russian stragetic missiles.

Tests of the SS-9 vehicle with multiple warheads certainly began at least as long ago as January, 1969 when a three-warhead MRV test over a range of some 8,000 km was observed in the USSR's Pacific testing area. Other tests were observed up to November, 1970, after which no further tests were detected for a very long time.

In the early days of these tests, because the "footprint" of the RV impact points appeared to correspond roughly with the layout of a US Minuteman complex (**2710.111**) it was thought for a time that the MRV programme had the specific objective of attacking the Minuteman force. This view was later abandoned – the "footprint" being treated as a chance coincidence – in favour of the thought that the MRV exercise was a step in the direction of a Russian MIRV system..

When testing ceased in 1970, and was not resumed in 1971 or 1972, it was deduced that the Russians had either abandoned MIRV development or at least sent the project back to the drawing board.

In January, 1973, however, a new test of what had come to be known in the USA as the SS-9 Mod 4 was detected. Once again, three RVs were carried; but these were of a new design and were equipped with parachutes for soft landing and recovery. Further Mod 4 tests were observed during 1973 and it was noted that there had been some improvement in targeting flexibility, suggesting early experiments in the MIRV technique. Up to early 1974, however, the Mod 4 system could not be classified as MIRV.

STATUS:

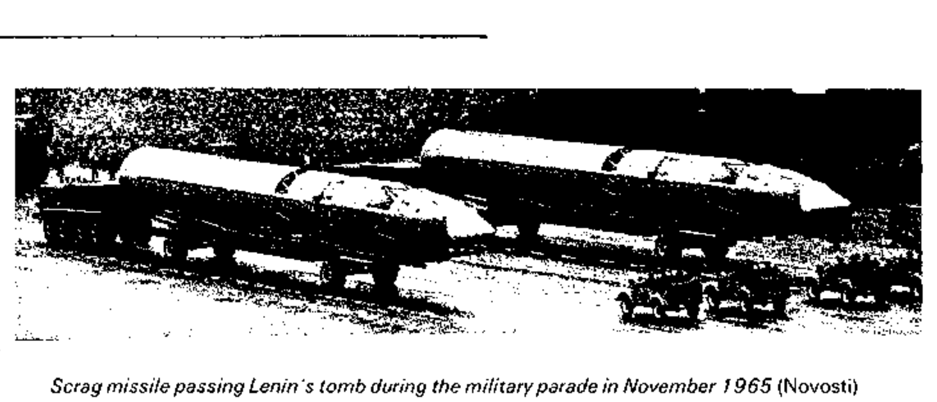
The status of the SS-9 Mod 4 is uncertain. So far as is known it is not at present deployed as an operational weapon, though presumably it could be so deployed with MRV warheads to put a number of additional heavy warheads into the Russian ICBM inventory: each of the three warheads would probably have a yield of some 4MT. Official US opinion, however, appears to be that the Russians are more likely to devote effort to their new large SSX-18 ICBM with MIRV (**2992.111**) than to continue the SS-9 Mod 4 MIRV programme up to the point of operational deployment.

2965.111
SS-10 (SCRAG) ICBM

DESCRIPTION:

Known also by the NATO code-name "Scrag" the SS-10 is a three-stage liquid propellant ICBM first shown in Moscow in 1965. It was then said to be a sister vehicle of the launch vehicle used for the Vostok and Voshkod spacecraft. The three stages are separated by truss structures with no interstage fairings.

Overall length of the missile is some 37 metres, including interstages, and the first stage base diameter is nearly 3 metres. The first stage has



Scrag missile passing Lenin's tomb during the military parade in November 1965 (Novosti) four gimballed nozzles, the second and third stages have single nozzles – that of the second being very large and that of the third quite small.

"Global range" was claimed for this weapon when it was first shown: and, having regard to its size, the published estimates of 8,000 km range seem conservative. It is believed not to be an operational weapon, but it may have been an intermediate stage in the process towards the SSX-18 missile (**2992.111**) which is the latest in the sequence of very large Russian missiles. Although the Scrag missile bears a higher number in the USA code than Scarp, the fact that the latter is evidently so successful may mean that it embodies more modern technology than does Scrag.

CHARACTERISTICS:

Type: Intercontinental Ballistic Missile

Guidance: Presumed inertial. Gimballed nozzles on first stage. Fixed nozzles on second and third stages.

Propulsion: 3-stage liquid-propellant motors

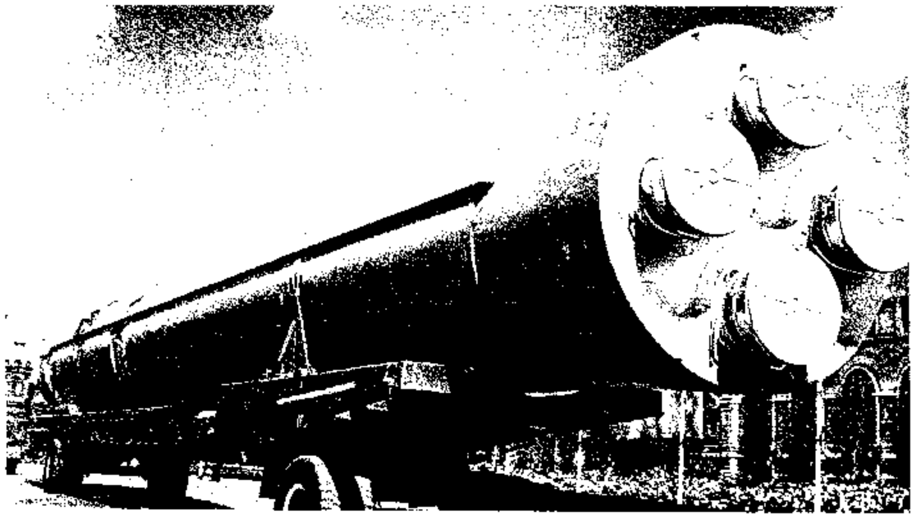
Missile Length: About 39 metres

Max Diameter: About 2.75 metres

Range: Reported as 8,000 km

STATUS:

Not operational. May have been only experimental and now abandoned.



Rear view of Scrag missile, showing the four first-stage nozzles (Tass, 1967)

2984.111

SS-11 Mod 1 ICBM

DESCRIPTION:

Currently the most widely deployed Russian ICBM, the SS-11 is believed to be a two-stage missile using storable liquid propellants and having a range of some 10,000 km. It is also believed to be of about the same length as the US Minuteman family (**2710.111**), but larger in other dimensions, and to carry a comparable payload.

None of these statements can be taken as firmly established. The SS-11 has never been identified with any of the missiles exhibited in Moscow parades (which, however, does not necessarily mean that it has never been so exhibited) nor, rather surprisingly, considering that it is supposed to have been deployed in Russia since 1966, has it been firmly associated with a NATO code-name. At various times and in various reports it has been identified with the name Savage but the general consensus appears to favour the application of this name to the SS-13 (**2958.111**) The only known positive indications of its physical appearance are two silhouette drawings published in the USA (see **2900.111** above).

According to US reports, three versions of the SS-11 have been tested and these have been numbered Mod 1, 2, 3 by the US authorities. Mod 1, to which this entry refers, is deployed in large numbers. Mod 3 is described below (**2988.111**). No definite information is available on Mod 2, other than that it is said not to have been deployed and that the US authorities believe that the programme has been terminated. Such meagre data as is available is given below for Mod 1. It has been said that the SS-11 is one of the missiles to which the new "cold-launch" technique is applicable (see **2980.111**).

CHARACTERISTICS:

Type: Silo-launched two-stage (possibly three) intercontinental ballistic missile

Guidance: Inertial

Propulsion: Storable liquid

Warhead: Single RV with nuclear warhead. Yield generally said to be 1-2 MT

Dimensions: No details known. Length appears to be about 20 m and base diameter about 2.5 m

Range: Estimates vary. Probably about 10,000 km

CEP: Said to be considerably greater than that of Minuteman

STATUS:

Large-scale operational deployment. Exact number of Mod 1 deployed is not known because a rapid Mod 3 deployment programme is reported to be in hand. It seems likely, however, that there are still 900 or more Mod 1 missiles operational. Some may be reduced-range variants targeted on China.

2988.111

SS-11 Mod 3 ICBM

DESCRIPTION:

SS-11 Mod 3 is a comparatively recently-deployed version of the SS-11 two-stage intercontinental ballistic missile which differs from the Mod 1 (**2984.111**) in the nature of its re-entry vehicle and warhead arrangements.

The Mod 3 is equipped with a multiple re-entry vehicle (MRV) arrangement of three warheads. The Mod 1 version of the missile, with its single warhead, is said by the US authorities to be considerably less accurate than the US Minuteman missiles (**2710.111** etc), and it would be expected that the addition of an MRV arrangement would reduce the system accuracy still further: the same authorities, however, give as two of the supposed reasons for the present increasing deployment of the Mod 3 "greater targeting flexibility and accuracy". It may reasonably be concluded, therefore, that the accuracy of the basic SS-11 missile system has been improved in the progression from Mod 1 to Mod 3.

Yield of the individual warheads of the MRV system is not known: but since the more complex MIRV system of the US Minuteman III missile (**2717.111**) can accommodate three 200 KT warheads it is a fair supposition that the SS-11 Mod 3 warheads have at least as great a yield as that.

CHARACTERISTICS:

Generally as for Mod 1 except for MRV warheads and improved accuracy.

STATUS:

Operational and being rapidly deployed but numbers not available. Tests were first detected by US reconnaissance in 1969.

2958.111

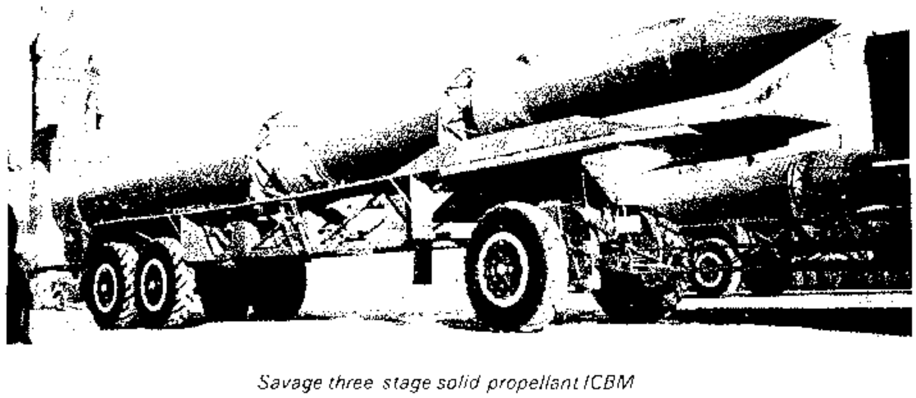
SS-13 (SAVAGE) ICBM

DESCRIPTION:

First seen in public in 1965, this missile, which may be known to NATO as Savage, is a three-stage solid-propellant ICBM that has been said to be comparable with the US Minuteman.

The three stages of the missile shown here are separated by truss structures and each has four nozzles. The two upper stages are believed to be identical with the two stages of the SS-14 Scapegoat missile (**2961.111**).

Although the missile has been in service for some time it has never been deployed statically on a large scale. So far as is known, moreover, it has never been equipped with other than a single warhead. One of the new generation of Russian strategic missiles is said to resemble the SS 13 closely and this missile (the SSX-16, **2990.111**) has also been reported to be limited at present to a single warhead.



Savage three stage solid propellant ICBM

CHARACTERISTICS:

Type: Intercontinental ballistic missile

Guidance Principle: Presumed inertial
Propulsion: 3-stage, solid-propellant motors
Warhead: Nuclear, estimated 1 MT capability
Missile Length: Over-all 20.0 metres (including interstages). 1st stage 8.7 metres. 2nd stage 4.0 metres. 3rd stage 3.5 metres. Nose cone
Missile Body Diameters: 1st stage 1.7 metres. 2nd stage 1.4 metres. 3rd stage 1.0 metre. Nose cone and re-entry vehicle 1.0 metre
Missile Base Diameters: 1st stage 2.0 metres. 2nd stage 1.9 metres. 3rd stage 1.4 metres
Range: 8,000-10,500 km

STATUS:

Operational. According to US reports 60 of these missiles have been deployed in silos. It may have been, and its top two stages are firmly believed to have been, deployed in a mobile role (see entries **2960.111** and **2967.111**).

2961.111
SS-14 (SCAPEGOAT) IRBM

DESCRIPTION:

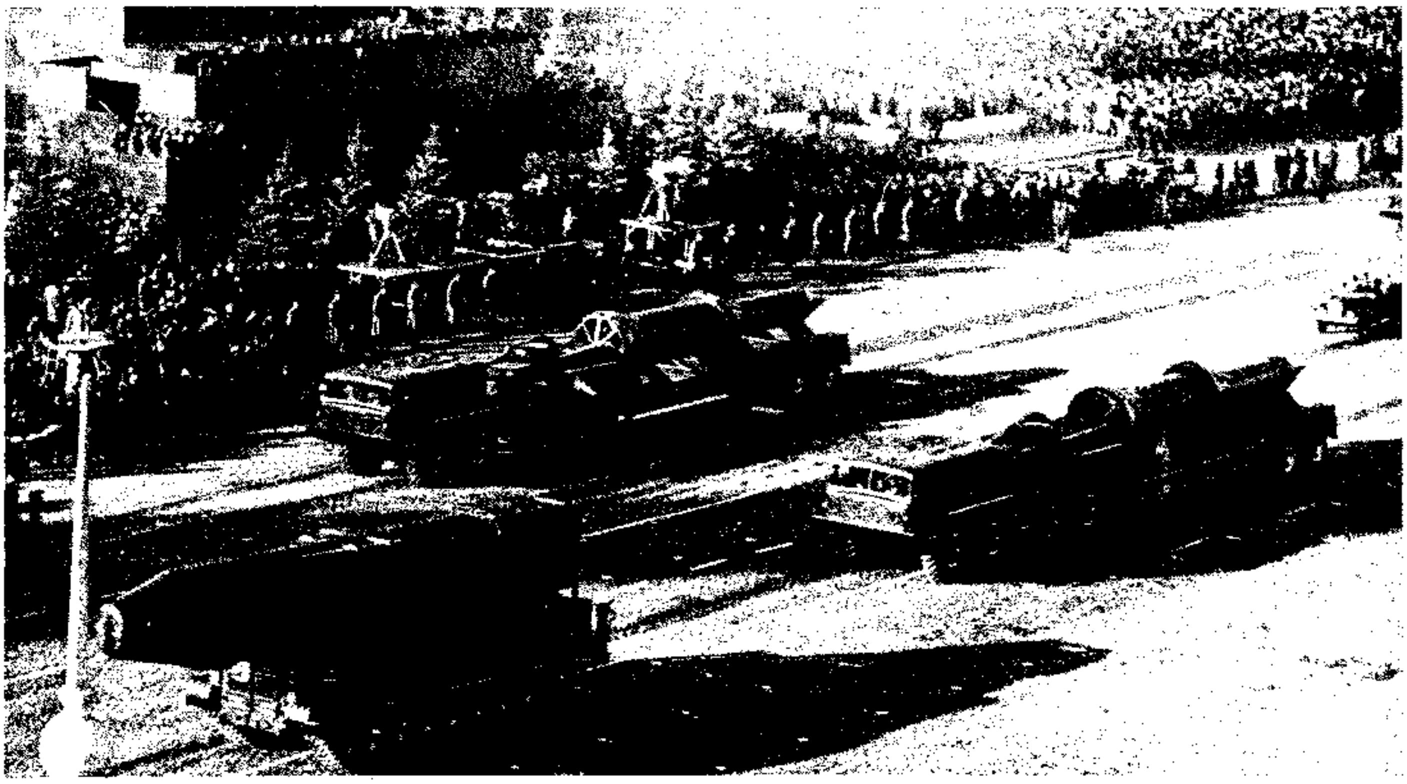
This two-stage solid-propellant IRBM appears to comprise the top two stages of the SS-13 Savage (**2958.111**) missile although the warhead section appears to be different from that of the larger missile and there may be other differences. Its length is approximately 10 metres overall. When loaded in its container and transported by its tracked erector/launch vehicle it becomes the weapon system known by the NATO code name Scamp (**2960.111**).

OPERATION:

Before firing, the missile, still in its container, is erected by the powerful hydraulic jacking system at the rear of the tracked Scamp vehicle. In the process, the cross-braced framework at the rear of the vehicle is lowered to the ground with the missile standing upright on it. The protective case is then opened to free the missile, lowered and closed again leaving the missile standing on its launching platform.

CHARACTERISTICS:

Type: Intermediate-range ballistic missile
Guidance Principle: Presumed inertial
Propulsion: 2-stage solid-propellant motors
Warhead: Nuclear That of the SS-13 missile is estimated at 1 MT but the payload of the SS-14 missile may be less and the warhead yield correspondingly smaller
Missile Length: Over-all 10.6 metres (including inter-stage). 1st stage 4.0 metres. 2nd stage 3.5 metres. Nose cone and re-entry vehicle 2.3 metres
Missile Body Diameter: 1st stage 1.4 metres. 2nd stage 1.0 metre. Nose cone and re-entry vehicle 1.0 metre
Missile Base Diameters: 1st stage 1.9 metres. 2nd stage 1.4 metres
Range: About 4,000 km



SS-14 Scapegoat missile preceded by a Scamp missile system in the 1967 parade (Novosti)

2990.111
SSX-16 ICBM

DESCRIPTION:

First of a series of four new Russian intercontinental ballistic missiles whose existence was detected by US reconnaissance during 1972 and 1973, the SSX-16 is the only one using solid propellants. A successor to the SS-13 missile (**2958.111**) it is similar in appearance – to judge by the little information that has so f · been made available – but has a greater maximum range and can carry a larger payload. Both improvements presumably result from the development of improved solid propellants.

At the time of writing the SSX-16 is reported as having been tested with only a single re-entry vehicle. Official US reports, however, say that there are indications of a Russian intention to add MIRV to this missile as has already been done for the other new missiles. It has been estimated that the SSX-16, with MIRV, could be deployed in 1975 if the programme were given a sufficiently high priority, but there is as yet no indication that this has been done.

It is also thought by the US authorities that the SSX-16 will be developed as a mobile ICBM. For such a role a mobile container of the type used for the SS-XZ (Scrooge) system (**2967.111**) would probably be used. Conceivably also the upper stages of the new missile could be used to form an improved mobile IRBM of the SS-14 Scamp/Scapegoat type (**2961.111** and **2960.111**).

CHARACTERISTICS:

Type: Intercontinental ballistic missile. Possibly mobile
Guidance: Inertial
Propulsion: 3-stage solid-propellant rocket motors
Warhead: Nuclear. Single RV with yield probably exceeding 1 MT. MIRV believed possible
Dimensions: Length about 20 m. Configuration generally similar to SS-13
Range: More than 8,000 km. Said to be more than that of SS-13

STATUS:

Advanced development. A few tests were recorded in 1972 and several more in 1973. Deployment in one form or another expected in 1975.

2991.111
SSX-17 ICBM

DESCRIPTION:

This two-stage storable liquid-propellant ICBM is one of two new Russian missiles regarded as possible successors to the widely-deployed SS-11 missile (**2984.111**). As can be seen in the illustration accompanying entry **2900.111** above both it and the other possible SS 11 successor, the SSX-19 (**2993.111**), are believed to be significantly larger than the SS-11; and this increased size is reflected in increased range and payload.

It is probable, however, that these larger missiles will be accommodated in the same basic silo as currently houses the SS-11, the additional room being provided by a change from hot to cold launching techniques (see entry **2980.111** below).

The most important aspect of these new missile developments, however, is the introduction of MIRV type warheads. Both the SSX-17 and the SSX-19 are reputed to have on-board computers and to have been tested with such warheads; furthermore, since the SSX-17 is credited with only a 4-warhead MIRV capability whereas the SSX-19 is said to be able to carry 4-6 MIRV warheads, it would seem that two different MIRV systems are involved. This lends colour to an official US view that the two missiles have been developed in competition with one another – although this seems to be a little out of keeping with normal Russian practice. Another and more recent suggestion is that one of the missiles (probably the SSX-17) is the SS-11 replacement while the other is designed for a mobile role.

CHARACTERISTICS:

Type: Intercontinental ballistic missile

Guidance: Inertial. Computer-controlled RV arrangement

Propulsion: 2-stage storable liquid-propellant rocket motors

Warhead: Nuclear. MIRV system of four warheads. Yield not known but probably not less than 200 KT each

Dimensions: No details known. Length appears to be about 24 m and base diameter about 2.5 m; but little reliance can be put on these figures

Range: Believed to be in excess of 9,000 km

STATUS:

Advanced development. Tests are said to have been observed for the first time during the second half of 1972 and there was intensive testing during 1973 and early 1974. Deployment expected some time in 1975 although recent reports have suggested that development difficulties may delay the programme.

2992.111
SSX-18 ICBM

DESCRIPTION:

Largest of the new series of Russian intercontinental ballistic missiles, the SSX-18 is said to be the functional successor to the SS-9 (**2962.111**). It is a very large two-stage liquid-propellant missile and carries a bus-type MIRV system with an on-board digital computer. This new post-boost vehicle is thought to be similar to those employed in Minuteman III and Poseidon (**2717.111** and **1133.411** and see also **2708.111**) and is believed to be capable of dispensing five to eight independently-targeted warheads. The US authorities are sure that increased accuracy has been a major consideration in the development programme, presumably with the intention of enabling the missile to attack hardened targets successfully. Some of the more recent tests, moreover, have been carried out using a single RV, from which it is deduced that the Russians may have a continuing interest in a missile with a single very powerful warhead.

The SSX-18 is somewhat larger than the SS-9 and appears to be the reason for the construction of 25 new large silos in the SS-9 fields. These silos were under construction at the time of the SALT 1 agreement and may therefore be furnished with new or additional "heavy" ballistic missiles without contravening the agreement. It has also been said that the "cold-launch" technique (**2980.111**) will be used for this missile.

CHARACTERISTICS:

Type: Intercontinental ballistic missile

Guidance: Inertial. Computer-controlled RV arrangement

Propulsion: Two-stage liquid propellant rocket motors

Warhead: Nuclear. 5-8 warhead MIRV capability. MIRV warhead yield not known but presumably in the region of 2 MT each. Single RV possible; yield again not known but presumably in excess of 25 MT. As much as 50 MT has been suggested

Dimensions: No details available. Length appears to be about 37 m and base diameter about 3 m

Range: At least 10,500 km. Probably much more

STATUS:

Advanced development. Tests were first observed at the end of 1972 and have continued at a high level ever since then. Deployment in the 25 new large silos in the SS-9 fields is expected to start in 1975; but unless the old SS-9 silos can be modified to accept the new missiles – or unless the SALT interim agreement is violated, deployment will be limited to these 25 silos.

2993.111
SSX-19 ICBM

DESCRIPTION:

Last to be detected of the four new Russian intercontinental ballistic missiles, the SSX-19 is a two-stage liquid-propellant weapon with an on-board computer and MIRV warhead system.

Believed to have been designed as a successor to the SS-11 missile (**2984.111**) it may have been developed in competition with the SSX-17 missile (**2991.111**); but another view – which does not necessarily exclude the first view – is that it is intended for use as a mobile ICBM carried in a container-launcher of the SS-XZ (Scrooge) type (see **2967.111**). Of much the same size as the SSX-17 its major difference therefrom appears to be in its MIRV system which has been said to be capable of dispensing 4-6 independently targeted warheads.

CHARACTERISTICS

Type: Silo-launched (or possibly mobile) intercontinental ballistic missile

Guidance: Inertial. Computer-controlled RV arrangement

Propulsion: Two-stage liquid propellant rocket motors

Warhead: Nuclear. MIRV system of 4-6 warheads. Yield not known but probably not much less than 200 KT each

Dimensions: Length about 20 m; base diameter about 2.5 m

Range: Believed to be in excess of 9,000 km

STATUS:

Advanced development. First tests were observed in the spring of 1973 and have continued at a fairly high rate since then. Deployment could probably begin – for the silo-launched version at least – in 1975.

2960.111
SCAMP MOBILE STRATEGIC MISSILE SYSTEM

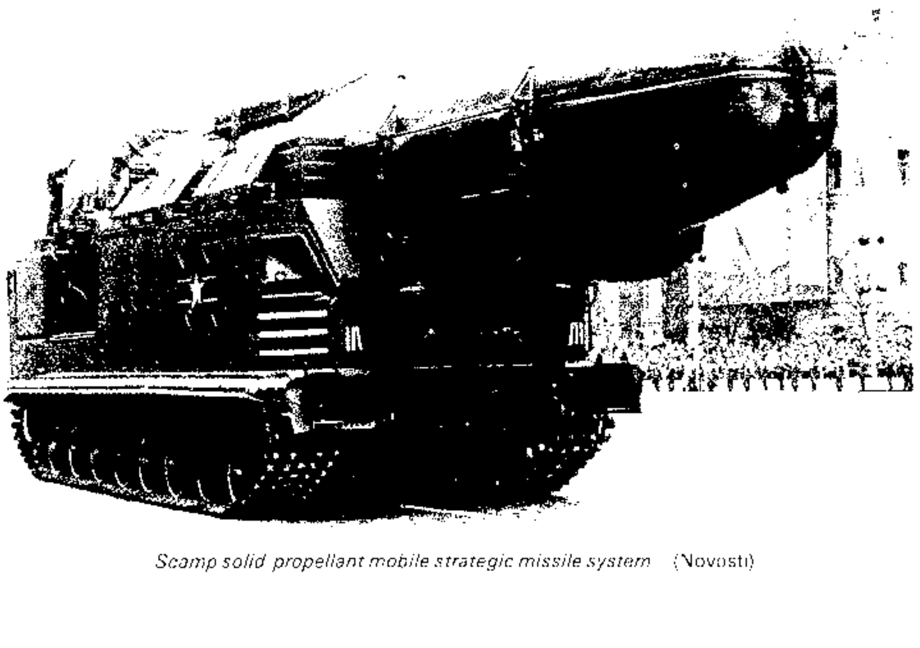
DESCRIPTION:

This NATO code-name is applied to a complete weapon system comprising the SS-14 Scapegoat missile and its associated erector/launcher. It was first seen in public in 1965, the missile itself then being enclosed in an all-concealing container – nicknamed the "Iron Maiden".

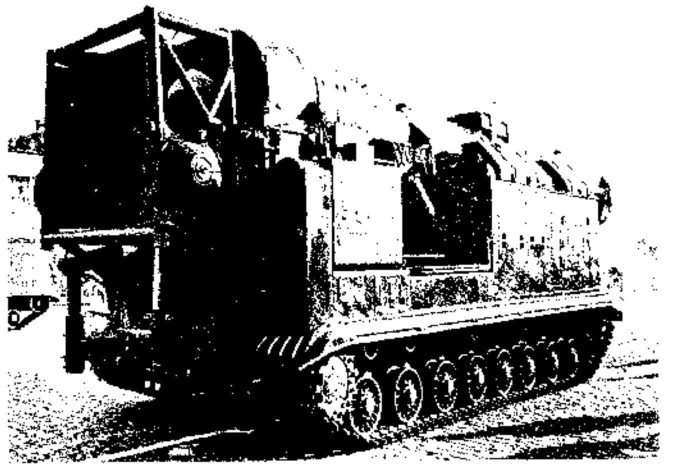
It was then learned that the missile inside was that now given the NATO name Scapegoat (**2961.111**), which was publicly shown without its container in 1967.

The role of the weapon appears to be that of a mobile strategic missile – constantly changing its firing position and always ready for action.

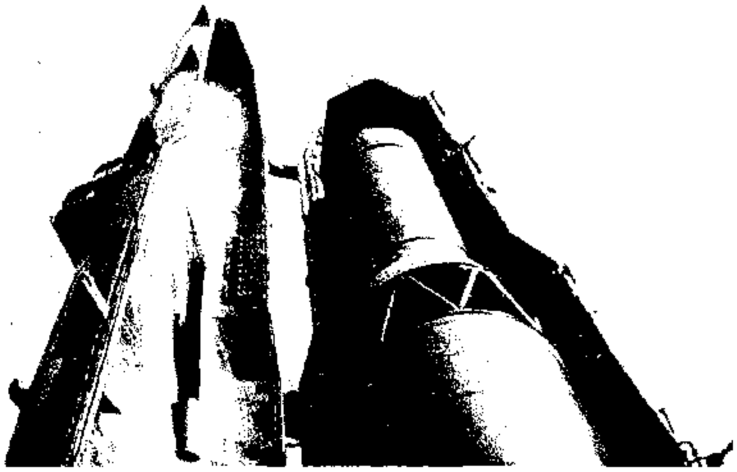
The chassis of the erector/launcher is the JS III which is also used for transporting missiles.



Scamp solid propellant mobile strategic missile system (Novosti)



Rear view of the Scamp missile system at a Moscow parade in 1966 (Novosti)



Scapegoat missile in place within the container of its Scamp transporters launch vehicle

2967.111
SS-XZ (SCROOGE) MOBILE STRATEGIC WEAPON SYSTEM

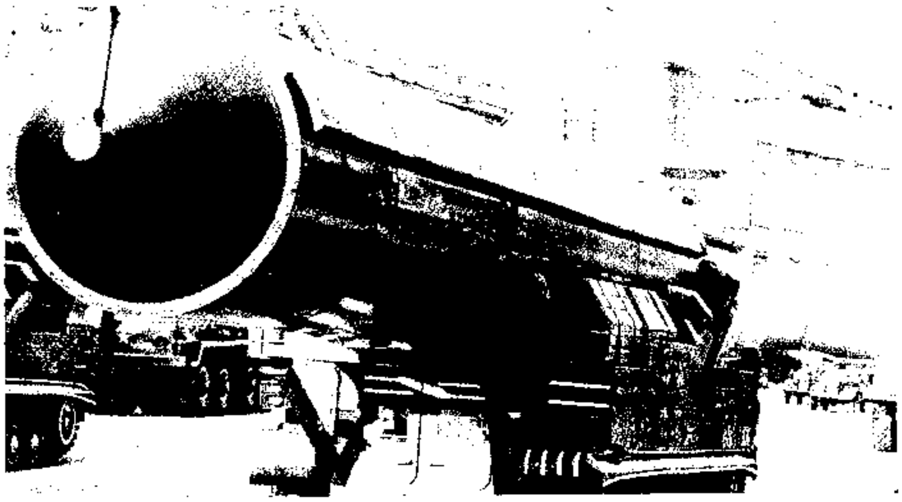
DESCRIPTION:

Scrooge is the NATO code name for a strategic missile which, like Scamp (**2960.111**), is carried in a container on a tracked transporter/erector/launch vehicle. Unlike the Scamp container which is hinged to open up (hence its nickname) the Scrooge container is tubular and is assumed to be used to launch the missile. The tracked vehicle that carries the missile is basically the same as that used to transport Scamp. The missile system is usually referred to in the USA as SS-XZ.

Scrooge is longer than Scamp and therefore presumably is intended to carry a longer-range missile. The launcher tube is some 20 metres long and 2 metres in diameter.

Until recently Scrooge was not believed to be an operational system. It now seems, however, that it is: it has been reported as being deployed near the Chinese frontier in Outer Mongolia.

There remains the question of the missile inside the container. Clearly it has to be a fairly thin one: which suggests that it probably uses solid propellants and, on the assumption that the Russians are more likely to have adapted an existing missile than to have developed a new one, we think it likely that another version of the SS-13 – possibly with a less powerful first stage – is used. This is, however, no more than an informed guess.



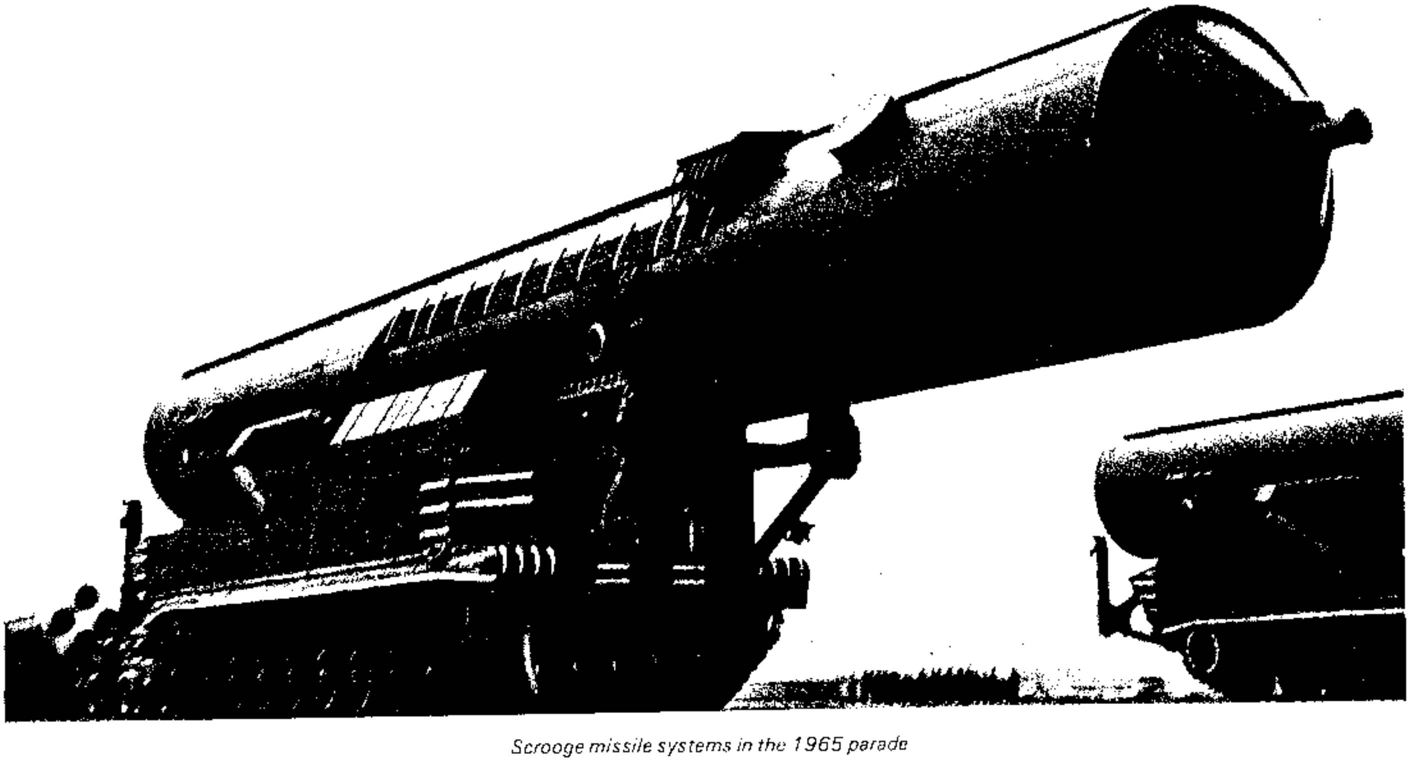
Scrooge mobile ballistic system (Tass)

CHARACTERISTICS:

Type: Mobile ballistic missile system
Guidance: Presumed inertial
Propulsion: Probably solid propellant, two or three stages
Warhead: Not known but could be 1 MT
Launcher Length: About 20 metres
Launcher Diameter: About 2 metres
Range: Uncertain. A minimum of 5,000 km seems reasonable and it could be much more

STATUS:

Operational as noted above. A recent press report from the USA has suggested that the SSX-19 missile (**2993.111**) may be used in the system, but on the information so far to hand this would appear to be impossible. The SSX-16 (**2990.111**), however, could well be a candidate.



Scrooge missile systems in the 1965 parade

2980.111
COLD-LAUNCHED BALLISTIC MISSILES
DESCRIPTION:

A feature of the 1973 November parade in Moscow was the first appearance of "cold-launch" canisters for ballistic missiles (a picture of these canisters is published on the first page of this strategic missile section in entry (**2200.111**).

There is nothing new in the idea of "cold launching" – a technique whereby a missile is ejected from its silo or launch tube by compressed air or by some other kind of gas generator instead of by the thrust of the main rocket motors since it has been used for SLBM launches by the concerned countries for some time. Its application to ICBM launches is novel, however, and has a number of advantages.

First, because the cold gas ejection is much less destructive than the hot efflux of an ICBM first-stage motor and because the technique delays the ignition of this motor until after the missile has cleared the silo, far less protection is required for vulnerable apparatus within the silo, furthermore, when the first-stage motor is used for ejection the operation is one of rocket thrust, not pressure ejection, so that adequate venting must be provided both below and around the missile but still within the protective shield. This means that the silo must be both deeper and much wider than the missile: with the cold-launch technique a much larger missile can be accommodated in a given silo.

Secondly, by developing container launcher tubes for each missile many of the difficulties of adapting old silos to new missiles are overcome.

Thirdly the use of these container-launchers simplifies the operation of reloading silos and enables missiles to be stored conveniently.

STATUS:

The container launchers exhibited in 1973 have been variously reported for use with the SS 11 (**2984.111**) and SSX 17 (**2991.111**) missiles. They are almost certainly too small for the latter missile but might be large enough for the former. In any case the canisters shown were probably experimental models.

It seems likely, however, that the Russians will proceed with this programme and deploy cold launched missiles even if they have not already done so.

TACTICAL SURFACE-TO-SURFACE MISSILES

2283.111
INTRODUCTION

This section deals with land-based or shipborne tactical systems whose primary function is to attack surface targets. All entries in the section relate to *guided* weapons. information on guns and barrage rockets – for use by land or naval forces – and on *unguided* weapons otherwise similar to those described in this section will be found in Section Three.

For convenience of study and reference, the weapons have been divided into four groups and are listed in alphabetical order of country of origin within these groups. The groups are:

Anti-tank/Assault Weapons
Battlefield Support Weapons
Coastal Defence Weapons
Shipborne Weapons

ANTI-TANK/ASSAULT WEAPONS

2284.111
INTRODUCTION
Guided Line-of-Sight Systems

Most of the weapon systems described in this sub-section are small (up to 75 kg but mostly much less), optically-aimed, guided missiles designed primarily to disable enemy armoured fighting vehicles but usually suitable also for attacking fortified portions. They range in size from systems which are sufficiently small and light to be carried complete by one man to crew-served systems which are suitable only for installation in a substantial vehicle. Many of the systems can be adapted for use in light aircraft and helicopters, and entries dealing with such applications will be found in the sub-section dealing with air-to-surface weapon systems. A few systems have also been adapted for naval use.

Reference is frequently made to various "generations" of such weapon systems. Usage in this respect is not firmly established, but the following rough definitions may be helpful.

First Generation. A weapon system in which the operator observes both missile and target and manually guides the one towards the other. Guidance in such systems is effected by the transmission of electrical guidance signals from the operator's control unit along a pair of thin wires reeled out from the missile as it flies towards the target.

Second Generation. A system in which the operator observes the target and keeps his sight trained on it. The missile is tracked automatically and the displacement between it and the operator's line of sight is used to generate guidance commands which are conveyed to the missile either by means of trailing wires or, as in the American Shillelagh system (**2809.111**) by some other form of command link.

Third Generation. A system in which, as in a second-generation system, the operator has only to keep his sight trained on the target but in which the deviation of the missile track from the sight-line (defined, for example, by a coded laser beam) is measured by apparatus which is carried by the missile and which generates appropriate guidance commands and applies them directly to the missile guidance system.

Other Guided Systems

One quite different anti-tank system is described in this sub-section: this is the terminally-guided sub-missile system (**2838.111**) being developed in the USA.

Other Anti-tank/Assault Weapons

Information on unguided anti-tank missiles, recoilless anti-tank weapons and anti-tank guns will be found in Section Three. Information on tanks and other armoured fighting vehicles having anti-tank roles will be found in Section Two

BRAZIL

2025.111
ANTI-TANK MISSILE

The Brazilian Army's Central Missile Commission has for some time been reported to be developing a wire-guided anti-tank missile which will have a range of approximately 3 km. Nothing has been heard of this project recently, however, and while it seems unlikely that it has been cancelled it is not definitely known to be in progress.

What is known, however, is that Brazil was one of the four countries to which production licences were issued for the German (MBB) Cobra wire-guided anti-tank missile (**2181.111**). It is possible that there has been some confusion here – although the range of Cobra is less than 3 km.

DEVELOPMENT AUTHORITY:

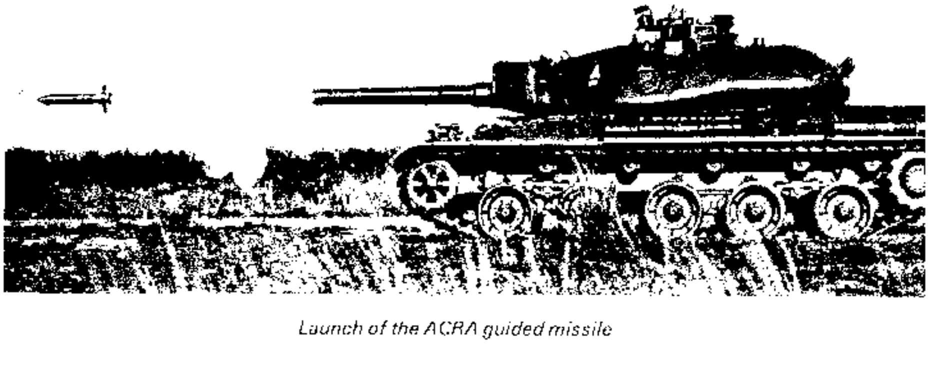
Comissao Central de Misseis

FRANCE

2071.111
ACRA ANTI-TANK WEAPON SYSTEM
DESCRIPTION:

ACRA (Anti Char RApide) is the acronym devised for the third generation anti-tank weapon system developed by the Groupement Industriel des Armements Terrestres (GIAT) at l'Atelier de Construction de Puteaux.

Two separate weapons are employed in the system, one a guided missile and the other an unguided rocket, both of which are gun launched. The guided missile is cylindrical in shape and has four narrow chord flip out folding tail fins for guidance and four small anti-roll fins for stabilisation. When assembled into its cartridge case (see picture) the complete round has an over all length of 1.25 metres. The calibre is 142 mm. The cartridge case is automatically ejected on launch.



Launch of the ACRA guided missile

OPERATION:
The gun launch gives the missile a high initial velocity of 150 m/sec as it leaves the muzzle whereafter its sustainer rocket enables it to achieve a cruising speed of some 970 knots (1,800 km/h), the time of flight to 3 km being less than 7 seconds. Infra-red guidance is used: the missile being guided along a director beam emitted by a laser.

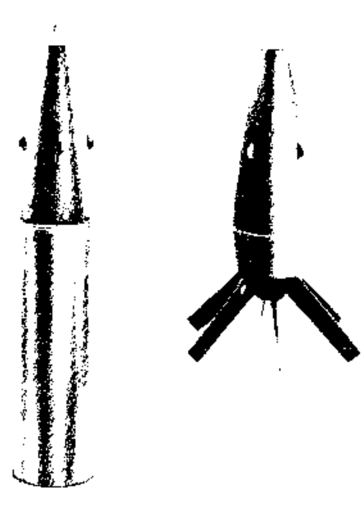
As an alternative to the missile, an unguided rocket-assisted spin-stabilised projectile can be fired from the same gun-launcher against soft targets. This projectile is smaller than the guided missile but is of the same calibre. The gun-launcher imparts an initial velocity of 1,070 knots (1,980 km/h); and immediately on leaving the nozzle the projectile's own propulsion charge boosts the speed to 1,360 knots (2,520 km/h). At the same time six folding fins in the base of the projectile open out to stabilise the projectile in flight.

LASER GUIDANCE:
Ground equipment of the TRT laser guidance sub-system comprises four small packages plus vehicle installed cooling systems equipped with ion exchangers. One package contains the laser emitter, working on a wavelength of 1.06 microns and having an output power in excess of 5W, the beam modulation devices, the laser crystal cooling system and the tube starting device. A second package contains the supplies for the laser pump and a third the sequencing and servo equipment. The fourth contains the pumps for the laser emitter cooling liquid.

The laser beam modulation is coded in such a way as to enable the missile to determine its position relative to the beam axis. In essence this is an angular determination, but a zoom lens is used to provide a guidance field of substantially constant diameter and to offset the tendency of the guidance error to increase with missile distance from the gun launcher.

Infra-red guidance equipment on the missile consists of three sub-assemblies. On the base of the missile is an array of four symmetrically disposed tubes containing photodiodes sensitive to 1.06 micron radiation and signals from these are passed to a 2AP7 (TRT) input system which includes a pre-amplifier and two limiters. The third unit is the 2T7 receiver which contains the azimuth and elevation data decoding and processing circuits, the outputs from which are used to control the flight of the missile. Weight of these three units is 1.05 kg and current consumption is 150 mA at −29V and 250 mA at +29V.

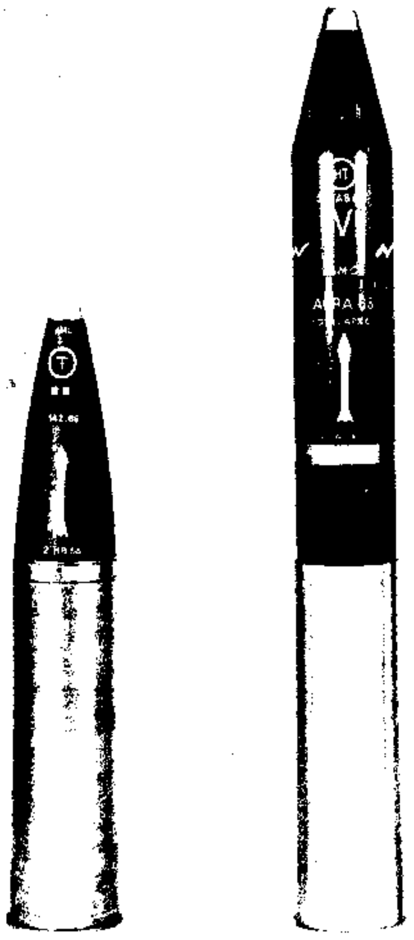
CHARACTERISTICS:
Type: Semi-automatic gun-launched heavy anti-tank guided weapon system
Guidance Principle: Infra-red beam-riding



The unguided projectile of the ACRA system showing the flip-out tail fins

Guidance Method: Control of missile tail surfaces
Warhead: Shaped charge
Calibre: 142 mm
Length of Round: 1.25 metres
Weight of Round: 26 kg
Speed: 500 m/sec
Range: From 25 m to at least 3,800 m
Time of Flight: Less than 7 sec to 3 km
Unguided Projectile:
Type: Fin-stabilised gun-launched missile with folding fin stabilisers and additional propulsion operating on departure from muzzle
Warhead: Choice of steel (2 kg RDX-TNT) anti-vehicle or cast iron (2 kg TNT) anti-personnel
Length: 90 cm with cartridge, 64 cm missile alone
Weight: 21 kg with cartridge, 15 kg missile alone
Muzzle Velocity: 550 m/s
Velocity at 1 km: 700 m/s
STATUS:
More than 500 missiles have been fired in trials during the development programme which terminates at the end of 1974.

During these trials, it is understood, the guidance system proved to be 100% effective from minimum range out to more than 3,800 metres. The effectiveness of the system against both stationary and moving targets was demonstrated as also was the possibility of engaging targets while on the move.



The unguided and guided weapons of the ACRA system

Nevertheless no financial provision is being made at present for putting the system into production.

MANUFACTURERS:
System:
Groupement Industriel des Armements Terrestres, 10 place Georges Clémenceau, 92211-Saint-Cloud, France
Unguided Projectile:
Compagnie Francaise Thomson Houston – Hotchkiss Brandt, 52 Avenue des Champs Elysées, Paris 8e, France.
Laser Guidance:
Télécommunications Radioélectriques et Teléphoniques (TRT), 88 rue Brillat-Savarin, 72-Paris 13e, France.

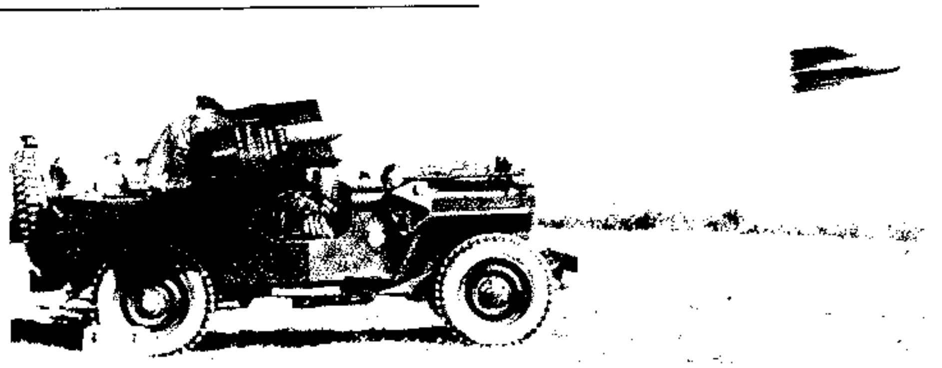
2081.111
ENTAC ANTI-TANK MISSILE

DESCRIPTION:
Entac is a first-generation, roll-stabilised, wire-guided, anti-tank weapon intended primarily for infantry use. The name is a contraction of Engin Téléguidé Anti-Char.

The complete weapon system comprises a fire-controller, a four-missile launcher, a Jeep or other carrier, check-out and test equipment and missiles. The missile is supplied complete in a polyester water-tight container.

OPERATION:
As with other first-generation wire-guided missiles, the operator uses an optical sight to locate and track the target and a manual control to command the missile to his line of sight. Remote control up to a maximum operator-missile separation of 110 metres is possible. A single operator can manage a firing post and control 10 missiles.

CHARACTERISTICS:
Type: Surface-to-surface, wire-guided anti-tank weapon system
Guidance Principle: Command to line-of-sight
Guidance Method: Optical sighting and manual remote control of missile



Entac anti-tank missile leaving its container-launcher

Propulsion: Two-stage solid-propellant rocket motor
Warhead: Shaped charge 4 kg
Missile Length: 82 cm
Missile Diameter: 15 cm
Launch weight: 12.2 kg
Maximum Speed: 305 km/h
Range: 400-2,000 metres
Armour Penetration: 650 mm
HISTORY:
Entac was developed by the Direction Technique des Armements Terrestres (DTAT) and is produced in quantity by Aérospatiale. In its Model 58 form it was adopted by the French Army in 1957 and is now standard equipment also in the armies of Australia, Belgium, Canada, Indonesia, the USA and other countries. Well over 130,000 missiles have been delivered.

MANUFACTURER:
Société Nationale Industrielle Aérospatiale, Division des Engines Tactiques, 2à18 rue Béranger, 92320-Châtillon-sous-Bagneux, France.

Launch of Harpon ground-to-ground missile

2095.111
HARPON BATTLEFIELD MISSILE

DESCRIPTION:

Harpon is a wire-guided battlefield weapon system intended for use on land vehicles, ships, fixed wing aircraft and helicopters. Manufactured by Aérospatiale, it has the same characteristics, performance and alternative warheads as the SS 11 B1 weapon (**2139.111**) also made by Aérospatiale, but has a greatly improved and automatic form of guidance.

CHARACTERISTICS:

Type: Surface-to surface (or air-to-surface) guided weapon for anti-tank or other battlefield roles
Guidance Principle: Automatic command to line-of-sight
Guidance Method: Optical target tracking. Automatic wire-guidance control of missile by varying thrust of sustainer efflux
Propulsion: Two-stage solid-propellant rocket motor
Warhead: Various (as SS 11 B1)
Missile Length: 121.5 cm
Missile Diameter: 16 4 cm
Wing Span: 50 cm
Launch Weight: 30 4 kg
Cruising Speed: 360-384 km/h
Minimum turning:
Radius: 1 km
Range: 400-3,000 metres
Armour Penetration: 600 mm

OPERATION:

With the improved TCA (Télécommande Automatique) guidance system incorporated in the Harpon system all that the operator has to do is to aim carefully at the target through his optical sighting device. Infra-red radiation from flares on the rear of the missile is detected by a precision goniometer so mounted that its reference axis is accurately parallel to the optical axis of the operator's sight. The angular deviation of the missile from line-of-sight thus measured, coupled with the estimated distance travelled by the missiles provide a measure of the missile's departure from the required track. This measurement is used in the computation of the signals that are transmitted over the trailing wires to correct the missile's course. This guidance system, it is claimed, will maintain the missile's flight within 1 metre of the instantaneous line of sight.

STATUS:

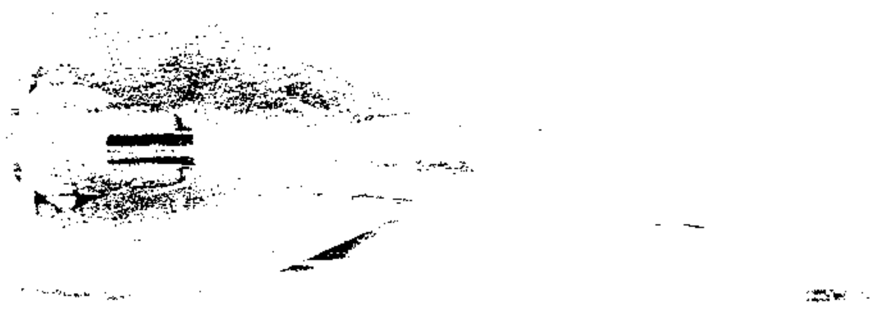
In production.

Four-round Harpon system on an AMX-13 tank

MANUFACTURER:

Société Nationale Industrelle Aérospatiale, Division des Engins Tactiques, 2à18 rue Béranger, 92320 - Châtillon - sous - Bagneux, France.

2139.111
SS 11 BATTLEFIELD MISSILE



SS II Missile

DESCRIPTION:

SS 11 is a line-of-sight wire-guided battlefield missile intended for firing from land vehicles, naval vessels and slow-moving aircraft. Normally fired from a launching ramp it may also be used with a simplified ground launcher. The designation SS 11 is applied to the surface-to-surface version; the generally similar air-to-surface version is known as the AS 11 (**1173.311**).

OPERATION:

The operator acquires the target by means of a magnifying optical device. As soon as the missile enters his field of vision after launch, the operator commands it to his line of sight by means of a joystick. The signals are transmitted over wires trailed from the missile. Tracer flares are installed on the rear of the missile for visual reference.

When installed in a helicopter or ship the simple sighting device used for land vehicles is replaced by a special stabilised sight.

CHARACTERISTICS:

Type: Surface-to-surface tactical guided missile
Guidance Principle: Command to line-of-sight
Guidance Method: Optical tracking and manual wire-guided remote control of missile by vectoring the thrust of sustainer efflux (T.V.C.)
Propulsion: Two-stage solid-propellant rockets motor
Warhead: Various (see text)
Missile Length: 120 cm
Missile Diameter: 16.4 cm
Span: 50 cm
Launch Weight: 29.9 kg
Average cruising speed: 360-584 km/h
Minimum turning radius: 1 km
Range: 500-3,000 metres
Armour Penetration (140AC warhead): 600 mm

SS 11 B1

Since 1962, the SS 11 B1 version, using transistorised firing equipment, has been in production. It is available with a variety of different warheads, including an inert type for practice, the Type 140AC anti-tank warhead capable of perforating 60 cm of armour plate, the Type 140 AP02 explosive warhead (2.6 kg of explosive) which will penetrate an armoured steel plate 1 cm thick at a range of 3,000 metres and explode about 2.1 metres behind the point of impact, and the Type 140 AP59 high-fragmentation anti-personnel type with contact fuse

Some 153,000 of the SS 11 series of missiles have been delivered – including both ground and airborne versions and including also the Harpon (**2095.111**) version – to more than twenty customer countries.

MANUFACTURER:

Société Nationale Industrielle Aérospatiale, Division des Engines Tactiques, 2à18 rue Béranger, 92320-Châtillon-sous-Bagneux, France.

2140.111
SS 12 BATTLEFIELD MISSILE

DESCRIPTION:

The SS 12 is a spin-stabilised, wire-guided surface-to-surface missile system derived from the Nord SS 11 The AS 12 is the air-to-surface equivalent.

Principal change in the missile is the incorporation of a much larger warhead – with consequent changes in the propulsion equipment – which makes the weapon effective against fortifications as well as tanks, ships and other vehicles. Available warheads include the type OP.3C which can pierce more than 40 mm of armour and explode on the other side.

The guidance system for the SS 12 is the same as that developed for the SS 11 and described under the entry for that weapon system (**2139.111**) in this section.

CHARACTERISTICS.

Type: Surface to surface tactical guiden weapon
Guidance Principle: Command to line of-sight
Guidance Method: Optical target tracking. Manual infra-red tracking of missile and wire-guided remote control by vectoring the thrust of sustainer efflux
Propulsion: Two-stage solid propellant rocket motor
Warhead: 30 kg HE
Missile Length: 187 cm
Body Diameter: 18 cm
Warhead Diameter: 21 cm
Span: 65 cm
Launch Weight: 75 kg
Range: 6,000 metres
Time of Flight: 32 sec
Average Speed: 190 m/s
Maximum Speed: 260 m/s

MANUFACTURER

Société Nationale Industrelle Aérospatiale, Division des Engines Tactiques, 2à18 rue Béranger, 92320 Châtillon-sous-Bagneux, France.

GERMANY (FEDERAL REPUBLIC)

2181.111
COBRA 2000 ANTI-TANK MISSILE

DESCRIPTION:

This weapon system – full designation BO 810 Cobra 2000 – comprises a small wire-guided anti-tank missile, a control box and cable links. It is a lightweight low-cost weapon suitable for operation by one man, who can readily carry, set up and fire two missiles.

OPERATION.

Unlike many other wire-guided missiles, Cobra is not launched from a container; the missile is simply set down on the ground and, when it is fired, a booster mounted on the underside gives it a jump start that lifts it clear of even rough ground before the sustainer develops full power.

Before launching the missile is connected to the control box by a cable. This control box contains a battery that supplies the power required to launch and control the missile and, once connected, the missile can be launched simply by pressing the launch button. By means of a junction box up to eight missiles can be connected simultaneously to the control box on which is mounted a selector switch that enables the operator to fire and control these missiles one at a time.

A target coincidence guidance technique is used. The operator has a joystick control which enables him to give lateral and vertical commands to the missile through the guidance wire trailed out behind it. Immediately after launch the missile has to be gathered rapidly into the operator's line of sight to the target and quite substantial movements of the joystick may be necessary to achieve this thereafter relatively small movements should suffice to keep the missile framed in the target. Tail-mounted flares make it easy for the operator to see the missile in flight.

An electrical testing device built into the control unit enables the controller to carry out a pre-launch check.

The cable attached to the missile is 20 metres long and that attached to the junction box is 50 metres long. The operator can thus position himself conveniently up to either 20 or 70 metres from any one missile.

DETAILED DESCRIPTION:

In the following description the figures in parentheses refer to the identification numbers on the accompanying cutaway drawing. The warhead (1) is an armour-piercing hollow-charge head, capable of destroying all types of tanks. A dummy head is substituted when the missile is used for training purposes.

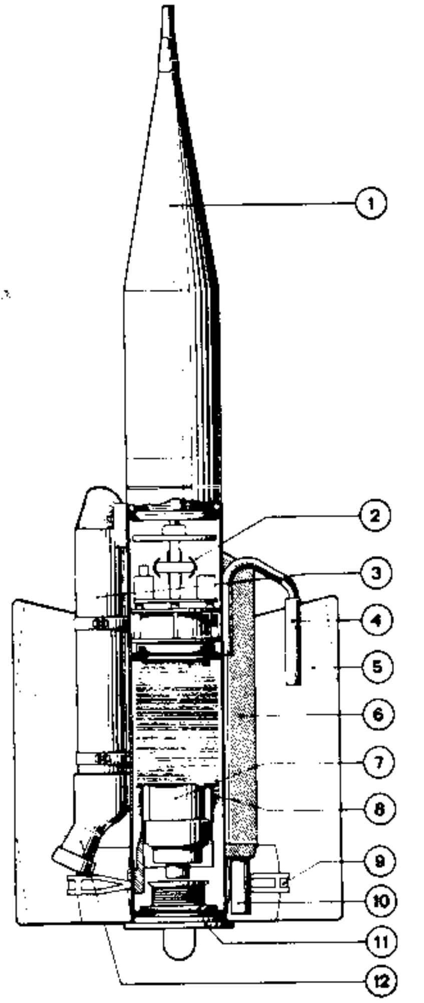
An adapter ring located at the front part of the missile permits rapid insertion and locking of the warhead to the missile. Four plastic wings (5) located 90° apart are fitted to the outside of the missile fuselage. Each wing has a spoiler assembly (9) which acts as an aileron to steer the missile and is protected by a cover against dust and water during transportation. A carrying handle (4) is located between the two upper wings. Directly behind the handle are the battery (6) and the two colour flare assembly (10). The booster rocket (3), used for launching, is located between the two lower wings.

The receiver-gyro assembly (2) is mounted directly behind the warhead adapter ring. The principal function of the receiver-gyro assembly is for stabilisation of the missile. It is fastened to the main fuselage tube, which contains the spar element that houses the sustainer rocket assembly (7). The spool assembly tube (8) containing the 2,050 m (2,240 yards) of guidance wire is fastened to the same spar. The rear end of the fuselage is protected by a removable cover lid (11) which also serves as water seal prior to launching and contains the 2-m (6.6 ft) launching cable with hook. Before launching the missile, the cable is fastened to an anchor peg by a snap hook. When pulling off the cover lid, the protection covers for the spoilers are automatically released.

Two solid-fuel rocket motors are used for propulsion. The nozzle of the booster motor (12) is curved and directed towards the ground, causing the initial flight to be at an angle of 20° to the ground. The missile can be launched from any surface without special devices.

Cobra missile ready for launch

Rear view of Cobra missile



Construction of Cobra missile (for description see text)

CHARACTERISTICS.

Type: Surface-to-surface anti-tank weapon system

Guidance Principle: Command to line of signt wire-guidance; optical gathering and tracking

Guidance Method: By control of spoilers in wings

Propulsion: Solid-propellant sustainer with separate non-jettisonable booster mounted below the missile

Warhead: (a) hollow charge 2.7 kg: penetration 500 mm armour

(b) ATS (anti-tank/shrapnel) 2.7 kg: penetration 350 mm armour prefabricated fragmentation with destructive effect within 10 m radius

Missile Length: 95 cm
Body Diameter: 10 cm
Wing Span: 48 cm
Launch Weight: 10.3 kg
Weight at burn-out: 8.0 kg
Maximum Speed: About 300 km/h
Range: 400-2,000 metres

DEVELOPMENT:

Cobra was designed and developed by Bölkow GmbH, the first design study being carried out in 1957. The system first went into service in 1960, since when more than 150,000 (including those manufactured under licence) have been supplied to the armed forces of 18 countries. A first generation missile, Cobra has been produced in two versions: the Cobra 2000 described here being slightly the heavier of the two and having a maximum range of 2,000 metres whereas the earlier Cobra had a maximum range of only 1,600 metres. It is still in production but its improved successor, Mamba (**2188.111**) has been so designed as to make it easy for countries using Cobra to change to the new system at whatever rate suits them best.

SIMULATOR:

The manufacturers make a special simulator for training purposes – the complete equipment for which is contained in a single field transport case. A standard control box is used by the operator and the target and missile presentation is by means of a dot and a circle on a cathode-ray tube.

MANUFACTURERS:

The complete system is manufactured by Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn bei München, Germany. The warhead and sustainer motor are made by OerlikonBührle, Switzerland.

2188.111
MAMBA PORTABLE ANTI-TANK WEAPON SYSTEM

DESCRIPTION:

Mamba is an anti-tank missile first announced by MBB late in 1972. Of the same general type as Cobra (**2181.111**) it incorporates two major improvements in the missile, in addition to numerous other changes, and MBB have developed a completely new controller for the system. The new missile, however, will accept Cobra warheads and can be used with existing Cobra controllers by users wishing to change to the new weapon; and existing Cobra vehicle launchers can readily be modified to accept Mamba.

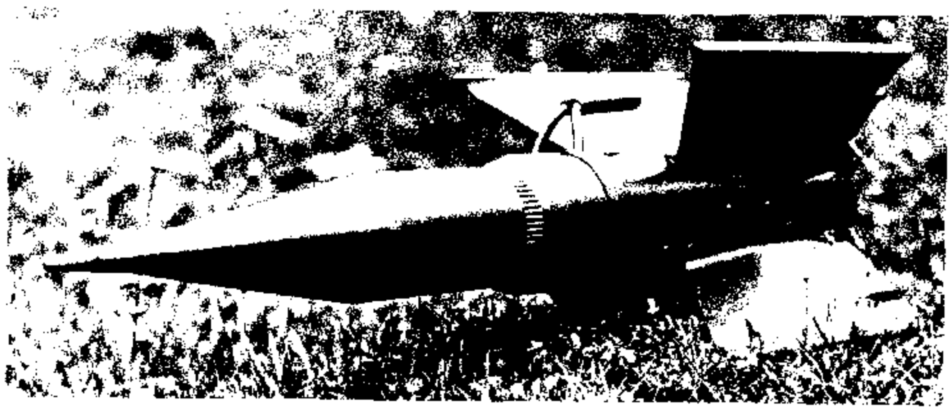
One of the major differences between Mamba and Cobra is that, whereas the latter used an oblique-thrust booster (to give a jump start) and an axial sustainer, Mamba has a one-cell dual-purpose oblique-thrust engine which not only retains the jump-start facility but also provides a weight compensation during the cruising phase. This saves the operator from having continually to counteract gravitational droop during the cruising phase. The other major change is the increase in maximum speed from 85 m/sec to 140 m/sec.

The new controller incorporates an extremely powerful monocular with an oblique (X7) eyepiece. This permits direct transition from observation with the naked eye to telescope magnification without head movement – thus avoiding the main difficulty of this transition. This control unit is completely independent of any power sources, batteries etc; it performs all the functions which are performed for Cobra by the test and control units; and it is operable from —40°C to +60°C.

Three output sockets from the controller can be connected to single missiles and a fourth can be connected either to a fourth missile or an eight-outlet junction box – giving a total control capability of 11 missiles selected by a switch on the controller. Missile launching is by push-button and guidance by joystick, power for the ignition impulse and the joystick signals being provided by a clockwork motor operating a generator. One winding of the motor suffices for eight launches.

The Mamba system thus comprises only the missile and the control unit. It is conveniently packaged in a water-, dust- and tropic-proof pack which is of a convenient size for carrying and stacking. Like Cobra Mamba can be fitted with alternative shaped-charge, ATS or training warheads and these are easily interchangeable.

Mamba is primarily designed to be launched from the ground; and since it can be laterally diverted up to 45° from its launching direction its envelope of action is very wide. If required, however, it can also be launched from a vehicle and a standard 3-missile launching frame has been designed for this purpose. Any kind of vehicle can be fitted with this frame, on which the missiles are mounted in a ready-to-fire position but from which they are easily removed. The controller can be either mounted on the vehicle or removed for remote operation.


Mamba anti-tank missile

CHARACTERISTICS:

Type: Surface-to-surface anti-tank weapon system

Guidance Principle: Command to line of sight with optical tracking

Guidance Method: Wire-guidance control of wing-mounted spoilers

Propulsion: Single-cell, dual-purpose- solid-propellant, oblique-thrust rocket motor

Warhead (a) Hollow charge, 2.7 kg, 475 mm armour penetration
(b) Anti-tank shrapnel (ATS), 2.7 kg, 250 mm penetration plus shrapnel over 10 m radius area
(c) Dummy for training. All warheads interchangeable

Missile Length: 955 mm

Body Diameter: 120 mm

Wing Span: 400 mm

Launch Weight: 11.2 kg

Maximum Speed: 140 m/sec

Effective Range: 300-2,000 m

Flight Times: 500 m 6 sec
1,000 m 10 sec
2,000 m 17.5 sec

Controller Dimensions: 300 × 250 × 100 mm, 9.55 kg

Packed Missile (with accessory bag): 365 × 402 × 605 mm, 18 kg

Cable System (including junction box, reel etc): 393 × 408 × 416 mm, 26 kg

TRAINING:

A special training aid, Type 112/1 SV, has been designed. This is a simulator using a combat area presentation on a TV screen with superimposed symbols – which move appropriately – to represent target and missile. The trainee operates a standard controller in conjunction with this display.

STATUS:

Development. The system was demonstrated to German Government officials in June, 1972.

INDIA

2286.111
INDIAN ANTI-TANK MISSILES

So far as is known, India has not yet undertaken the design and development of any anti-tank missiles. The budgeted defence expenditure under the new Five-Year Plan which started in April 1974, however, included a substantial sum for the provision of guided missiles, including anti-tank missiles.

In 1970/71 the firm of Bharat Dynamics Ltd was set up to undertake work on guided missiles for the Indian forces and specifically to implement a licence agreement made with Aérospatiale (France) in 1970 and covering a programme of co-operation aimed at Indian production of the SS-11 (**2139.111**) anti-tank missile.

Over a period extending from March 1971 to September 1973 the French manufacturers supplied information, parts and engineering assistance to the Indian company. The first batch of missiles made from sub-assemblies supplied by Aérospatiale was delivered from the Indian production line twelve months after the licence agreement was concluded and at the end of 1973 it was announced that the Indian company was in a position to make the complete missile without French assistance.

MANUFACTURER:

Bharat Dynamics Ltd, Hyderabad, India.

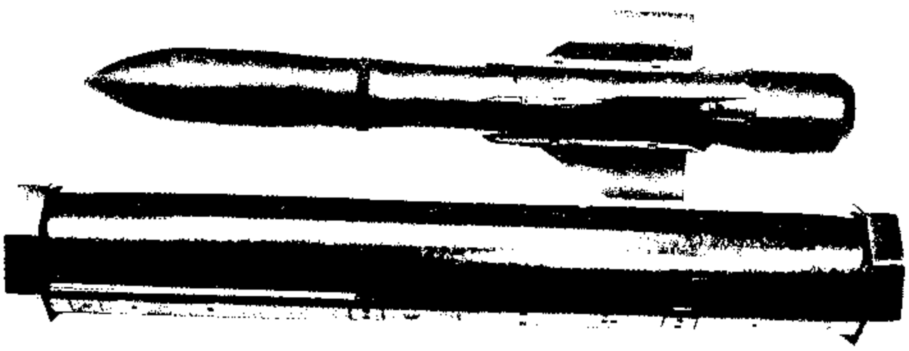
INTERNATIONAL

2212.111
HOT ANTI-TANK MISSILE

DESCRIPTION:

HOT (Haut subsonique Optiquement téléguidé tiré d'un Tube) is a heavy anti-tank weapon being developed by Aérospatiale and Messerschmitt-Bölkow-Blohm. With low-speed spin-stabilisation like Milan (**2215.111**), it is a tube-launched, wire-guided missile of larger size and with a higher performance than Milan – development of which is running to parallel with it – but has the same general principles of operation. HOT is planned as a replacement for the SS 11 (**2139.111**) missile; and its mission profile corresponds to a NATO requirement for a missile to operate primarily from armoured or un-armoured vehicles and helicopters.

Like Milan, the missile has tail fins which fold


HOT missile and its launcher/transporter tube

down against the body when it is in its launch tube are open out to spin stabilise it in flight. Because of its comparatively high speed the time of flight to a target is only about one half of that for the Aérospatiale SS 11. Guidance is by means of the TCA type of optical/infra-red system developed for the Aérospatiale Harpon missile (**2095.111**) with optional manual guidance.

With the TCA system of guidance, all the operator has to do is to aim carefully at the target with an optical sighting device. When the missile is launched, infra-red radiation from its tracer flares is detected by a precision goniometer that is associated with the optical sight and that has its reference axis accurately parallel to the optical axis. Departure of the missile from the optical axis gives rise to an angular error signal which can be combined with an estimate of range (based on the known flight characteristics of the missile) to give a measure of the linear departure of the missile from the line of sight. This measurement is then used to generate command correction signals for the missile whose flight is controlled by means of a jet vane system.

OPERATION:

To operate the system, therefore, once the target has been visually acquired, all that the operator has to do is aim carefully at the target, launch the missile and maintain his aim steadily during the missile's flight. An advantage of this guidance system is that, because the departure of the missile from the line of sight is measured by the system, the amount of flight correction required can be determined to a similar degree of accuracy and, as a result, the initial gathering of the missile on to the line of sight can be accomplished quickly. This has the important effect of giving the system a good short-range performance.

HOT can be fired from armoured or other vehicles, from helicopters, from ships or from dug-out positions and in all conditions of visibility that permit the operator to aim at the target. In particular, a special installation has been designed for the widely-used M-113 APC and enables a twin launcher and periscope to be added to the vehicle with minimum modification. Weight of the complete HOT unit for such an installation is 500 kg.

The missile's hollow charge warhead is effective against all known types of tank and against ships and field fortifications. The tube from which the missile is fired serves also as a transport and storage container. After the missile is fired this tube is thrown off automatically and according to the nature of the installation, a new tube can be loaded manually or automatically. Some typical launcher arrangements are described below.

LAUNCHING GEAR 800 (MANUAL):

This gear is particularly suitable for light vehicles. The missile is locked manually on the ramp and aimed roughly before firing by swivelling the entire gear. Precise aiming is achieved by means of a periscope.

LAUNCHING GEAR 800 (HYDRAULIC)

In this gear the missile is locked hydraulically on the ramp. The target is tracked by the periscope aiming system and the entire launching gear is moved in elevation and azimuth by the hydraulic synchronising system.

LAUNCHING GEAR FOR TURRET VEHICLE

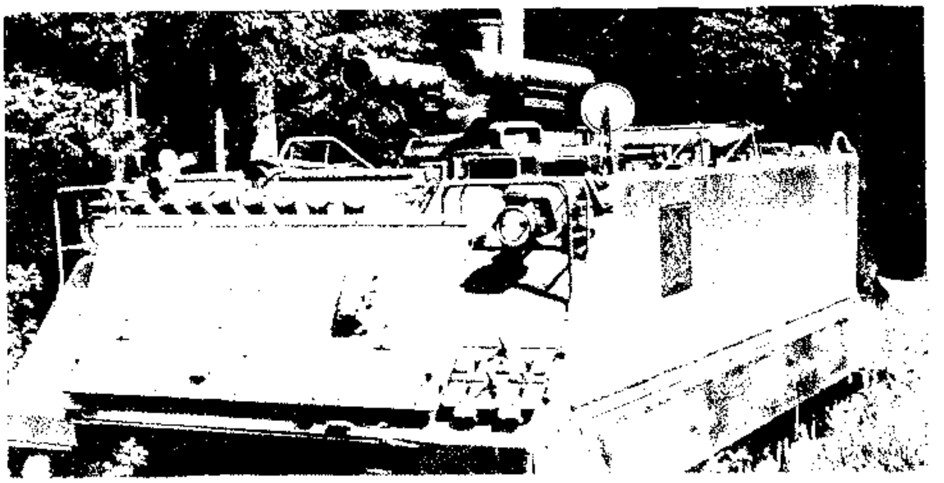
Here the missiles are carried in launching boxes on either side of the turret (see photograph). The guidance system is divided into small units for flexibility in installation and can be associated with any available type of gunner's sight. Aiming is accomplished by turning the turret.

LAUNCHING GEAR FOR CASEMATE VEHICLE

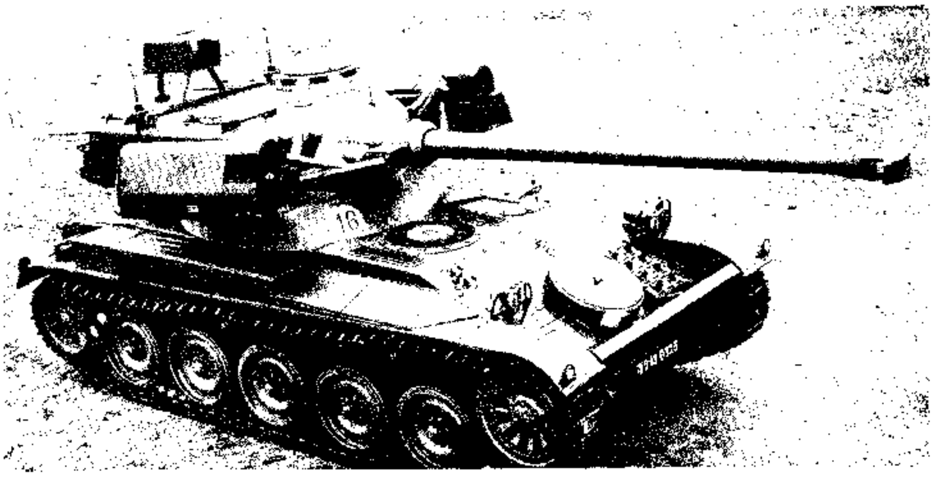
This consists of either one or two retractable clamp systems and a periscope guidance unit. Empty launch tubes are automatically thrown clear after launching and reloading is automatic on retraction of the clamp system into the vehicle. The clamp system is controllable in elevation and azimuth, and slaved to the motion of the periscope guidance unit.

CHARACTERISTICS:

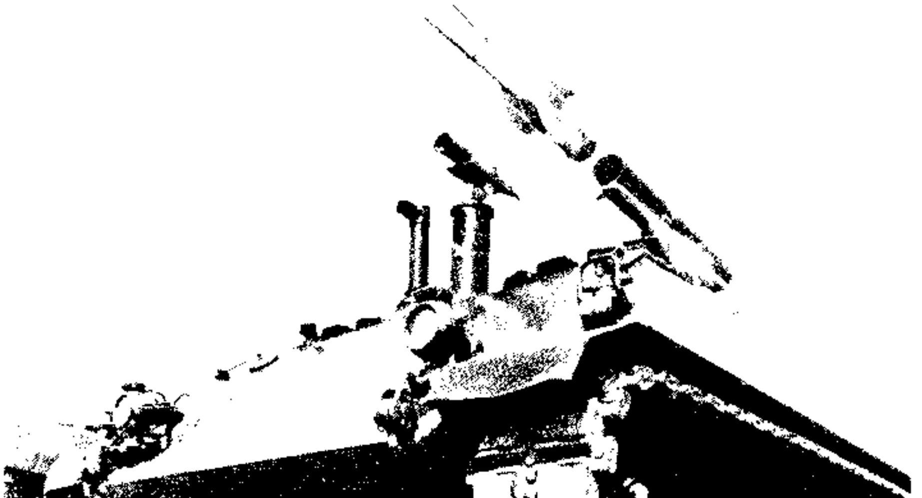
Type: Long-range, vehicle-mounted, wire-guided, anti-tank weapon with shipborne and airborne applications



HOT Launching Gear 800 (Manual) mounted on a M-113 APC. The aiming periscope can be seen between the two missile tubes



AFV installation of HOT anti-tank weapon system



Launch of a HOT missile from the Casemate Vehicle Launcher

Guidance Principle: Command to line-of-sight. Optical aiming with automatic infra-red tracking. Optional manual tracking

Guidance Method: Wire guidance control of jet vane system

Propulsion: Solid-propellant booster and sustainer

Warhead: Hollow charge

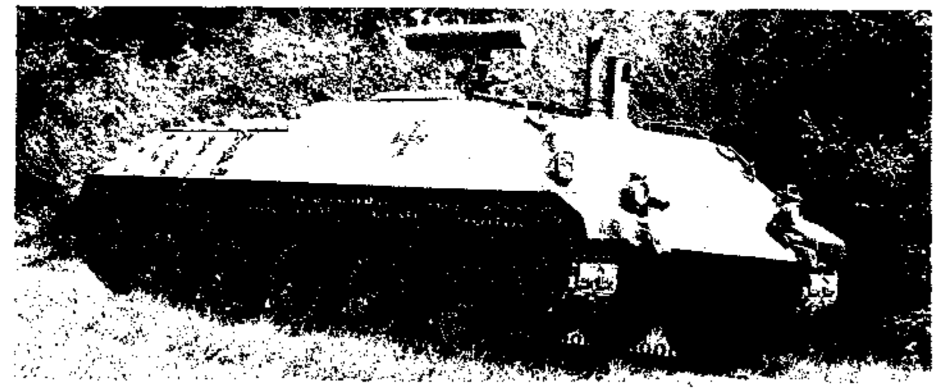
Missile Length: 1.275 metres

Missile Diameter: Warhead, 136 mm. Span 310 mm

Launch Tube Length: 1.3 metres

Launch Tube Diameter: 175 mm
Weight: Missile and container 28 kg. Missile at launch 22 kg
Maximum Speed: 950 km/h
Flight Duration: 2,000 8.7 s
3,000 m 12 5 s
4,000 m 16.3 s
Range: 75 m to more than 4 km
Penetration: More than 800 mm of solid armour. NATO triple-armour target at 65° incidence
Operating Conditions: —40° to +52°C at up to 95% r.h.

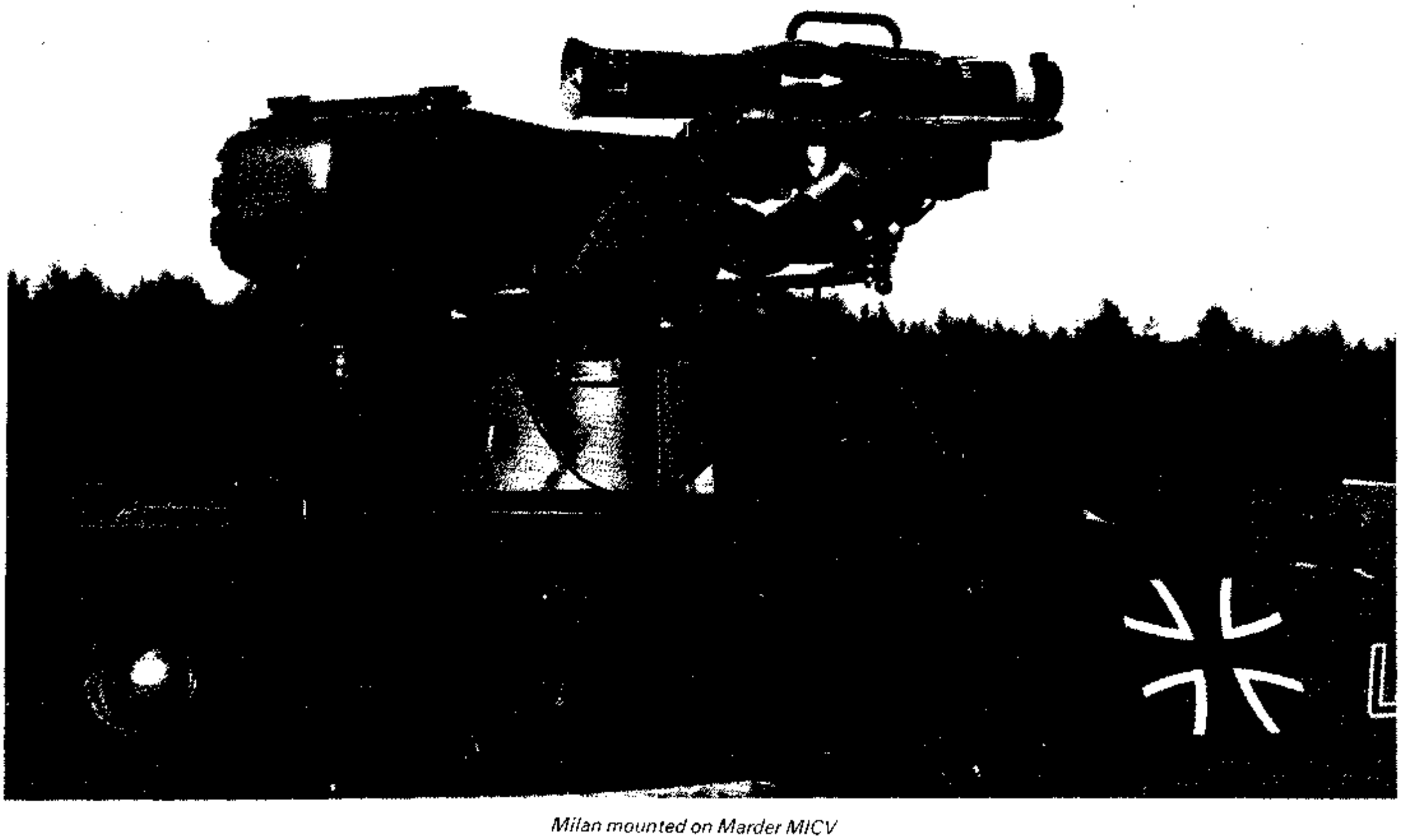
DEVELOPMENT:
The first design study for the system was made in 1964. Development is now complete and the weapon system has been evaluated (including helicopter trials) by the French and West German Forces. It is also one of the three systems (with TOW and Airstrike Swingfire) being considered for helicopter-launched applications by the British Army.


German Tank Destroyer with HOT Casemate Vehicle Launcher

MANUFACTURER:
Responsibility for management, sales and production is now vested in Euromissile, 37 Boulevard de Montmorency, 75016-Paris, France.

2215.111
MILAN ANTI-TANK MISSILE
DESCRIPTION:
Milan (Missile d'Infantrie Léger ANtichar) is a wire-guided, spin-stabilised, anti-tank missile system.
An advanced second-generation system, Milan incorporates a semi-automatic guidance technique that requires the gunner to do no more than maintain the cross wires of his guidance unit on the target during the missile's flight. The system comprises a missile in a container and a launch and control unit. Before the launch the container – which also serves as a launch tube – is mounted on the launch and control unit. This in turn can be either mounted on a tripod to be fired from a ground position or, mounted on a pivot, from a vehicle.
Although heavier than some of the small first-generation anti-tank missiles, Milan is readily portable. It is also suitable for operation from armoured or unarmoured vehicles. In its simplest form operation is effective in daylight, at dawn and dusk and, by means of battlefield flares, at night. It can be fired over fresh or salt water.


Milan – prone firing position


Milan mounted on Marder MICV

OPERATION:

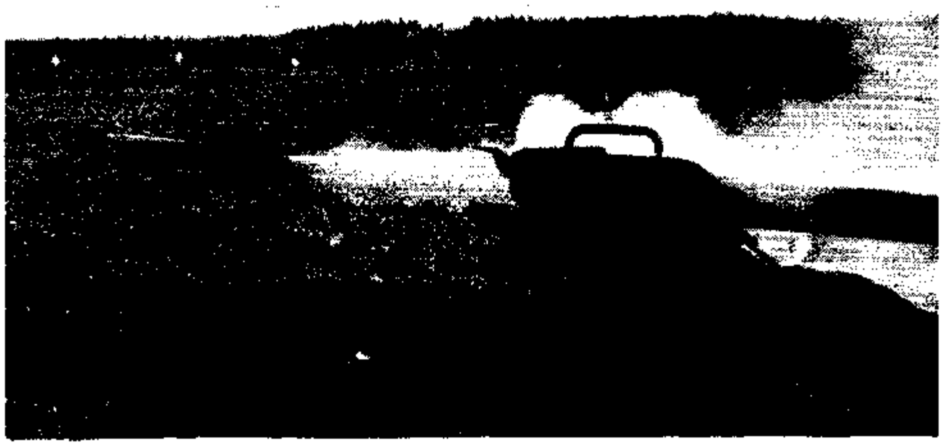
At launch the missile is popped from its container by a plunger which in turn is propelled by a gas generator located at the rear of the launch tube and working on the recoilless principle. This end of the tube is protected for storage and transit by a cap which must be removed before firing.

As the missile emerges from the tube, the tube is disconnected from the launch unit, and the forces in the system are sufficient to throw it backwards from the launcher to a distance of about three metres, leaving the launcher ready for reloading.

When the missile is ejected from the tube its wings, which impart a slow spin to the missile, flick open. The missile then coasts forward until, at a sufficient distance from the launcher to avoid harm to the gunner, the sustainer rocket ignites.

Built into the launcher/control unit is an infra-redTCA guidance system similar in operation to that described above for HOT (**2212.111**). After launching, the missile is gathered to the gunner's line of sight using wide-angle detection. Detection sensitivity in this phase is presumably relatively low but at close range the signal strength from the infra-red flares in the missile's tail will be high. For subsequent guidance narrow-angle detection is used.

Milan – standing firing position



Launching a Milan anti-tank missile. Picture shows missile in flight and container tube being ejected to the rear. Note that the periscope type sight enables the firer to keep his head well down

CHARACTERISTICS:

Type: Surface-to-surface, man-portable, anti-tank weapon system

Guidance Principle: Automatic command wire-guidance

Guidance Method: Optical tracking of target only. Automatic infra-red tracking of missile and control by varying thrust of sustainer efflux

Propulsion: Booster-ejector in tube. Single solid-propellant sustainer

Warhead: Hollow charge

Penetration: Against triple NATO target at 65° incidence average of 352 mm steel perforated. NATO heavy tank target perforated on nearly 90% of occasions: medium tank target on nearly 99% of occasions

Missile Length: 0.77 metre

Body Diameter: 0.09 metre

Fin Span: 0.27 metre

Weights: Missile and container: 11.5 kg; Launcher and Control Unit with tripod: 15.5 kg

Max Speed: 200 m/sec

Range: 25-2,000 metres

Time of flight: 7.1 sec to 1,000 m. 12.5 sec to 2,000 m

DEVELOPMENT:

Following the Franco-German agreement discussion started between Nord-Aviation and Messerschmitt-Bölkow in 1962 a design study was completed in 1963. Technical evaluation and firing demonstrations by and for the French and West German forces were completed in 1971. User trials in France, Germany and other countries followed; as a result of which the French Army has ordered the weapon and Germany is expected to follow suit. In June 1972, a successful series of demonstrations was given to representatives of some 30 countries. During the official Franco-German trials, which were designed to test the weapon's efficiency in a wide range of environmental conditions, a hit probability of 88.6% was established in 665 firings.

STATUS:

First batches of 10,000 missiles and 200 launch units have been ordered for both French and West German armies. Further orders are expected soon.

Large-scale production has been planned on the assumption of a total market of 200,000 missiles and 5,000 launch units. Initial production is planned at 1,000 missiles per month rising to 2,000 with launch units running at 50 per month.

Milan on Kraka vehicle

MANUFACTURERS:

Messerschmitt-Bölkow-Blohm GmbH, Munich, and Aérospatiale, Paris, are main contractors. Eltro, Luchaire-STRIM and SAT are also involved.

Management, sales and responsibility for production: Euromissile, 37 Boulevard de Montmorency, 75016-Paris, France.

2238.111
MOSQUITO ANTI-TANK MISSILE

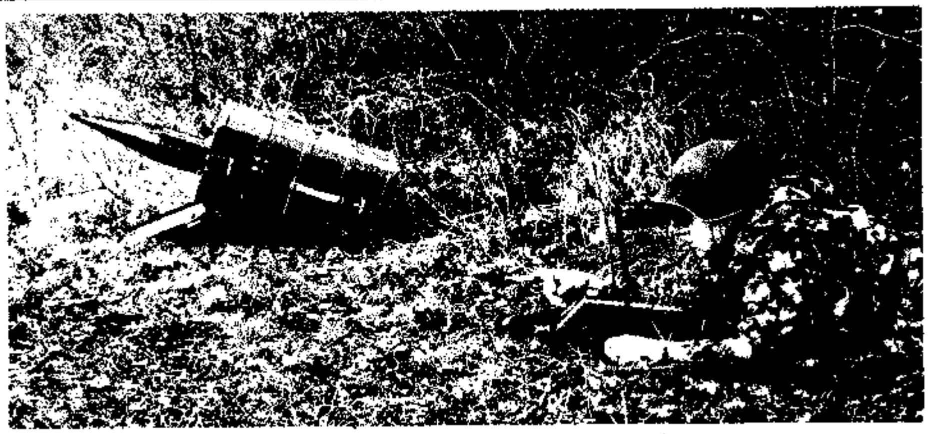
DESCRIPTION:

Mosquito is a wire-guided roll-stabilised infantry anti-tank guided weapon system. It can be carried and operated by one man using an optical sight and joystick control to guide the missile to the target.

MISSILE:

The Mosquito missile is of conventional design and consists of a cylindrical glass-fibre body and folding cruciform wings of sandwich construction. In flight the missile is controlled by vibrating spoilers on the trailing edge of each wing and is roll-stabilised by a gyro.

For storage and transport, a single Mosquito is



Mosquito anti-tank missile

packed into a container, with its wings in place and only the warhead detached. Alternative warheads are a hollow charge type capable of penetrating more than 66 mm of armour plate, or a fragmentation type. The complete package, with missile inside, weighs 22.0 kg. Six Mosquitos can be transported, ready for firing, on a Puch-Haflinger light cross-country vehicle. This weapon has also been mounted on Agusta-Bell 47 helicopters.

For training purposes, the Mosquito can be fitted with a parachute recovery system instead of a warhead.

CHARACTERISTICS:
Type: Man-portable, anti tank guided missile
Guidance Principle: Command to line of sight with optical aiming
Guidance Method: Manual command from optical tracking. Wire-guided control of vibrating spoilers on missile wings
Propulsion: Two stage solid-propellant rocket motor
Warhead: Choice of hollow charge or fragmentation. 4 kg
Missile Length: 1.11 metres
Missile Diameter: Body 12 cm. Span 60 cm
Launch Weight: 14.1 kg
Cruising Speed: 90 metres/sec
Range: 360-2,300 metres

STATUS:
The weapon system is in production.

MANUFACTURER:
Contraves Italiana SpA, Via Tiburtina 995, Rome.

2251.111
SPARVIERO ANTI-TANK MISSILE

DESCRIPTION:
Sparviero (Hawk) is the name given to a third generation anti-tank missile currently under development and intended to enter service in the 1980s.

An IR guidance system developed by Officine Galileo will be used for the system, which otherwise will comprise an optical aiming device, a tripod mounted launcher and a missile stabilised by flip out fins and carrying a 4 kg hollow-charge warhead more than 3,000 metres. All up weight will be 60 kg of which the missile accounts for 16.5 kg.

MANUFACTURERS:
System: Breda Meccanica Bresciana SpA, Via Lunga 2, 25100 Brescia, Italy.
IR Guidance: Officine Galileo, Florence, Italy.

JAPAN

2262.111
KAM-3D ANTI-TANK MISSILE

DESCRIPTION
KAM-3 is a command-controlled wire-guided anti-tank missile system which is standard equipment for the Japan Ground Self-Defence Force.

The KAM-3D missile has an orthodox configuration, with a cylindrical metal body and cruciform metal wings incorporating full-span trailing-edge spoilers for control. Propulsion is by a two-stage Daicel Co solid propellant rocket-motor, the booster stage of which accelerates the missile to its cruising speed in 0.8 seconds, after which the sustainer stage maintains this speed.

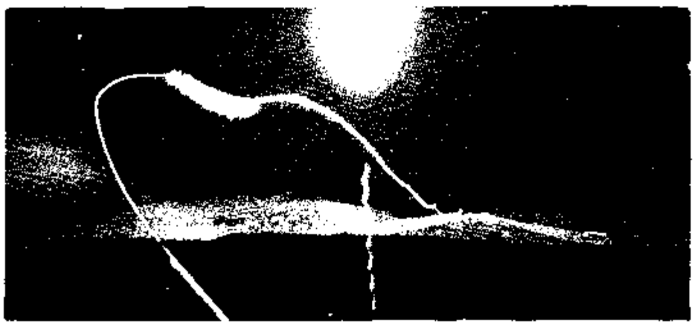
The missile can be fired singly or in multiple units by infantry and is carried by jeeps and helicopters. It is launched at an elevation of 15° and the operator controls it via an optical tracking system, using a flare by day and the sustainer rocket exhaust by night as a visual reference. A gyro-stabilisation system is embodied in the missile. A two-man firing team is required to operate the system. Control is achieved by using a thumb-button control box.

CHARACTERISTICS:
Type: Man-portable wire-guided anti-tank missile
Guidance Principle: Command to line-of-sight with optical tracking
Guidance Method: Wire-guidance control of vibrating spoilers on wing trailing edges
Propulsion: Two-stage solid-propellant rocket motor
Missile Length: 100 cm
Missile Diameter: Body 12 cm. Span 60 cm
Launch Weight: 15.7 kg
Cruising Speed: 85 metres/sec
Turning Radius: 250 metres
Range: 350-1,800 metres

DEVELOPMENT:
Following a design study carried out in 1956, development of this missile was started in 1957, under a contract awarded by the Technical Research and Development Institute of the Japan Defence Agency. The KAM-3 weapon system was adopted as standard equipment of the JGSDF in 1964 after several hundred test rounds had been fired, and has the official designation, Type 64 ATM. Trials showed that the missile's velocity control system enabled three out of four unskilled operators to hit a target with their first round after completion of a two week training course with the ATM simulator. Skilled operators could score 19 hits in 20 firings.

TEST AND TRAINING EQUIPMENT:
A field test set (KAM-3TE) and a simulator (KAM-3TP) are made by the main contractor

MANUFACTURERS:
Manufacturers of the complete system are Kawasaki Heavy Industries Ltd, Aircraft Division, 4-1 Hamamatsu-cho 2-chome Minato-ku, Tokyo. Other manufacturers known to have been associated with the system are:
Warhead – Daikin Kogyo Co
Rocket Motor – Daicel Co.; Nippon Oil & Fats Co.
Missile Guidance – Nippon Electric Co.
Guidance Wire – Fujikura Cable Works.



KAM 3 anti-tank missile
A KAM-3 night firing.
Picture shows the missile track and that of an illuminating flare

2263.111
KAM-9 (TAN SSM) BATTLEFIELD MISSILE

DESCRIPTION:
KAM-9 is an extended range, higher-performance version of the KAM-3, which can be used against armoured vehicles or both land and water. The missile is launched from a tubular container, which is used also for transport and storage. A solid-propellant launch motor ejects the missile from the container to a safe distance from the operator; the flight motor then ignites and accelerates the missile to its cruising speed in a few seconds.

Prior to launch, the container is placed on the launch and tracking unit, which consists of the firing mechanism, sight, and missile checkout device. The optical sighting device is designed to be operated by one man. During the missile's flight, the operator simply keeps the optical sight trained on the target, and sensors translate the course deviation to electrical signals which are fed into computer. The computer then feeds course corrections into the missile through the guidance cable

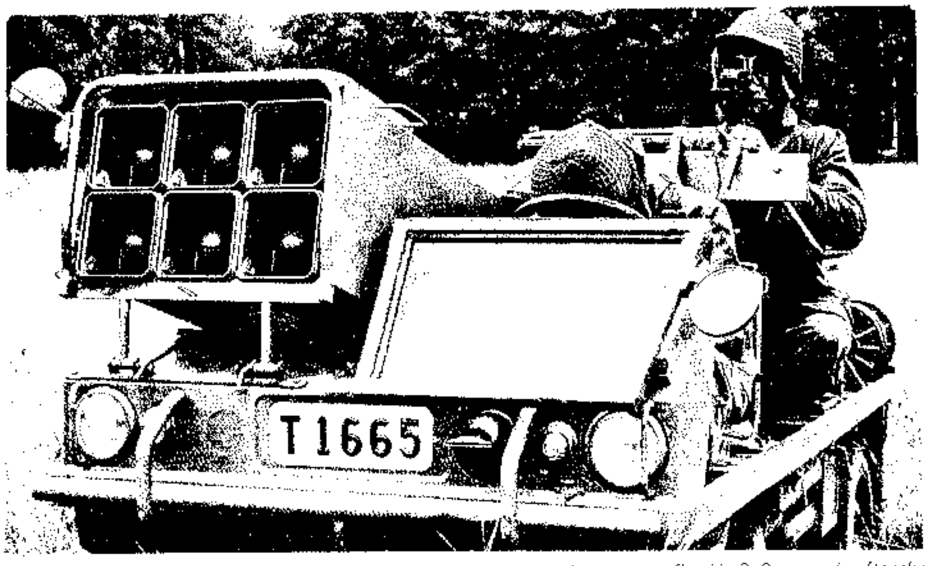
DEVELOPMENT:
Development of the missile was instituted by the Technical Research & Development Institute, Japan Defence Agency, and the first design study was started in April 1964. The system is now at the engineer production stage.

CHARACTERISTICS:
Type: Surface-to-surface, wire-guided tactical missile
Guidance Principle: Command to line-of sight with optical aiming and automatic – probably infra red – tracking
Guidance Method: Wire guidance. No other details known
Propulsion: Solid-propellant booster and sustainer
Warhead: Armour piercing. Type unknown
Missile Length: 1.5 metres
Missile Diameter: Body 15 cm. Span 33 cm

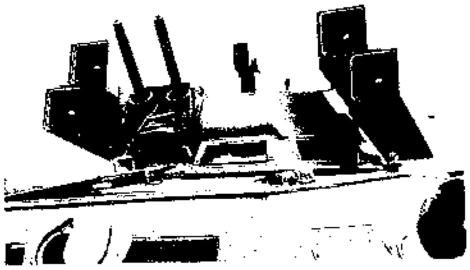
MANUFACTURERS:
System – Kawasaki Heavy Industries Ltd.
Flight Motor – Daicel Co. Ltd.
Launch Motor – Nippon Oils & Fats Co.
Guidance System – Nippon Electric Co.
Guidance Wire: Fujikura Cable Works.

SWEDEN

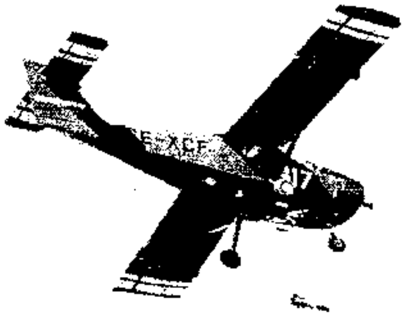
Launching a Bantam missile



The 6 Bantam missiles pointing forwards on the Puch-Haflinger jeep can be fired in 2-3 seconds after the vehicle has stopped. Six more missiles are carried at the rear of the jeep



Four Bantam missiles installed on the turret of a Cadillac Gage V-100 AFV



Bantam launched from SAAB MFI-17

2363.111
BANTAM ANTI-TANK MISSILE

DESCRIPTION:

Bantam is a small wire guided anti-tank missile, designed for operation by a single infantry soldier, but suitable also for use when mounted in land vehicles or small military aircraft. The missile has a hollow-charge warhead and is said to be able to "kill" the most modern heavy tank.

The complete system in its simplest configuration comprises the missile in its combined transport and launching container with carrying harness, a control unit and 20 metres of cable. All this weighs only 20 kg of which the launching weight of the missile is 7.5 kg.

OPERATION:

Time for setting up and firing is about 25 seconds. The container is positioned on the ground with the missile pointing in the direction of interest and the operator stations himself in a convenient position up to 20 metres away (or, with extra cable, up to 120 metres away) with the control unit which is connected to the container by cable. The control unit is fitted with a sighting device and a joystick to control the flight of the missile, command signals being conveyed through the wire trailed from the missile in flight.

Each wire spool contains 2,000 metres of guiding wire and in each is mounted a microswitch. One of these ignites the sustainer and up to four (as preselected by the operator) tracer flares in the rear of the missile after 40 metres of flight, the other arms the warhead after 230 metres.

When the missile is launched from the container its folding wings open. These have bent rear corners to give the missile rotation in flight and vibrating spoilers on their trailing-edges which are used to control the direction of flight. The missile battery which powers the control and fusing mechanisms is only activated when the missile starts its flight.

Also activated on firing is the missile gyro. This is energised by a powder pellet and after the missile has travelled 3 cm from rest a pin is withdrawn that uncages the gyro. Guidance signals for the spoilers are amplified by a transistor amplifier in the missile and passed to the spoilers by way of a commutator connected to the gyro. Due to the rotation of the missile the spoilers on each pair of wings switch from traverse guidance to elevation guidance or vice versa at each quarter rotation.

CHARACTERISTICS:

Type: Surface-to-surface anti-tank guided missile with air-to-surface capability
Guidance Principle: Wire guidance
Guidance Method: By control of vibrating spoilers on trailing edges of wings
Propulsion: Two-stage (booster/sustainer) solid-propellant motor
Warhead: Hollow charge; electrical fuse: weight 1.9 kg; armour penetration better than 500 mm
Missile Length: 0.85 metres
Missile Diameter: Body: 0.11 metre. Span: 0.40 metre
Weights: Container with missile: 11.5 kg; Minimum system with one missile: 20 kg
Range: Less than 300 metres to 2,000 metres
Hit Probability: 95-98% at 800-2,000 m
Cruising Speed: 85 metres/sec

DEVELOPMENT HISTORY

Bantam was designed and developed by AB Bofors as a private venture started in 1956. It is in large-scale production for the Swedish and Swiss Armies with which it is standard equipment having gone into service in Sweden in 1963 and Switzerland in 1967.

In addition to its use as an infantry weapon, Bantam can be used from land or other vehicles. In particular it has been designed into the Puch-Haflinger light cross-country vehicle, being available in this installation both for direct fire from the vehicle or for off loading for use by individual infantrymen.

Bantam also has air to surface applications. Missiles have been fired successfully from both helicopters and light aircraft.

MANUFACTURERS

Manufacturers of the complete system, of associated test instruments for the missile and of a firing simulator for training are:

AB Bofors, S-690 20 Bofors, Sweden.

2450.111
SWINGFIRE ANTI TANK MISSILE

DESCRIPTION:

Swingfire is a long range command-controlled anti-tank weapon system designed primarily for firing from a vehicle and capable of engaging and destroying the heaviest armour. The missile is wire-guided, command signals being generated by an operator's joystick control, and the commands are interpreted by the missile as demands for a change of heading, thrust vector control is employed.

An important feature of the system is its ability to operate with the firing vehicle concealed behind cover in such a way that there is no clear optical sight-line from launcher to target. The operator can be stationed a considerable distance (over 50 metres) from the launcher, and the missile will be automatically gathered into his field of view by means of the automatic programming of the initial flight of the missile.

Two basic methods of operation are possible. In one, in which the missile is controlled from the launching vehicle, the operator uses a periscopic sight that forms part of the main vehicle installation and can engage targets in his field of view over a 90 degree arc – that is, 45 degrees on either side of the direction in which the missile launcher is pointing. In the other method the operator uses a portable separation sight and stations himself in a suitable observation position while the launch vehicle remains concealed in a hollow or behind a building in any direction relative to the operator. A variation on this latter method is the use of a pallet-mounted system: since the weapon is battery operated it can be transported to a selected operational site and left there to be fired by an operator with a separation sight.

A typical vehicle installation comprises the periscope sight and joystick unit, a junction box and sequence firing unit, a programme generator and data store, a vehicle tilt compensating unit, a missile selector, a number of missiles, a power supply and a fault location indicator. A plug-in point permits the separation sight cable to be connected to the system. The system can be installed in almost any kind of military vehicle and installations have been devised for a wide range of tanks, armoured personnel carriers, armoured cars and scout cars. In some instances provision can be made for reloading within the vehicle in which case a rate of fire can be obtained that is comparable with that of a gun system. Vehicle installations do not require traversing or elevating gear, and the missiles can be fired from launcher boxes stowed in specially prepared bins or attached externally to the vehicle at the correct launch attitude. When the separated mode of fire is being used, vehicle tilt compensation is provided by the tilt unit. In all cases emphasis has been laid on protecting the equipment and the crew so that the system has a high degree of survivability on the battlefield.

Operation:

After the launch the missile is gathered into the operator's field of vision by the automatic gathering phase in the programme generator which functions in both azimuth and elevation. The inputs to this generator are the relative positions of the launcher, the operator, and the target; the operator-launcher relationship being predetermined when the periscope sight is used and separately programmed in when the separation sight is used.

When firing takes place from the vehicle the operator sets a selector switch to "Direct Fire" and aligns his vehicle sight with the target, thereby automatically feeding the required azimuth and elevation angles into the programme generator. When the separation sight is used, the separation cable is run out to the sight, positioned and levelled with its reference mark parallel to the launch direction. In the vehicle the selector switch is set to "Separate Fire"; and the programme generator is adjusted to allow for the vehicle tilt angles, the estimated distance of the separation sight, the angle between the launcher direction and the separation sight and the angle of elevation of the highest point over which the missile must fly. These last measurements are made with an alignment gauge that forms part of the installation. Target angles are then obtained from the separated sight as in the direct fire role.

In this way the missile is guided approximately onto the target sight line and final gathering is carried out by the operator. Swingfire has a velocity control system and movement of the operator's joystick in any direction alters the heading of the missile in that direction: maintaining the joystick stationary once the missile is framed in the target is sufficient to hold it on its collision course. Pitch and yaw demands are conveyed to the missile by the trailing wires and are referred to roll and heading gyros in the missile autopilot. Different signals are used to control the missile heading by altering the direction of thrust of the main motor and the servo loop is completed by a heading response unit so that the thrust deflection is reduced as the missile approaches the demanded heading.

Characteristics:

Type: Mobile anti-tank guided missile system. Pan-climatic. Missiles prepacked in hermetically sealed launcher boxes

Guidance Principle: Wire-guided. Heading demand signals referenced to autopilot. Optical sighting with automatic initial gathering. Manual control (local or remote). X1 or X10 magnification sights

Guidance Method: Thrust deflection of main motor

Propulsion: Rocket motor (solid propellant) designed to give low initial acceleration thus facilitating the engagement of targets at short ranges

Warhead: Hollow charge powerful enough to defeat all known combinations of armour

Range: Minimum – from less than 150 m at direct fire to 300 m with maximum separation. Maximum – 4,000 m

Fire Arcs: Azimuth +45 deg. without turret traverse. Elevation +20 deg to —15 deg relative to mounting plane

Special Features: Ease of concealment. Immunity to ECM

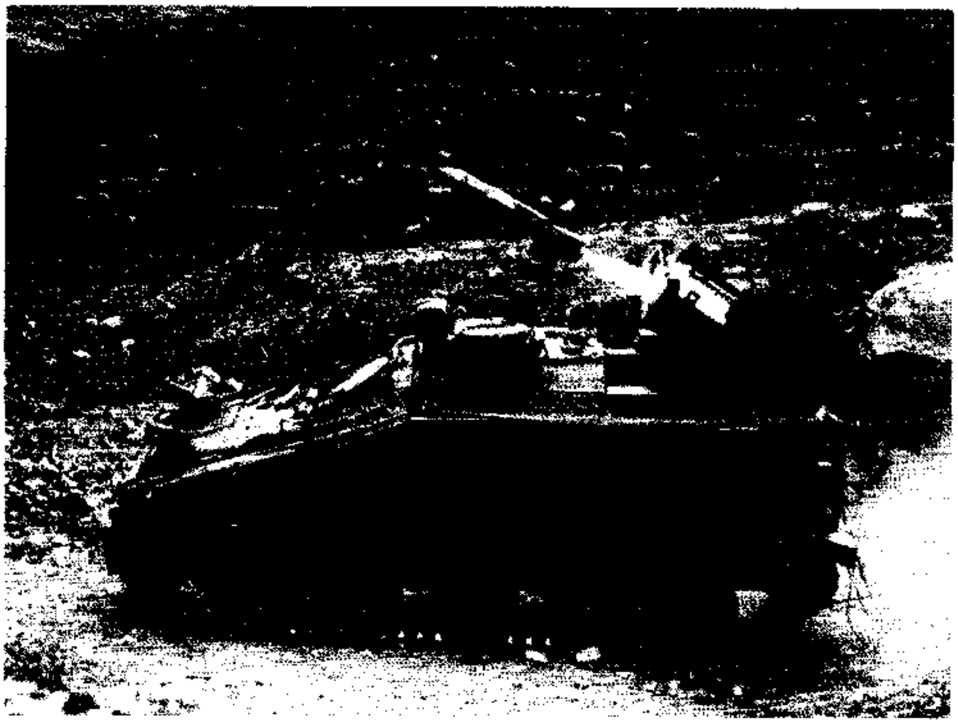
Development History:

British Aircraft Corporation (Guided Weapons) Ltd. based their design, development and production programmes on experimental work originally done by Fairey Engineering Ltd. The first design study was made in 1958 and the first public announcement concerning the system was made in 1962. The system went into service with the British Army in 1969. Although already extremely versatile and effective the system is regarded as being suitable for further development.

Future Development:

Work is now well advanced on three new applications of the Swingfire System. These are:

1. **Striker** – The Guided Weapons vehicle in the new CVR(T) Series.
2. **Infantry Swingfire** – A crew-portable version. It can be transported on and fired from any vehicle or trailer from a 1-ton truck or ¾-ton long-wheelbase Land Rover upwards. It can be carried over short distances (of the order of 400 metres) and deployed by its 3-man crew. For this purpose it is broken down into 2 manloads. When in action it is always used in the "separated fire" mode and covers an arc of fire in excess of 180° without traversing the launcher. It can be air-transported and air-dropped as a complete system. The British Army designation is **Beeswing**.
3. **Helicopter Installation** – Work is in hand to



Swingfire launch from Striker combat reconnaissance vehicle during firing trials. 1974 photograph

Infantry Swingfire – a version of the Swingfire system being developed for the British Army develop Swingfire as a "button-on system" for the new range of British Army Helicopters. As it is an easily removable system it will be readily adaptable to other helicopters of similar load carrying capacity to the British Army Gazelle and Lynx helicopters. The manufacturer's designation is **Airstrike Swingfire** and the British Army's, **Hawkswing**.

TEST AND TRAINING EQUIPMENT:

In addition to the built-in fault-locating equipment referred to above, the manufacturer offers a complete range of test equipment for unit and field workshop repair. A field trainer, for use in the vehicle or with the separated-fire sight, is available for continuation training in the field, whilst a multi purpose trainer, which provides a synthetic target and a means of assessing a trainee's performance, is available for initial training either in the classroom or in the field.

MANUFACTURER:

British Aircraft Corporation (Guided Weapons) Ltd, Stevenage, Hertfordshire, England.

2471.111

VIGILANT ANTI-TANK MISSILE

DESCRIPTION:

Vigilant is a man-portable wire-guided anti-tank missile system. Suitable for use by infantry, armoured regiments or paratroops it can be brought into action in seconds and is lethal against the heaviest battle tank.

In its simplest configuration the system comprises a launcher box containing one missile, a sight controller, a pocket battery and a length of interconnecting cable. The launcher box is set down on the ground with the missile inserted, pointing in the direction from which a threat is anticipated, and the operator, who carries the sight controller and its associated battery, takes up a suitably unobtrusive position where he has a good field of view. This position may be up to 63 metres from the launcher box. Thus positioned the operator can engage targets over arcs of fire of +10° in elevation and +35° in azimuth and at ranges of from 200 to 1600 metres.

To engage a target, the operator grips the sight controller with both hands, with a finger of one hand on the firing trigger and the thumb of the other on the guidance control cup, and fires. The thumb controller transmits signals to the missile guidance system through a wire link trailed out by the missile when in flight and operates as a velocity controller – so that movement of the cup in any direction alters the missile's heading in that direction: restoration of the cup to its initial position re-establishes the initial heading with the missile travelling on a path displaced from, but parallel to, its original path. Once the missile flare is framed in the target, therefore, centring the cup is sufficient to hold the missile on its collision course.

For daylight operations the missile is fitted with a special rear flare that can readily be seen by the operator. At night the light from the thrust pipe is found to be sufficient. The Sight Controller is fitted with a monocular sight that is useful for long-range engagements.

Vigilant missile at the moment of launch from the twin traversable launcher

Vigilant missile leaving its launcher

In the missile is a gyro autopilot, signals from which are combined with the elevation and azimuth demands from the thumb control and fed to a roll-resolving commutator. This ensures that whatever may be the roll-attitude of the missile the correct pair of control surfaces is actuated so that missile movement is in the same direction as thumb movement.

As the missile changes direction the gyros measure the change and bias the positioning signals back as the demanded heading is approached. The missile thus continues to fly on this heading until the removal of the demands from the thumb cup initiates the reverse process that brings the missile back to a new path parallel to its original path. The missile responds only to thumb control signals: disturbances caused by high winds are automatically corrected by the autopilot.

Optional system extras include a selector box to enable one operator to control up to six missiles in turn; a remotely traversable launcher containing two missiles that can be slewed through 340° in 8 seconds; a selector box that enables one operator to control three such launchers. Other system variants include mountings for scout cars or Land Rovers.

CHARACTERISTICS:

Type: One-man portable anti-tank missile system. Pan-climatic

Guidance Principle: Wire-guided. Heading demand signals referenced to missile autopilot. Optical sighting. Manual or semi-automatic control

Guidance Method: Servo-controlled surfaces in pairs

Propulsion: Two-stage solid-propellant motor

Warhead: Hollow charge. Weight in excess of 5 kg with fuse

Range: 200-1,375 m

Special Features: East of concealment. Immunity to ECM

DEVELOPMENT HISTORY:

Vigilant was developed by Vickers-Armstrongs (Aircraft) Ltd, as a private-venture weapon system from a design specification issued in 1956. Test firings took place in 1957-58 and the production weapon was tested in 1960. The system has since been widely sold and went into service with the British Army and the Defence Forces of Finland and Kuwait in 1963, of Saudi Arabia in 1964 and of Libya in 1968 and, on Ferret 2/6, to the Abu Dhabi Defence Forces in 1971.

TEST AND TRAINING EQUIPMENT:

The manufacturers, British Aircraft Corporation, offer a comprehensive range of test equipment for use with the system together with a classroom trainer and a field trainer.

THE UNITED STATES OF AMERICA

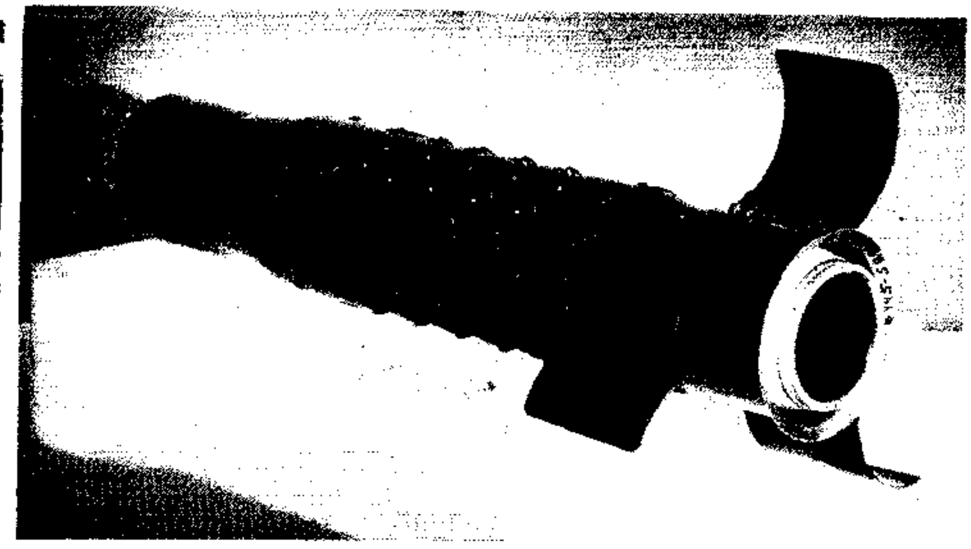
2573.111

DRAGON ANTI-TANK/ASSAULT WEAPON

DESCRIPTION:

Formerly known as MAW (Medium Anti-tank Assault Weapon System) Dragon has been developed for the US Army and Marine Corps as a weapon light enough to be carried and shoulder-fired by one man; yet having a warhead large enough to destroy most armour and other infantry targets encountered on the battlefield. It is superior in range accuracy and hit probability to the 90 mm recoilless rifle that it is intended to replace.

Aiming the Dragon missile from cover



Dragon missile

Dragon fired by gunner standing in the hatch of an APC during Engineering Tests in 1972

Dragon employs a command-to-line-of-sight guidance system and consists of three main items; a tracker, a recoilless launcher and a missile. The tracker includes a telescope for the gunner to sight the target, a sensor device and an electronics package. The tracker is reusable and is attached to the launcher, the missile is never seen by the gunner and after firing the launcher is discarded.

The missile is ejected from the tube by a gas generator using a recoilless technique. When it emerges folding fins flip open and the missile starts to roll. Thereafter propulsion is provided by the 60 small sustainers which fire in pairs on demand from the tracker. In operation, the gunner sights the target through the telescopic sight, then launches the missile. While he holds his sight on the target, the tracker senses the missile position relative to the gunner's line of sight and sends command signals over wire to the missile.

As commands are sent continually to the missile, the side thrusters apply corrective control forces. The thrusters are fired at appropriate roll angles so that the missile is automatically guided throughout its flight.

CHARACTERISTICS:

Designation: M-47
Type: Anti-tank guided missile
Guidance: Wire-guided, command to line of sight
Propulsion: Recoilless launched, solid-propellant rocket motor
Warhead: High explosive
Launch Weight: 12.25 kg
Range: 1 km

DEVELOPMENT:

Award to McDonnell Douglas of a $133 million contract for production engineering and production of Dragon was announced on June 28, 1968. The US Army announced in February 1970, however, that the missile would require further testing and would continue in development until June 1971.

The first manned firing of a Dragon armed with a live warhead took place at Redstone Arsenal on January 21st, 1971.

STATUS:

A small production test quantity of 560 missiles and 28 trackers was purchased by the Army in FY 1972 and in FY 1973 missile procurement was 3950. Purchases and supplementary requests for FY 1974 covered 7,000 missiles and for FY 1975 15,200 missiles and 1,200 trackers have been requested for the Army and 1378 missiles and 158 trackers for the USMC. 300 night sights have also been requested for the Army.

MANUFACTURER:

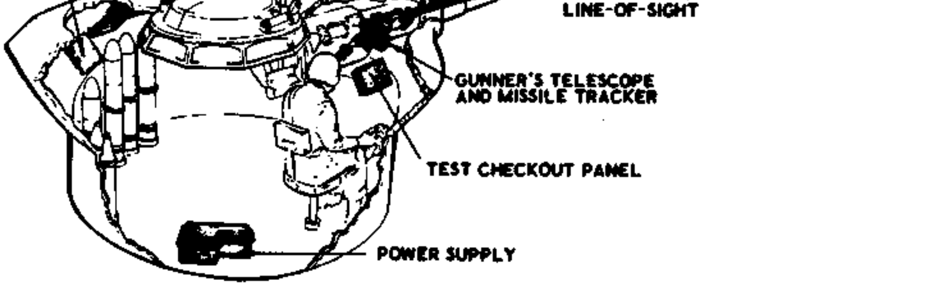
McDonnell Douglas Astronautics Co, TiCo Plant, Titusville, Florida.

2809.111
SHILLELAGH CLOSE SUPPORT WEAPON SYSTEM

DESCRIPTION:

Shillelagh is a lightweight close-support army guided weapon system intended primarily for use in a ground-to-ground role but suitable also for air-to-surface launching from helicopters. It is a direct-fire missile which can be carried by a variety of land vehicles ranging from armoured reconnaissance vehicles to main battle tanks.

Shillelagh is capable of high accuracy against both stationary and moving targets. The missile is fired from a 152 mm dual-purpose gun and missile launcher which also can fire conventional ammunition. Shillelagh is fired by a gunner, who guides the missile to its target using an infra-red command guidance system. He merely points the cross hairs at the target and follows the target during the missile flight to the point of impact. A missile tracker associated with the gunner's telescope measures the deviation of the missile's flight path from the line of sight, and the resultant



General arrangement of Shillelagh missile guidance system signals are converted into commands that are transmitted by the infra-red transmitter to the missile receiver. Here the commands are translated into actuation signals for the jet reaction flight controls. The missile is fitted with flip-out fins which open when it leaves the launcher.

CHARACTERISTICS:

Type: Lightweight land-mobile surface-to-surface guided weapon system

Guidance Principle: Infra-red command guidance to gunner's line of sight

Guidance Method: Hot-gas jet reaction

Propulsion: Cannon launch. Single-stage solid-propellant sustainer (Amoco Chemicals)

Warhead: Octol shaped charge

Missile Length: 1.14 metres

Missile Diameter: 152 mm

Launch Weight: 27 kg

DEVELOPMENT HISTORY:

The initial research and development contract was awarded to the Aeronutronic Division of Philco Ford by the US Army in 1959 following an industry-wide competition. The weapon system is managed by the US Army Missile Command, Redstone Arsenal, Alabama; and other government agencies have provided development support for specific components such as the warhead, fusing, propellants and optics.

Successful tests were carried out at White Sands Missile Range, New Mexico, in Arctic conditions in Alaska and in tropical conditions in Panama.

Limited production began in 1964; first production deliveries were made to the US Army in 1966; and the system was first deployed in 1967. Since then it has been made in larger numbers than any previous US guided missile. Philco-Ford Corporation received a $34.1 million production contract in September 1969.

Shillelagh is the main armament of the General Sheridan lightweight, air-transportable armoured reconnaissance vehicle, forming the Sheridan/Shillelagh weapon complex; it has also been adapted to an advanced version of the US Army's M60 Main Battle Tank – the M60 A2 (**5025.102**). It was also specified for the joint American-German MBT-70 Main Battle Tank (**5029.102** but see **2853.102**) development of which was cancelled.

The gun-launcher used in the M60 A2 differs from that used in the Sheridan. Sheridan gunners speak highly of the Shillelagh missile, which they find easy to use, but firing the conventional round, which has a fully-combustible cartridge, has been said to be less than satisfactory in the Sheridan – partly, no doubt, because it is lightly constructed for firing so large a weapon. It is said, however, that in the M60 A2 – as finally developed – the gun can be used more satisfactorily and with greater reliability and maintainability than in the Sheridan, while the Shillelagh performance is unimpaired.

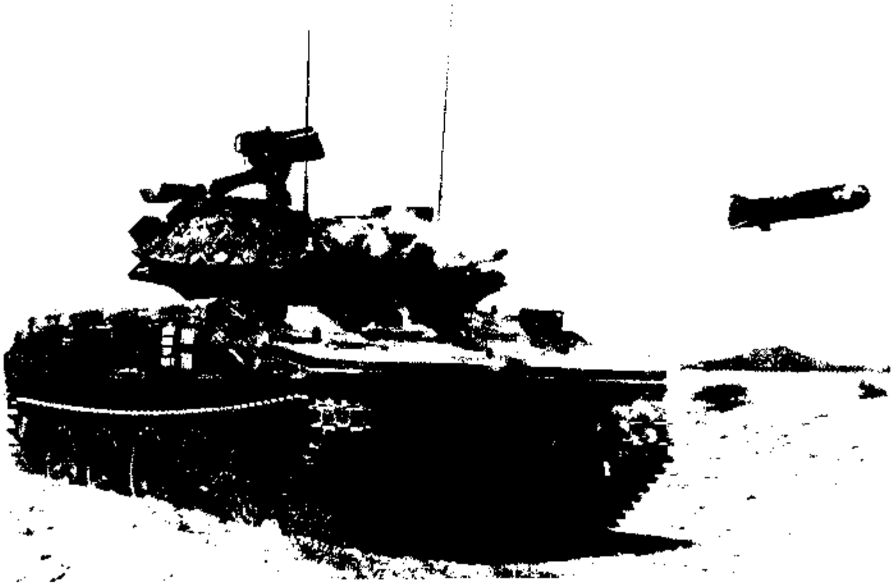
For helicopter-launching in its air-to-surface role Shillelagh is used in conjunction with a gyro-stabilised sight, also developed by Aeronutronic.

STATUS

The first procurement of Shillelagh was completed in 1970. In January 1972, however, the manufacturers announced receipt of a contract for nearly $12 million for modifications to the system. Details of these modifications have not been made public but they were said to affect both the missile itself and its guidance and control equipment.

MANUFACTURERS

Complete System: Aeronutronic Division, Philco-Ford Corporation, Newport Beach, California.



Shillelagh close-support missile leaving combination gun/launcher in General Sheridan AFV

2830.111
TOW ANTI-TANK MISSILE

DESCRIPTION:

TOW is an acronym for Tube-launched, Optically-tracked, Wire-guided, and describes a heavy assault ground-to-ground (or air-to-ground) anti-tank guided weapon system.

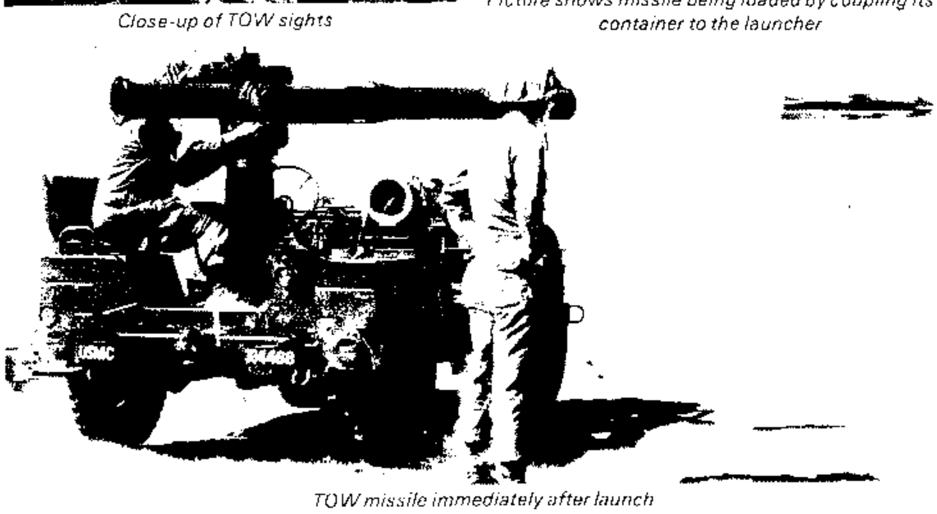
The TOW launcher system, for infantry use, is made up of five elements none of which weighs more than 24 kg, although the complete launcher weighs 78 kg when assembled and ready to fire. Four of these elements are a tripod and a traversing unit, mounted upon the tripod, to which the tripod launch tube and optical sight are attached. The gunner's optical sight is of high magnification and equipped with aiming cross-hairs which when combined with the smooth, stable motion of the traversing unit permit very accurate tracking of moving targets after very little operator training. The fifth individual element is the electronic guidance computer which sends steering commands automatically to the missile in flight.

The missile itself is contained in a sealed storage and transport container which becomes a launch tube extension when placed in the launcher breech. After the breech locks, all electronic contacts to the missile are automatically closed, and TOW is ready to fire.

The missile contains two solid propellant motors. The launch motor ejects the missile from the launch tube and is burned out by the time the missile has left the tube. Only after the missile has flown several metres does the flight motor ignite, so that no protection is necessary for the gunner against hot exhaust gas and propellant particles. The flight motor is mounted in the centre of the missile with its two exhaust nozzles mounted on either side. This arrangement prevents interference with the guidance wires which are placed at the tail of the fuselage. Steering commands are transmitted by the two wires which uncoil from two separate spools. Cruciform, short wings in the

Close-up of TOW sights

TOW heavy anti-tank guided weapon system. Picture shows missile being loaded by coupling its container to the launcher



TOW missile immediately after launch

centre of the missile and the cruciform rudder surfaces all unfold after leaving the launch tube. Missile manoeuvring is done entirely aerodynamically (without jet vanes) so that TOW maintains good manoeuvrability throughout missile flight. The electronics unit is mounted between the flight motor and the armour-piercing warhead

The flight motor accelerates the missile rapidly to its peak velocity and then burns out so that TOW leaves no visible smoke trail, which could allow an enemy to trace the flight path back to the place of launching. In addition, the missile does not continue to leave a heat trail which could interfere with tracking or the use of a night sight. Owing to the high initial speed a target once detected can quickly be engaged and a high rate of fire is possible. Due to its use of aerodynamic control, the TOW manoeuvre capability gives it a very low minimum firing range and at this short range targets can be engaged effectively even though they may be crossing at speeds of up to 50 km/h.

The anti-tank warhead has been designed to penetrate the armour plate of all types of tanks known or expected in the planned life of the system. It has also been shown to be effective against concrete bunkers and similar fortifications.

After the missile leaves the launch tube, a light source in the tail comes on so that the optical sensor on the launcher, which is bore-sighted with the gunner's telescope, can track the missile along its flight path. The light source does not distract the gunner, and it is sufficiently strong to allow automatic guidance to the maximum range of the missile under all conditions in which the target is visible to the gunner.

OPERATION:

The gunner's only job is to keep the cross-hairs of his telescope on the target during missile flight. The light source in the missile is tracked by the sensor which measures the angle between the flight direction of the missile and the gunner's line of sight. These displacements are transformed by the computer into guidance commands for the missile.

MOBILE INSTALLATIONS:

TOW can also be installed in most of the available wheeled or tracked vehicles capable of cross-country travel. The US Army is using it on armoured personnel carriers, jeeps and UH-1B and AH-1G HueyCobra helicopters; the US Marine Corps has tested it on the "mechanical mule". Moreover, the American Army plans to operate the system on more advanced armoured vehicles similar to the German Schutzenpanzer.

The adaptability of TOW for the armament of fighting helicopters has been thoroughly demonstrated. Missiles can be fired even at high speeds and still hit the target, and during an attack the helicopter can fly evasive manoeuvres. The missile was used in this role with considerable success in Vietnam; and in manoeuvres in Germany in 1972 the possibility of destroying as many as 20 tanks for every helicopter lost was demonstrated (see **2831.311**).

TOW mounted on the FMC XR311 high-mobility wheeled vehicle

CHARACTERISTICS:

Military Designation: BGM-71A

Type: Heavy anti-tank guided weapon system

Guidance Principle: Automatic missile tracking and command guidance from optical target tracker

Guidance Method: Wire guidance control of gas-operated aerodynamic tail surfaces

Propulsion: Two-stage solid-propellant motor. First stage quadruple; second stage single. Recoilless launch

Warhead: High-explosive shaped charge armour piercing

Missile Length: 117 cm

Missile Diameter: 15.2 cm

Launch Weight: 18 kg

System Weight: 102 kg including one missile

Speed: Believed to be at least 1,000 km/h

Range: Minimum: 65 metres
Maximum: 3,000 metres

Rate of fire: 3 launches in 90 sec

Crew: 4

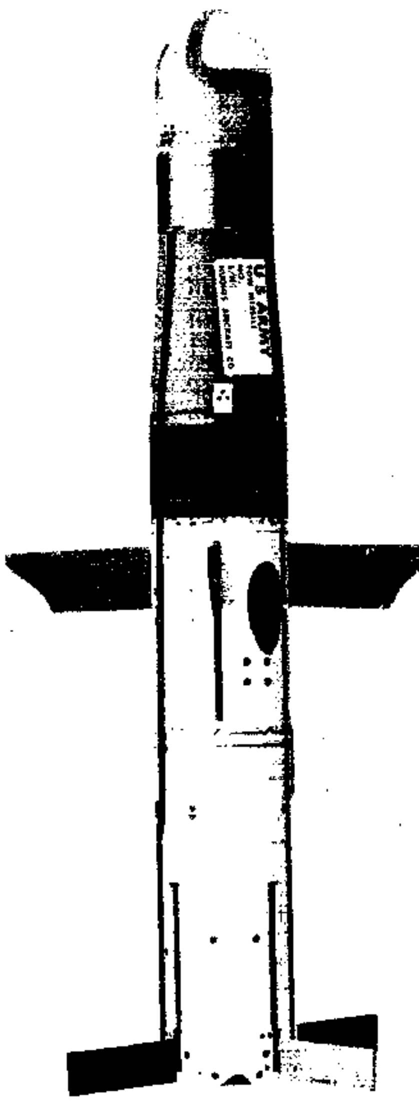
DEVELOPMENT:

The system has been under development since 1962, when the Hughes Aircraft Company won a competition with several other defence contractors.

TOW production missile firings began in August 1969, and by February 1970 more than 75 missiles had been expended.

STATUS:

TOW is in full production for the US Army. \$62.7 million was authorised for procurement in FY 1972 and \$43.3 million was spent in FY 1973 when 12,000 missiles were bought. Initial and supplementary requests for FY 1974 covered 23,425 missiles and 1618 launchers (including an initial quantity of both for the USMC) and totalled \$153.8 million (including spares and RDT&E expenditure) and \$138.4 million was requested for FY 1975 to cover the purchase of 30,319 missiles and 1041 launchers as well as providing the comparatively large sum of \$10.7 million for RDT&E.



THE TOW missile

TOW has also been sold to Italy, West Germany, Iran and the Netherlands and is one of three missiles being considered by the British Army for helicopter-launched applications – the other two being HOT and Airstrike Swingfire (**1654.311**).

MANUFACTURERS:

Hughes Aircraft Company, Culver City, California, is the prime contractor for the system having developed it for the US Army Missile Command.

Emerson Electric Co, Electronics and Space Division, 8100 Florissant, St Louis, Missouri 63136, are prime suppliers of the launcher, missile guidance set, optical sight and traversing unit.

2838.111

TERMINALLY GUIDED SUB-MISSILE (TGSM)

DESCRIPTION:

Conceived originally as a means of extending the range of operational applications of the Lance battlefield support missile (**2682.111**) the terminally-guided sub-missile (TGSM) is an anti-armour weapon which could be used in conjunction with any ballistic or quasi-ballistic launch vehicle having a comparable or higher apogee and range.

Whereas most other anti-tank weapons are line-of-sight weapons, the TGSM offers an indirect-fire option to a force commander, enabling him to engage reinforcements to the rear of enemy formations.

As the system is at present envisaged, six or nine TGSM would be loaded into the warhead compartment of a missile which would then be fired in the direction of a group of armoured vehicles or similar target located by reconnaissance. The warhead compartment has an ogive-shaped steel casing and is furnished with linear explosive charges which, at a predetermined time after the carrier missile has passed its apogee, cut the shell longitudinally and circumferentially. The resulting casing segments, as they move outwards and are decelerated by air resistance, eject the sub-missiles laterally to give the required dispersion.

The TGSM are equipped with timing devices which begin to operate on ejection: at the same time the covers over the rear ends of the sub-missiles are blown clear, drawing a paraballoon out of the aft end of each missile. This paraballoon stabilises the flight of the sub-missile. After a preset interval the timer opens two fixed and two movable tail fins from slots in the rear casing of the missile, at the same time detaching the paraballoon and activating the search mechanism of the sub-missile's guidance system.

This search mechanism scans the ground until the required target is identified – the dispersion of the sub-missiles being planned to keep to an acceptably low level the chance that more than one TGSM will lock on the same target. When the target is acquired, the guidance system locks to it and guides the sub-missile in unpowered flight using the moveable tail fins for control. If the control is inadequate to guide the weapon to the target the search mechanism is re-activated to seek another target. This is a relatively undesirable sequence of events, however, and the general aim would be to release the sub-missiles high enough to provide adequate time and energy for manoeuvre but not so high that target acquisition became difficult.

The target acquisition system is likely to use an infra-red detector tuned to the typical emission spectrum of armoured vehicles. It is understood, however, that a millimetre-band radiometric correlator is also being considered – the latter having the advantage of being less affected by environmental conditions than an IR system.

Although primarily designed as an anti-armour device the TGSM could evidently be used for other purposes – provided the target was of a kind that could be identified by a suitably small seeker head.

CHARACTERISTICS:

Type: Unpowered, missile-launched, guided anti-armour missile

Guidance Principle: Passive, selective IR or millimetre radiometric correlation homing

Guidance Method: Control of aerodynamic tail surfaces

Propulsion: Propulsive energy supplied by carrier

Warhead: HE anti-armour. Other warheads possible

Missile Dimensions: Length 76 cm; diameter 15 cm; span 46 cm; weight about 15 kg

Range: Dependent on carrier. Up to about 160 km with Lance missile

STATUS:

Development. Ejection and allied processes have been satisfactorily demonstrated using a rocket-sledge, and homing and guidance systems have been tested by dropping missiles from helicopters. Full-scale testing is believed to be imminent at the time of writing. Possible deployment date – given adequate financial support – is thought to be 1978

MANUFACTURER:

Michigan Division of LTV Aerospace Corporation, PO Box 5003, Dallas, Texas 75222.

THE UNION OF SOVIET SOCIALIST REPUBLICS

2983.111
AT-1 (SNAPPER) ANTI-TANK MISSILE

DESCRIPTION:

Snapper is the NATO code name for the wire-guided anti-tank missile believed to be known to the Russians as Shmell (Bumblebee) or 3M6 and known also by the US code AT-1. It is a vehicle-borne system, now usually deployed on the BRDM armoured amphibious vehicle, and is similar in general configuration to such missiles as the MBB Cobra and Contraves-Oerlikon Mosquito.

The missile is launched from a guide rail, a triple mounting being standard in the BRDM vehicle, whereas quadruple mountings were used on the GAZ-69 light cross-country vehicle on which the missile was formerly deployed. The triple mounting is retractable, the weapons being transported under cover plates which open up for firing. There is also a ground launcher for infantry use.

Provided with periscope binoculars embodying an illuminated variable-brightness reticle with which to sight the target, the operator uses a joystick to control the missile, keeping it on the line of sight to the target with the aid of tracking flares on two of the wings. The missile can be fired and guided by an operator stationed anywhere up to 50 metres from the launcher.

Multiple launcher for Snapper anti-tank missiles

CHARACTERISTICS:

Type: Surface-to-surface guided anti-tank missile

Guidance Principle: Wire-guided, command to line-of-sight; optical tracking

Guidance Method: By control of vibrating trailing-edge spoilers

Propulsion: Solid-propellant rocket motor

Warhead: Hollow charge

Missile Length: 1.13 metres

Missile Diameter: 14 cm

Launch Weight: 22.25 kg

Cruising Speed: 320 km/h

Range: 500-2,300 metres

STATUS:

In service with Warsaw Pact countries and in Cuba and the United Arab Republic

2985.111
AT-2 (SWATTER) ANTI-TANK MISSILE

DESCRIPTION:

Swatter is the NATO code name for a wire-guided anti-tank missile which is known as the AT-2 in the US code and which, like the AT-1 (**2983.111**), is carried on the BRDM armoured amphibious vehicle.

Of similar size to the AT-1 it is believed to be a more advanced missile – probably in the class of the French SS.11 – and certainly has a different configuration. Control is by elevons mounted on the trailing edges of the rear-mounted cruciform wings.

The standard mount on the BRDM vehicle carries four missiles mounted on guides. Operation of the missile is presumed to be similar to that for the AT-1, except that the missile appears to have some form of terminal guidance system – believed to be an infra-red homing device – mounted in the nose.

Range is believed to be 2,500 m; propulsion is by solid propellant motor; missile length is 114 cm and diameter is 132 cm

STATUS:

Believed to be in service only with Warsaw Pact forces.

BRDM I showing the mounting arrangements for the four Swatter anti-tank missiles (Tass)

2950.111
AT-3 (SAGGER) ANTI-TANK MISSILE

DESCRIPTION:

Sagger is the NATO code name for a small wire-guided anti-tank missile, also known by the US code AT-3 and, first seen in the VE-Day anniversary parade in Moscow in 1965. More compact than either the AT-1 (Snapper) or AT-2 (Swatter) missiles (**2983.111** and **2985.111**), but apparently carrying an equally powerful warhead, it is known to be deployed in various vehicle mountings including a 2 × 3 mounting on the BRDM-1 amphibious reconnaissance car (**5034.102**) and a single mount on the BMP-76PB armoured personnel carrier (**5054.102**). There is also a single manpack mounting that enables it to be fired from the ground.

In the BRDM vehicle the two clusters of three

This close-up of the BMP-76PB mounting shows clearly the short launch rail of the AT-3 missile

Sagger anti-tank missiles mounted on BMP-76PB armoured personnel carriers seen in the Moscoow parade in November 1967 (Novosti)

missiles are mounted retractably and are shielded when in the firing position by the cover plate that protects them when in the retracted position.

Like the two earlier missiles, the AT-3 is powered by a solid-propellant rocket motor.

CHARACTERISTICS:

Type: Surface-to-surface guided anti-tank missile
Guidance: Wire-guided; command to line of sight; optical tracking
Propulsion: Solid propellant motor
Warhead: Hollow charge C. 3 kg
Missile Length: About 70 cm
Missile Diameter: About 12 cm
Range: 2.5 km
Penetration: 400 mm

STATUS:

Formerly believed to have been used only by Warsaw Pact forces, the AT-3 is now in service in the Middle East and was extensively used against Israeli tanks in 1973. Reports indicate that it is an effective weapon.

BATTLEFIELD SUPPORT WEAPONS

2285.111
INTRODUCTION

This section is concerned primarily with large land-mobile tactical guided missiles designed for use as super-heavy artillery over ranges from a few tens to several hundreds of kilometres and many of them equipped with nuclear warheads.

Such missiles, however, are not the only land-based tactical nuclear weapons that are available to the commanders of the armed forces of major military powers: conversely, the guided missiles themselves are not necessarily equipped with nuclear warheads – although their cost-effectiveness if equipped only with HE warheads is open to question.

A few brief notes on the main categories of land-based tactical nuclear weapons may help the reader to identify and locate the weapons which are of interest to him.

Tactical Ballistic Missiles – Guided

Described in this section, these are all substantial ramp-launched rocket-propelled weapons almost all of which have been designed from the outset to be armed with nuclear warheads but most of which have an alternative HE warhead. They are sometimes referred to as short-range ballistic missiles (SRBM) to distinguish them from the longer-range strategic missiles.

Most of these weapons are inertially guided; but the early versions of the Russian Scud missiles (**2969.111**) are believed to have used radio command guidance and it is believed that one of the missiles developed in Egypt (**2050.111**) was wire-guided.

Almost all the missiles of this type that are known to have been developed are either American or Russian: the only other weapon that is known to have been completely developed is the French Pluton (**2130.111**). A British development programme, for a missile known as Blue Water, was cancelled – but on political/econommic grounds: technically it was considered by some to be superior to the American Sergeant missile (**2804.111**). Notwithstanding claims, suggesting the contrary, that were made during the 1973 Arab-Israeli war the German-aided missile development programme in Egypt (**2050.111**) never resulted in significant deployment of operational missiles. The situation regarding the Israeli Jericho missile (**2226.111**) is far from clear. We have received no information on Chinese People's Republic developments in this field but clearly they could develop weapons of this kind if they wished to do so. A battlefield support missile is, however, reported to be in an exploratory development phase in Taiwan.

Tactical Ballistic Missiles – Unguided

Missiles of this type, though still quite widely deployed, must be regarded as obsolescent at least. Weapons believed to be still in use are the American Honest John (**2652.113**) and most of the Russian Frog missiles (**2920.113** etc). In earlier editions of this book these missiles were described in this section; but recent developments have tended to blur the distinction between these weapons and other unguided artillery rockets and to accentuate the importance of the distinction between the guided and unguided types of weapon: the descriptions are therefore now to be found, with those of the other land-based unguided artillery rockets, in Section Three.

Tactical Cruise Missiles

Although several types of guided tactical cruise missile have been developed since the end of the Second World War, the only ones currently deployed as battlefield support weapons are of Russian origin and are described in this section. Weapons believed to be identical to these are also available for use for coastal defence; but since several other weapons, not used for battlefield support, are also available for coastal use a separate section, following this one, is devoted to such weapons.

Interest in the use of remotely piloted vehicles for military purposes, which has waxed and waned several times since such remote control became a practical possibility, is currently on the increase. It will not be surprising, therefore, if other countries introduce either nuclear or non-nuclear RPVs for battlefield support. An early example is quite likely to come from the USA: emphasis there is currently on air-launched and submarine-launched strategic or tactical cruise missiles, but much of the development work would be relevant if a land-based missile were required.

Heavy Tube Artillery

Both the USA and the USSR have operational large-calibre artillery weapons which can fire nuclear ammunition with kiloton-range yields. The American weapons – such as the M-110 203 mm SP howitzer (**5523.103**) and the M-109 155 mm SP howitzer (**5508.103**) and variants – are in service in several other NATO armies and a few non-NATO armies. Few, if any, of the weapons in non-American forces have nuclear ammunition available to them, however, and any such ammunition is in the custody of US forces. So far as is known, neither Britain nor France has yet developed nuclear shells for artillery weapons although both have the ability to do so: the British Army uses American nuclear-capable weapons and France has weapons of similar calibre (see especially **5574.103**).

Ammunition for the Russian M-55 203 mm gun-howitzer (**5540.103**) is believed to be controlled in much the same way as is the nuclear ammunition for the American weapons. Some of the M-55 weapons, however, were supplied to the Chinese People's Republic some years ago, and it is conceivable (though perhaps unlikely at the present time) that nuclear ammunition has been developed for them in China.

Since these heavy weapons, even when firing nuclear ammunition, are controlled and operated in the same way as other tube artillery they are not described in this section. Available details can be found in Section 3.

Miniature Nuclear Warheads

Classification of battlefield support weapons has been complicated by the emergence of the miniature low-yield nuclear warheads to which development effort has been applied recently in the USA and possibly elsewhere. The possibility of equipping a shell or rocket warhead with a physically small nuclear charge having a yield of, say, 0.1 KT considerably modifies the potential tactical significance of many bombardment weapons of quite modest size; and the allied possibility of equipping larger missiles with several of these devices, with or without terminal guidance, could in certain circumstances reduce the need for basic missile accuracy and would in any event give grounds for re-classifying some unguided rocket weapons as weapon *systems*.

For the time being, however, since deployment of these miniature nuclear weapons is not expected - in Western forces at least - before about 1978, discussion of them is limited to a few details in entry **2725.103** in Section 3. Multiple warheads, specifically related to the Lance missile system (**2682.111**) are discussed in the previous section (**2838.111**) and reference should also be made to the Pave Pepper programme (**2839.111**) which may relate to both strategic and tactical missiles.

Rocket Assisted Projectiles (RAP)

Rocket-assisted unguided projectiles for field artillery weapons have been available to the US forces for some time and are described in Section 3 (**2834.103** and see also **6091.203** for naval applications). A note on guided projectiles is included in this section (**2837.111**). The techniques involved could be applied to nuclear ammunition but it is believed that they have not

Static Nuclear Weapons

In addition to the various rockets, shells and other missiles which can be used in nuclear warfare there exist many nuclear devices which are designed for use in a static role to hold up an enemy advance or otherwise deny territory to him. Details of such devices are not available; but their general nature and principle of operation is sufficiently obvious for further discussion here to be unnecessary.

EGYPT

2288.111
BATTLEFIELD SUPPORT MISSILES (1973)

During the 1973 Arab-Israeli war, President Sadat of Egypt was reported to have threatened to attack Israeli cities with a long-range missile which he is said to have described as the Zafir.

Dating back to about 1961 there was a programme of missile development in Egypt, in which German scientists and engineers are believed to have been involved, which resulted in the creation of three rockets. Two of these were single-stage missiles, the smaller called Al Zafir and the larger Al Kahir, and the third was a two-stage rocket (Al Raid) which may or may not have been intended for military purposes. Brief descriptions of these rockets - which were first seen in public in 1962 - were last published by us in the 1972-73 edition (**2050.111**).

So far as is known, the three projects were dropped, briefly revived and then finally abandoned in the middle to late 1960s. The reason for abandoning them is believed to have been failure to develop a reliable guidance system, and because of this it seems most unlikely that President Sadat's threat was backed by *Egyptian* missiles, although what is believed to have been the design performance of the original Al Zafir (500 kg warhead and 375 km range) would have been reasonable in the context.

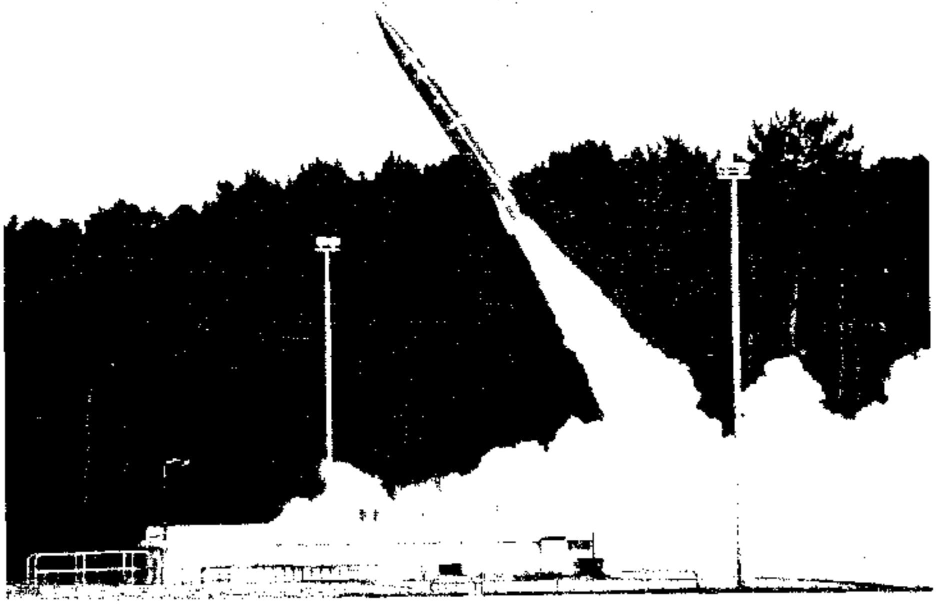
On the other hand US reconnaissance reports revealed the presence in Egypt at that time of a quantity of Russian Scud missiles (**2969-70.111**) complete with nuclear warheads: and while it is probable that such dangerous weapons would have remained effectively in Russian custody in one way or another it could well be that it was their presence in Egypt that prompted President Sadat to issue his threat.

FRANCE

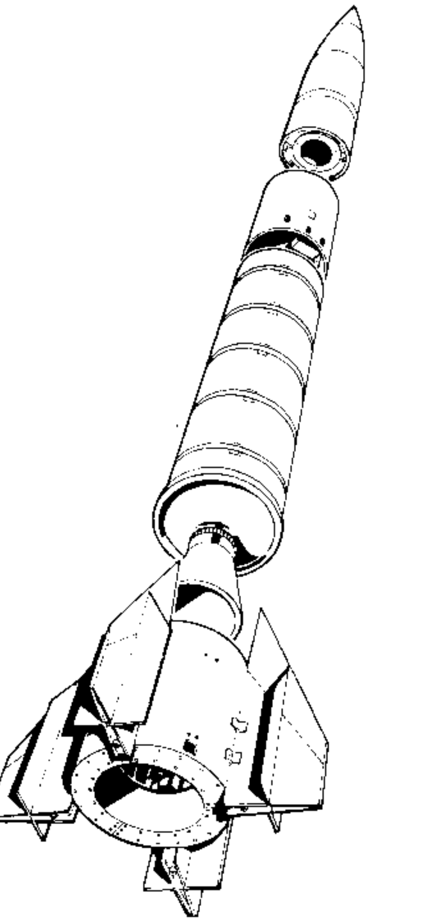
2130.111
PLUTON BATTLEFIELD SUPPORT MISSILE

Description

Developed to meet a French Army requirement, Pluton is a surface-to-surface tactical nuclear missile. The weapon, which is intended to have a range capability from 10-120 km, is installed on and fired from the AMX-30 tank chassis, the missile container being used as a launching ramp.



Launch of Pluton missile



Main components of Pluton missile

Missile and warhead are supplied separately to operational units.

In addition to the AMX-30 launching vehicle the system includes command vehicles containing data processing equipment organised round the IRIS 35M computer of the Plan Calcul Militaire. This is a third-generation general purpose computer capable of operation under severe environmental conditions. If operational circumstances require it, target data can be obtained in real time from an R.20 drone (**2127.351**) equipped with a Cyclope passive IR reconnaissance system (**1070.353**). Missile guidance is by means of a simplified inertial system based on a SFENA stable platform. The warhead is the AN-52 tactical nuclear weapon which is also used for air-dropped bombs. It has a yield of 10-15 kilotons.

Characteristics

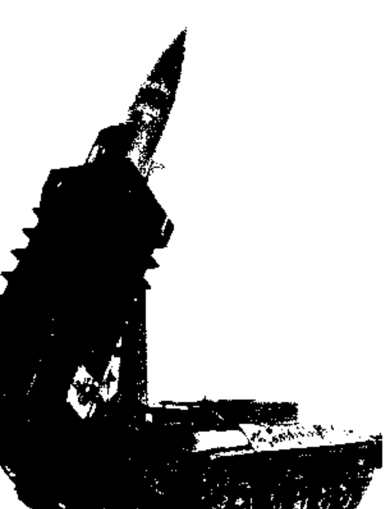
Type: Land mobile, vehicle-launched, tactical nuclear weapon system

Guidance: Inertial

Propulsion: Dual thrust solid propellant rocket motor. Propellant weight 1,200 kg

Warhead: Nuclear: reputedly 10-15 kilotons

Missile Length: 7.7 metres



Pluton missile on launcher vehicle

Body Diameter: 63 cm
Span: 141 cm
Launch Weight: 2,400 kg
Range: 10-120 km
CEP: Believed to be 200-400 m depending on range
Crew (Launch Vehicle): 4

STATUS:

Test firings have been carried out. Initial production contracts were awarded in 1972, and deliveries to the French Armed Forces began early in 1974. The last reported order quantity was 120 missiles, and it is believed that the initial deployment will be of six regiments, each armed with six missiles, with the French 1st Army. Army evaluation firings began late in 1972.

It was at one time thought that the French authorities had no intention of exporting Pluton. Recent comments in the French press concerning the purchase of Lance (**2682.111**) by European nations, however, suggest that the French missile is in fact on offer. There is, however, no official confirmation of this.

DESIGN AUTHORITIES:

Programme direction: Direction Technique des Engins.

Nuclear Warhead: Commissariat à l'Energie Atomique.

Command and Control System: Direction Technique des Armements Terrestres.

MANUFACTURERS:

Project management, aerodynamic studies, structure, guidance and control system: Aérospatiale, 37 Boulevard de Montmorency, 75016 Paris, France. Others involved are –

Rocket Motor: SEP

Propellants: SNPE

Main Body Equipment: SFENA, Air-Equipment, Auxilec

Warhead Equipment: SERAT

Nuclear Charge: CEA

Launch Vehicle (tank portion): DTAT / AMX

Crane: Griffet

Turbine: Microturbo

Vehicle Equipment: CII, CIT, SINTRA, SOPELEM

Vehicle Integration: DTAT / GIAT

Command Antenna: SPAIR

Command & Control Equipment: CII (Computer), CIT, SINTRA

Command & Control Integration: DTAT / SEFT

ISRAEL

2226.111
ISRAELI BATTLEFIELD SUPPORT MISSILES

DESCRIPTION:

There have been persistent reports in recent years that Israel has one or more surface-to-surface weapons programmes under way.

One of these relates to a missile known as Jericho, another relates to a two-stage surface-to-surface rocket whose project reference is MD 660. The two programmes may well be one and the same thing; and indeed the only reason for supposing that they may not be is an earlier association of the name "Jericho" with an earlier number, MD-620.

So far as is known, the Israelis have at no time in the recent past admitted that either project still exists as a current venture, indeed, at and around the time of the 1973 Arab-Israeli war reporters were firmly told that no such project existed. These denials have to be viewed in the context of a threatened attack by Russian Scud missiles based in Egypt, however – circumstances of a kind in which most people would argue that some distortion of the truth would be permissible.

While not denying the Israeli denials, therefore, we think it right to record what has been said about the Jericho project in other quarters. According to the reports referred to above the MD-660 is fired from a mobile ramp and is said to have a design range of 450 km. The warhead can be high-explosive or nuclear – the nuclear warheads being made in Israel.

STATUS:

MD-660 programme history extends back over several years and that of the MD-620 programme even longer. Nevertheless it is not definitely known that the Jericho or any similar programme exists: nor is it known, even if the programme does exist, that nuclear warheads could or would be made available for use with the missiles.

MANUFACTURER:

Not known – but it is known that Dassault were involved in the early days prior to the arms embargo. There is, however, certainly no French involvement now.

THE UNITED STATES OF AMERICA

2682.111
LANCE BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:

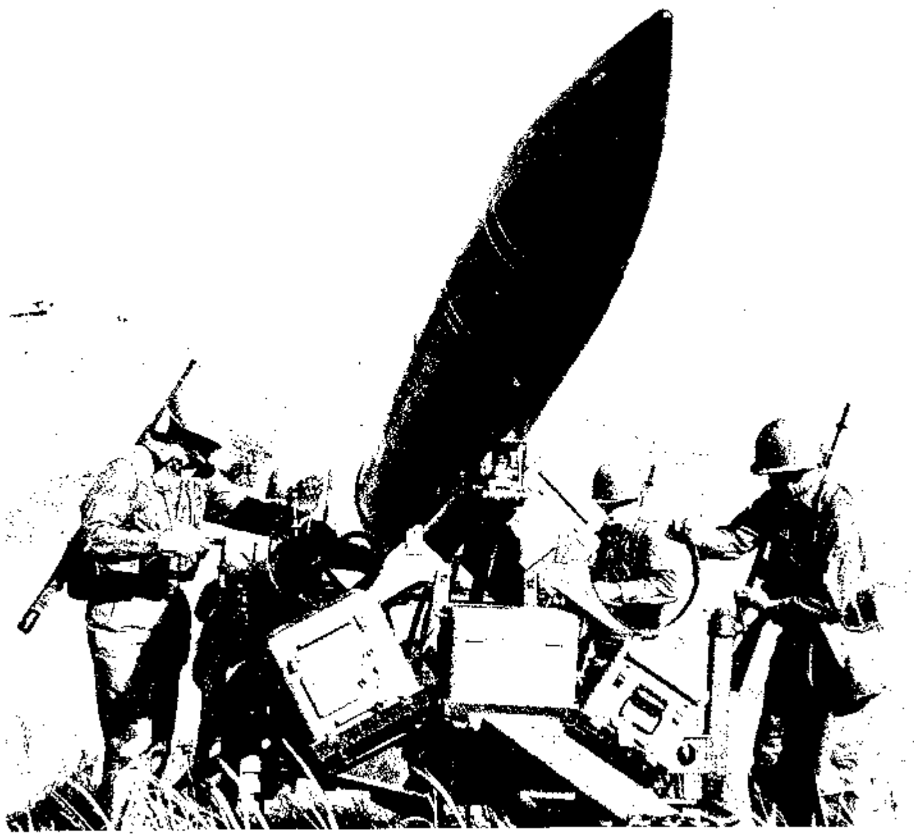
Lance is a surface-to-surface guided missile designed to provide general battlefield fire support for an Army corps. It will replace both Honest John and Sergeant missiles. It can carry either a nuclear or conventional high-explosive warhead and its range has been estimated at approximately 110 km. It requires a six-man crew, half the number required for Honest John (**2652.111**) and Sergeant (**2940.111**).

This highly mobile missile can be delivered by plane or it can be airdropped. It also has a good mobility over ground and can swim inland waterways. Lance uses simplified inertial guidance, and is the first US Army missile to use ready-packaged and storable liquid propellants. Major ground support equipment includes a self-propelled launcher, a fully mobile lightweight launcher and a transporter-loader.

In the field, Lance will complement conventional divisional tube artillery and extend the resources for nuclear or non-nuclear supporting fire available to the divisional commander.

The Lance missile comprises a warhead section, a guidance package, fuel tankage and an engine. The guidance package is a rugged low-cost device conceived and developed in the US Army Missile Command's Guidance and Control Laboratory. Over the operational range of the missile it is claimed to have a high degree of accuracy and reliability.

Spin-stabilisation in flight is achieved initially by venting some of the propellant gases through canted vents in the body of the missile. After initial spin has been imparted in this way it is maintained



Lance on its lightweight launcher

by aerodynamic pressure on the canted fins at the base of the missile.

Propulsion is by a Rocketdyne storable liquid-propellant engine comprising two concentrically-mounted sections. The outer section provides thrust during the boost phase of the missile's flight, and during this phase, which corresponds to a flight of about a mile (1,600 m), the missile is under tight control by the control and guidance electronics. When the on-board inertial system detects that the predetermined velocity has been achieved, the boost motor is extinguished and the missile continues on a zero-g flight powered by the (inner) sustainer motor. At a predetermined point in the flight this motor, too, cuts out, and the missile finishes its journey in free flight.

For land-mobile operations the weapon system will be transported on two XM-667 vehicles (US Army's M-113 family of tracked vehicles) one of which will function as an erector-launcher while the other carries two extra missiles and a loading hoist. For air mobile operations the lightweight launcher will be more appropriate; and this and the missile can be taken into the battle zone by helicopter or parachuted from a fixed-wing aircraft.

CHARACTERISTICS:

Designation: MGM-52A

Type: Mobile surface-to-surface tactical guided missile

Guidance: Simplified inertial

Propulsion: Two-part, concentric pre-packed storable liquid-propellant motor

Warhead: Nuclear or high-explosive

Length: Approx 6 metres.

Diameter: Approx 55 cm

Launch Weight: Approx 1,500 kg

Speed: Supersonic

Range: Estimated 110 km

DEVELOPMENT:

The Lance prime contractor was selected in 1962. The research and development contract was awarded in January, 1963. The first test firing was made at White Sands Missile Range in March 1965. The first firing from the engineering model lightweight launcher was in July 1965; and first firing from the self-propelled launch vehicle came the following month. In October of the same year the first successful parachute drop was made. Ground testing was begun in March 1966 at Redstone Arsenal, Alabama. The missile was fired successfully in temperatures of 140 degrees and 40 degrees below zero in 1969. Thirty-seven static tests and six flight tests were conducted in 1969.

Lance development was delayed for approximately one year when problems were encountered with the propulsion system and the rocket engine, but these difficulties were subsequently overcome. The first production model was delivered to the US Army for service testing in April 1971; the first Army launch took place that August and service testing was completed in March 1972.

During development a total of 156 flight tests were conducted – including 37 Army launches, all but one of which were successful.

STATUS:

Lance was type-classified "Standard A" early in 1972 and the first training battalion was activated in April. The weapons are now replacing Honest John (**2652.103**) and Sergeant (**2804.111**) units and it now seems likely that replacement in US service will be completed in 1975. The first operational launch took place in November 1972. It is expected that Lance will also be bought at least by those of the Eurogroup of NATO who currently have either Honest John or Sergeant missiles. The value of this European purchase has been estimated at £250 million.

The standard A release relates only to the system with a nuclear warhead. To extend the range of tactical applications of the weapons the US Army wish to have a non-nuclear warhead also: this would employ a USAF cluster bomb and would be used against softer targets than those for which the nuclear warhead is required. Funds for this development were denied by Congress in FY 1972 and funds were not explicitly requested in the FY 1973 proposals. It was however thought possible that the Department of Defense might arrange to re-programme previously-authorised funds for this purpose.

LTV revealed, late in 1972, that they were studying a multiple warhead version of Lance; while this study was not explicitly concerned with the US Army proposals it was evident that the basic operational requirement was the same (see **2838.111** in the preceding sub-section).

A total of $85 million was included in the FY 1973 budget for the Lance system. Of that, $30 million was for 194 missiles less warheads and the balance was for warhead sections (excluding the nuclear device which is separately budgeted and procured from the Atomic Energy Commission) both for the US Army and for Lance systems "sold or expected to be sold" to NATO countries.

The budget for FY 1975 covers any study work done on the non-nuclear warhead but specifically excludes any procurement thereof.

MANUFACTURERS:

LTV Aerospace Corporation, PO Box 5907, Dallas, Texas 75222 – Prime Contractor.

American Bosch Arma Corp, Arma Division, Roosevelt, N.Y – Gyroscope.

Systron-Donner Corp, Donner Division, Concord, Calif. – Guidance Components.

North American Aviation Inc, Rocketdyne Division, Canoga Park, Calif. – Propulsion

Hawker-Siddeley Canada Ltd, Toronto, Ontario, Canada – Lightweight Launcher.

FMC Corp, Ordnance Division, San Jose, Calif. – Vehicles.

2683.111
LANCE-DERIVED EXPERIMENTAL BATTLEFIELD MISSILE

DESCRIPTION:

This entry relates to an experimental project undertaken by LTV Aerospace – makers of the Lance missile (**2682.111**) – on behalf of the US Army Missile Command.

The purpose of the project is primarily to test and demonstrate in conjunction with Lance the use of a new low-cost missile guidance system, using fluidics instead of electronics, which has been developed by the US Army's Harry Diamond Laboratories.

A secondary objective is to demonstrate the use of a new low-cost solid-propellant propulsion system, developed for LTV by United Technology Centre, in place of the prepackaged storable liquid bi-propellant rocket motor now used in Lance.

It is expected that the demonstration missile will be less accurate than Lance; but it is believed that the inaccuracy will be almost entirely in range; the fluidic guidance system is expected to lead to minimal cross-track error. The range error is thought to be acceptable for applications in which Lance is used as an area weapon – eg with its single nuclear warhead or possibly with multiple warheads. It is unlikely, however, that the degree of error envisaged would be acceptable with the TGSM system (**2838.111**) although it may be possible to upgrade the accuracy of the new system later. The main advantage of the new guidance and propulsion systems will lie in cost reduction.

STATUS:

Experimental project on a $1.2 million contract from US Army Missile Command.

MANUFACTURER:

Michigan Division of LTV Aerospace Corporation, PO Box 5003, Dallas, Texas 75222.

2765.111
PERSHING 1A BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:

Pershing 1A is an improved version of the Pershing 1 ground-to-ground guided weapon system (**2764.111**). It has replaced Pershing 1 and is now deployed with the US Army and the Federal German Republic.

The most obvious change that has taken place is the replacement of the XM-474 tracked vehicles on which Pershing 1 system components were mounted by a set of wheeled vehicles based on the M656 five-ton truck. The system now has an improved erector-launcher which is an articulated truck and trailer combination that carries both the missile and its warhead (previously carried on separate vehicles) and which is capable of both paved road and cross-country travel. The other vehicles are a transporter for the programmer-test and power stations, the firing battery control centre truck, and the radio terminal set vehicle with an inflatable antenna. All the equipment is transportable by the CS-130 cargo aircraft.

System reaction time of the Pershing 1A has been reduced below that of Pershing 1 by improvements in the erector-launcher and by the introduction of automatic countdown. The radio communications system has also been expanded. There is no change in the missile itself.

Most recent of the improvements is an Automatic Reference System (ARS) which employs gyro compass techniques similar to those used in navigation and which enables the missile to be fired from a previously unsurveyed site in something like half the time previously required for surveying.

DEVELOPMENT HISTORY:

A $66 million development contract was awarded to Martin Marietta in 1966. This was followed by two production contracts, one for $52 million in 1967 and one for $32 million in 1968. Production started in November 1967 and was completed in 1971.

Pershing 1A equipment began deployment with US and West German forces in Germany in the summer of 1969 and was completed in 1971.

CHARACTERISTICS:

Military Designation: MGM-31A

Type: Land-mobile air transportable surface-to-surface tactical ballistic missile system

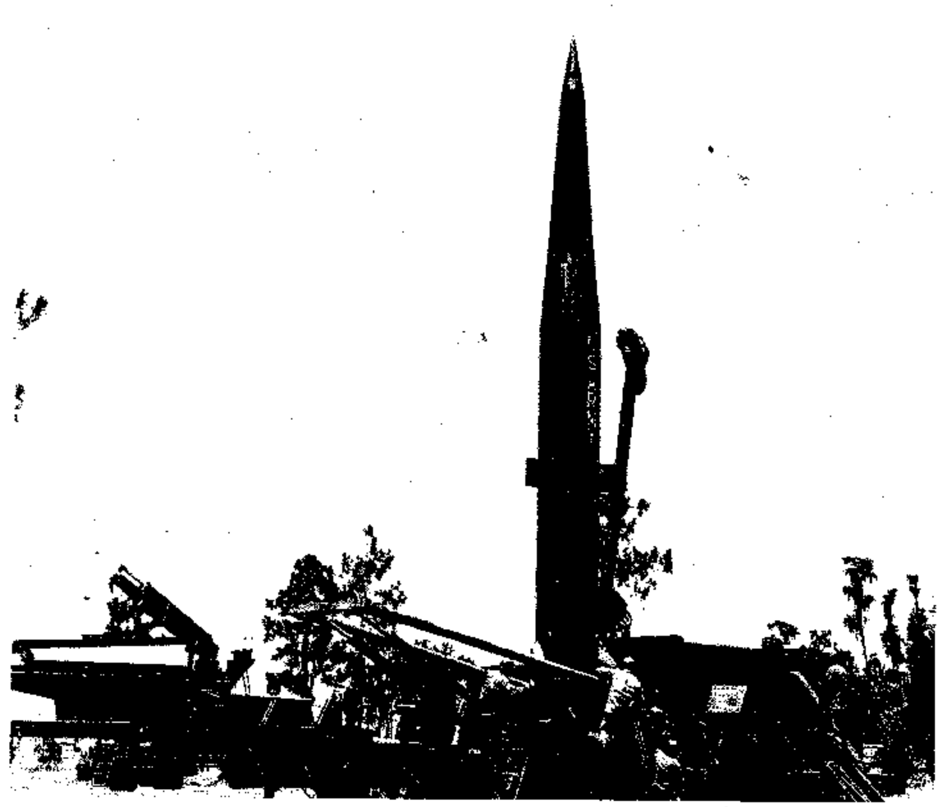
Guidance: Inertial
Propulsion: Two-stage solid-propellant rocket motor
Warhead: Nuclear. The majority of deployed weapons are believed to be equipped with 400 KT warheads but some have lower yields – down, it is believed, to 60 KT
Missile Length: 10.5 metres (approx)
Missile Diameter: 1 metre (approx)
Launch Weight: About 4,600 kg
Speed: Mach 8
Range: 160-840 km

STATUS:

Operational. Funding requested for FY 1975 covered $7.9 million for 54 Automatic Reference Systems and $11.1 million for component replacements to prolong the operational life of the missiles. This replacement operation covers 88 missiles and is the final stage of a four-year modernisation programme.

MANUFACTURERS:

Complete System: Martin Mariette Corporation, Orlando Division, Orlando, Florida.
Propulsion: Thiokol Chemical Corporation.
Communications: Collins Radio Company.
Inertial Navigation: Bendix Corporation, Eclipse-Pioneer Division.



The Pershing missile on the Pershing 1A erector launcher. The programme-test and power station vehicle is in the background

2767.111
PERSHING II BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:

Pershing II is the name assigned to a US defence project, outlined in the FY 1975 budget proposals, for improving the accuracy of the Pershing missile (**2765.111**) and thus permitting the use of a lower-yield nuclear warhead to perform the same military function.

Most Pershing missiles currently deployed are believed to carry 400-kiloton warheads, and these have been criticised for being excessively large and destructive for battlefield use. What is now proposed is the addition of what has been described as a Radar Area Correlation Guidance system, a form of terminal guidance system which is expected to produce the desired improvement in accuracy and thus make the use of a smaller warhead operationally sensible – with consequent improvement in the political acceptability of the weapon.

Details of the correlation system are not known but it clearly involves a process of matching a radar picture obtained by missile-borne equipment with a similar picture obtained previously by reconnaissance. This principle has been known for some time and a rather similar notion is embodied in the TERCOM system for re-entry vehicles (see **2719.111**).

STATUS:

It is understood that earlier experimental work has now bought the project to an advanced development stage. $11 million was requested, in the FY 1975 budget, for further development work.

2804.111
SERGEANT BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:

Sergeant is a field artillery ballistic missile, capable of carrying either a nuclear or a high-explosive warhead, and intended to provide missile support to a corps or field army. A second-generation system, it replaced the Corporal missile, and among the improvements offered were inertial guidance and solid-propellant propulsion. These features reduced the amount of ground handling equipment required by the system and resulted in a shorter reaction time than that of the command-guided liquid-fuelled Corporal.

Recent improvements in the electronics and procedures for automatic count-down have resulted in a still further reduction in reaction time. Units already in the field have been modified to incorporate these improvements.

The missile is composed of four major sections. These are the warhead, guidance, rocket motor and control surfaces. These sections are assembled just before firing and are transported to the firing position in special sealed containers. Similar missile sections are interchangeable. The guidance system is immune to known countermeasures.

Major items of a firing battery are the Launching Station, Organizational Maintenance Test Station, and the Missile Transport Trailer. In addition, the XM68E2 Sergeant Trainer, which simulates all technical characteristics of the missile, is used as a training device.

A Sergeant missile battalion comprises a headquarters, a headquarters battery, and two firing batteries with one launcher per firing battery. The battalion is usually assigned to a field army and

MGM-29A Sergeant missile erected for launching attached to a corps. Normally, three battalions will be found in each field army.

The Sergeant may be employed against large troop concentrations, enemy nuclear delivery systems, communications centres, and command and supply installations. Its mobility and air-transportability allow for rapid occupation and displacement from position.

CHARACTERISTICS:

Military Designation: MGM-29A

Type: Surface-to-surface tactical guided missile

Guidance: Inertial

Propulsion: Single stage solid-propellant rocket motor

Warhead: Nuclear or high-explosive

Missile Length: 10.5 metres

Missile Diameter: 79 cm

Launch Weight: 4,536 kg

Speed: Supersonic

Range: 45 to 140 km

DEVELOPMENT HISTORY:

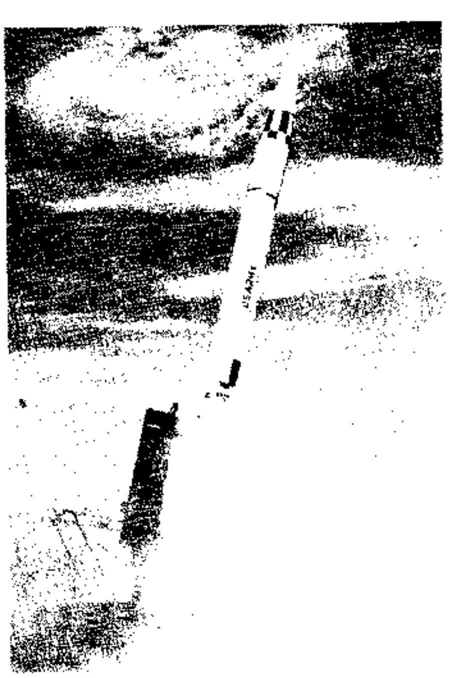
In 1955, Jet Propulsion Laboratories (JPL), the developing contractor for Corporal, predecessor of Sergeant, was awarded a contract for the Sergeant System. Sperry Utah Company entered the programme in 1956 as the co-contractor for research and development and the prime contractor for equipment production. The Sperry Utah Company, now the Univac Salt Lake City Company, took over complete prime contractor responsibility for the system in July 1960.

The Sergeant system is in operation with US troops in the United States and overseas. West Germany also has Sergeant. It is expected that Lance (**2682.111**) will replace Sergeant during the 1970s – and probably by 1975 in the USA.

MANUFACTURERS:

Prime Contractor: Univac Salt Lake City Company, Salt Lake City, Utah.

Rocket Motor: Thiokol Chemical Corporation, Bristol, Pennsylvania.



Launch of a Sergeant at White Sands Missile Range, New Mexico

2837.111
ROCKET-ASSISTED GUIDED PROJECTILES

DESCRIPTION:

Rocket-assisted projectiles have been in use for US field artillery for several years (see **2834.103**) but all such missiles in service are unguided.

Development of a terminal homing guidance system for such projectiles was initiated by the US Navy, but was subsequently handed over to the US Army. Laser guidance is known to be among the techniques being explored. No details are available but it seems reasonable to suppose that an accurate long-range fire capability, although desirable in itself, is not the sole reason for the development and that nuclear warheads have at least been considered.

MANUFACTURERS:

It is known that Martin Marietta and Texas Instruments have been competitively involved in one guided projectile project.

THE UNION OF SOVIET SOCIALIST REPUBLICS

2925.111
FROG 7 GUIDED BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:

FROG (Free Range Over Ground) is a NATO name applied to what has grown to be a substantial family of heavy battlefield support weapons which can carry either nuclear or high-explosive warheads.

The majority (and possibly all) of these weapons are unguided and are described in Section 3 (**2920-24.103** and **2926.103**). A recent report, however, has suggested that the most recently introduced member of the family, Frog 7, may also exist in a guided version (the unguided version is described in **2926.103**). This report is based on evidence which came to light during the 1973 Arab-Israeli war when some, possibly guided, Frog 7 missiles with high-explosive warheads were fired against the Israeli forces by the Syrian Army.

If such a version of Frog 7 does exist it may confidently be expected to be radio command-guided, but no other information is available.

STATUS:

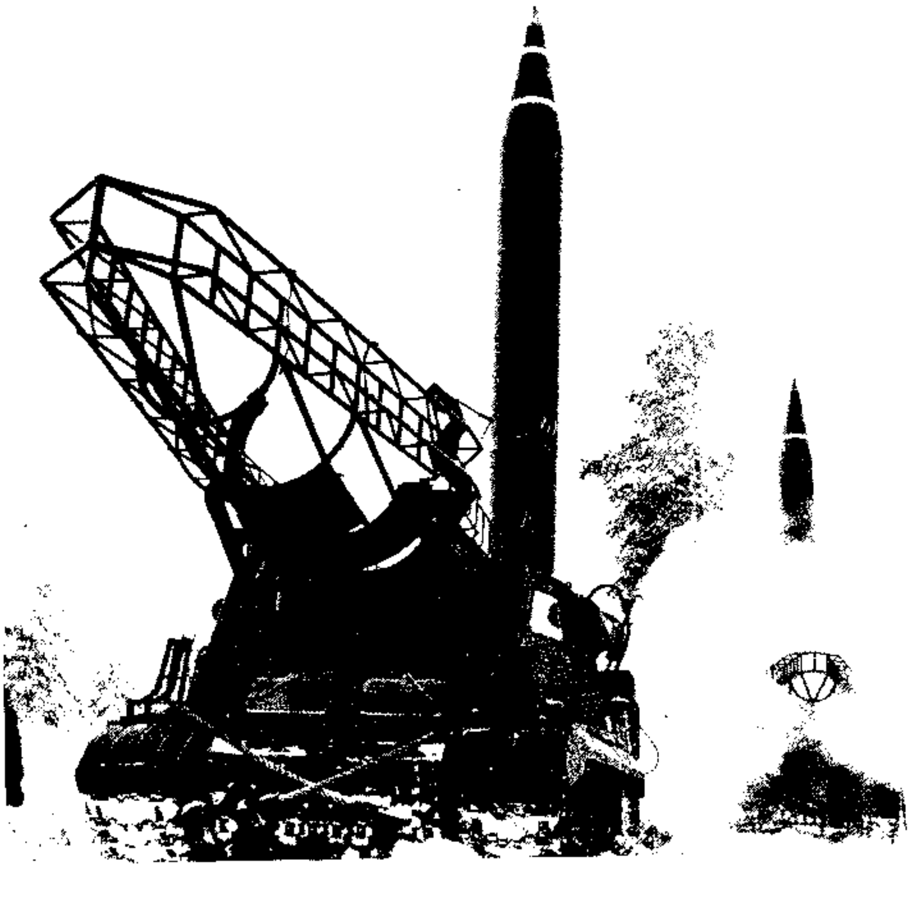
Not definitely known to exist but by no means an impossibility.

2969.111
SS-1B (SCUD A) BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:

The family of heavy artillery rockets known by the NATO code name of Scud has two or, according to some sources, three members. The first, Scud A, which is generally identified with the US code SS-1B, is carried on and fired from a tracked vehicle, with a JS-III chassis similar to that used for Frog 1, has a liquid-propellant motor, is about 11 metres long and has a range of about 150 km. The tubular metal cradle in which it is supported elevates with it into the firing position; ladders in each side of the cradle give access to the warhead section when the missile is erected. According to Soviet reports the preparation time of this missile in service with army corps is more than one hour.

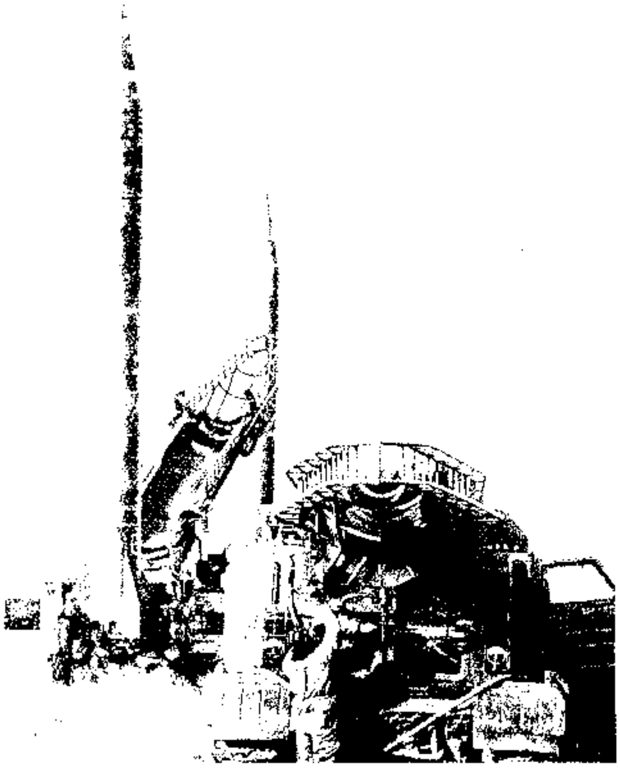
Unlike the Frog series of unguided missiles the Scuds have movable fins. The method of guidance used for the later Scuds is believed to be a simplified inertial system but appears previously to have been some form of radio command guidance. According to most sources Scud A is still a command-guided weapon.



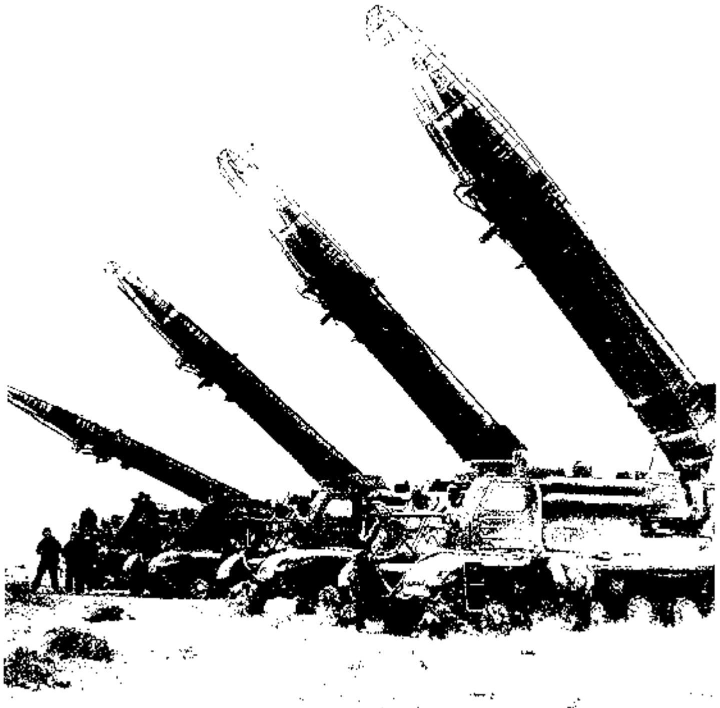
Scud-A missiles on exercises in January 1970 (Tass)

CHARACTERISTICS
Type: Surface-to-surface guided tactical missile
Guidance Principle: Radio command guidance
Guidance Method: By movable tail fins
Propulsion: Liquid propellant sustainer
Warhead: Believed optional nuclear or high explosive
Missile Length: About 10.5 metres
Missile Diameter: About 85 cm
Launch Weight: About 4,500 kg
Range: 80-150 km

STATUS:
Operational in Warsaw Pact forces



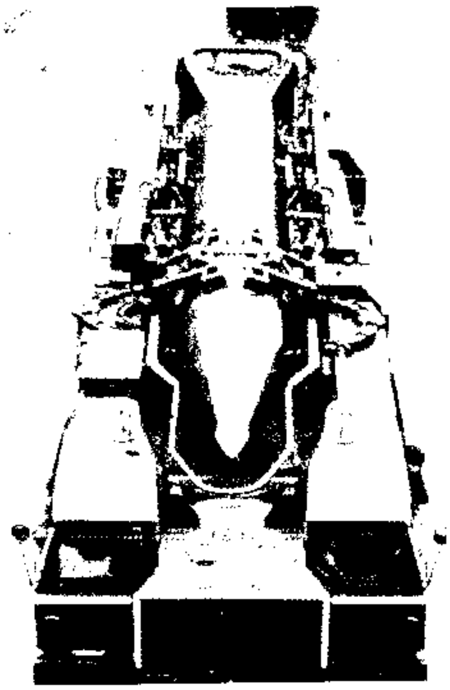
Scud-B missiles being erected (Novosti)

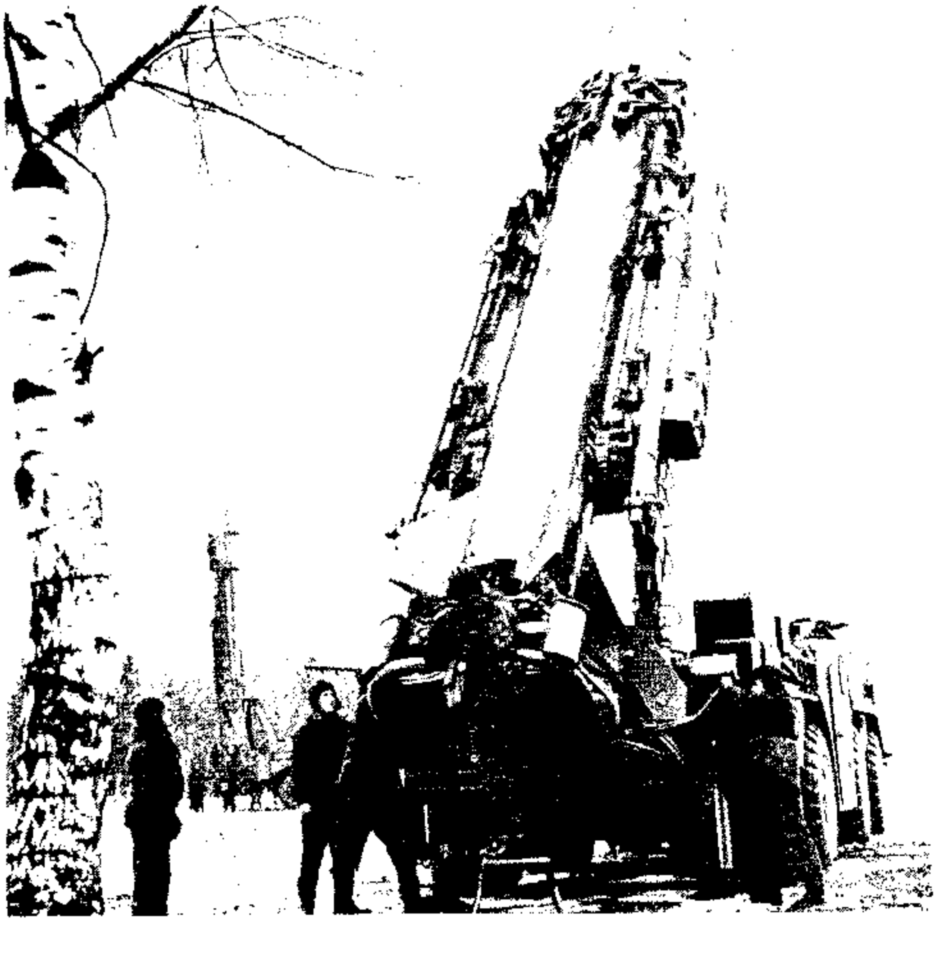


Two views of Soviet troops undergoing training with Scud-B surface-to-surface guided missiles (Tass)

2970.111
SS-1C (SCUD B) BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:
Scud B, which is generally identified with the US code SS-1C, is somewhat larger than Scud A (about 0.5 metre longer) and is credited with a longer range. It first made its appearance mounted on a JS-III chassis similar to that used to transport Scud A but with the cradle mounting arrangements modified to accommodate and give front support to the longer missile. It is generally agreed that this missile is inertially guided.



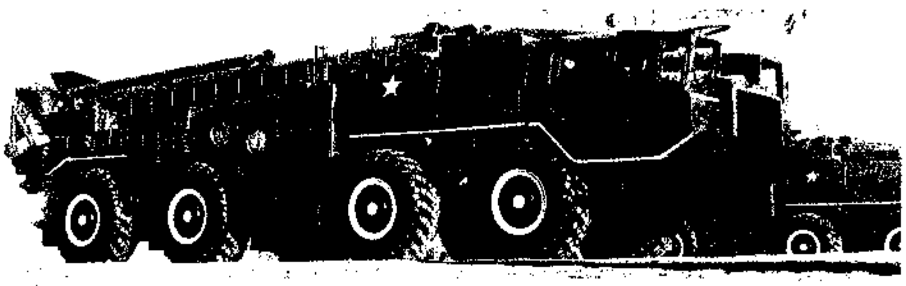


Scud B MAZ-543 mounting viewed from above

In 1965, however, the missile was seen mounted in a MAZ-543 wheeled transporter/erector/launch vehicle. The driver occupies the left-hand cab at the front and the launch operator with his console occupy the right-hand cab at the front. Behind them are seats for other members of the crew. A pair of sideways-hinged doors, between the two inner wheels on the left-hand side of the vehicle, give access to the control equipment.

CHARACTERISTICS:

Type: Surface-to-surface guided tactical
Guided Principle: Simplified inertial
Guidance Method: By movable tail fins
Propulsion: Liquid propellant sustainer
Warhead: Believed optional nuclear or high explosive
Missile Length: About 11 metres
Missile Diameter: About 85 cm
Launch Weight: Said to be about 6,300 kg



Scud-B surface-to-surface weapon system (Tass)

Range: 165-280 km – possibly a little more

STATUS:

Operational in Warsaw Pact forces. Also two brigades of "Scud missiles" were reported to have been deployed on the West bank of the Suez Canal at the time of the 1973 Arab-Israeli war. It was also reported that they were equipped with nuclear warheads. It is not definitely established that they were Scud B missiles but it seems probable.

2971.111

SS-1D (SCUD C) BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:

There have been several references in the literature to a third member of the Scud family identified as Scud C or SS-1D. It now appears, however, that these references are in all probability erroneous, and that the idea that this third missile exists arises either from confusion with the longer-range Scaleboard missile (**2959.111**), which is also transported on a MAZ-543 vehicle, or from the change of transport vehicle for Scud B.

2959.111

SS-12 (SCALEBOARD) BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:

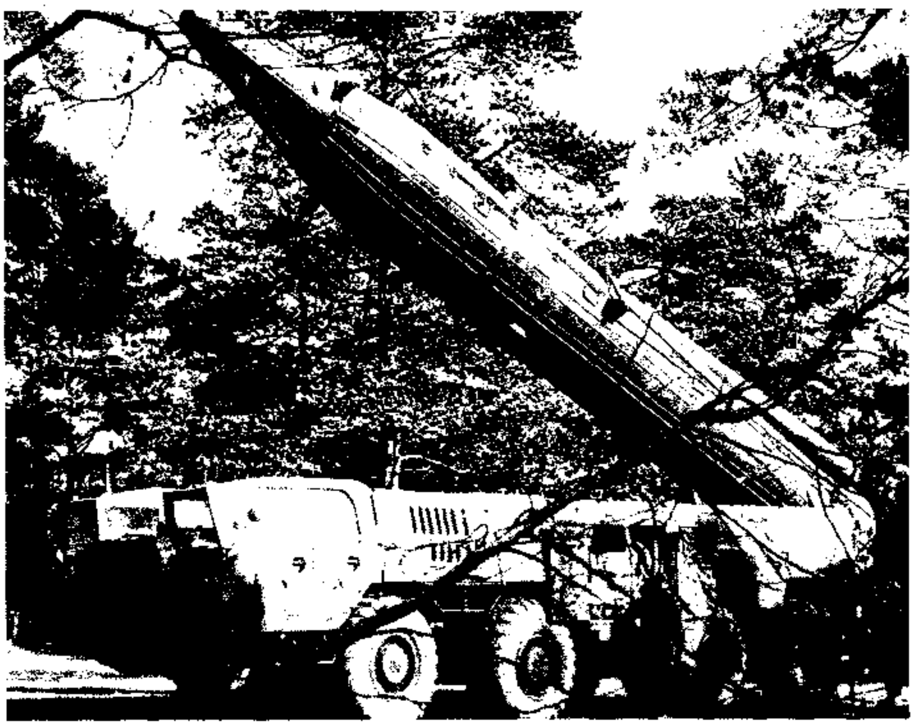
Scaleboard is the NATO name for a short medium-range ballistic missile which is identified by some sources with the SS-12 in the US series. It is a mobile missile and is normally transported on a MAZ-543 eight-wheeled vehicle similar to that sometimes used for Scud-B (**2970.111**). Its warhead has been reported to be in the megaton range. This suggests that it has rather greater destructive power than its approximate equivalent in NATO, the American Pershing missile (**2965.111**).

Unlike the Scud missiles, which in transit are exposed to view as they rest in their elevating cradles, the Scaleboard missile is enclosed in a ribbed split metal casing which is elevated with the missile into the firing position.

Scaleboard appears to be approximately the same length as Scud-B – rather more than 11 metres – but larger in diameter. Its range has been estimated in the region of 7-800 km. Nothing is known about its guidance system but it is presumed to be some form of inertial guidance suitable for use with a missile that is elevated from the horizontal to the vertical shortly before firing.

STATUS:

Believed to be fully operational in the USSR.



Scaleboard missile being erected. The access doors to the control equipment are open

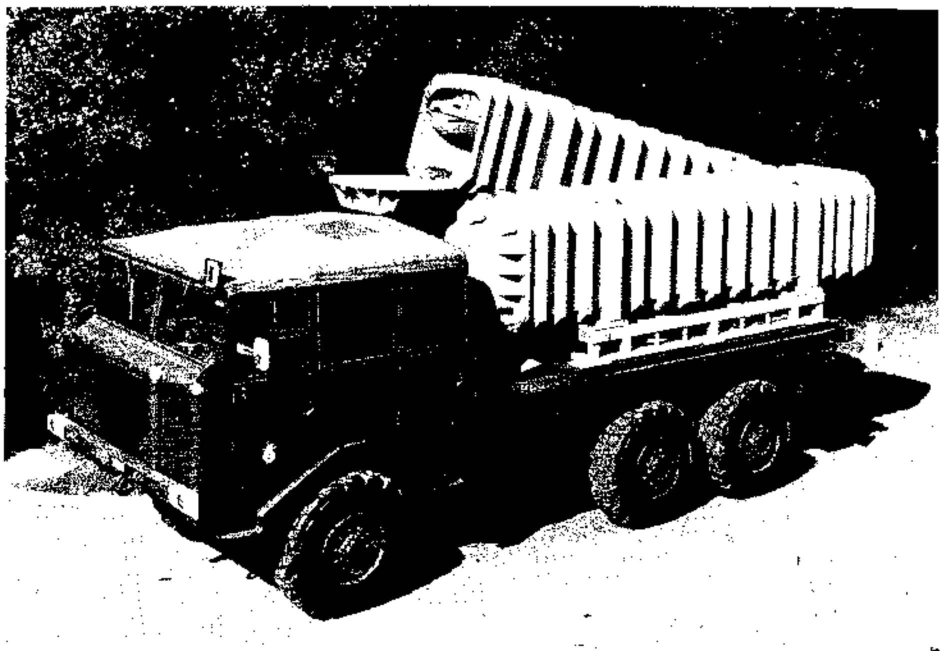
COASTAL DEFENCE WEAPONS

FRANCE

2118.121
EXOCET COASTAL DEFENCE WEAPON
Description

This entry relates to a proposal by Aérospatiale, principal manufacturers of the MM38 Exocet ship-to-ship missile system (**1156.221**), to use the missile in a coastal defence role.

The proposal has not as yet been spelt out in detail so there is no information on the radar and other ancillary apparatus that might be used. General information on the weapon system can be found in the Shipborne Weapons sub-section below. The reader's attention is particularly drawn to the note on Improved Exocet in entry number **1156.221** because one of these versions of the missile could well form the basis of a coastal defence system.



Exocet launched from fixed container

INTERNATIONAL

1337.121
OTOMAT ANTI-SHIP MISSILE (FRANCE/ITALY)
Description:

The Otomat is an anti-shipping missile initially developed for launching from naval vessels but also designed in fixed and mobile land launched and air-launched versions. Range for the land-based version, either fixed or in a vehicle, is up to 200 km and speed is in the region of Mach 1. Inertial guidance plus a radio altimeter is employed for the cruise phase of the missile's trajectory with a Thomson-CSF active homing head for the terminal phase. A more detailed description is given in Entry No. **1336.221**

Manufacturers:

Engins Matra, 78-Velizy, France.
Oto Melara, La Spezia, Italy.

SWEDEN

2372.121
RB 08 COASTAL DEFENCE WEAPON
Description:

The Swedish RB 08 surface-to-surface cruise missile is intended for use either as a shipborne weapon or for coastal defence.

Detailed information on this system will be found in the Shipborne Weapons sub-section below (**2366.221**).

RB 08A boosted off its launcher

THE UNION OF SOVIET SOCIALIST REPUBLICS

2953.121
SALISH CRUISE MISSILE
Description:

This is the NATO code-name given to a cruise missile which is similar to and probably derived from the air-launched missile whose NATO code-name is Kennel (**1148.311**) as also is the missile known as Samlet (**2951.111** below).

Powered by a turbojet motor this missile has a range that has been estimated as anything from 100 to 200 km. Since Samlet appears to be the more modern of the two missiles it may be wise to assume not more than 100 km for Salish.

When shown publicly, Salish has appeared mounted on a short ramp on a low trailer. Mounted for launching, however, it has been seen on a larger ramp and with a JATO bottle attached.

Like Samlet, Salish has a radome above the air intake in the nose. This is believed to cover a semi-active homing equipment. There are no other obvious indications of guidance equipment.

Approximate dimensions are given below in the entry for Samlet.

2951.111
SAMLET CRUISE MISSILE
Description.

Like Salish, the missile known to NATO as Samlet is a surface-to-surface version of the air-to surface jet powered cruise missile whose NATO code name is Kennel. It has been operational in the USSR, Poland and Cuba as a coastal defence weapon. When shown publicly Samlet has been mounted on what appears to be its launching ramp constructed as a trailer. For launching a JATO bottle is presumably necessary.

Samlet, like Salish, has a radome over its jet air intake. The radome is larger than that on Salish and Samlet also has what seems to be an electronics pod mounted on its tail fin. The radome is assumed to cover a semi-active radar homing seeker: the other device may contain the receiver and associated apparatus of a command guidance link. Apart from these differences the two missiles appear very much alike and the following approximate data are probably equally true of both.

CHARACTERISTICS:

Length: Approx 7.0 m

Wing Span: Approx 5.0 m

Weight: Believed about 3 tons

Cruising Speed: Mach 0.8-0.9

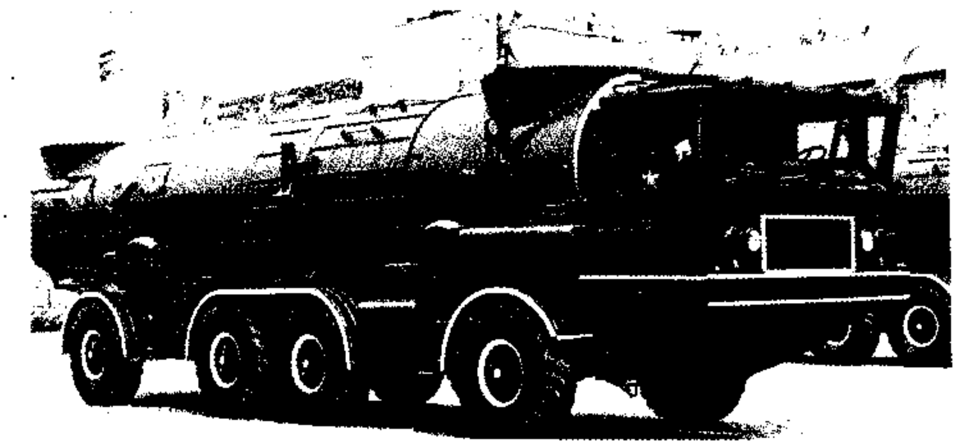
Range (Samlet): Possibly as much as 200 km with mid-course guidance

2975.121
SHADDOCK MOBILE CRUISE MISSILE

DESCRIPTION:

Too little has been seen of this missile on public display for it to be described with confidence. The general view seems to be that it is a ramjet or turbojet-powered cruise missile with hinged wings that open out when the missile leaves its cylindrical launcher. Initial boost is provided by two rocket units under the rear of the fuselage. Length of the missile is estimated at about 10 metres and the diameter of the fuselage is probably around 1.0 metre.

Shaddock – or a missile very like it – is best known as a naval weapon and is described as such below (**2976.221**). It appears, however, that it is used by the land forces of the USSR; and this view is reinforced by the appearance of the container/-transporter illustrated here which is clearly capable of elevating the missile to an inclined launch position.



Shaddock surface-to-surface cruise missile in its mobile container launcher (Novosti)

While no doubt it could be used as a ground-to-ground weapon, however, it seems rather more likely that it would be used as a coastal defence weapon – if only because of its ability to cruise at speed at low altitude over water.

Guidance is by radio-command with infra-red homing. Range capability is in the order of 450 km, but mid-course guidance by aircraft or helicopter would be necessary for such a long mission.

SHIPBORNE WEAPONS

INTRODUCTION.

This section deals with shipborne surface-to-surface weapons for anti-ship and shore bombardment purposes. In certain cases it will be found that the missile employed in such systems has other roles, and the practice in these instances is to cross refer to the appropriate entries for other applications of a given missile. In general it will be found that the most comprehensive description of the missile as a 'round' will appear under the entry for its principal function, but adequate data for an appreciation of a missile's performance is given in the entry for each system in which it is employed.

Naval guns and unguided bombardment rockets are contained in Section Three of this volume, and naval fire control systems are described in this section of the book (One).

CANADA

2035.221
CANADIAN SEA SPARROW MISSILE SYSTEM

DESCRIPTION:

This system is described more fully in a later section of this book dealing with shipborne surface-to-air weapon systems, which is the principal function of the Canadian Sea Sparrow System, also known as CCRMS (Canadian Close Range Missile System), under Entry **2036.231**. The version of Sparrow III missile used is the AIM-7E2, as applied to shipborne use and which then carries the designation RIM-7H. This missile is also employed in the NATO Sea Sparrow system (**2770.231**) but in that system the missile is provided with folding wings which allow the use of smaller containers. Both air and surface targets can be engaged by the Canadian Sea Sparrow system.

STATUS:

Early sea tests of the Canadian Sea Sparrow were conducted in the summer of 1973 and full firing tests have been scheduled for 1974. Four DDH280 Class destroyers are fitted.

MANUFACTURERS:

System – Raytheon Canada Ltd, Waterloo, Ontario, Canada.

Fire Control System – N.V. Hollandse Signaalapparaten, Hengelo (O.), Netherlands.

FRANCE

1156.221
MM 38 EXOCET SURFACE-TO-SURFACE MISSILE

DESCRIPTION:

Exocet is a surface-to-surface tactical missile designed to provide surface warships with all-weather attack capability against other surface vessels. It can be fitted in major and minor warships including fast patrol boats and hydrofoils.

The missile is in the form of a streamlined body equipped with four cruciform wings and four tail control surfaces in the same planes as the wings.

Propulsion is provided by a two stage, solid propellant motor.

Exocet's range is about twenty nautical miles (38 km), flying at very low altitude. Its cruising speed is high subsonic and it carries a high explosive warhead.

Missiles are stored in box-type containers which also serve to launch them. These launcher-containers may be installed in fixed positions or on rotatable mountings.

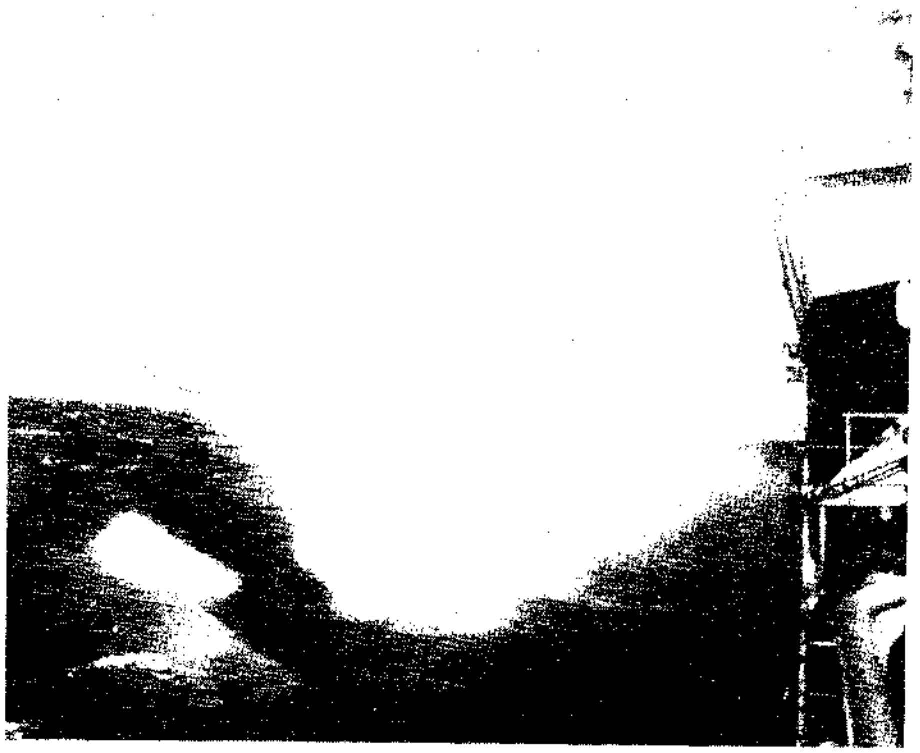
The missile flight consists of a preguidance phase during which it flies towards the target, whose range and bearing have been determined by the fire control computer and set up in the missile preguidance circuits before firing, and a final guidance phase during which the missile flies directly towards the target under the control of its active homing head. Throughout the whole flight the missile is maintained at very low altitude by a radio-altimeter.

Exocet is understood to use several elements similar to those fitted on the German Kormoran air-to-sea missile (**1180.321**) developed jointly by Messerschmitt-Bölkow-Blohm and Aerospatiale for instance the twin-gyro inertial guidance system for the initial trajectory. The long burn cruise motor is an extended range version of the motors used on the Kormoran and the TV version of Martel. The radio altimeter is produced by TRT under the designation RAM 01. The warhead is reported to weigh between 150 and 200 kg.

The terminal guidance phase (approximately the last 10 km) is by means of the ADAC radar homing head developed by Electronique Marcel Dassault.

To launch Exocet, the ship's fire control system is normally connected to the ITS (Installation de Tir Standard, or Exocet ship system). The ITS is assembled by the Ruelle Establishment (DTCN) under SNIAS as prime contractor, with several British sub contractors. ITS is fitted on the French, British and W. German ships armed with Exocet. The Thomson-CSF Vega fire control system (**1053.281**) can be used with or without ITS.

The TRT RAM.01 radio altimeter carried by the Exocet missile is reported to be capable of permitting safe flight at a height of between 2 and 3 m above the wave crests of the sea at a speed of Mach 1.



Exocet launch

DEVELOPMENT

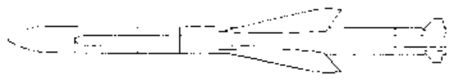
Development has been carried out by Aérospatiale in collaboration with the French Government military research establishments, to meet a French Navy requirement.

STATUS:

Exocet has been adopted as the standard surface-to-surface missile of the French Navy. Official announcements have been made regarding orders from West Germany, Greece and the United Kingdom and other negotiations are in progress with countries interested in purchasing the system for either shipborne or shore-based applications. Early in 1972 it was the manufacturer's view that there was a market for a minimum of 1,500 missiles and by the end of that year some 600 had been ordered. Production at that time was under 10 units per month but a rate of about 25 per month was thought possible without retooling.

Manufacturer's tests were concluded in July 1972 with a direct hit, by a missile fitted with a live warhead, on a 350-ton hulk which was sunk.

Evaluation trials by the French Navy, with the participation of the Royal Navy and the West German Navy, began in October 1972.



MM38 Exocet

The first French naval vessel to be equipped with the missile is the ASW frigate *Tourville*. Six Exocet launchers are mounted.

The missile is already operational on four FPBs of the Greek Navy, each of which is equipped with four missiles. Deliveries to the Royal Navy began in March 1974. Other countries known to have ordered Exocet are Brazil, Chile, Malaysia and Peru.

Improved Exocet

An improved version of Exocet, using an improved solid propellant motor, is in development. It is understood that final decisions on possible configurations have not yet been taken but because the new motor offers the possibility of producing either a smaller and lighter missile with the MM 38 performance or a missile of the size of the MM 38 with superior performance it may be that more than one "Mark 2" version will be tried. Smaller versions could find applications on hydrofoils and other light vessels or on submarines (**2219.421**) whereas the more powerful versions would be useful in coastal and possibly some airborne applications.

In the latter part of 1973 two air-launched versions of Exocet were revealed under the designations AM-38 and AM-39, for helicopter and fixed-wing deployment, respectively. These are described in the section on air-to-surface tactical weapon systems which appears later in this book.

MANUFACTURERS:
Aérospatiale, Rue Béranger, Chatillon-sous-Bagneux, France (System Manufacturer)
Electronique Marcel Dassault (ADAC electromagnetic homing head), also Plessey.
TRT (altimeter)
British Aircraft Corporation (radomes).

INTERNATIONAL

1336.221
OTOMAT ANTI-SHIP MISSILE (FRANCE / ITALY)

DESCRIPTION:

Otomat is an anti-ship missile intended initially for launching from naval platforms of any size from fast patrol boat upwards, but also capable of land deployment (fixed or mobile), and use from aircraft. The main physical characteristics of the missile are: length 440 cm, diameter 40 cm (front) and 46 cm (rear), wing span 1.19 cm, and weight about 700 kg (shipborne version). Weight for the aircraft-launched version is much reduced by elimination of the boosters which are not required in this mode of operation. The helicopter and land versions weigh the same as the shipborne model. A semi armour-piercing warhead of over 200 kg is carried. The speed has not been revealed but may be assumed to be close to Mach 1.

Otomat missiles are delivered in containers which also serve as launchers, the containers being mounted on prepared locations. Propulsion during cruise is by a Turboméca turbojet engine, the four air inlets for which are in the wing roots. Two lateral jettisonable boosters are attached for the launch phase. Range is over 80 km, but fuel capacity is stated to be sufficient for ranges beyond the conventional radar horizon of a ship.

A Mark II version of Otomot has been developed, the principal features of which are increased range (about 100 km) and the use of a new homing head produced by the Italian SMA concern (Segnalamento Marittimo e Aero). The latter allows Otomat to follow a sea-skimming flight path up to the point of impact with the target. The Otomat Mk I, which is fitted with a Thomson-CSF 'Col vert' homing head performs a late 'pull-up' and dive trajectory to the target. A third version, which has a reported range of 200 km, is in development for the Italian forces under the designation Téséo. This is probably for coastal defence applications.

OPERATION:

Subsequent to launching the Otomat follows a cruise phase towards the target's predicted position, flying at low level under radio altimeter control and inertial guidance. An active homing head is used for the terminal phase.

The Otomat is claimed to be compatible with any normal target designation radar and fire control system.

DEVELOPMENT:

Development of the Otomat began in 1969 under a fixed-price contract and was jointly undertaken by Engins Matra in France and Oto Melara in Italy. The programme was first revealed in late 1970. Prior to the combined effort, each of the two concerns had been working individually in this area of missile technology.

Frame from cine-record of Otomat test firing

STATUS:

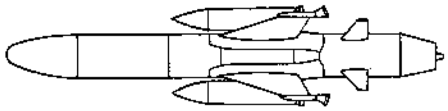
First test firings took place in early 1971, booster acceleration tests taking place in Sardinia in April of that year. Guided test firings started in December 1971 and the first complete test of the system took place in February 1972 and was completely successful, the missile impacting on its target several tens of kilometres away.

The first launch of Otomat Mk II took place in January 1974.

An extended range version, known as Téséo, is in development for coastal defence purposes.

STATUS:

In February 1974 it was announced that orders had been received for 120 Otomats. Most of these are for the Italian Navy which will equip six hydrofoil patrol craft and some coastal batteries. Forty are stated to have been ordered by Venezuela to arm four patrol boats, and these are due for delivery in 1974. A third, unnamed country is reported to have ordered Otomat.



Otomat Mk I

MANUFACTURERS:
Engins Matra, 78-Velizy, France.
Oto Melara, La Spezia, Italy.

ISRAEL

6019.221
GABRIEL SHIPBORNE SURFACE-TO-SURFACE MISSILE

DESCRIPTION:

Gabriel is a shipborne anti-ship missile developed in Israel and designed for installation in ships from about 250 tons upwards.

A sea-skimmer, the missile is transported in, stored in, and launched from hermetically sealed, reinforced fibreglass containers which also hold the missile launching rail and the hydraulically-operated container door. The missile is pre-adjusted and tested and requires no further tests or adjustments after installation. The standard

Gabriel firing from Israel fast patrol boat. One of the launch cells can be seen launcher carries three missile cells on a rotatable pedestal, but single, possibly fixed, cells also exist. The missile, whose general configuration can be seen from the accompanying photograph, is powered by a solid-propellant rocket motor.

A sophisticated guidance and homing electronics system is carried by the missile, all parts of which appear to have been developed in Israel. While details of this system have not been made public it appears that over the major part of its trajectory the missile is radar-guided in the horizontal plane and maintains its height above surface by means of radio altimeter. A manual/optical alternative control system is available for use in conditions where radar guidance is not practical. When it nears the target the missile's homing system takes over: this has been described as a semi-active radar homing system, but it seems probable that an alternative form of homing is also available for use in ECM conditions.

Gabriel's cruising speed is in the high subsonic region. It was announced during 1972 that there were two versions of Gabriel in production, one having nearly twice the range of the other. It is believed, however, that the only differences between the two are that one has a larger propulsion unit and may incorporate additional guidance equipment for over-the-horizon operation.

According to one American source, the latter capability is achieved by adding a television camera to the Gabriel missile and providing the necessary video and command links.

CHARACTERISTICS:

Type: Shipborne surface-to-surface guided weapon system

Guidance: Radar control from ship plus missile-borne homing system

Propulsion: Solid-propellant two-stage rocket motor. First stage 3,600 kg for 3 seconds. Second stage 77 kg for 100 seconds (short-range version) or 200 seconds

Warhead: High-explosive 180 kg

Length: 3.35 m

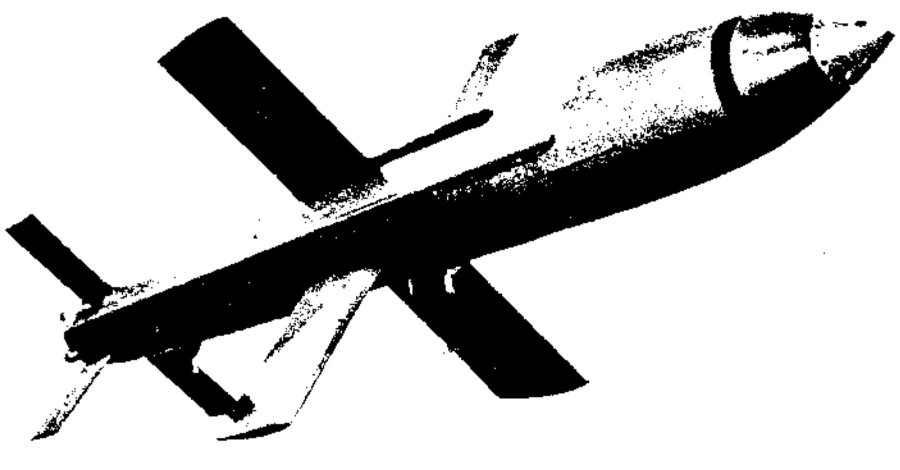
Diameter: 32.5 cm

Wing Span: 60 cm and 138 cm

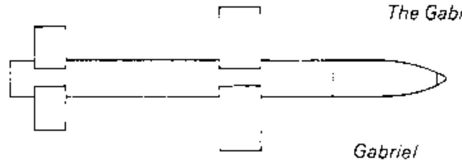
Launch Weight: 400 kg

Range: 2 – 22 km (1 – 14 nm) or 2 – 41 km (1 – 26 nm)

Speed: Mach 0.7



The Gabriel missile



Gabriel

STATUS:

Developed in Israel during the nineteen-sixties, the missile is now operational in fast patrol boats of the Israeli Navy. In addition, up to the end of May 1972, export orders to a value in excess of £15 million had been received for the missile. Names of customers have not been disclosed but at least one is believed to be South American and Singapore has been quoted as another user.

Missile prices have been reported to be in the region of £35-40,000 or about £1 million for a six-launcher installation with radar, directors, etc. This gives some indication of the scale of Gabriel sales overseas.

The launch of the first of a new series of Israeli-built 415-ton patrol boats was announced in February 1973. It is understood that these vessels will be equipped with the long-range Gabriel missile.

MANUFACTURER:

Israeli Aircraft Industries Ltd, Lod Airport, Israel.

Gabriel missile in its launch container

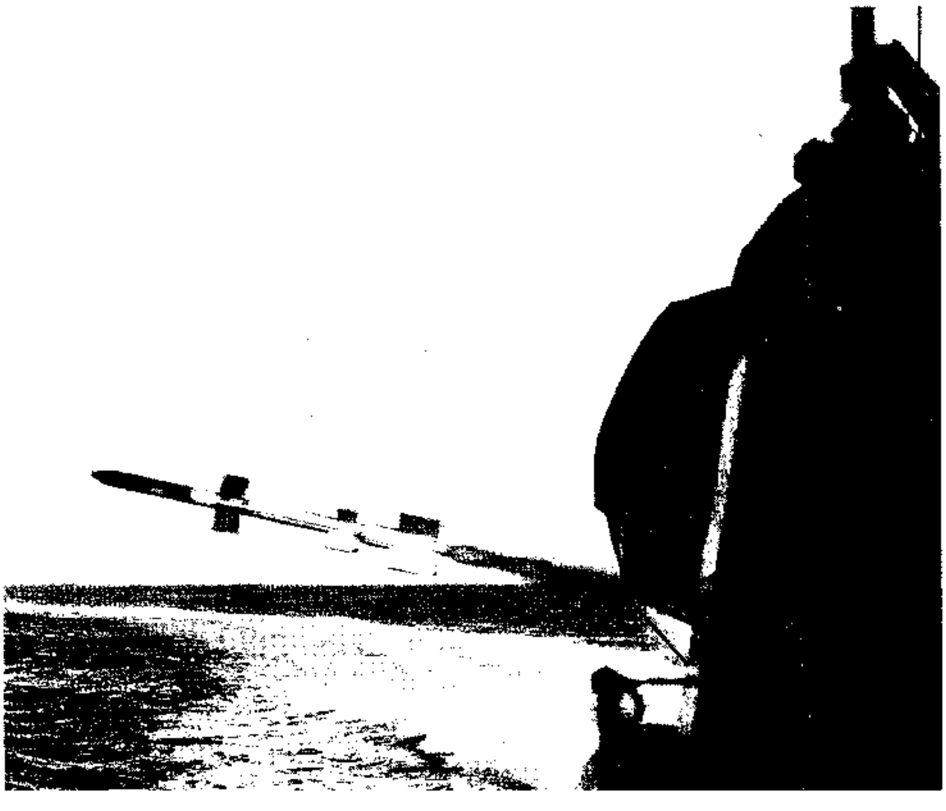
ITALY

2241.221
SEA KILLER MISSILE SYSTEMS

The Italian shipborne surface-to-surface missile systems Nettuno (**2240.221**) and Vulcano (**2253.221**) have long been known outside Italy as Sea Killer Mk 1 and Sea Killer Mk 2 respectively. Both systems were originally developed by Contraves Italiana SpA and were taken over by Sistel SpA when that company was formed in 1969.

Sistel (Sistemi Elettronici) SpA was formed jointly by Montecatini Edison, Contraves Italiana, Fiat, Finmeccanica and Snia Viscosa, to develop new products in the missile field, benefiting from the experience of Contraves in this area. This venture has been supported by the Italian Ministry of Defence.

The alternative names mentioned above have now been abandoned officially in favour of the Sea Killer nomenclature, which has been retained for the latest weapon of this family, Sea Killer Mk 3 (**2242.221**).



Sea Killer Mk 2 launch

2240.221
SEA KILLER MK 1 (Nettuno)

DESCRIPTION

A short-range ship-based surface-to-surface guided missile, (formerly Nettuno but now officially the Sea Killer Mk 1) is now in service with the Italian Navy. Both the Mk 1 and Mk 2 Sea Killer missiles can be employed in the Marte (**1651.231**) helicopter anti-ship weapon system.

OPERATION:

Launched from a trainable five-round multiple launcher the missile normally operates as a beam-rider for bearing guidance – using the Sea Hunter (**7021.281**) or similar fire control radar – while altitude control is provided by means of a missile-borne radio altimeter which can be controlled from the launch point to adjust the height of the missile in flight. Alternatively, if beam-riding is rendered impossible by interference, provision is made for radio command control of the missile – optical tracking being by means of a television sub-system which, together with the command transmitter, is mounted on the Sea Hunter radar pedestal. An important characteristic of the guidance technique is the achievement of a very low flight altitude which makes it difficult for an enemy to detect and track the missile.

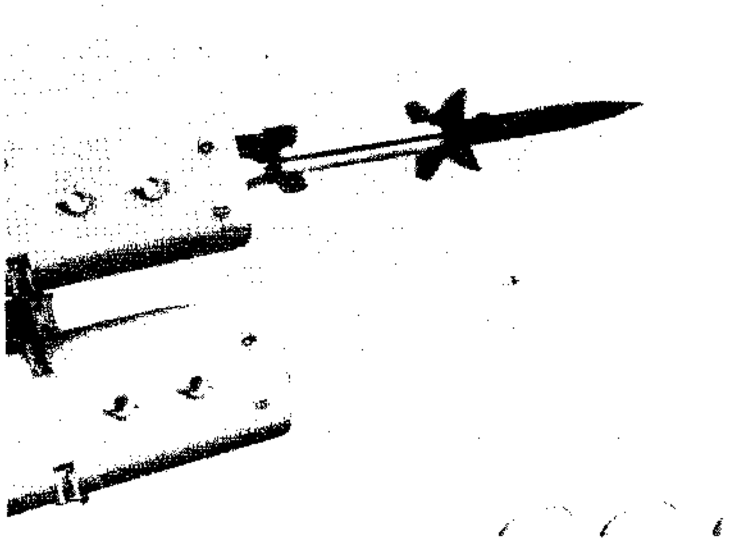
Sea Killer Mk 1 is intended to be integrated with the ADT A40 (Sea Hunter 2) or a similar fire control system although integration with other similar radars has been studied and offered to a number of potential users. The ADT A40 is basically a gun fire control system but it can be upgraded to a gun/missile control system by the addition of a small quantity of additional apparatus.

CHARACTERISTICS:

Type: Shipborne short-range surface-to-surface tactical guided missile

Guidance Principle: Beam-rider/radio command/radio altimeter plus optical/radio command guidance in interference conditions

Guidance Method: By control of movable cruciform surfaces at mid-point on body. Stabilisation by cruciform tail fins.



Sea Killer Mk 1 launch

Propulsion: Solid-propellant rocket motor, 2000 kg st for 5 seconds

Warhead: High explosive (35 kg) fragmentation type with impact/proximity fuse

Missile Length: 3.73 metres

Missile Diameter: Body (cylindrical): 0.206 metres. Span: 0.857 metres

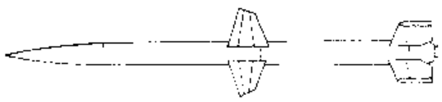
Launch Weight: 170 kg

Speed: Subsonic after burnout

Range: Over 10 km

DEVELOPMENT:

Development was initiated by Contraves Italiana SpA in 1963 and the first prototype was completed in 1966. The first service installation was made in 1969. In the same year responsibility for the project was taken over by Sistel SpA.



Sea Killer Mk 1

Subsequently, the Sea Killer Mk 1 has been applied to the helicopter-launch role in the Marte programme (**1651.321**) described in the air-to-surface tactical missiles section.

MANUFACTURER

Sistel SpA, Via Tiburtina 1210, 00131-Rome, Italy.

2253.221
SEA KILLER MK 2 (Vulcano)

DESCRIPTION

Similar in many respects to the earlier Sea Killer Mk 1, the Mk 2 Sea Killer (once bearing the Italian designation Vulcano) is a shipborne surface-to-surface tactical guided missile. It is, however, larger than Sea Killer Mk 1 and is powered by a two stage rocket motor. Both the Mk 1 and Mk 2 Sea Killer missiles can be employed in the Marte (**1651.231**) helicopter anti-ship weapon system.

OPERATION:

Like the Mk 1, Sea Killer Mk 2 can be launched from a trainable five-round multiple launcher and uses the same beam-riding plus radar altimeter guidance supplemented by radio command guidance when required. The missile can also be launched from deck-fixed launching containers if this is operationally more convenient. The missile's ability to cruise close to the surface of the sea is operationally important.

Sea Killer Mk 2 is also intended to be integrated with the ADT A40 (Sea Hunter 4) or a similar fire control system, the missile checkout, firing and guidance control being centralised in the missile control console. No launcher crew and no shipboard maintenance of missiles is required.

CHARACTERISTICS

Type: Shipborne medium-range surface-to-surface tactical guided missile

Guidance Principle: Beam-rider/radio command/radio altimeter plus optical/radio command guidance in interference conditions

Guidance Method: By control of movable cruciform surfaces at mid-point on body. Stabilisation by cruciform tail fins

Propulsion: Solid propellant booster and sustainer. SEP 4,000 kg st and SEP 100 kg st

Warhead: Semi-armour piercing high explosive (70 kg). Impact and proximity fuses

Missile Length: 4.7 metres

Missile Diameter: Body: 0.206 metres. Span: 0.999 metres

Sea Killer Mk 2 launch

Launch Weight: 270 kg

Speed: Transonic. Subsonic after burn out

Range: 25 km

DEVELOPMENT

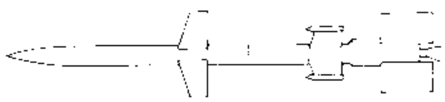
Development was initiated by Contraves Italiana SpA in 1965 and the first prototype was completed in 1969. In the same year the project was transferred to Sistel SpA. The system is operational on four Vosper Mk 5 frigates of the Imperial Iranian Navy and the missiles are in production.

Like the Sea Killer Mk 1, the Mk 2 version is used in the Marte helicopter-launched anti-ship missile system (**1651.321**).

MANUFACTURERS

The missile is manufactured by Sistel SpA, Via Tiburtina 1210, 00131 Rome, Italy.

Sea Killer Mk 2 missile



Sea Killer Mk 2

2242.221
SEA KILLER MK 3 SHIPBORNE SURFACE-TO-SURFACE MISSILE

DESCRIPTION:

This third missile in the Sea Killer series, now under development, incorporates features that have proved satisfactory in earlier members of the series but is a larger and more powerful weapon with a bigger warhead, a longer range and a more elaborate guidance system. Significant missile changes are the provision of a second sustainer motor and the addition of radar homing.

Basically, the system comprises a missile control console (MCC), launchers and missiles, but with these must be associated a stabilised platform, the ship's log, an anemometer and appropriate primary and secondary radars or other target information sources; the platform and log, of course, provide ship's motion data to the MCC.

Once a target has been identified as hostile its position data are inserted, in digital form, into the MCC where the launch computer determines, from these and the other input data, whether or not the target can be engaged. If it can, the computer generates a flight programme for the missile which, after a predetermined boost phase, will bring the missile to within radar homing range of the target.

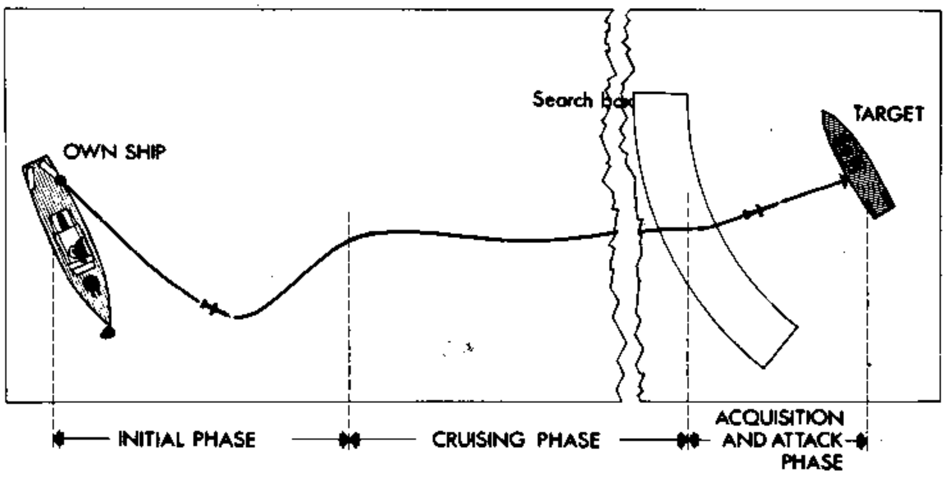
This programme is continuously updated until the firing command is given, whereupon the computer takes control of the automatic launching sequence.

The first phase of the missile's flight is a booster-powered climb during which the booster burns out and separates. At the peak of the climb the missile reaches an altitude of 120 metres. Following booster separation roll control is activated, the missile flight is stabilised and the missile is automatically guided according to the programme inserted by the MCC. Azimuthal guidance is by directional gyroscope and the required altitude is maintained by reference to a radio altimeter. During all the post-boost phases propulsion is provided by the sequential firing of the two sustainer motors.

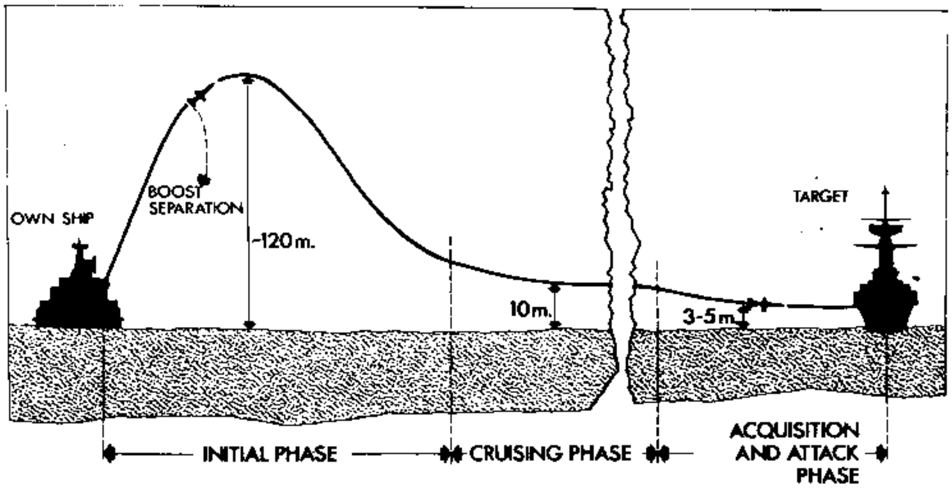
This second or cruise phase of the flight ends when the missile reaches a point within a "box" which is close enough to the target for the radar homing system to work with a high probability of success. Once automatic detection has taken place the homing radar tracks the target and steers the missile to its destination. During the search phase of this final process the homing radar uses a 4 km distance gate (although the maximum acquisition range of the radar on a typical ship target is considerably more than that). After lock-on the antenna search stops and range and azimuth tracking circuits are energised, using the target co-ordinates determined during the acquisition phase as imputs.

CHARACTERISTICS:

Type: Shipborne extended range surface-to-surface tactical guided missile



Flight phases in horizontal plane



Flight phases in vertical plane

Guidance Principle:
Cruising phase:
Horizontal: directional gyroscope system
Vertical: radar altimeter
Attack phase:
Horizontal: active radar homing
Vertical: radar altimeter

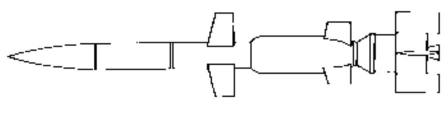
Guidance Method: By one set of cruciform wings at the centre of the missile

Propulsion: Solid propellant booster with approx 10,000 kg st for 1.6 sec plus two solid propellant sustainers each of approx 100 kg st for 70 secs

Warhead: HE, semi-armour-piercing. Weight 150 kg. Impact/proximity fuse

Missile Length: 5.3 metres

Wing Span: 1.09 metres



Sea Killer Mk 3

Cruising Speed (after booster burn-out): 280 m/sec

Launch Weight: 548 kg approx

Range: More than 45 km. Very low level

STATUS:

Development

MANUFACTURER:

Sistel SpA, Via Tiburtina 1210, 00131-Rome, Italy.

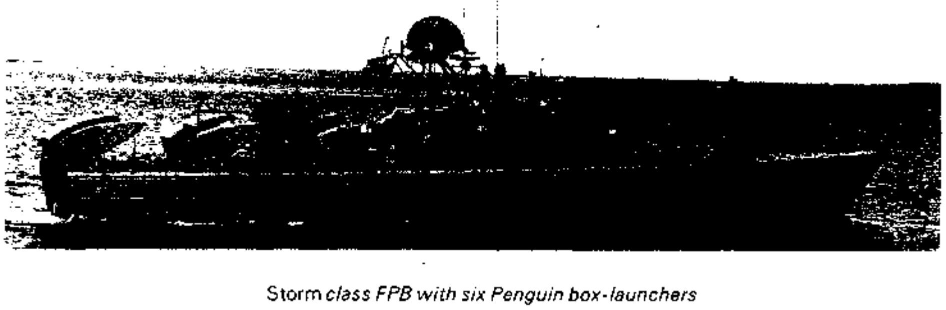
NORWAY

1339.221
PENGUIN ANTI-SHIP MISSILE

DESCRIPTION:

Penguin is a surface-launched anti-shipping missile primarily intended to provide small, fast naval craft with a powerful striking capability against larger vessels. It carries a 120 kg Bullpup ASM-N-7A warhead at Mach 0.7 over a range of at least 20 km. An impact fuse is fitted and the boost and sustainer motor is solid-propellant powered.

The missile is mounted on a simple launcher which is built into a container which serves as protection against weather and also serves as packing for transport to and from the ship. This unit, the box-launcher, is delivered as a complete and tested item from the base to the ship. Combined weight of box-launcher and missile is about 500 kg. Typical ship installations comprise four or six deck-mounted box-launchers. These are located on prepared mounts which incorporate an



Storm *class FPB with six Penguin box-launchers* umbilical cord connection. When fitted, the missiles are ready for immediate firing and no on-board service or repair is performed. Automatic testing can be effected from the missile control panel in the operations room.

OPERATION:

The Penguin missile employs inertial guidance for the cruise phase of its flight path, with passive infra-red homing to the target for the terminal phase. After launch the missile is thus independent of the parent vessel which is thereby freed to take evasive action or engage a further target.

Design requirements included missile range comparable to the maximum effective radar range for fast patrol boats and a passive mode of operation. Target detection, acquisition and designation is therefore by means of the launch vessel's radar and fire control system. Upon target acquisition, the fire control computer calculates the bearing so the predicted point of impact and the missile inertial guidance system is automatically slaved to the Kongsberg SM-3 computer data. The missile is then fired in the general direction of the target. After launch, the missile follows a programmed trajectory toward the predicted impact area. This programme can be varied.

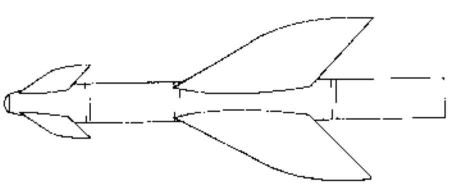
Prior to acquisition of the target by the missile's infra-red homing system this operates in a search mode, scanning a sector ahead of the flight path. Upon detection of the target, the homing system tracks the target and generates signals which are used to direct the missile to the target.

The Norwegian operational requirements relating to the Penguin system call for a warhead capable of inflicting serious damage on a destroyer. A vessel of this type, in normal circumstances would be capable of detecting an attacking fast patrol boat whilst still beyond the latter's radar range. Although not mentioned by the Norwegian authorities, the Penguin system would appear to have the potential to counter this by a completely passive mode of attack.

Passive direction finding equipment could provide bearing information on the radar transmissions of a potential target, and this information could be used to provide the Penguin missile guidance system with initial cruise data.

CHARACTERISTICS:

Type: Shipborne surface-to-surface tactical guided missile



Penguin

Guidance Principle: Inertial en-route guidance with infra-red terminal homing

Guidance Method: Aerodynamic by moving wings

Propulsion: Two-stage solid-propellant motor

Warhead: 120 kg semi-armour-piercing. Impact fuse

Length: 3.00 m

Diameter: 28 cm

Span: 1.40 m

Launch Weight: 330 kg

Weight with Box-Launcher: 500 kg

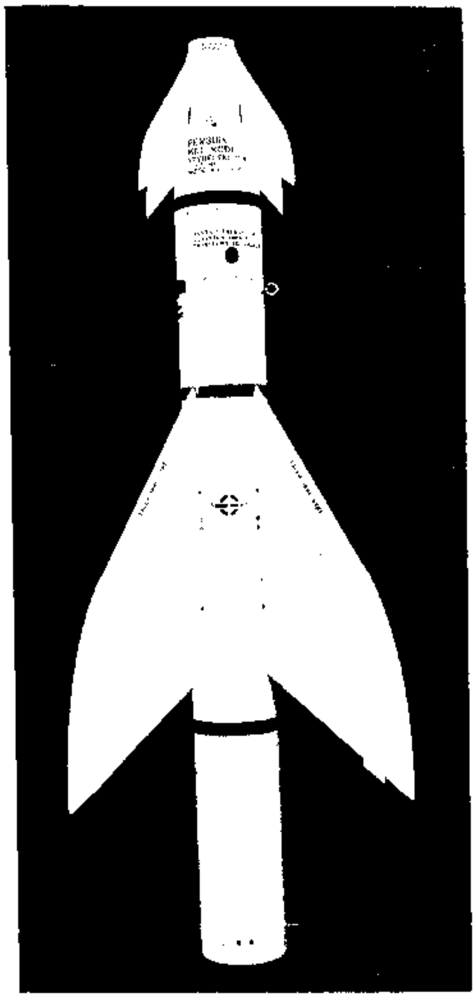
Cruising Speed: Mach 0.7

Range: At least 20 km (11 nm)

DEVELOPMENT:

Development was initiated in the early 1960s at the Norwegian Defence Research Establishment in response to an assessment of Royal Norwegian Navy requirements. These two bodies and A/S Kongsberg Vaapenfabrikk have worked in close co-operation since the inception of the programme. Financial support, through bi-lateral agreements, has been given by the US and West German Governments. Technical and test support facilities have been provided by the US Navy.

Although originally designed for deployment on smaller naval craft, the Penguin system is well suited to use on larger vessels. It is also being considered for use in coastal defence and studies have been made of its use from helicopters. In the latter case, minor modifications only are stated to be necessary. Additionally, a modified version without the booster motor and with a smaller wingspan is being considered for use from jet fighters, but so far as is known, this project has not progressed beyond the study stage.



The Penguin missile

STATUS:

Operational in *Snogg*-class and *Storm*-class patrol boats and Oslo Class frigates of the Norwegian Navy, and on patrol boats of another country.

MANUFACTURER:

A/S Kongsberg Vaapenfabrikk, Postboks 25 – 3601 Kongsberg, Norway.

SWEDEN

2366.221

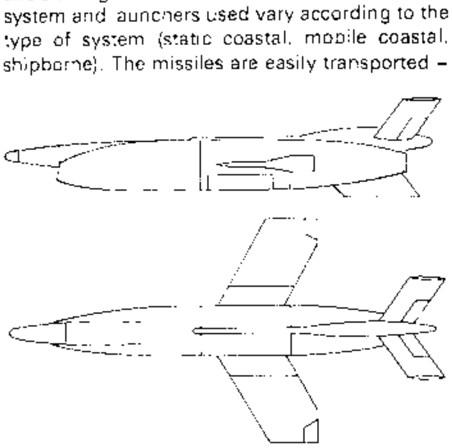
RB 08A

DESCRIPTION:

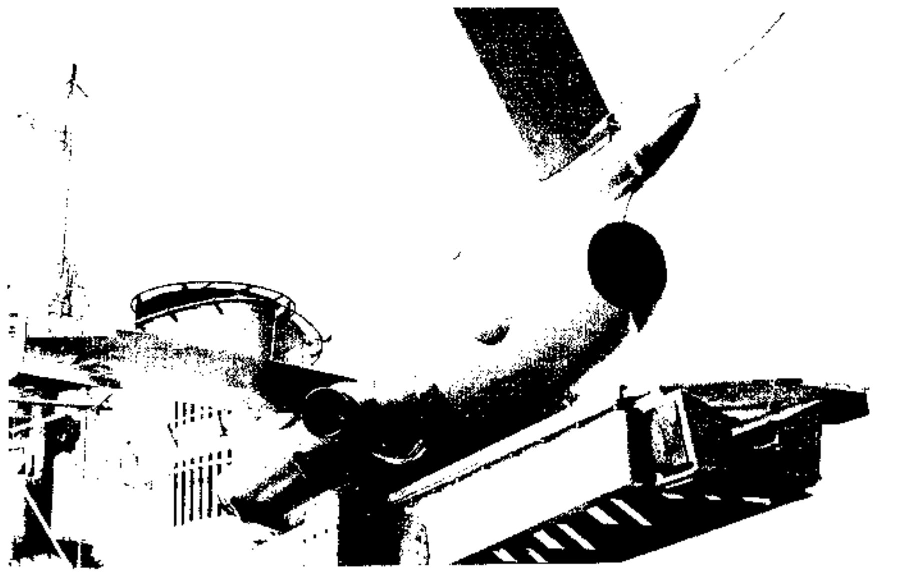
RB 08A is a surface-to-surface long-range cruise missile system intended for coastal defence and ship-to-ship use.

Based on the Nord CT 20 target drone, the missile is a rocket-launched turbojet-powered monoplane carrying a warhead large enough to destroy an average freighter. The complete system comprises the missile, the fire control system and starting box and the launchers; of these the missile and starting box are common while the fire control system and launchers used vary according to the type of system (static coastal, mobile coastal, shipborne). The missiles are easily transported – the wings fold – and the amount of other equipment required for a mobile battery is not great.

The range of the system is not disclosed, but it may be noted that the Nord CT 20 drone has an endurance of 60 minutes and a maximum speed of 900 kmn at 10,000 metres. Since the all-up weight of the RB 08 is considerably greater than that of the CT 20 and since the RB 08 has the same power plant as that version of the CT 20 to which the figures above refer, a substantial reduction in endurance must be expected; nevertheless it seems probable that the system range is more likely to be limited by other factors than by the range capability of the missile.



RB 08A



RB 08A cruise missile on a shipboard launcher

SYSTEM DESCRIPTION:

The target is detected (by radar or by other means such as patrol boats or reconnaissance aircraft) and the target data are sent to a fire control director assisted by a computer. On the basis of these data and missile performance, the computer gives orders to the launcher.

The missile is launched by a booster unit which separates when expended. After climbing and further acceleration the missile reaches cruising altitude and speed; the climb being interrupted at a pre set altitude which is then held by a constant altitude device. In the last part of the flight the missile is guided towards the target by the homing equipment.

AUTOPILOT:

The autopilot consists of a constant altitude device, a programmer, two free gyros, one rate gyro, a signal transforming head and logic circuits. Signals from the homing head, the constant altitude device and the gyros are converted to steering signals fed to the wing spoilers and the elevator actuator. Pitch demands are met by elevator movement: yaw demands are met by actuating the spoilers to roll the missile and then by elevator movement.

HOMING EQUIPMENT:

No details have been released concerning the operation of the homing equipment, but it seems likely that it is a radar operating in one of the higher frequency bands and capable of distinguishing between the target vessel and the surrounding sea clutter. The homing head is mounted in the nose of the missile; the warhead is mounted in the middle of the fuselage. It has been reported in France that homing heads for the RB 08A are supplied by Thomson-CSF.

CHARACTERISTICS:

Type: Surface-to-surface cruise missile system

Guidance Principle: Directional launch, followed by autopilot control, terminal guidance probably active radar homing

Power Plant: Turbomeca Marboré IID (400 kg static thrust) Booster rocket assembly for launch

Span: 3.01 metres

Length: 5.72 metres

Height: 1.33 metres

Missile gross weight: 900 kg

Booster unit weight: 315 kg

Total launch weight: 1,215 kg

HISTORY

Work on the RB 08 system was initiated by the Royal Swedish Navy and the first design study was carried out in 1959. There followed several years of development and investigation work, and then in 1964 Saab was appointed prime contractor for the system. RB 08 first went into service in Sweden in 1967.

Production of the weapon ceased in February 1970. It is understood that no successor system is planned.

MANUFACTURERS:

Prime contractor. Saab-Scania, 581 88 Linköping, Sweden.

Missile body and autopilot: Aérospatiale, France.

Turbojet engine. Turboméca, France.

Electronics: Thomson-CSF, France: Standard Radio & Telefon AB, Sweden. AB Jungner, Sweden.

THE UNITED STATES OF AMERICA

2641.221

HARPOON SHIPBORNE SURFACE-TO-SURFACE MISSILE (RGM-84A)

DESCRIPTION:

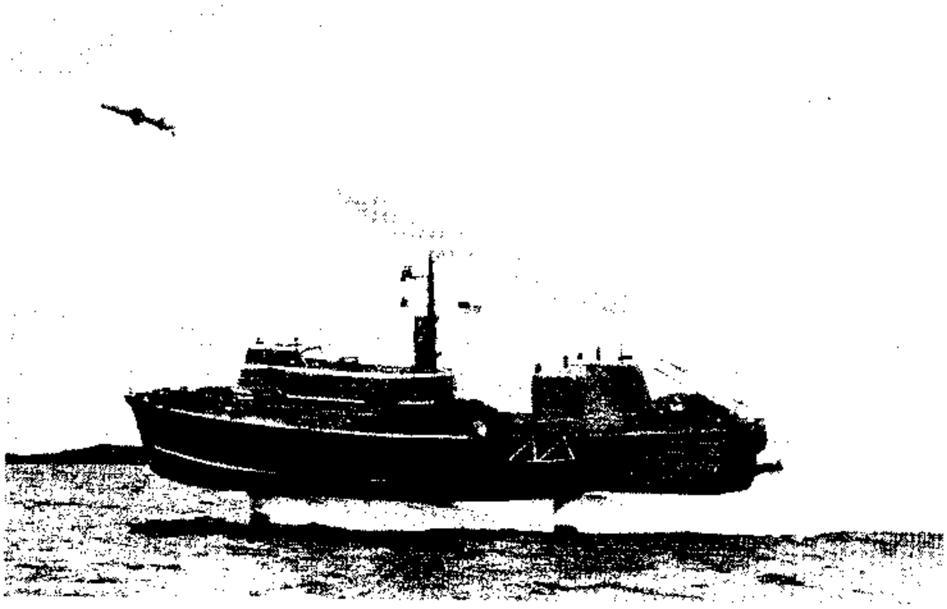
Harpoon (RGM-84A) a high-subsonic anti-ship tactical cruise missile which is being developed for the US Navy and which is expected to enter service in the mid-1970s.

This missile is officially regarded as the principal anti-ship weapon and has been designed for launch from all classes of USN surface ships (except patrol gunboats), the S-3 Viking and P-3 Orion maritime patrol aircraft, USN A-6 and A-7 attack aircraft, and in a special encapsulated form, from all but the oldest nuclear attack submarines. The airborne and submarine versions are described elsewhere in this book (entries **1301.221** and **2642.421** respectively) and the following description relates primarily to the shipborne version, although much of the system is common to all three applications.

An all-weather system, Harpoon has been specified in a way that is intended to achieve operational flexibility and adaptability to existing systems. The main body of the missile with its cruise-phase propulsion and guidance systems, homing and terminal manoeuvring systems, ECCM facilities and warhead is common to all applications; the aerodynamic surfaces of this part of the system exist in two forms, one of which will always be used for airborne and sometimes for surface launchings while the other will always be used on submarines but also for certain types of surface launchings.

For all other than airborne launchings an additional boost section contains a solid-propellant boost motor. This propels the missile on a ballistic trajectory which it follows until the booster separates: after which the missile descends to a low cruise altitude, determined by its altimeter, and flies to the target under the power of its turbojet cruise motor. In the terminal phase the missile executes a "pop-up" manoeuvre to evade close-in enemy defences and enhance the effectiveness of its warhead. Aerodynamic control throughout is by four movable fins on the main missile body.

The weapons control system for Harpoon AN/SWG-1(V), is produced by McDonnell-Douglas, with Sperry as subcontractor for the Command and Launch console. Targeting data are provided by a Command and Launch Subsystem, which interfaces with the missile-borne equipment to programme and launch the missile. The Harpoon Data Processor is a general-purpose digital computer which receives targeting and attitude data from standard shipborne equipment (or from a third party for over the-horizon operations) and computes the necessary missile and launcher orders. After launch, en-route guidance is provided by a missile-borne system consisting of a strap-down attitude reference assembly and a digital computer: no data inputs from the ship are required by the missile after it has been launched. Cruise altitude is monitored by a radar altimeter and flight control commands are interpreted by electromechanical actuators operating on the fins. This guidance system is designed to operate satisfactorily when the missile is launched at any angle up to 90° from the required course line.

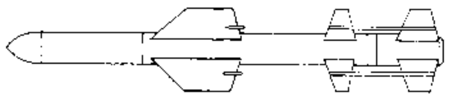


Harpoon launch from PCH-1, High Point, the US Navy's oldest operational hydrofoil. A series of test firings to evaluate a canister-type launcher/container was carried out in December, 1973 and January, 1974 at the joint Canadian-US range in Nanoose, Canada

Terminal guidance is achieved by means of a Texas Instruments DSQ-28 active radar homing system which maintains its lock until final impact. Included in the terminal guidance system is provision for the terminal manoeuvre referred to above: it should be noted, also, that the high degree of manoeuvrability implicit in this terminal pattern also means that the missile is capable of engaging targets that are taking high-speed evasive action. The radar homing system is frequency-agile, and this facility, coupled with extensive on-board computer logic circuitry, provides considerable ECCM capability to the missile in the terminal phase.

CHARACTERISTICS:

Type: Shipborne surface-to-surface tactical guided missile



Harpoon

Guidance Principle: Pre-programmed attitude reference plus radar altimeter in cruise phase; active radar homing

Guidance Method: By electromechanical control of four moving fins

Propulsion: Solid propellant booster. Teledyne CAE J402 turbojet cruise engine

Warhead: High-explosive blast type

Missile Length: With booster 4.57 m
Without booster 3.84 m

Missile Diameter: 34 cm

Launch Weight: With booster 635 kg
Without booster 500 kg

Range: Up to 60 nm (110 km)

LAUNCHERS:

Harpoon can be launched from Tartar, Terrier or ASROC launchers. In addition, however, a special Canister Launcher has been developed which will make possible the use of Harpoon on vessels (or coastal installations) where these standard types of launcher are not available. This type of launcher is, however, particularly aimed at providing Patrol Hydrofoil Missile (PHM) ships and other small surface vessels with a means of using Harpoon. Weighing some 900 kg, the launcher consists of a cluster of four Harpoon canisters, each containing one missile, and associated support structure. For use in these canisters the aerodynamic surfaces of the missile are modified to enable them to be folded within the diameter of the canister.

DEVELOPMENT:

The full history of this project can be traced back – as an air-to-surface concept – to about 1968. The idea of combining this with a ship-launched missile programme is much more recent. Requests for proposals were issued in January 1971; and in May of that year McDonnell Douglas Astronautics was selected as prime contractor and awarded a $66 million contract.

The project is now in an advanced stage of development. Successful launches have been made to demonstrate aircraft, surface ship and submarine capabilities. Entry into service is planned for the mid-1970s.

STATUS:

The weapon system development contract was awarded in June 1973. This provides for 40 prototype missiles and command and launch systems for P-3 and S-3 aircraft and a variety of surface craft. These are being used for test and evaluation work which started in early 1974. If a review of results proves satisfactory, pilot production will be initiated later in 1974. The Fiscal Year Budget allocates $58 million for development, $78 million for procurement of 150 missiles (58 for operational test and evaluation and 92 for the first operational deployment of Harpoon). 20 of the 58 test rounds are for use in Encapsulated Haproon development.

MANUFACTURERS:

Programme Direction: US Naval Air Systems Command supported by the Naval Ordnance Systems Command.

System Contractor: McDonnell Douglas Astronautics Company, 5301 Bolsa Avenue, Huntington Beach, California 92647.

Propulsion: Teledyne CAE (turbojet), Aerojet Solid Propulsion Co (booster).

Guidance: IBM, Lear Siegler, Texas Instruments.

Radar Altimeter: Honeywell

2669.221
INTERIM SURFACE-TO-SURFACE MISSILE (ISSM)

DESCRIPTION:

Initiated in 1971 as the Interim Surface-to-Surface Missile, but more recently referred to in official US quarters as the Standard SSM (Surface-to-Surface Missile) programme, this development was undertaken to provide an interim anti-ship missile capability until such time as Harpoon (**2641.221** above) could be developed and deployed. As the programme has progressed, three different versions of Standard have been involved, of which two were operational and the third was still in development in the first half of 1974. As a consequence, this version, Active Standard, is no longer regarded as an interim weapon as it is running concurrently with Harpoon which has the same function.

The first of the three, Standard SM-I-MR, has been installed in six DEG class ships and two Patrol Gunboats (PG) not previously missile-equipped. Thus, with the vessels already fitted with Standard in its original anti-aircraft role, a total approaching 100 have been given a limited anti-ship missile capability. Standard SM-I-MR employs semi-active radar homing so that range is limited to the radar range of the associated illuminating radar. For extension of operating range beyond the horizon Standard ARM (Anti-Radiation Missile) and Active Standard were initiated. The former, which is designed to home onto radiating sources on the target, is to be installed on 12 DDG-Class ships and four Patrol Gunboats.

Development delays with Active Standard have ruled out its use as an interim SSM weapon, and under the schedules applicable in early 1974 it could be introduced into USN Fleet service only a few months before Harpoon. Development of the latter, however, was not regarded as sufficiently advanced to justify cancellation of Active Standard and it was retained as a back-up to Harpoon. As its name implies, Active Standard employs an active radar homing head to provide for over-the-horizon operation.

Standard SM-1-MR firing from the USN patrol gunboat USS Antelope *during sea trials of the system*

1758.211
US NAVY CRUISE MISSILE

DESCRIPTION:

The USN Cruise Missile programme is also known as SLCM (Submarine-Launched Cruise Missile) since the principal aim of the project is to provide a long-range, penetration, cruise missile capability for US submarines, similar to that already available to Soviet submarines in the form of the SS-N-7. However, it is also proposed to provide for surface ships launching of SLCM, and the USAF is engaged in collaborative development with the USN in the project with the aim of producing an Air-Launched Cruise Missile (ALCM). Broad areas of responsibility allocated to the two Services are propulsion (cruise) to the USAF, and guidance to the USN.

The general capability called for by the Navy envisages two versions: a tactical model with a range of 300 nautical miles (555 km), and a strategic model with a maximum range of about 1500 nautical miles (2780 km). Nuclear or conventional warheads will be available for both versions. Turbofan engine propulsion for the cruise phase will be used and it is expected that the guidance system will embody the TERCOM (Terrain Comparison) technique pioneered by the USN. As an aid to penetration when used in the strategic or shore target bombardment role, a low-level cruise profile will be followed.

More details of this programme will be found in the section of this book dealing with Sub-surface-to-surface weapon systems (Entry No **1759.411**).

STATUS.

The US 1975 Fiscal Year Budget allocated a total of $45 million for SLCM development.

THE UNION OF SOVIET SOCIALIST REPUBLICS

2949.221
RUSSIAN NAVAL SURFACE-TO-SURFACE MISSILES

There is some uncertainty regarding the identification of some of the surface-to-surface missiles installed in Russian surface vessels and for use on some of their submarines when surfaced. In part, of course, the uncertainty stems from the general lack of information from official Russian sources – plus the suspicion that attaches to such information as does come from these sources – and much of the information that is available results from observation of and speculation regarding the activities of the Soviet Navy and the navies of the other Warsaw Pact countries.

An added complication, however, is the Russian practice of continuous weapon development and modification. All countries practise this to some extent; but in the USSR it seems that there is both a greater readiness to put an improved device into service, even on an experimental basis, and a greater willingness to keep older equipment in service than is apparent in most Western countries. Older equipment seems seldom to be withdrawn totally from service: it may be relegated to reserve formations or handed over to the armed forces of satellite nations; but so long as it remains operationally useful, to however restricted an extent, it is seldom scrapped. This is, of course, a perfectly sensible policy provided it is consistent with reasonable efficiency in manpower training – and here it seems likely that the very large numerical strength of the Soviet armed forces is an important consideration.

Like much other Russian military equipment the naval missiles are commonly identified in three ways – by an alpha-numerical code of US origin, by a NATO code-name and sometimes by some other name. The US code numbers appropriate to these missiles are SSN-1, SSN-2 etc. and it is known that missiles up to SSN-11 have been thus identified. For two of these missiles the NATO code-name is known with reasonable certainty: SSN-2 is Styx (**1155.221**), the missile that has for many years been carried by the "Komar" and "Osa" fast patrol boats, and SSN-3 is the naval version of Shaddock (**2976.221**) which is carried by some submarines and several surface vessels.

Most authorities agree that the NATO code-name for the SSN-1 is Scrubber (**2968.221**); but many identify it with the missile widely known by the non-NATO name Strela (**2986.221**). The balance of probability is inclined towards these two missiles being one and the same; but there is a slight discrepancy between their reported sizes, Strela being noticeably larger than Styx whereas Scrubber is said by some to be similar to Styx. The subject is more fully discussed in the entry for Scrubber.

2968.221
SCRUBBER SHIPBORNE SURFACE-TO-SURFACE MISSILE (SSN-1)

DESCRIPTION:

The SSN-1 cruise missile is the earliest known weapon of this kind deployed by the Soviet Fleet. Two code-names have been associated with the SSN-1, Strela and Scrubber, but on the evidence available, the latter is regarded as the correct NATO designation.

Little is known with any certainty of the precise dimensions or configuration of Scrubber beyond the fact that it has an aircraft-type layout and requires a launch ramp about 17 metres in length. This ramp is carried on a mount that can be trained over an angle of about 200 degrees and elevated. It is surmounted at one end by a 'hangar-type' enclosure, presumably used to house one missile in a 'ready-to-fire' state. To the rear of the launcher a deckhouse is located for the housing and preparation of reload missiles.

In 1973 two "Krupny" class destroyers remained in service with installations of this sort fore and aft, while four "Kildin" class destroyers were then in use with a single aft Scrubber installation.

The SSN-1 Scrubber is thought to fly at subsonic speeds and to carry a high-explosive warhead. The probable means of propulsion is by ramjet, with a solid-propellant booster rocket for the initial launch and acceleration phases. A maximum range of about 100 nautical miles (185 km) has been credited to Scrubber in some quarters, but the practical operating range is probably considerably less. If, as is generally assumed, command guidance by radio is employed for the cruise phase, the operating range could be extended by use of a co-operating aircraft. The "Krupny" destroyers carry their own helicopter, but the Kildins are not so equipped. Infra-red homing during the terminal phase is considered likely, although opinions on this differ and it is possible that alternative homing heads may have been developed during the long life of this weapon.

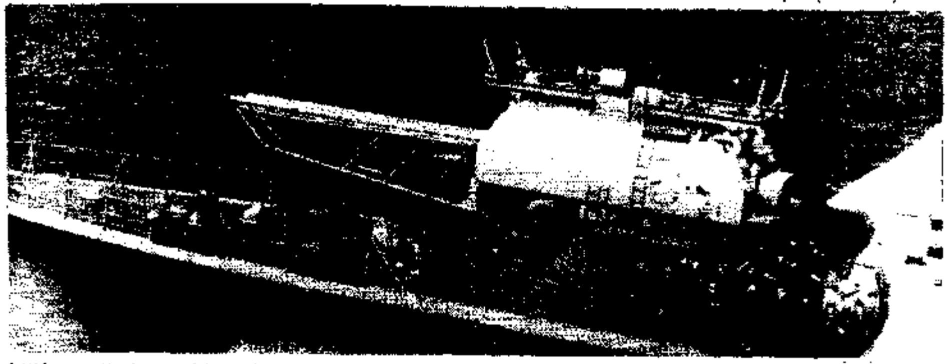
DIMENSIONS (PROVISIONAL):

Length: 7.6 m
Diameter: 100 cm
Span (Max): 4.6 m

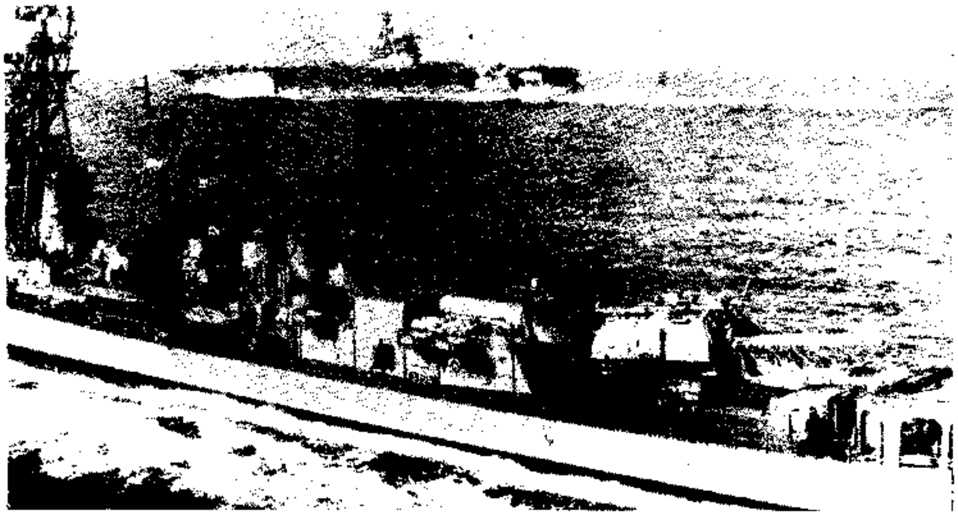
STATUS:

Entry into service was in 1958-59 with "Krupny" and "Kildin" class destroyers of the Soviet Fleet. The numbers of these vessels fitted have decreased over the years as a result of conversions, and it is likely that the next year or so will bring the complete disappearance of Scrubber as an operational weapon.

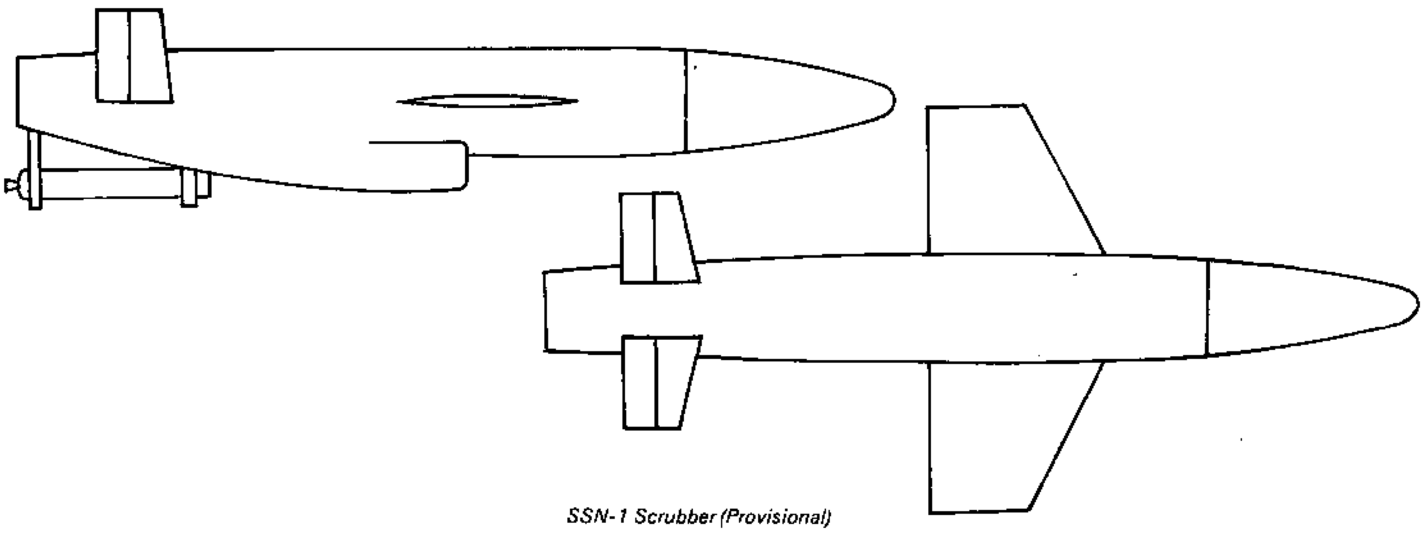
Scrubber shipborne surface-to-surface cruise missile launched from a Soviet destroyer (NOVOSTI)



A "Krupny" class guided missile armed destroyer showing forward Scrubber launcher (OFFICIAL US NAVY PHOTOGRAPH)



A "Krupny" class guided missile armed destroyer showing aft Scrubber launcher (OFFICIAL US NAVY PHOTOGRAPH)



SSN-1 Scrubber (Provisional)

1155.221
STYX SHIPBORNE SURFACE-TO-SURFACE MISSILE (SSN-2)

DESCRIPTION:

The SSN-2 Styx anti-ship missile is a short/medium range weapon which is very widely deployed by the Soviet Fleet and the navies of many of its allies. Entry into service was in 1959 or 1960, but despite the length of service this indicates, new Styx installations are apparently still being made. This weapon also has the distinction of being the first of its type to have been used operationally, in the 1967 war between Israel and Egypt, and more recently by Indian ships against Pakistan vessels in December 1971.

The general configuration is that of a small aircraft, with a delta planform wing and a triple tail-surface arrangement. A jettisonable booster rocket is used for the launch and acceleration phases, after which an internal motor sustains a cruising speed of about Mach 0.9. Range is estimated as about 20 nautical miles (40 km) maximum.

During the relatively long service life of Styx it is probable that several guidance modes have been employed, and some references quote the existence of 'A' and 'B' versions of the SSN-2 (but without agreement as to the differences between the two models). They probably relate to various combinations of the following alternatives: (1) the cruise phase could be carried out under either autopilot or radio command guidance, (2) the terminal phase could rely upon continuation of command guidance, active radar, or infra-red homing. Over the years, the launcher/hangars associated with Styx have undergone progressive changes and it seems reasonable to assume that the guidance apparatus also has received periodic updating, in which case all of the above methods may be employed in different installations.

DIMENSIONS (PROVISIONAL):
Length: 6.25 m
Diameter: 75 cm
Span (Max): 2.75 cm

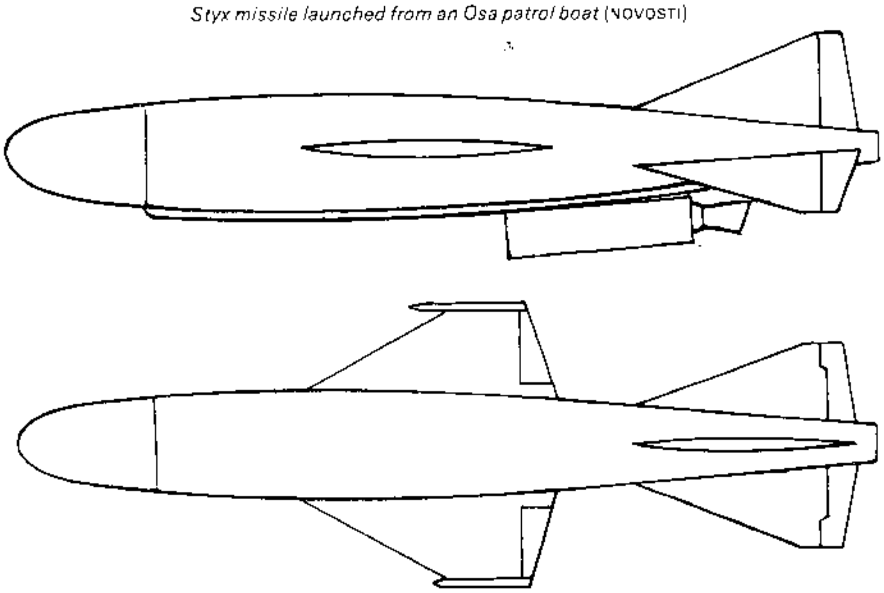
STATUS:

Styx has been in operational service since 1959 or 1960 and is now widely deployed with Soviet Navy forces and those of numerous friendly states. Most widespread are the fittings on board the "Osa" and "Komar" Class missile boats which are operated by the navies of Algeria, Bulgaria, China, Cuba, Egypt, East Germany, India, Indonesia, North Korea, Poland, Romania, Syria, Yugoslavia, and possibly Pakistan, this last nation thought to have been supplied by China. Komar boats carry two launchers and "Osa" class vessels have four each. Exclusive of Chinese and Soviet figures, the above navies in 1973 had a total of 121 boats of both classes to produce a potential total of 348 Styx missiles. The Soviet Styx force in the same period comprised 25 "Komar" Class and 65 "Osa 1" Class boats to yield a total of 310 missiles. It should be mentioned that the Soviet Navy has 55 Osa II boats which each carry four Styx-type launchers of obviously later design and which are held to contain a newer missile designated SSN-11, about which little is known except that it performs a similar function to Styx and is of later design.

More recently, information has been received of a modified version of the Soviet Navy's "Kildin" Class of destroyer, which now has four launcher/containers of the same sort as those on the Osa II boats.

The People's Republic of China is another important user of SSN-2 and there is good evidence that after having been supplied with initial quantities of Styx missiles and Komar and Osa missile boats, the Chinese have now established their own production lines. Provisional figures (1973) for these amount to about 40 Komar type boats and up to 55 Osa I boats, yielding a potential total of 300 SSN-2 launchers. In addition, China seems to have been the first nation to add Styx to the armament of larger vessels. The new class of destroyers of indigenous design, but based on the Soviet "Kotlin" class in some respects, has two twin or triple launchers for what is almost certainly Styx (Chinese version) amidships. It has also been learned that at least one of the ex-USSR Pacific Fleet "Gordy" class destroyers has been equipped with Styx-type launchers in place of the original sets (2) of torpedo tubes. It is believed that a twin SSN-2 launcher replaces each torpedo mount. The same source has also reported that China has a number of Styx missiles deployed as coastal defence weapons.

Styx missile launched from an Osa patrol boat (NOVOSTI)



SSN-2 Styx (Provisional)

2976.221
SHADDOCK SHIPBORNE SURFACE-TO-SURFACE MISSILE (SSN-3)

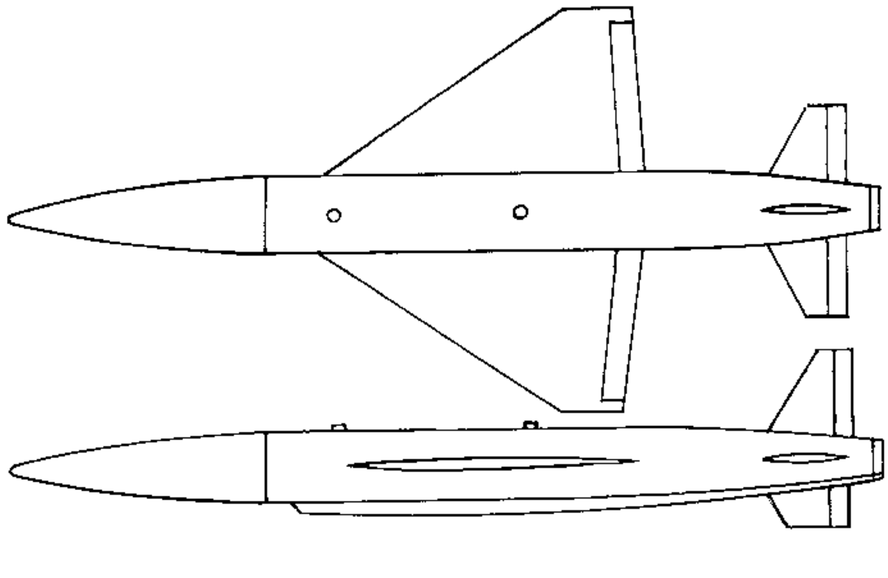
DESCRIPTION:

Shaddock is the largest of the Russian cruise missiles. It is not known to what extent, if any, the missile that is installed in many surface vessels and submarines of the Soviet Navy differs from the Shaddock missile displayed (in its container) at Moscow parades and used by Russian land forces (**2975.121**) but it is generally assumed that there are some differences: moreover it appears that there are several different missiles of the Shaddock type in naval use.

DESCRIPTION:

Powered by either a ramjet or a turbojet engine. Shaddock is boosted by two large JATO units under the rear of the fuselage. These give the missile a great deal of power at launch, and a notable characteristic of the missile's flight pattern is a very steep climb immediately after launch.

Command guidance is used; and for surface vessel installations the missile is tracked by Scoop Pair radar (**1324.253**) and course corrections transmitted to it by radio. For the terminal phase it is believed that infra-red homing is used; but it may be assumed with some confidence that this is



SSN-3 Shaddock (Provisional)

Shaddock missiles installed on Soviet W class submarine

one feature of the missile that will have been affected by modifications in the 10 years or so that these missiles have been in service, the most likely development being the provision of an active radar homing head.

Missile speed is believed to be transonic and range is limited mainly by radio/radar horizons. With mid-course guidance the maximum achievable range is believed to be about 300 nautical miles, but practical ranges are nearer to 100 nautical miles for missiles launched from cruisers and less than that for submarine-launched missiles.

It is believed that the standard warhead is nuclear with a yield in the kiloton range.

One of the most interesting aspects of this weapon system is the extent to which it has been installed in submarines and the length to which the Russian engineers have gone to find the most satisfactory form of installation. Of several types of submarine installation the most elaborate is the four-missile arrangement in the W-class "Long Bin" submarine (illustrated here) which involves the insertion of an additional section – about six and one-half metres long – into the submarine hull and constructing thereon a streamlined conning tower in which are built four forward-firing missile launchers, in two pairs both inclined to the horizontal by about 15 degrees.

STATUS:

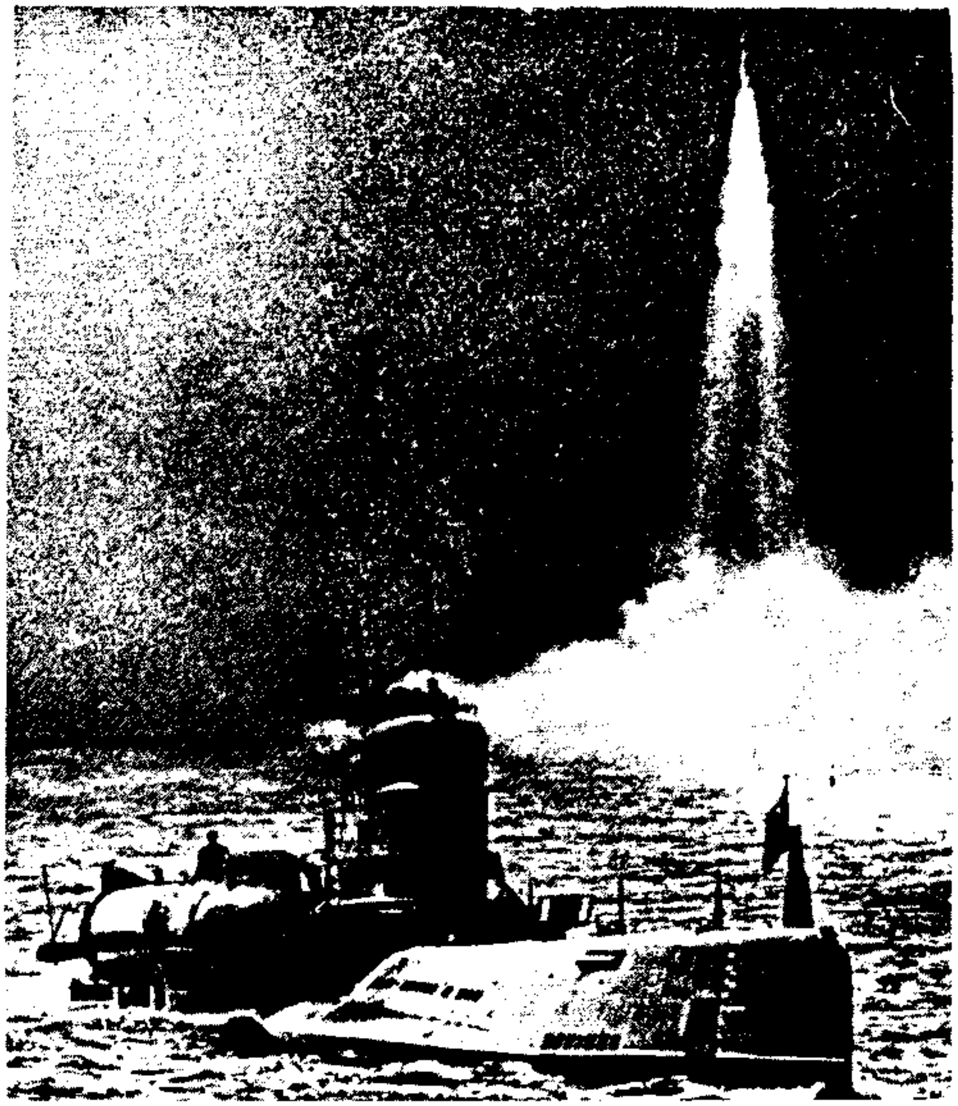
Shaddock-type missiles are installed operationally in "Kresta I" and "Kynda" class guided missile cruisers and in submarine classes E1, E2, J and W. The E1 and E2 nuclear submarine classes carry respectively 6 and 8 missiles in pairs, the launchers being let into the hull so as to present a smooth surface except when elevated for launching. The J-class non-nuclear submarines have similar launching arrangements for four missiles. In the W-class submarines two arrangements are still current – one being the Long Bin arrangement described above and the other the "Twin Cylinder" arrangement in which two launching tubes are mounted on the deck aft of the conning tower.

Each of the "Kresta" class cruisers carries four Shaddock-type missiles in twin launchers which can probably not be reloaded in action. The "Kynda" class carry two quadruple launchers fore and aft and probably carry eight further missiles with which to reload the launchers. The "Kresta" launchers and all the submarine launchers can be elevated for firing but cannot be trained. The "Kynda" launchers, on the other hand, can be trained through about 250 degrees and elevated up to about 30 degrees.

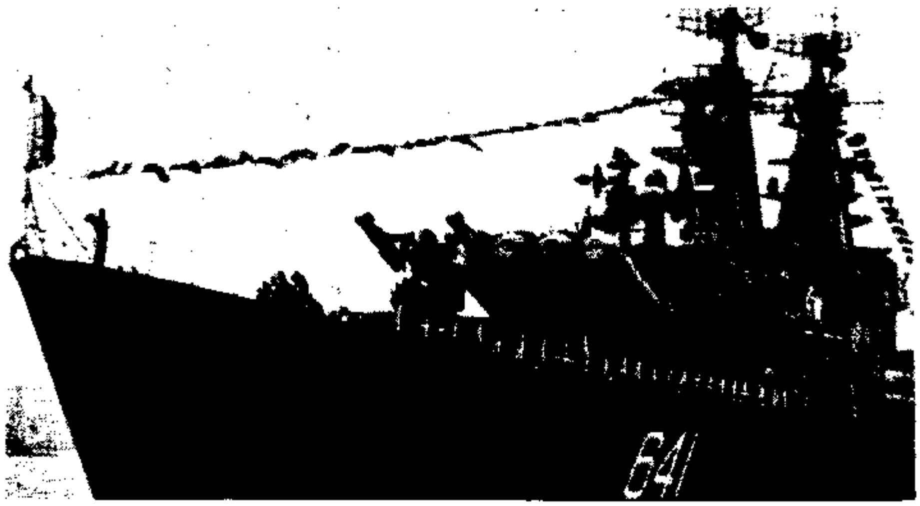
On the basis of the latest available figures for each class of vessel, the Soviet Navy has a total of 48 Shaddock launchers on surface ships and no less than 336 on submarines.

NONEMCLATURE:

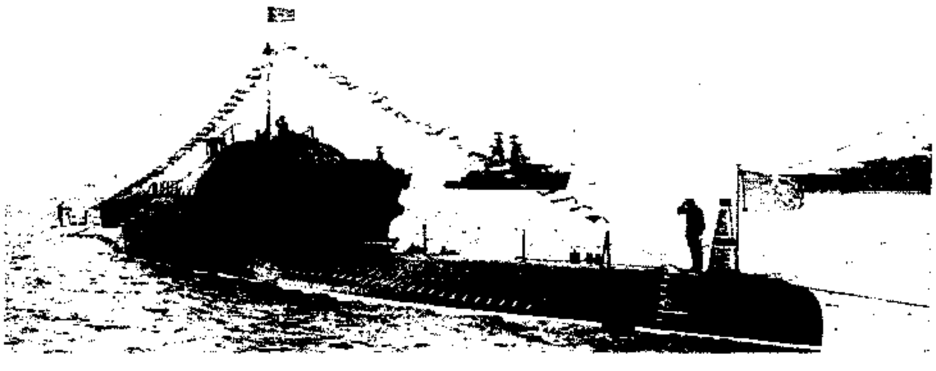
It seems to be generally agreed that the cruise missiles described specifically in this entry are those known in the American code as SSN-3, that they are about 12-13 metres long, and that they have a range capability (as noted above) of at least 300 nm (c. 550 km) and it has been suggested that the maximum range may be as much as 450 nm (c. 840 km).



W-class submarine with "twin cylinder" Shaddock missile launcher installation. Missile launch in background is probably Shaddock (NOVOSTI)

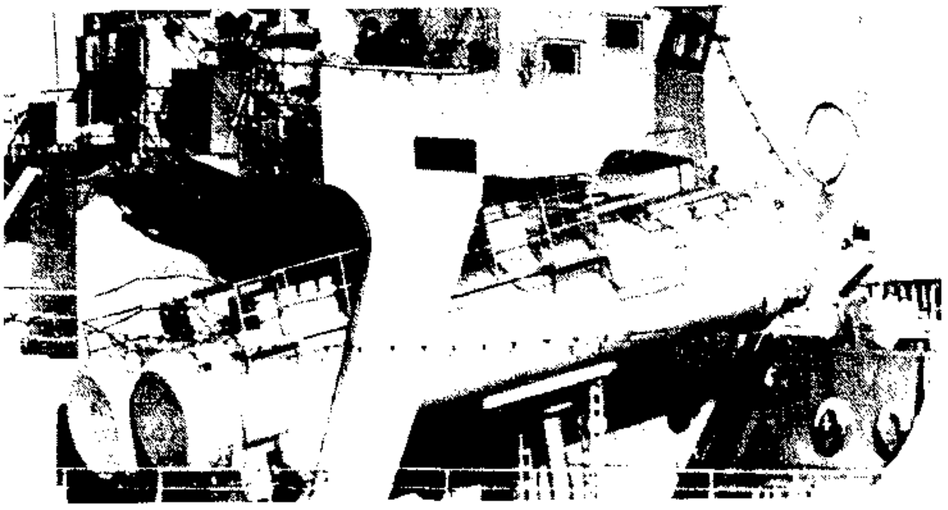


"Kynda" *class GM cruiser with quadruple Shaddock launcher* (NOVOSTI)



W class "Long Bin" submarine with enclosed Shaddock launchers. In the background can be seen a Shaddock-armed "Kynda" *class cruiser and the 150 mm guns of a Sverdov class cruiser* (NOVOSTI)

It can be seen from the accompanying illustrations, however, that the "Kresta I" and "Kynda" launchers are significantly different from those on the W class submarines — the "twin-cylinder" version of which resembles that of the land version of Shaddock (**2975.121**). According to one source, the "Kresta"/"Kynda" version is known as SSN-3B in the American code while the other is known as SSN-3A.



Shaddock launchers on a "Kresta I" guided missile armed destroyer (OFFICIAL US NAVY PHOTOGRAPH)

1760.221
SSN-9 SHIPBORNE SURFACE-TO-SURFACE MISSILE

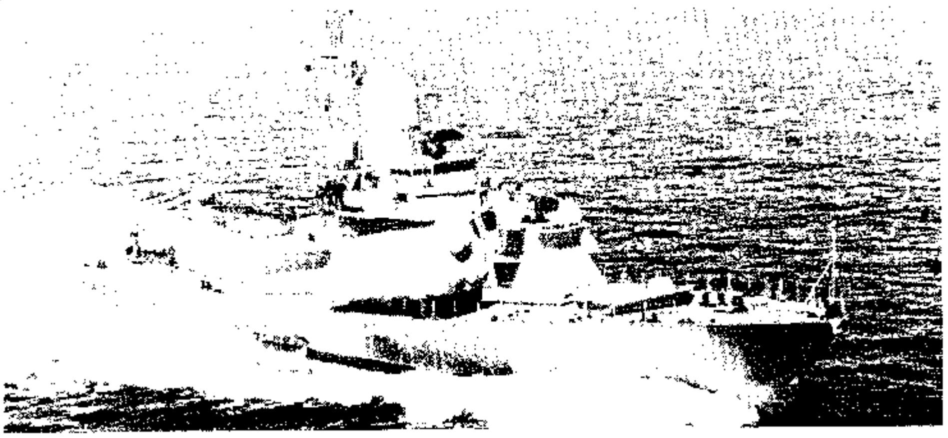
DESCRIPTION:

The designation SSN-9 has been allocated to the surface-to-surface missiles carried in the two triple launcher/containers aboard the Soviet "Nanuchka" Class missile boats which made their appearance in 1969. To date, no pictures or official details of the missiles themselves have been made public, and hence performance figures must be regarded as provisional. No other class of vessel has been definitely associated with the SSN-9, and neither has any NATO code-name for this weapon been made public. It has been conjectured, however, that the anticipated new "Papa" Class of Soviet submarine may employ SSN-9 or a derivative as its cruise missile armament, although the existing SSN-7 may be retained for this class of boat.

The estimated range of the SSN-9 is up to 150 nautical miles (about 275 km) with external mid-course guidance by co-operating aircraft or helicopter. A normal operating range of about 40 nautical miles (about 75 km) seems likely. Autopilot, with or without radio command link guidance, is the probable method of cruise phase control and active radar homing may be the normal terminal homing technique. The associated search and fire control radar group on "Nanuchka" Class vessels is reported to be code-named Band Stand.

STATUS:

Fittings so far confirmed are confined to the "Nanuchka" of missile boats, each of which has two triple launchers to give a total of 36 launchers at the end of 1973.



Soviet "Nanuchka" Class missile boat. Triple launchers on each side of bridge structure house SSN-9 surface-to surface missiles. Also to be seen is the lid of the retractable launcher for the new SAN-4 anti-aircraft missile system, on fore-deck (NOVOSTI)

1761.221
SSN-10 SHIPBORNE SURFACE-TO-SURFACE MISSILE

DESCRIPTION:

The designation SSN-10 has been allocated to the surface-to-surface missiles carried in new container/launchers fitted aboard "Kara", "Kresta II", and "Krivak" Class vessels of the Soviet Navy. As yet no NATO code-name for this weapon has been made public. Neither has any official data or any photograph of the missile itself, and therefore any published performance figures must be regarded as provisional. The SSN-10 is thought to have a cruising speed in excess of Mach 1 and a range of about 30 nautical miles (55 km) has been quoted, although compared with the maximum of 300 nm credited to the SSN-3 Shaddock which arms the older Kresta I ships this figure appears decidedly modest. It is thought more likely that the figure of 30 nautical miles might apply to the maximum autonomous range, ie when launched without the assistance of a co-operative aircraft for mid-term cruise guidance control. No reliable information as to the form of terminal homing used has been obtained, but the most likely candidate is active radar, possibly with an optional anti-radiation passive homing mode.

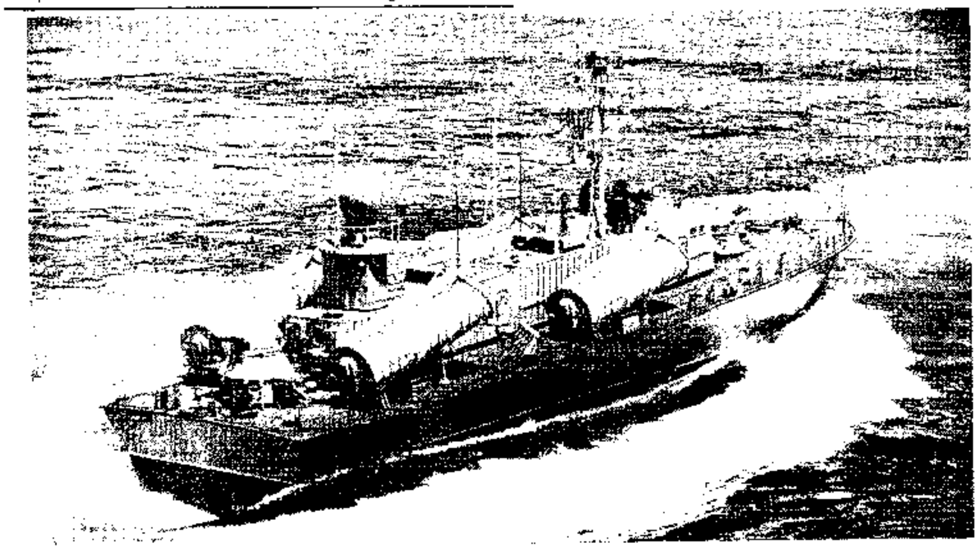
STATUS:

The SSN-10 became operational in 1968, and the latest available deployment figures show a possible total of 84 launchers. These are distributed as follows: six Kresta II with eight launchers; five Krivak's each with four; and two Kara Class light cruisers with eight launchers each.

1762.221
SSN-11 SHIPBORNE SURFACE-TO-SURFACE MISSILE

DESCRIPTION:

The designation SSN-11 has been given to the surface-to-surface missile carried in the new type container/launchers seen on the latest version of Osa missile boats of the Soviet Fleet. The missiles themselves have not been seen in public but are generally believed to be an advanced version of the SSN-2 Styx (**1155.221**). The performance is assumed to be similar in terms of range and speed, but the guidance techniques are expected to be more advanced. In addition to the "Osa II" Class vessels with which the SSN-11 was initially associated it has recently been learned that a modified version of the Soviet Navy "Kildin" Class of destroyer has been seen with four SSN-11 type launcher containers, two on each side of the after funnel, both pointing aft. It is possible that these have been installed as a replacement for the elderly SSN-1 Scrubber at one time seen on this class of destroyer. Two twin gun turrets have been fitted in the space vacated by the large Scrubber launch assembly.



"Osa II" *Class missile boat of the Soviet Fleet showing the four SSN-11 container/launchers* (NOVOSTI)

STRATEGIC AIR DEFENCE WEAPONS

THE UNITED STATES OF AMERICA

2574.131
ADVANCED BALLISTIC MISSILE DEFENCE

DESCRIPTION:

Complementing the long-standing ABRES programme of work on re-entry systems (**2709.111**) the US authorities have for some years been sponsoring programmes of work on ballistic missile defence techniques. Just as the ABRES work has from time to time become interlocked with specific ballistic missile development programmes so has the ABMD work overlapped with specific defensive system developments such as Safeguard (**2798.131**) and Site Defence (**2806.131**). In general, however, the programme has been concerned with problems rather than programmes and some of the areas of investigation are listed below.

Optical Techniques Both the aftermath of nuclear explosions and the ionized wake of hypersonic interceptors interfere with radar measurement and radio command guidance. Passive and active (laser) optical techniques of overcoming these difficulties have been studied.

Manoeuvring Interceptors Special techniques are required to cause a hypersonic interceptor to manoeuvre violently enough to intercept a manoeuvring re-entry vehicle. In Project **Upstage** two methods have been studied, each of which uses the aerodynamic forces on a missile of elliptical cross-section to aid a manoeuvre which is initiated either by burning a hypergolic fuel to part of the periphery of the missile base or by ducting a gas jet from an internally burnt propellant to provide the required turning movement.

Faster Interceptors Investigations aimed at improving on Sprint II (**2807.131**) performance by a factor of between 1.5 and 2.0.

Improved Components General investigation into improvement in sensors, hardened components and nuclear warheads.

Non-nuclear Warheads Apart from its cost andundesirable side effects, a disadvantage of the nuclear warhead for missile interception is that the authority of the US President is required before even defensive nuclear operations can begin. Various techniques for destroying incoming re-entry vehicles without recourse to nuclear warheads have been investigated – from simply strewing he predicted path of the missile with hard objects to the US Army's **HIT** programme (**2575.131**). Perhaps the biggest difficulty to be overcome in developing any non-nuclear warhead technique is that of devising adequate terminal guidance and manoeuvring systems – because a greater degree of precision is required for a successful non-nuclear interception than will suffice if a nuclear warhead is used, since the relative speeds of re-entry vehicle and interceptor warhead may be well in excess of 10 km/sec at the start of the terminal manoeuvre it is evident that fast and accurate pinpoint measurements will be required for success; and missile-borne laser radars are among the systems being considered.

STATUS:

Continuing programme.

MANUFACTURERS:

Various.

2575.131
HOMING INTERCEPT TECHNOLOGY (HIT) WARHEAD

DESCRIPTION:

Homing Intercept Technology (HIT) is the inelegant interpretation of a convenient acronym for a programme designed to provide an optically-guided non-nuclear warhead for an ABM missile. A potent reason for undertaking this development was the thought that a non-nuclear interceptor could be launched against a suspected hostile re-entry vehicle in an emergency without the need for Presidential authorisation of nuclear operations. Other factors were such known disadvantages of using nuclear interceptor warheads as the creation of radar blackout and interference with other (friendly) interceptors.

The HIT warhead comprises a combined propulsion and target destruction assembly and a guidance package. The latter consists of an optical sensor and a small digital computer and control mechanism, and round it is wrapped a cluster of small rocket tubes – the whole being spin-stabilised at a very high spin rate. The optical sensor detects the target and the computer controls the firing of the rockets so as to manoeuvre the warhead on an interception course. On close approach to the target the rocket rods are released in the path of the incoming vehicle to destroy it.

The warhead package is of sufficiently simple design to be suitable for economical mass production; and it was originally intended that several warheads, independently targeted, should be carried by a single Spartan missile (**2811.131**). Such multiple warhead arrangements, however, were specifically prohibited in the SALT 1 agreement and the US authorities have shelved the multiple-HIT programme for the time being. Instead, they are considering the installation of a single HIT warhead in a smaller missile. This is a much simpler proposition: the multiple warhead system would have involved the creation of a large missile-borne optical sensor to work in conjunction with ground control and to detect and identify the incoming re-entry vehicles and programme the HIT warheads to intercept them. With a single-warhead missile this large missile-borne sensor is not required.

STATUS:

Single-warhead system in development. Multi-warhead system shelved but could be reactivated if required.

MANUFACTURER:

LTV Aerospace Corporation.

2723.131
NIKE HERCULES AIR DEFENCE MISSILE

DESCRIPTION:

One of the earlier surface-to-air guided weapon systems still in commission, the Nike Hercules missile, successor to the Nike Ajax, is widely deployed in the USA and other countries. It first became operational in the USA in 1958.

Nike Hercules, a second-generation missile, possesses greater destructive ability and has a better performance than Nike Ajax. It has proved successful against high-performance aircraft at a variety of altitudes and has successfully intercepted short-range ballistic missiles and other Nike Hercules missiles in tests.

System units are a low-power acquisition radar, a high-power acquisition radar, a target tracking radar, or missile tracking radar, electronic data-processing equipment and remote-controlled launchers. A relatively recent introduction to the system, the high-power acquisition radar (HIPAR – **2499.153**), enables Nike Hercules mobile units to get the same full target detection capability as batteries at fixed sites. The HIPAR's three vans house radar gear transmitter, receiver and control equipment. One of its two semitrailers hauls the 43-foot-wide, fan-shaped antenna. The other semi-trailer carries power generators. Before the mobile HIPAR was adopted, more than 20 vehicles were required to move the radar system.

When a target is detected by the acquisition radar it is interrogated by the associated AN/TPX-46 IFF Mark XII interrogator and if adjudged hostile its location is transferred to the target tracking radar which pinpoints it for intercept purposes. The missile tracking radar issues guidance and burst orders to the missile.

Each Hercules battery can operate as a part of a defence network or as an autonomous unit, capable of detecting, tracking and engaging targets. The system operators are located in a battery control trailer, a tracking radar control trailer and a launcher control trailer. The Hercules is capable of operating in an electronic countermeasures environment.

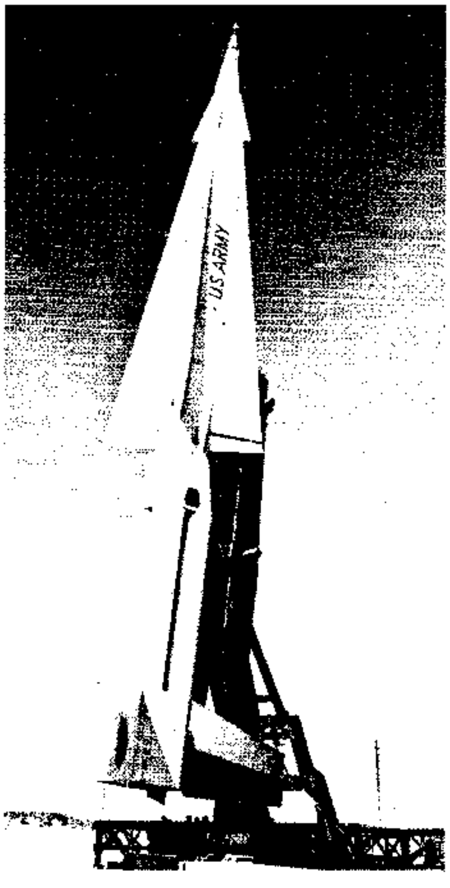
CHARACTERISTICS:

Type: Surface-to-air, strategic, guided missile
Guidance: Command
Propulsion: Two-stage solid-propellant rocket motor
Warhead: Nuclear or high-explosive
Missile Length: 12.5 metres
Diameter: 80 cm
Launch Weight: 4,500 kg
Speed: Supersonic
Range: More than 140 km
Ceiling: More than 45 km

STATUS:

Major improvements were made to this system in 1961 when new radars and modifications were added to enable the system to remain operational until replaced by the SAM-D missile in the mid-1970s. The number of active batteries has steadily declined since 1963, however, when there were 134 batteries. In March 1971 the Army ordered the inactivation of 27 firing batteries and 11 headquarters organisations and activities in 15 states by June 30. Included in the reduction were 16 active Army and 11 National Guard batteries. The cutback left only 13 operational batteries in the active inventory, with 27 other batteries manned by the National Guard.

It was announced in February 1972 that a further modification programme had started in 1971. This series of modifications was aimed at making the missile more manoeuvrable and better able to withstand ECM. The programme is going on at the White Sands Missile Range and suc-



Nike Hercules on launcher at White Sands proving ground, New Mexico cessful tests have been carried out close to specified limits of range and interception height.

A non-nuclear version of the Nike Hercules missile is being produced by Mitsubishi Heavy Industries Ltd for the Japanese Army under a licensing agreement with the American manufacturer.

Apart from Japan, Nike Hercules is also widely deployed in NATO and other countries with which the USA has friendly military relationships. Countries believed still to have the missile in strength are Belgium, Denmark, France, Greece, Italy, The Netherlands, Norway, South Korea, Taiwan, Turkey and West Germany. Until quite recently some of these countries still had small numbers of the earlier Nike Ajax missile. It is believed however that almost all of these have now been replaced.

In February 1974, the US Army announced that 48 Nike Hercules batteries within the continental United States would be de-activated and phased out by the end of 1974. Included among these were all the batteries manned by the National Guard. The decision, however, does not affect operational Nike Hercules units deployed with the US Army or overseas stations.

MANUFACTURERS:

Prime Contractors: Western Electric Company, Burlington, North Carolina.

MAJOR SUBCONTRACTORS:

McDonnell Douglas Astronautics Company, 5301 Bolsa Avenue, Huntington Beach, California 92647.

Bell Telephone Laboratories, Burlington, North Carolina.

General Electric Company, Syracuse, New York.

AAI, Inc, Cockeysville, Maryland.

Raytheon Company, Wayland, Massachusetts.

2798.131 SAFEGUARD ANTI-BALLISTIC MISSILE SYSTEM

INTRODUCTION:

Safeguard is the name which was given to the anti-ballistic missile (ABM) system proposed by the Nixon administration as a replacement for the five-billion-dollar Sentinel programme first announced in September 1967. The Safeguard proposal involved the deployment, at up to twelve sites, of long-range and short-range ABM missiles to provide a limited defence in depth against incoming ballistic or fractional-orbital bombardment missiles.

Whereas the original Sentinel proposals were for a comprehensive defence system giving substantial protection both to the civilian population and to the deterrent forces, Safeguard had more limited aims. Emphasis was placed on the protection of the Minuteman sites and only light overall protection of the population would have been provided even when all sites had been completed.

In making these proposals the US defence authorities were anxious to avoid giving the impression – especially to the USSR authorities – that they were seeking to alter the strategic balance. By proposing only limited protection for the major population centres – adequate perhaps to deal with a minor or accidental attack but totally inadequate to defeat a major attack – they hoped to make it clear that they were seeking only to protect their deterrent forces. Many experts at that time took the view that the development and deployment of ABM systems would have a destabilising effect on US/USSR relationships. This view is perhaps not so widely held today.

In August 1969 the US Senate approved, by only one vote, the Phase I deployment of the system, thereby authorising the commencement of construction work on two sites at Malmstrom AFB, Montana, and Grand Forks AFB, North Dakota.

The Phase II deployment authorised by Congress in December 1970 provided for construction of a third site near Whiteman AFB, Missouri; advanced preparation work for a fourth site near Warren AFB, Wyoming; and completion of Spartan and Sprint Missile inventories for the Phase I sites. The administration request to begin advanced preparation at four other sites was not approved.

For the Fiscal Year 1972 the administration proposed a programme which would either continue development at the Warren site or begin advanced site preparation for a site in the Washington, D.C. area, to protect the US National Command Authority (NCA). This approach was said to have been chosen in order to maintain sufficient flexibility in the programme in hopes of reaching an arms limitation agreement with the Soviet Union. Deployment would be limited to one of the two locations in the FY 1972 programme.

In November, 1971, Congress authorised continuation of the Grand Forks and Malmstrom deployments, advanced preparation at Whiteman and similar preparation at Warren. For the NCA system all that was authorised was the expenditure of some money on systems studies.

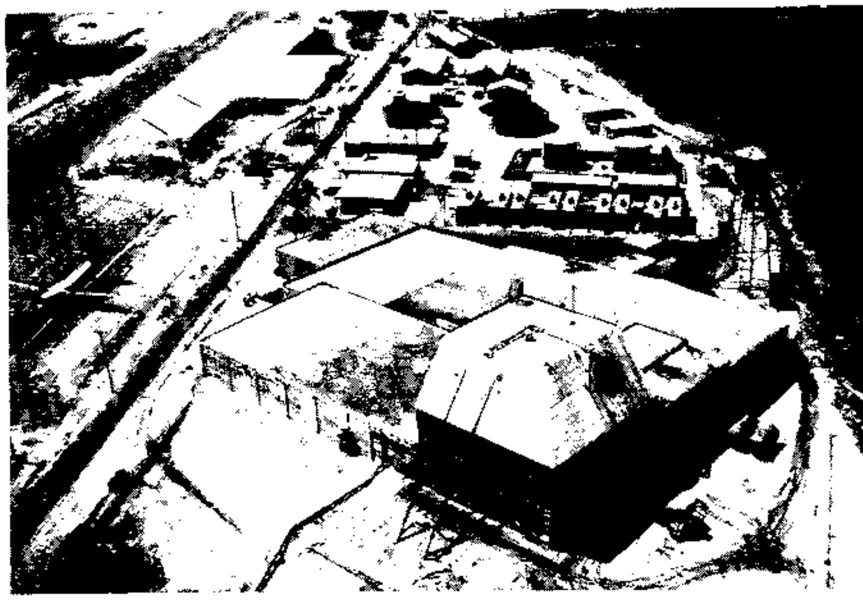
Following President Nixon's visit to Moscow and the USA/USSR ABM treaty, however, the whole Safeguard programme has been changed. Each country agreed to limit its ABM deployment to two complexes – one round the capital city and one other. For the USA the "one other" was the Grand Forks complex, which was about 18 months ahead of the Malmstrom complex in terms of constructional work, and on May 27th 1972 the US Secretary of Defense ordered the suspension of work at Malmstrom.

Whether a second complex will ever be constructed at Washington or not is unclear. At the height of US/USSR cooperation it seemed highly unlikely; and it is probably still unlikely – but now rather because a new approach to the whole problem of ballistic missile defence seems to be needed (see **2806.131**) than because it is not thought to be necessary to defend Washington.

SYSTEM DESCRIPTION:

Safeguard – and although the original project may have been reduced to a single ABM complex it is still both serviceable and convenient to retain the system name – incorporates two types of ABM defence called area defence and terminal defence.

The area defence system is capable of intercepting ICBMs, SLBMs and FOBS above the atmosphere at ranges of several hundred kilometres, and hence can protect large areas of the country, hundreds of kilometres across. A large, long-range radar, called the Perimeter Acquisition Radar (PAR – **2790.153**) detects and accurately tracks missiles at ranges of 1,500-4,000 kilometres. Based upon information from the PAR, a long-range missile (Spartan) carrying a warhead in the megaton range with a lethal radius of many kilometres is launched to intercept the incoming missile. Spartan (**2811.131**) is a slightly enlarged version of the earlier Nike Zeus missile and has undergone several successful flight tests at Kwajalein Island. A smaller radar, called the Missile Site Radar (MSR – **2791.153**), is located at the Spartan launch site and is used to steer the Spartan interceptor close to the incoming missile. A prototype of this radar has been operating at Meck Island in the Kwajalein Atoll since September 1968. It is said to have met or improved upon all its design objectives and with its associated computers has successfully demonstrated the possibility of ICBM interception.



Prototype Missile Site Radar on Meck Island, Kwajalein Atoll

Because of the large coverage from any one Spartan site only 12 sites would have been required to provide protection for almost all of the contiguous United States. The long-range radars would have been placed around the borders of the USA to provide for early detection of missiles coming from all directions. The MSRs and Spartan sites would then have been spread around the country to maximise protection of retaliatory forces as well as to provide area coverage of the country as a whole.

Such an area defence, however, has its shortcomings because it operates above the atmosphere. Very lightweight confusion devices such as chaff and metallic balloons can be distributed by an incoming missile. Nuclear warheads can also be deliberately detonated outside the atmosphere to create large regions of ionized gas which would be opaque to the long-range PAR radar for many tens of seconds.

How significant these shortcomings would be would depend on the ability of the potential enemy to exploit such confusion techniques – themselves necessarily the result of extensive research and development – and on the extent to which electronic counter-countermeasures (ECCM) had been developed by the defenders at the relevant time.

Granting that all reasonable ECCM steps would be taken, however, the views taken by the US proponents of Safeguard appear to have been, first that since the primary objective of Safeguard was the preservation of enough of the 1,000-Minuteman strategic deterrent force to be a credible deterrent even after a major ICBM assault, some penetration of the defences in such conditions would have been tolerable provided it were severely limited. Secondly, in the case of a major assault it was to be assumed that the primary objectives would be the retaliatory forces.

Assuming some penetration of the area defence system, therefore, the Safeguard proposal was for a second line of defence that would go into action after the effects of the confusion devices had been dissipated. Since only a few seconds would then remain before impact, however, this second line –

terminal defence – would have to employ a small and very fast interceptor missile. This missile (Sprint – entries **2812.131** and **2807.131**) exists and has been successfully tested. It operates in conjunction with the MSR which sorts out the confusion devices as the missiles come into the atmosphere and guides the Sprint to destroy the missile with its low kiloton-range warhead.

Because the radar must be close to the point where the missile comes into the atmosphere and since the response time is short, an MSR and Sprint site can protect an area only a few tens of kilometres across, and must be located near that area. In the proposed Safeguard deployment the Sprints were to be used to defend the radars themselves and the retaliatory missiles nearby.

The nuclear warheads of both Spartan and Sprint have elaborate safety devices to prevent them exploding at altitudes at which they would damage people or property below.

DEVELOPMENT:

As already noted, the prototype MSR began radiating power in September 1968 and has been operating ever since. Tracking of local targets was first accomplished with the MSR software in July 1969, and in December 1969 two ICBMs launched from Vandenberg AFB, California, were successfully tracked. The first PAR is being fabricated at the North Dakota site and is expected to become operational in October 1974. The USAF AN/FPS-85 radar, which is technologically similar to the PAR, has been operational at Eglin AFB since late 1968, and a limited engineering development model of the PAR was constructed at the General Electric plant at Syracuse, NY, during 1969.

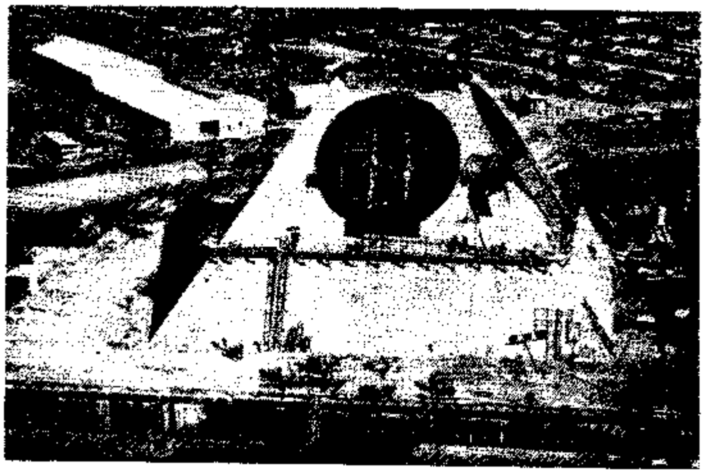
Integration of all major system components except the PAR was begun at Meck Island on Kwajalein Atoll in early 1970, and the first system test, which employed a Spartan missile, was conducted on April 14, 1970. By the end of 1973 there had been 49 system tests, of which 42 had been successful, two partially and five failures.

STATUS:

The Grand Forks site, with 30 Spartan and 70 Sprint launchers, one MSR and one PAR is scheduled to be completed in FY 1975. The equipment readiness date is, at the time of writing, still estimated as October 1974 and an initial operational capability is expected to be achieved in June 1975.

MANUFACTURERS:

Prime system contractor for development and testing is the Western Electric Company who are assisted by Bell Telephone Laboratories in engineering and design. Major component contractors are General Electric (PAR), Raytheon (MSR), McDonnell-Douglas (Spartan) and Martin-Marietta (Sprint). Subsidiary contractors are too numerous to list here but some additional details can be found under the entries for the individual system components.



Missile Site Radar (SR) and Perimeter Acquisition Radar (PAR) under construction at North Dakota sites. The SR (left) will have phased rays on each of its four sloping faces and will have a detection range of several hundred kilometres on a re-entry vehicle. The PAR building shown on the right is a kind intended to have only one phased array (on its sloping face): PARs proposed for some other sites would have had arrays on more than one face

2806.131
SITE DEFENCE

DESCRIPTION:

Formerly known as Hardsite (**2639.131**) and subsequently as SDM-Site Defence of Minuteman but now referred to in the USA simply as Site Defence (although we retain the SDM abbreviation for convenience), this is an ABM system that was originally conceived as a follow-on supplement to Safeguard (**2798.131**) which would be deployed only in response to an impending increase in the total ballistic missile threat to the USA beyond that which Safeguard was designed to meet.

Although the Nixon-Brezhnev agreement limits the total ABM deployment in the USA to two systems the SDM programme is continuing; partly as an insurance for the future (since, so far as the published texts of the Moscow agreement reveal, there is no ban on such developments) and partly because it is thought in some quarters that the SDM system will be superior to the original Safeguard system. It appears, indeed, that the provision in the Moscow agreements that permits the installation of up to 20 ABM radars at each site was insisted upon by the US negotiators specifically to permit the SDM programme to continue to the point of deployment if desired.

SDM components will include a small General Electric phased-array radar (**2792.153**) with a radiating aperture about one-fifth of the size of the Safeguard MSR radar, a Control Data Corporation 7700 computer subsystem, made up of two CDC 7600 computers, and an improved version of the Sprint missile known as Sprint II (**2807.131**). So far as is known the basic principle of operation of the system will be identical with that of the endo-atmospheric interception phase of Safeguard: the attractions of the system are understood to be improved missile performance and lower total cost – particularly of the radar sub-system. Performance requirements of the specified system components are all considered to be well within the state of the art: the important feature of the programme is the creation and demonstration of system capability; and there is consequently considerable emphasis on software development.

DEVELOPMENT:

The SDM programme was initiated in January 1971 and on June 3 a system engineering and technical assistance contract was awarded to Brown Engineering Company, Huntsville, Alabama, for $4 million. Six days later, contract definition awards of $2.5 million each were received by Hughes Aircraft Company, McDonnell Douglas Astronautics Company and Raytheon Company. On February 28, 1972, McDonnell Douglas was selected as prime contractor and awarded a five year, $382 million contract.

Contract definition for the Sprint II missile was completed in September 1971 by Martin Marietta Corporation and at mid-1972 that effort was in advanced design. On May 31, 1972, however, one week after the SALT treaty was signed, the US Army announced that Martin Marietta was being awarded a $168,360,000 cost-plus-incentive-fee contract for Sprint II development. The current estimate of total programme cost is $700-800 million to put the US authorities in a position to deploy the system in the late 1970s if they so wish.

Introducing an item of $160 million for this programme in the FY 1975 budget, the US Defence Secretary pointed out that not only would the programme lead to a Minuteman defence capability – should that be thought to be necessary – but it would also give the US the option of deploying a more advanced ABM system for NCA defence (Washington – see **2798.131**) if required.

STATUS:

Development. System integration testing scheduled to begin at Kwajalein, 1977.

MANUFACTURERS:

System: McDonnell Douglas Astronautics Co.
Major Subcontractors to McDonnell Douglas:
General Electric Co. (Radar)
TRW, Inc. (Software)
Braddock Dunn and Macdonald Inc.
Control Data Corp. (Computer)
GTE, Sylvania, Inc. (Communications)
Martin Marietta Corporation. (Missile)

2811.131
SPARTAN ANTI-BALLISTIC MISSILE MISSILE

DESCRIPTION:

Spartan is a command guided anti-missile missile powered by a three-stage, solid-propellant rocket and carrying a nuclear warhead. Now designated as the long-range element of the Safeguard missile defence system (**2798.131**), Spartan has been under development since 1965.

The missile will operate in conjunction with perimeter acquisition radar (PAR – **2790.153**), missile site radar (MSR – **2791.153**), computers and other support equipment.

Approaching missiles will be detected by the PAR (or in appropriate cases by BMEWS **2525.181**) and the MSR will be programmed to acquire them. The computer will calculate the best course for an interception and, provided such interception is possible, the Spartan missile will be launched from its vertical underground silo.

In flight the missile will be under command guidance, but the burning of the first two stages will be automatic, the second stage igniting as the first burns out and separates. The third stage, however, will not ignite automatically; ignition will be by ground command and will generally take place outside the atmosphere. This third stage is used for terminal manoeuvring followed by warhead detonation on command from the ground.

Designed for exo-atmospheric target engagement the standard Spartan warhead is believed to have a yield of five megatons – thus producing a hard X-ray energy density sufficient to destroy or disable incoming missiles over a considerable area by destroying their re-entry shields. More recently, however, a modified missile has been under development and this has a smaller and lighter warhead.

Improved Spartan

This new missile, so far known as Improved Spartan, is capable of greater acceleration and higher speed than the earlier model. Because of this it was seen to have several possible functions in the Safeguard system. First, its faster reaction makes it more suitable for the engagement of depressed trajectory ICBMs or low-altitude SLBMs for both of which the approach warning time may be substantially less than for an ICBM on a minimum-energy trajectory. Secondly, its greater range capability would have made it possible for Improved Spartans from one battery site to defend some of the area of an adjacent battery in the event of a saturation attack. Thirdly, while Safeguard deployment remained below the full 12-site configuration required for CONUS defence, the added range of the new missile was seen as a valuable system extension for protection against a light attack – such as might be threatened by China in the course of the next few years. The Safeguard programme changes necessitated by the USA/USSR ABM treaty obviously modify the validity of these reasons but they by no means extinguish it.

Improved Spartan, according to the US Defence Secretary, has been in Safeguard planning since the March 1969 Safeguard deployment announcement and plans until recently were and possibly still are to use a mix of the two missiles in the Safeguard system – the mix being dependent on the nature and direction of the threat envisaged. So far as is definitely known the basic missile is the same for both weapons, although it has been said that a modification is in development – the so-called "loiter" capability – whereby the motors are shut down for a brief period and then re-ignited on ground command after final target designation. The status of this particular development is not known, but it has been reported that the addition of the loiter capability involves a reduction in warhead yield from what is believed currently to be some 5MT to nearer 1MT.

DEVELOPMENT:

Development of Spartan started in 1965 and the first firing, from a concrete cell, took place in 1968. In April 1970 the US Army announced that the Spartan development test phase had been completed. Of the 15 test firings, 11 had been completely successful, two had been partially successful and two had been failures.

The first operational intercept test of the Safeguard system occurred on August 28, 1970, when Spartan launched from Kwajalein Atoll intercepted a Minuteman I modified test vehicle launched from Vandenberg AFB, California, 4,200 miles away. A prototype Missile Site Radar located and tracked the incoming nose cone and launched and controlled the Spartan to the intercept point outside the earth's atmosphere. Neither the Spartan nor the test nose cone carried explosive warheads, but the US Army announced that the test had been determined to be successful by ground instruments which indicated that the Spartan's final stage passed close enough to the target to have caused its destruction.

On January 11, 1971, two Spartan missiles controlled by a single MSR and launched seconds apart successfully intercepted targets. This was the ninth Safeguard system test and the first in which two interceptors were launched in a single test. One missile intercepted an ICBM nose cone while the other intercepted a fixed point in space.

CHARACTERISTICS:

US Army Designation: XLIM-49A

Type: Land-based silo-launched anti-ballistic missile missile

Guidance: Radar Command

Propulsion: 3-stage solid-propellant. Thiokol TX500 (225,000 kg st), TX454 and TX239

Warhead: Thermonuclear, believed 5 MT. Non-nuclear warheads have been considered – see entry **2575.131**

Missile Length: 16.825 m

Body Diameter: 107 cm

Fin-Span: 300 cm

Launch Weight: 13,000 kg

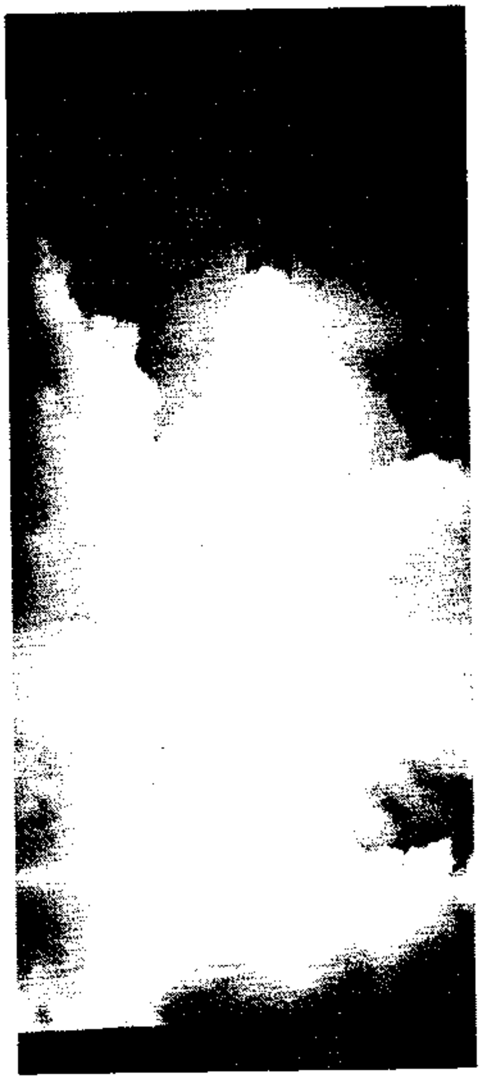
Max Slant Range: About 750 km

Max Engagement Altitude: About 550 km

Launch Reaction Time: About 30 sec

MANUFACTURERS:

Prime contractor for Spartan is Western Electric Company. Bell Telephone Laboratories have research and development responsibility; and McDonnell Douglas Astronautics, under the direction of Bell Telephone Laboratories, has responsibility for missile development. The rocket motors are by Thiokol Chemical Corporation and the missile-borne guidance system by Honeywell.



Spartan launch

2812.131
SPRINT ANTI-BALLISTIC MISSILE MISSILE

DESCRIPTION:

Sprint is a two-stage solid-propellant cone-shaped missile carrying a nuclear warhead and intended for use as an anti-missile missile. It is launched from an underground cell.

Originally conceived as part of the Nike-X programme, Sprint is currently serving as the terminal interceptor in the Safeguard ballistic missile defence system (**2798.131**).

A full description of the relationship between Sprint and the Safeguard defence system will be found under the Safeguard heading. Here it will suffice to say that the Sprint missiles, which form the second line of defence in the system and which will be targeted on such missile re-entry vehicles as constitute a threat to their defence area, are to be located at sites where there are also MSR **2791.153**) tracking and guidance radars. Warning of a threat will be given by PAR(**2790.153** long-range acquisition radar (which may or may not be co-located with the MSR) and the MSR and associated computing equipment will acquire and track the re-entry vehicle, calculate the interception trajectory and guide the missile to the interception.

Launched from an underground cell, Sprint is "popped up" by the ignition of a powder gas generator in the bottom of the silo. The gas propels a piston on which the missile rests and pushes the missile through the silo exit membrane, the piston being checked by a decelerator cage at the mouth of the silo. As the missile clears the silo its enormously powerful first-stage motor ignites and at the same time the missile tilts over in the direction required for interception.

During the burning of the first stage motor, the guidance commands from the ground are translated into course changes by fluid injection into the single nozzle. During the second stage flight the control is by aero-dynamic fins.

Warhead detonation is also commanded from the ground and is said to be intended to take place between 1,500 and 30,000 metres up. It is understood that incoming missiles are expected to be knocked out partly by simple blast and partly by the effect of high-velocity neutrons from the Sprint warhead on the fissile material in the incoming warhead: the neutrons cause it to deform and prevent it from detonating.

A complete interception takes about 15 seconds.

Sprint accelerating

CHARACTERISTICS
Type: Ground to air missile interceptor
Guidance: Radar command
Propulsion: Two-stage Hercules solid-propellant rocket motor. First stage approx 300,000 kg st
Warhead: Nuclear. Low kiloton range
Missile Length: 8.2 metres
Missile Base Diameter: 1.4 metres
Launch Weight: 3,400 kg
Range: About 40 km

DEVELOPMENT HISTORY:
The Orlando Division of Martin Marietta was selected to develop this missile in 1963 after a design study competition. The development at that time was part of the Nike X programme and Martin Marietta became a member of the Nike X team as sub-contractor to Bell Telephone Laboratories.

The first Sprint missile was successfully launched in November 1965 – less than three years after the first design study. Development testing was completed at White Sands Missile Range in August 1970.

The first system test utilising Sprint against an actual target occurred on December 23, 1970, when an ICBM target nose cone launched from Vandenberg AFB, California, was successfully intercepted. A development version of the system's MSR located and tracked the incoming target and launched and guided the Sprint to the intercept point. This was the eighth system test.

On March 17, 1971, two Sprint missiles launched less than one second apart successfully intercepted a Minuteman I nose cone. The missiles passed close enough to the target to have destroyed it if they had been armed with nuclear warheads. This was the eleventh system test and the first utilising two Sprints.

The first system test against a sea-launched missile occurred on May 7, 1971, when a Sprint intercepted a Polaris warhead over the Pacific. The Polaris, which follows a trajectory very different from that of the Minuteman warheads used in previous system tests, was launched from the USS Observation Island, a Navy missile test-firing ship.

The first series of sixteen system tests ended in the Autumn of 1971. Twelve of these tests were completely successful, two were partially successful and there were two failures.

A second series of system tests started in mid-1971 and ended in December 1973. There were 32 tests in this series, making a total of 48 system tests from the Spring of 1970 to the end of 1973. Of this second series 29 tests were completely successful.

STATUS:
In October 1973, it was announced that a $125.5 million contract had been awarded to the Western Electric Company for continued production and installation of Safeguard to the end of September 1974.

Martin Marietta's share of this contract for Sprint production is $18.4 million.

MANUFACTURERS:
Missile system: Martin Marietta Corporation, Orlando Division, Orlando, Florida.
Rocket Motors: Hercules, Inc.
Motor Cases: Brunswick Corporation.
Injection Valves: Ling-Temco-Vought.
Launch gas generator: Aerojet General.
Guidance and Control: Honeywell Inc., Western Electric.

2807.131
SPRINT II ANTI-MISSILE MISSILE

DESCRIPTION:
Currently under development by the Martin Marietta Corporation, Sprint II is an improved version of the Sprint ABM missile used in the Safeguard ABM system. Sprint II is destined to be the interceptor missile in the Prototype Demonstration Programme for Site Defence (**2806.131**).

Sprint II improvements over Safeguard Sprint include greater accuracy, greater manoeuvring capacity (three times that of the earlier missile), increased reliability, hardening and strengthening against nuclear blast and manoeuvre stress, and a faster launch process.

DEVELOPMENT:
In May 1971, the Martin Marietta Corporation received a $1.5 million US Army contract for a contract definition study of Sprint II to determine technical modification requirements, estimate costs and prepare schedules. This four-month contract was followed in October by a design contract for some $2.5 million for advanced design work on the new missile project.

In March 1972, it was stated by the Safeguard System Manager, Lt-General W.P. Leber, that Sprint II was in the advanced design stage and that this stage was scheduled for completion by 30th May 1972. On 31st May, Martin Marietta signed a $168 million contract with the US Army for the development and flight testing of the prototype interceptor. This contract was placed after and in accordance with the SALT Moscow agreement and had an anticipated duration of 57 months with an initial funding of $14.4 million.

STATUS:
Development. System integration testing with prototype radar and data processor is scheduled to begin at the Kwajalein missile range in 1977.

MANUFACTURER:
Martin Marietta Corporation, Orlando Division, Orlando, Florida.

THE UNION OF SOVIET SOCIALIST REPUBLICS

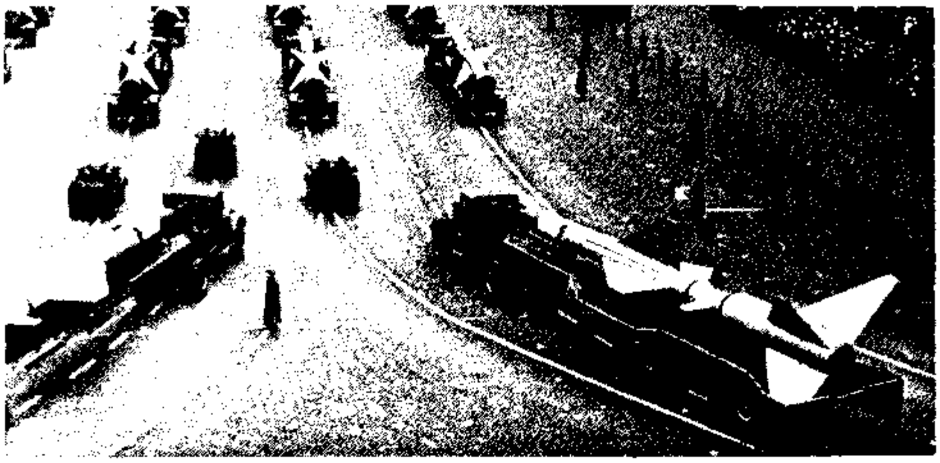
2940.131
SA-5 (GRIFFON) LONG-RANGE AIR DEFENCE MISSILE

DESCRIPTION:
Griffon is widely accepted as the NATO code name for a large surface-to-air weapon first displayed in public in 1963. It is also widely believed to be the missile known in the US alphanumeric code as the SA-5. Griffon has been variously described as an unmanned long-range interceptor, an anti-aircraft missile and an anti-missile missile, but it seems probable that although it may have some anti-missile capability it is primarily suitable for long-range anti-aircraft operations.

The nose of the missile houses a radar reflector of at least 60 cm diameter which can be combined with an active radar target seeking system.

Generally similar in size and weight to the US Nike Zeus missile, Griffon is thought to be somewhat inferior in performance and to have a smaller anti-missile capability. The fact that it is evidently manoeuvred aerodynamically indicates that its ability to home on to targets travelling at missile speeds must be very limited.

Although the missile evidently has two stages, it has been suggested that it may in fact have three – the third being a motor built into the warhead section and used to power the warhead and homing system during the final stages of interception.



Griffon missiles preceded by Guild missiles in the November parade in Moscow in 1963 (Novosti)

CHARACTERISTICS:
Type: Long-range surface-to-air guided missile
Guidance Principle: Radar homing
Guidance Method: By control of moving control surfaces on wings and tail
Propulsion: 2- or 3-stage solid-propellant
Missile Length: 16.5 metres
Missile Diameters: Booster: 1.0 metres
Second stage: 0.8 metres
Launch Weight: About 10,000 kg
Range: About 250 km
Ceiling: About 29 km

STATUS:
Operational – there are believed to be some 900 in service. For further discussions of Russian ABM and air defence systems see entries **2899.181, 2945.181** and **2989.181**.

2932.131
SA-7 (GALOSH) ANTI-BALLISTIC MISSILE MISSILE

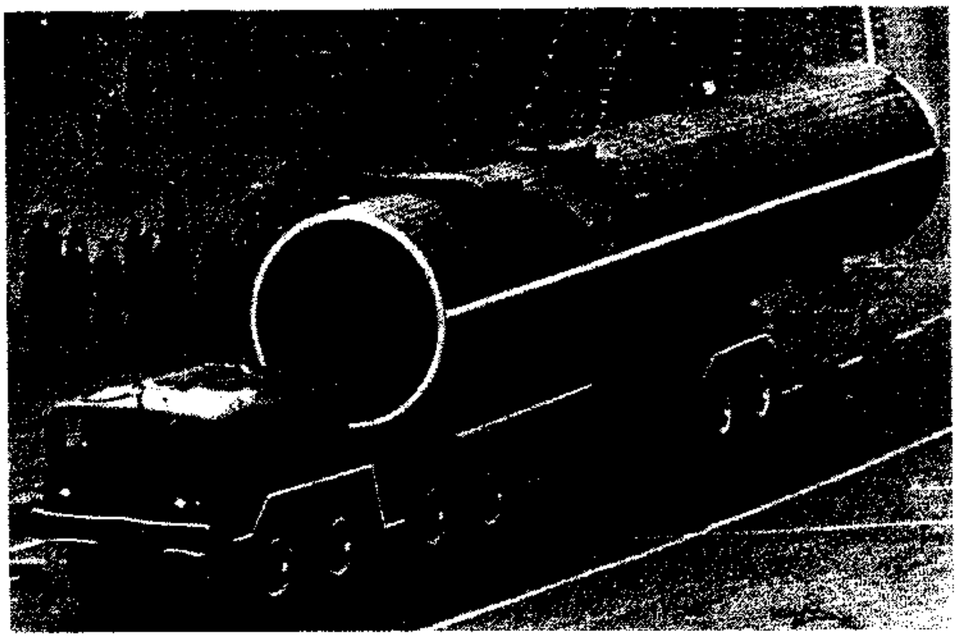
DESCRIPTION:
Galosh is widely accepted to be the NATO code name for the Soviet anti-ballistic missile missile, first "shown" to the public in 1964 and known as SA-7 in the US alphanumeric code. Since the missile has so far only been thus "shown" housed in an almost all-enveloping container little is known about it, other than that it has four first stage nozzles and that the container is some 20 metres long and has an internal diameter of about 2.75 metres. Soviet pictures purporting to show the launch of a long-range ABM missile that could well be Galosh have been seen; but they convey little information other than that the missile is more or less conical in shape.

It is believed, however, that Galosh carries a multi-megaton warhead suitable for exo-atmospheric missile interception and that it has a range of at least 300 km. On this assumption it is somewhat inferior to the US Spartan missile; moreover the giant "Henhouse" and "Doghouse" radars (**2864.153** and **2879.153**) with which it is associated for early warning and control are thought by some to be inferior in performance to the new phased-array radars of the US Safeguard system – the Henhouse radar was first observed in the late 1950s. These views are by no means generally accepted, however, and in some quarters it is thought that both missile and radars are in many respects superior in performance to the corresponding elements of the American Safeguard system.

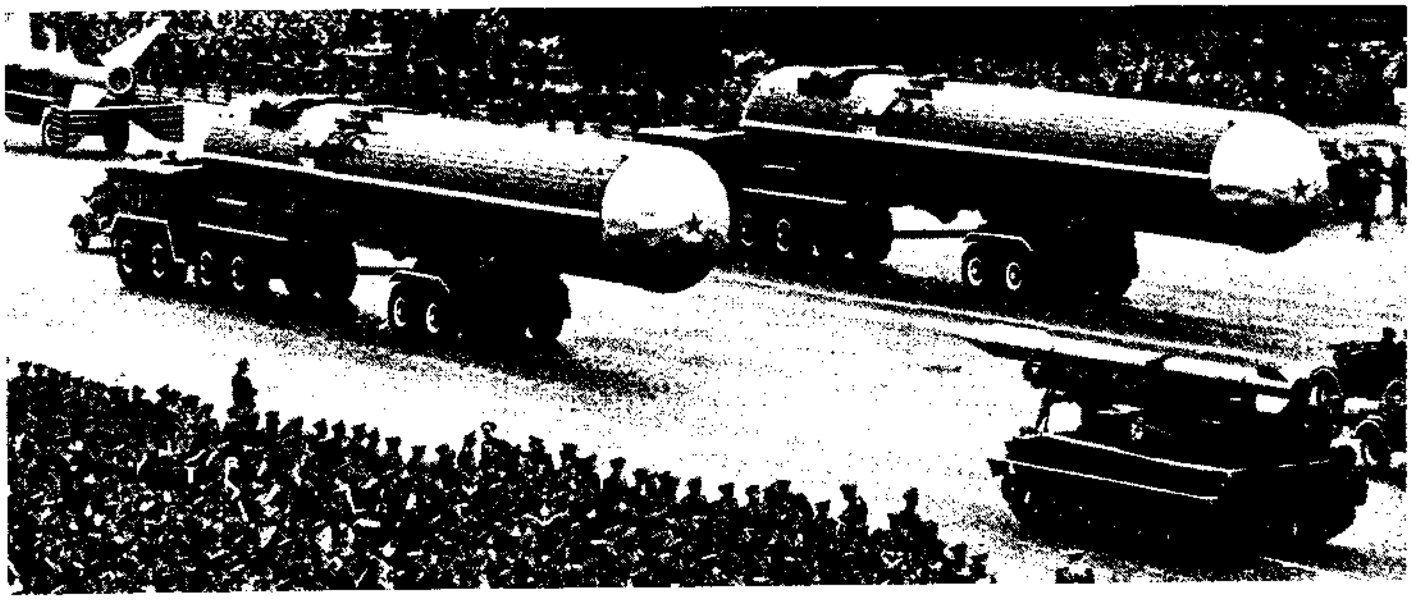
Moreover, Galosh is an operational system. There are reported to be 64 launchers in a system in the region of Moscow; and it is considered that with known system components these are capable of providing a "thin" defence of the capital. Because deployment slowed in 1968 it was at one time thought that the Russian authorities were abandoning the idea of ABM defences: it now seems, however, that the slowdown was associated with a reconfiguration of the radar system to take account of the potential threat from China and with improvements in the ABM system itself. These improvements have included the development of an improved missile (**2933.131**) – which is said to have a "loiter" capability similar to that mentioned in connection with Spartan (**2811.131**) – and a new and improved tracking radar.

CHARACTERISTICS:
Type: Surface-to-air anti-ballistic missile missile
Guidance Principle: Radar command
Propulsion: Probably 3-stage solid-propellant
Warhead: Multi-megaton nuclear
Missile Length: About 20 metres
Range: Estimated in excess of 300 km
STATUS:

Operational at Moscow in four sites containing a total of 64 launchers. Further deployment limited by ABM treaty and it is reported that the Russians are taking up their option of installing a further 36 missiles in the Moscow region – but which of the two versions of Galosh will be installed is not known. For further discussion of Russian ABM and air defence systems see entries **2899.181, 2945.181** and **2989.181.**



Galosh anti-missile missile (Novosti)



Galosh missiles in the 1966 May Day Parade in Moscow (Novosti)

2933.131
IMPROVED GALOSH ANTI-BALLISTIC MISSILE MISSILE

DESCRIPTION:

As noted in entry **2932.131** above, the Russians are reputed to have developed an improved version of the Galosh ABM missile, an important feature of the new development being a "loiter" capability.

At first, it was thought that this added capability was simply a way of improving the missile's exo-atmospheric interception capability. Recent reports of a fairly detailed nature, however, suggest that the new missile differs in function from the earlier one as well as in performance. Whereas the basic Galosh missile is believed to be a high-altitude exo-atmospheric interceptor, the new version – while still retaining a slant range capability of some 200-400 nm (350-700 km) – can stop and start its motor four or five times at upper altitudes – while decoys are sorted from warheads by the ground radars – and make a high-altitude interception in the re-entry vehicle's terminal phase.

STATUS:

Flight tests have been reported from American sources but otherwise the status is unknown. Since it appears that the Russians are in process of taking up their option of deploying 36 more ABM missiles in the Moscow area to make up the total of 100 launchers permitted by the SALT 1 agreement, it may well be that they plan a missile mix of the two versions of Galosh.

2935.131
NEW ABM MISSILES

DESCRIPTION:

There have been references, in several official statements from the US Department of Defence in the past year or so, to the development of two new Russian ABM missiles. No details of developments specifically identified with these references have come to our notice: it seems probable however, that the "Improved Galosh" missile (**2933.131**) is one of them and that it may also be the "new long-range ABM missile" that has been referred to by some other commentators.

We have no information on the second development: but since the most obvious omission from the Russian strategic missile inventory is a high-performance short-range interceptor like the American Sprint (**2812.131**) it seems to be at least a plausible speculation that the unidentified development programme relates to a missile of this type.

That the Russians should not have developed such a missile at an earlier stage in their ABM programme is not very surprising. The successful development and operation of a short-range, "last-ditch", endo-atmospheric interceptor requires, as a minimum, a highly sophisticated missile-borne electronic and electromechanical package which must also be extremely light, high performance microwave phased-array radars and elaborate data-processing facilities and a missile propulsion system with an enormous thrust-to-weight ratio. It is known that Russian technology still lags behind that of the Americans in microelectronics and in phased-array radar techniques (although they have narrowed the gap considerably in recent years) and, having regard to the manner in which they have bludgeoned their way into the space and missile business with giant launch vehicles, it seems likely that their knowledge of high-performance rocket motor technology is also some years behind that of the Americans. It may well be that they have only recently reached a point at which it would be reasonable to undertake the development of a Sprint-type missile.

LAND-MOBILE SURFACE-TO-AIR WEAPONS

2290.131
INTRODUCTION

Described in this section are weapons having a wide range of sizes and performance capabilities. All are suitable for use against hostile aircraft, and a few also have an anti-missile capability. All are to some extent mobile, and some are man-portable, but some of the larger systems take several hours to bring into action and are better suited to a semi-static defence role – e.g. of airfields or base installations – than to operations in defence of forward units.

Among the more recently developed systems there has been a noticeable emphasis on fast-reaction short-medium range weapons for defence against low-flying aircraft and tactical missiles; there have also been interesting developments in man-portable weapons capable of giving infantry units a degree of self-protection against aircraft attack that they have never previously known.

For convenience of system comparison, these mobile systems have been subdivided into three sub-sections – one dealing with mobile (but not portable) guided weapon systems; one dealing with mobile gun and rocket systems; and a third dealing with portable guided missile systems. While the first and third sub-sections are concerned with guided weapons which can be unambiguously distinguished from unguided weapons, there is some difficulty in defining the border between self-contained AA gun systems – which are described in the second sub-section below – and associations of AA guns with separate fire control systems. While we have endeavoured to follow a consistent line here, the reader may find it useful to consult "Land-based Anti-Aircraft Fire Control Systems" later in Section One and the ordnance entries at the beginning of Section Three.

MOBILE SURFACE-TO-AIR GUIDED MISSILE SYSTEMS

CHINA (PEOPLE'S REPUBLIC)

2050.131
CHINESE ANTI-AIRCRAFT MISSILES

Little is known about Chinese developments in the anti-aircraft missile field. It is known that they possess a number of missiles supplied to them by Russia before the two countries became estranged, and according to US statements these are all SA-2 Guideline missiles (**2942.131**).

Some of these Guideline missiles have in turn been supplied by China to Albania and installed in missile sites constructed under Chinese supervision. It was at one time suggested that some such sites, as yet unequipped, would be receiving Chinese-developed missiles, but there has been no further news on the subject for a long time. It seems clear, however, that the Chinese must be manufacturing Guideline missiles at least, because according to US reconnaissance reports several hundred of the missiles had been deployed in China by mid-1973. The US official view is that this deployment will continue for a few years yet: on the other hand the magnitude of the effort that is thought to be involved in the ICBM development makes it seem unlikely that much effort could be spared for new surface-to-air missile development.

FRANCE

2074.131
CROTALE LOW-ALTITUDE GROUND-TO-AIR MISSILE

DESCRIPTION:

Crotale is a completely automatic short-range surface-to-air missile system for the all-weather interception of low-altitude targets. The complete weapon system can be mounted on wheeled vehicles, semi-mobile launchers or shipboard launchers and is air-transportable.

Mounted on wheeled vehicles, the complete system comprises up to three combined launch and command guidance vehicles and a surveillance radar vehicle. Four missiles, in containers, are carried by each launch vehicle, the missile being in ready-to-fire condition. Also carried by this vehicle is a monopulse fire-control radar capable of guiding two missiles simultaneously, missile tracking being aided by a transponder mounted on each missile. Radar acquisition of the missile immediately after launch is aided by infra-red detection of exhaust heat: there is also an optical tracking device. Guidance signals are transmitted to the missile by radio.

On the second vehicle is a pulse-Doppler S-band surveillance radar having the good anti-clutter performance necessary for low-altitude target detection. Associated with the radar is an automatic target evaluation system that gives the weapon system its fast reaction time. Up to three launch vehicles can be served by a single acquisition vehicle.

DESCRIPTION – ACQUISITION UNIT:

On the surveillance radar vehicle is mounted a Thomson-CSF radar. This S-band equipment has an accuracy of target designation that is consistent with the requirements of the tracking radar on the other vehicle while permitting the high data renewal rate resulting from an antenna rotation rate of 60 rev/min. Two stacked beams make it possible to extract height information from the radar data and a sub-clutter visibility of 60dB gives the radar good performance on low-flying targets.

Associated with the radar are an IFF interrogator-decoder, a non-saturable extractor, a real-time digital computer, a display console and a digital data link (optional radio or cable). The computer, which is identical with that used in the firing unit, is used for the generation of synthetic video symbols and for the continuous processing of the system's twelve track-while-scan loops – the latter being used for the generation of accurate data for target designation and for confirmation of threat evaluation.

Crotale Acquisition Unit

The operational console consists of a PPI and an operation panel. On the PPI is displayed a synthetic video picture (computer generated) of the air situation together with threat indications (level of threat, initiated targets, IFF response) and a video map showing the locations of the firing units.

Initiation of the track-while-scan loops is either automatic – if the radar-computer combination considers that a threat is urgent – or manually by operator's joystick control. On initiation a push-button corresponding to the loop is illuminated, the computer triggers the IFF interrogator and the final result of threat evaluation is displayed by a signal lamp associated with the push-button.

Also on the console is an operation panel on which are signal lamps indicating the status of the firing units, three "fire designation" push-buttons, whereby the operator may assign the selected track-while-scan loop to one of the firing units, and three further push-buttons whereby the operator may order destruction in flight of the missiles in case of a late IFF recognition.

Data transmission to the firing units is by digital link either by cable (up to 400 metres) or by radio (from 50 to 5,000 metres). Target designation data and operational orders are transmitted to the firing units and information on operational status is received from them.

A crew of not more than two is required to man the acquisition unit – a chief operator, an assistant operator if required and a driver. The vehicle is of a "semi-cross-country" type and is electrically propelled. This method of propulsion results in reduced vibration levels and flexible driving; it also permits sealing of the vehicle for NBC protection. Electrical power is provided by a thermal motor driving an alternator and each wheel of the vehicle has its own electric motor. A hydraulic circuit provides for power-assisted steering, breaking, vehicle suspension and automatic levelling by jacks. Finally the vehicle is, of course, air-conditioned.

FIRING UNIT:

A Ku-band ecartometric monopulse radar is used with this part of the system. This is mounted concentrically with the launcher turret, which carries four missiles, and can track one target and guide two missiles simultaneously towards the same target. Other units in the vehicle include an X-band telecommand transmitter, an infra-red gathering system, a television tracking system for standby use, a real-time digital computer, an operating console and a digital data link.

Radiation from the radar is circularly polarised and is in frequency diversity. The use of Ku-band makes the achievement of a 1.1 degree beam-width possible despite the small dish size. The infra-red gathering system has a field of view of $\pm$ 5 degrees to enable it to generate missile/radar axis angular deviation data during the pre-guidance phase. The standby television system is for optical tracking if for some reason radar tracking is impossible.

Identical with that used in the acquisition system, the real-time digital computer is used, first, to make parallax corrections to the target designation data and to put the radar on target. It also computes the possibility of interception – to avoid wasting missiles – generates guidance orders during both the gathering and guidance phases, orders the arming of the missile's proximity fuse when it is nearing the target, orders the destruction of the missile if necessary and notifies the end of the engagement.

The operational console of the firing unit is designed primarily for supervisory purposes – so that the operator can supervise the status of the unit – and undertake its maintenance – and supervise the firing sequence in normal conditions. Provision is made, however, for him to intervene if necessary. An A-scope display enables him to check target and missile tracking, and manual radar and firing controls are provided. If the television system has to be used, of course, the operator will track the target manually.

Apart from changes necessitated by the different superstructure the design of the firing unit vehicle is generally similar to that of the acquisition unit vehicle.

MISSILE:

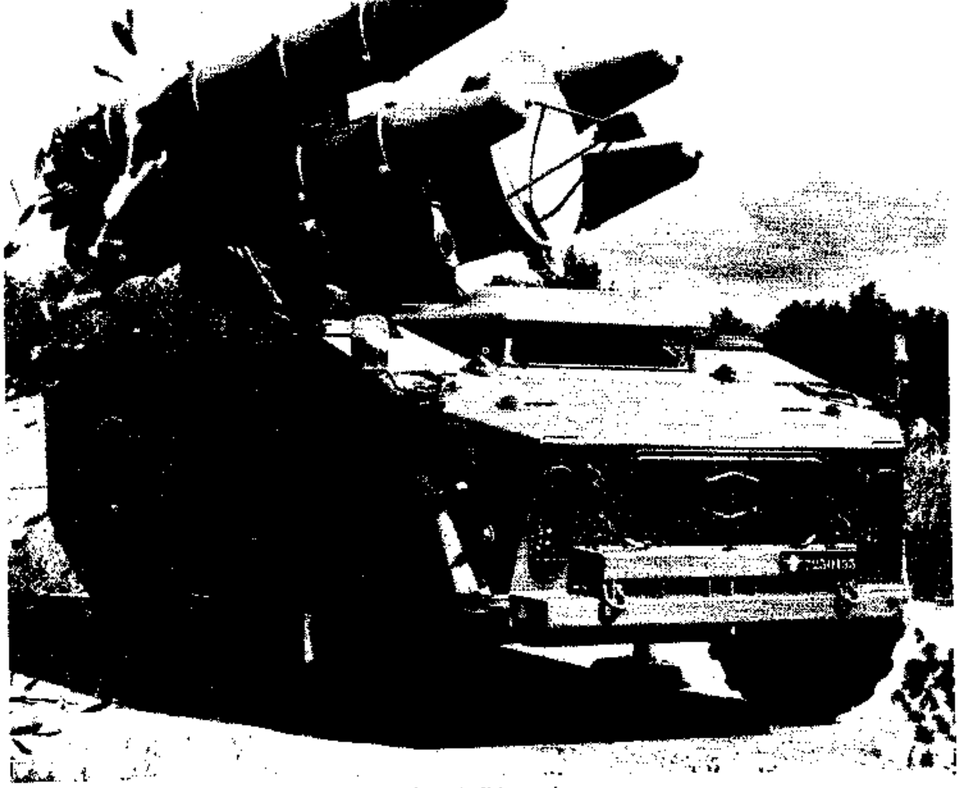
A canard configuration gives the missile great manoeuvrability and it is roll-stabilised by rear control surfaces for high-precision guidance. Its 15 kg warhead is detonated by an infra-red proximity fuse and produces a high-velocity (2,300 m/sec) directed fragmentation burst that is effective up to 8 metres. The warhead is armed by ground command through a telecommand receiver which also receives the guidance commands and, if appropriate, the destruct command. The telecommand receiver also triggers the transponder that the missile carries to make location easier.

Servo motors operating the control surfaces, controlling yaw and pitch at the front and roll at the rear, respond to the demands of an autopilot unit comprising three rate gyros and a gyroscope.

Propulsion is by a single-stage solid-propellant rocket motor that accelerates the missile to Mach 2.3 in 2.3 secs.

MONOVEHICLE SYSTEM:

Crotale's modular assemblies can be regrouped to form a single vehicle installation if required. For example, an arrangement of this kind on an AMX-30 tank chassis would permit the carriage of four missiles (as usual) on the turret with a reserve of a further four carried inside the tank. Reloading time for an arrangement of this kind would be 20 seconds.



Crotale firing unit

CHARACTERISTICS:

Type: Land-mobile, automatic, all-weather, surface-to-air guidance weapon system

Guidance Principle: Command guidance by digital radio link

Guidance Method: Infra-red missile gathering; secondary radar missile tracking by target tracking radar; command control of missile control surfaces via autopilot

Propulsion: Single-stage solid propellant motor

Warhead: 15 kg, high-explosive, directed burst, fragmentation type with infra-red proximity fuse

Missile Length: 2.89 metres

Missile Diameter: 15 cm

Span: 54 cm maximum

Launch Weight: Approx 80 kg

Speed: Mach 2.3 reached in 2.3 secs. 16 sec time of flight to 8 km

Typical Target Data:
Speed: Mach 1.2
Altitude: 50 to 3,000 m
Manoeuvre: 2 g
Radar-cross section: 1 sq metre, fluctuating

Performance Against Typical Target (0.9 interception probability):
Maximum engagement range: 8.5 km
Minimum Range: 500 m
Maximum crossing range: 3000 m

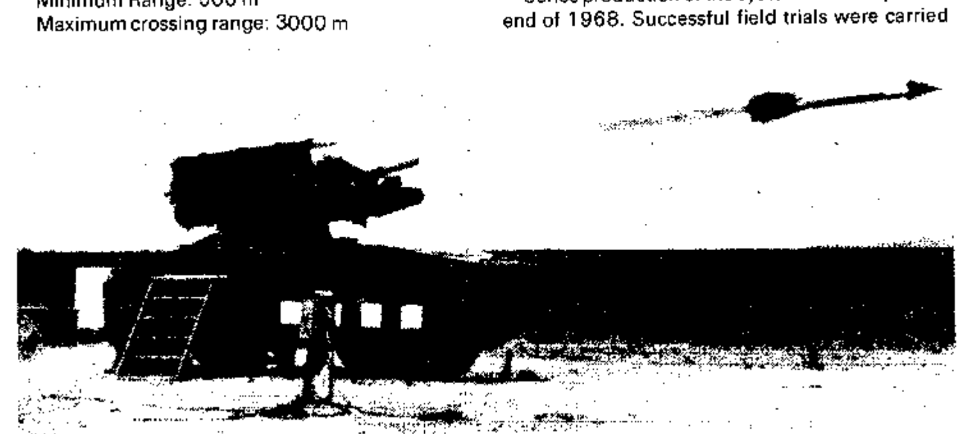
Crotale Acquisition Unit prepared for air transport

Reaction Time: 6 seconds from first detection to missile launch

DEVELOPMENT:

Work started on the project in 1964 both at Thomson Houston and Engins Matra and a prototype missile was completed in the following year. Over-all responsibility for the development lies with the Division Systèmes Electroniques of the Thomson-CSF group – while full responsibility for the missile lies with Matra.

Series production of the system started up at the end of 1968. Successful field trials were carried



Crotale firing

out at Landes, and deliveries to the South African forces began towards the end of 1971. The French Air Force ordered a quantity for the first part of an airfield defence network associated with their strategic nuclear forces. The system has also been discussed with various NATO countries.

In November 1970 Thomson-CSF were awarded a contract for nearly $1.5 million for a Crotale evaluation programme in the USA. Testing has been carried out at White Sands Missile Range and reports have been good. From the point of view of the US Army Missile Command, Crotale is a contender for its low-altitude Forward-area Air Defence System (LOFADS) which is intended to replace the Chaparral (**2542.131**) system in the late 1970s. Other contenders are the Franco-German Roland system and the British Rapier.

TEST AND TRAINING EQUIPMENT:

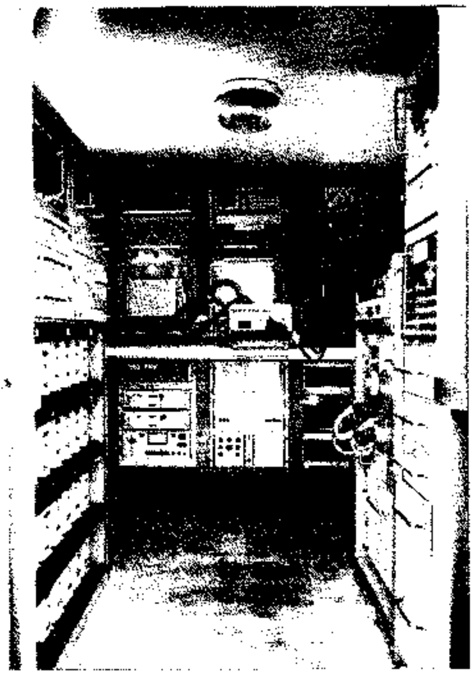
An automatic 3rd-echelon test bench has been made by Thomson-CSF in co-operation with Engins Matra.

SETAC – a tactical training simulator – is made by Thomson-CSF.

MANUFACTURERS:

Thomson-CSF, 1 rue des Mathurins, 92222-Bagneux.

Engins Matra, ave Louis Breguet, 78-Velizy.



Crotale automatic test bench

INDIA

2287.131
INDIAN SURFACE-TO-AIR MISSILES

According to a report published in the Indian press, the Indian Government has made an agreement with the Russian Government whereby the latter will supply SA-6 (Gainful – **2930.131**) and SA-7 (Grail – **2941.131**) anti-aircraft missiles to India together with information to enable these missiles to be manufactured in India.

No details of this agreement are available – in particular it is not known whether the SA-6 production arrangement covers only the missile system or extends also to vehicles – but the arrangement is in keeping with that negotiated with France for anti-tank missiles (**2289.111**) and with the provisions of the new Indian Five-Year Plan.

MANUFACTURER:

Not definitely known, but almost certain to be Bharat Dynamics Ltd, Hyderabad, who make the anti-tank missiles.

INTERNATIONAL

2213.131
HELIP – HAWK IMPROVEMENT

DESCRIPTION:

HELIP is an acronym for Hawk European Limited Improvement Programme and refers to a programme of work on the modernisation of the American Hawk missile (**2640.131**) that was being undertaken in NATO countries. The object of the programme was to make a more robust version of the missile for introduction into service in 1976.

This programme now appears to have been superseded by a more far-reaching agreement between Raytheon and other concerned US manufacturers and the governments of, and appropriate manufacturers in, Denmark, France, Greece, Italy, the Netherlands and West Germany. This covers a programme of work amounting to some $750 million to bring the European Hawk missiles and supporting equipment up to Improved Hawk standards – including the provision of AN/TPX-46 Mk XII IFF equipment from Hazeltine and conversion of AN/TPQ 21 simulators to AN/TPQ-29 simulators by conversion kits supplied by Applied Devices Corporation.

MANUFACTURER:

Prime US contractor, Raytheon Company.

2292.131
MIFLA SURFACE-TO-AIR WEAPON SYSTEM

DESCRIPTION:

Mifla is understood to be the designation of a surface-to-air weapon project now under study as an international venture in Britain, France and West Germany.

No details of target specification have been released but it is understood that the operational requirement is for a system similar in general concept to the American SAM-D (**2800.131**) but less elaborate and much cheaper. It is worth noting that whereas the three countries have, jointly and severally, created three anti-aircraft weapon systems to counter the low-level air threat (Crotale, **2074.131**, Rapier, and Roland, **2218.131**), none of them has a current programme for a longer-range weapon. To some extent, no doubt, the decision to investigate the Mifla project was encouraged by the successes scored by the Russian SA-6 missiles (**2930.131**) in Egypt and Syria during the 1973 Arab-Israeli war. It has indeed been reported that the French authorities were considering the unilateral development of a similar system.

STATUS:

Project.

MANUFACTURERS:

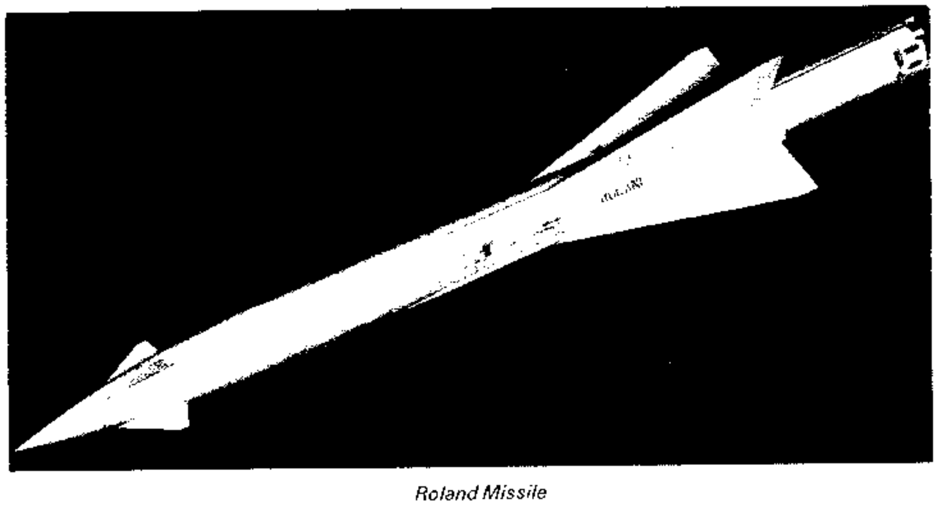
Not yet known.

2218.131
ROLAND MOBILE ANTI-AIRCRAFT WEAPON SYSTEM

DESCRIPTION:

Roland is a surface-to-air missile system intended to provide protection for highly mobile armoured fighting units against attack by low-flying aircraft. The system has the same degree of mobility, armour-plating and ABC protection as the units that it is designed to protect. A crew of three is all that is required to operate the system – commander, aimer and driver.

The complete system is carried on a tracked launch vehicle and in its first-phase configuration comprises a target acquisition and identification radar sub-system, an optical infra-red tracking and guidance sub-system and a launcher with missiles. The launcher is loaded from magazines of missiles carried in the vehicle by a hydraulic system that lifts a new missile into position each time one is fired.



Roland Missile

In its second phase (Roland II) configuration all the sub-systems listed above are retained so that the second-phase system can be operated in exactly the same manner as the first – but an accurate target tracking radar is added to enable the system to be used in visibility conditions that make optical target tracking impossible. Additionally, the possibility of switching from automatic to optical tracking even while the missile is in flight provides a useful counter-countermeasures facility.

CHARACTERISTICS:

Type: Land-mobile surface-to-air weapon system, using tube-launched guided missile

Guidance Principle:

Roland I Command to line-of-sight with optical aiming and automatic infra-red tracking

Roland II As above but with automatic radar aiming

Guidance Method: Jet vane missile control by command microwave radio link

Propulsion: Two stage (booster and sustainer) solid-propellant rocket motor

Warhead: High-explosive with proximity fuse

Ammunition Round:

Length: 2.6 metres

Diameter: 28 cm

Weight: 75 kg

Missile Length: 2.40 metres

Missile Diameter: Body: 16 cm. Span: 50 cm

Launch Weight: 63 kg

Cruising Speed: Approx Mach 1.6

Range: 500-6 500 metres

Radar Range: 15-18 km

Weight of Firing Unit: 6 tons

All-up Weight in SPz or AMX30: 32 tons

OPERATION:

Target detection in azimuth and IFF identification is performed by a pulse-Doppler surveillance and search radar on the launch vehicle, with a range of 15-18 km.

The weapon system commander is also the operator of the acquisition radar. He selects the target and, in the **Roland** I configuration directs the optical sight to the target azimuth. The aimer then searches in elevation and acquires the target, whereupon a missile may be launched. After launch the aimer maintains his aim and the missile is gathered to and guided along this track by an infra-red guidance technique (TCA) which is described in more detail in the entry for HOT **(2212.111)**.

Details of the acquisition radar have not been made public, but judging by the appearance of the scanner, and the operational data that have been released, it seems likely that the radar is generally similar to the Thomson-CSF Domino 30 **(2083.153)**.

In the **Roland** II configuration a tracking radar is used in place of the periscope sight, otherwise the principle of operation is the same. Since one of the features claimed for the system is that rapid transition from radar to optical or optical to radar tracking is possible – even with the missile in mid-flight – it is reasonable to assume that the radar and optical axes are maintained in alignment.

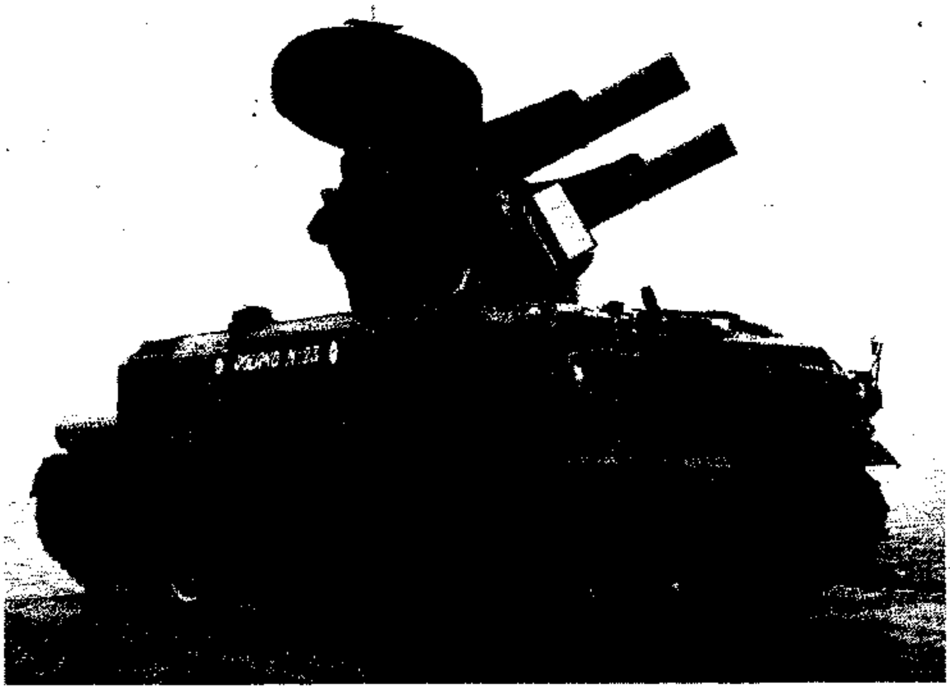
The tracking radar is a monopulse type with a magnetron transmitting valve and Doppler receiver circuits to reduce clutter returns. It is said to have a parabolic Cassegrain aerial and to use circular polarisation. The aerial is gyro-stabilised in bearing and elevation – necessary because the radar is required to have a high resolving power and the weapon system is intended to be used, if necessary, on the move.

The radar deals simultaneously with the target and the missile, missile position in relation to the radar beam being established by continuous-wave transmission from the missile beacon.

Command signals are passed to the missile in flight by a radio link and the commands are interpreted as steering movements of vanes in the efflux from the sustainer motor. This command link has been reported to be a microwave link, but this report is unconfirmed.

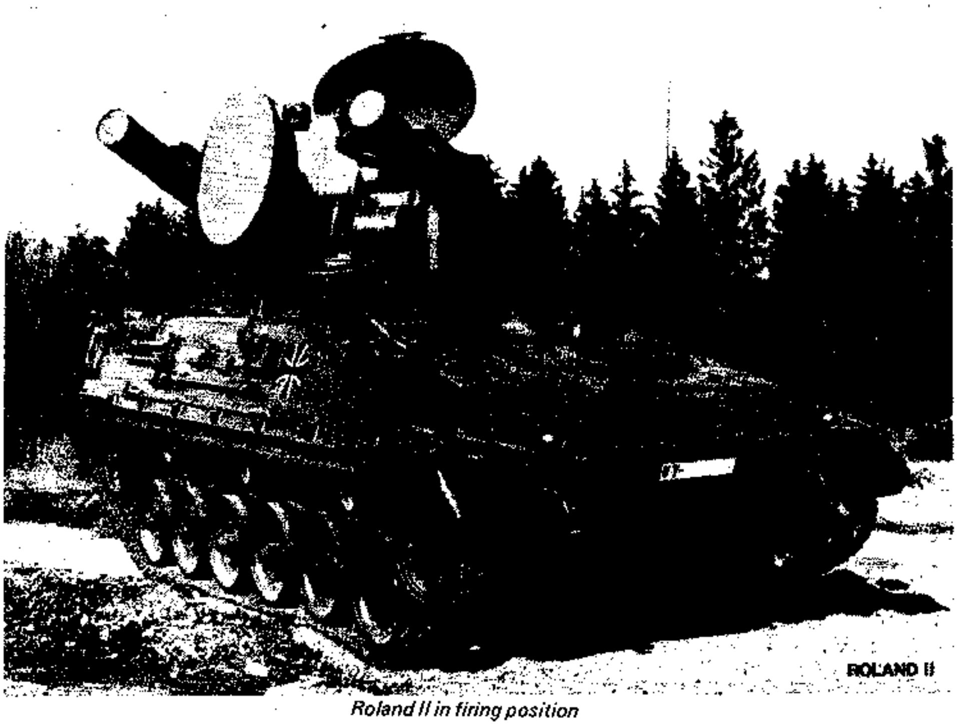
DEVELOPMENT:

Development of Roland has been one of the joint Franco-German operations carried out by Messerschmitt-Bölkow-Blohm and Aérospatiale. The first design study was made in 1964. The French Army was prepared to accept the Roland I configuration when it became available (evaluation in 1971-72) but the German Army decided to wait for Roland II. Other customers are Brazil and possibly the USA who have evaluated Roland



Roland I in firing position

Roland launch



Roland II in firing position

II successfully.

TEST AND TRAINING EQUIPMENT:

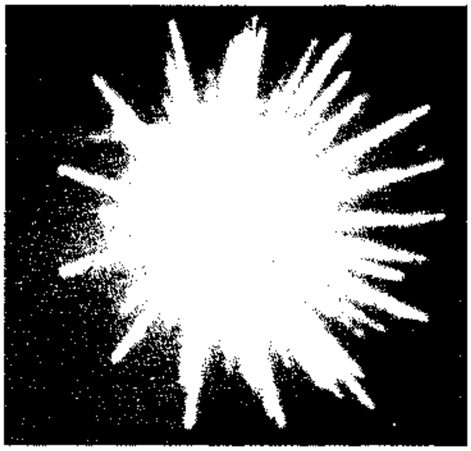
Special test equipment has been developed by Aérospatiale and training equipment by MBB.

MANUFACTURERS:

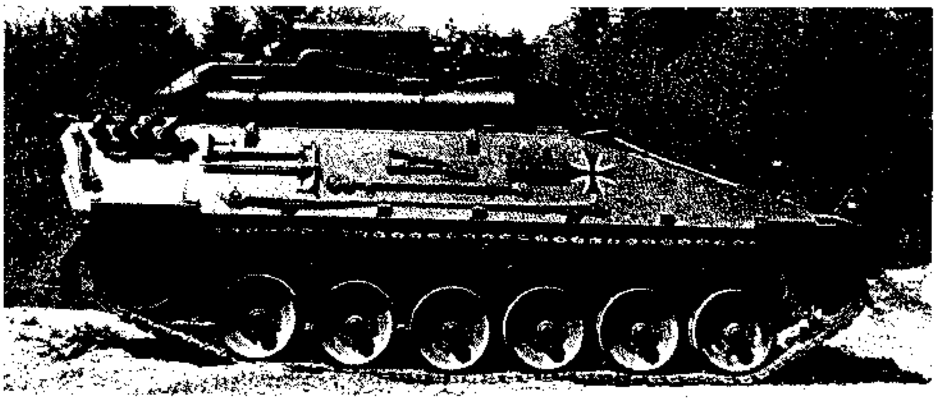
System: Messerschmitt Bölkow-Blohm, GmbH, Munich, Germany, and Aérospatiale, 92-Chatillon, France.

Radars: Thomson-CSF, Paris Siemens, Munich.

Management, sales and responsibility for production: Euromissile, 37 Boulevard de Montmorency, 75016-Paris, France.



Roland warhead explosion



Roland II in travelling position

ITALY

2235.131
INDIGO MOBILE ANTI-AIRCRAFT WEAPON SYSTEM

DESCRIPTION:

Indigo is a short-range surface-to-air land-based weapon system. It has undergone an extensive series of successful trials at the Italian firing range in Sardinia and is now fully operational with the Italian Army in a towed version.

This towed version comprises one or more Indigo trailer launchers and associated trailer power units together with a modified Superfledermaus fire control system (**2291.151**) and LPD/20 pulse doppler search radar (**1529.153**), both of which are made by Contraves. The modification to the Superfledermaus consists mainly of the addition of missile engagement and guidance computers, a missile control panel, a command transmitter and an infra-red tracker.

A self-propelled version is being developed. This will have an Officine Galileo fire control system and Thomson-CSF Eldorado/Mirador radars (**2082/2117.153**). Two tracked vehicles will be used, one carrying the missile launcher and the other the radars and fire control system.

Indigo is intended to respond quickly to an attack. Standard time from target detection alarm to launch sequence initiation is 6 seconds and to motor burn-out (speed 850 m/sec) is 10.5 sec.

Targets can be engaged either with single missiles or with two-missile salvoes. In more than 80 development trial firings with the Superfledermaus system, a single-shot kill probability of 50% was established.

CHARACTERISTICS:

Type: Land-mobile surface-to-air tactical guided missile

Guidance Principle: Beam riding/radio command with standby optical and IR tracking/radio command

Guidance Method: By control of movable cruciform control surfaces at centre of missile. Stabilisation by cruciform tail fins

Propulsion: Solid-propellant rocket motor, 3,800 kg st for 2.5 sec

Warhead: High-explosive (21 kg) fragmentation type with impact and infra-red proximity fuses

Missile Length: 3.32 metres

Missile Diameter: Body: 0.195 metres, Span: 0.86 metres

Launch Weight: approx 121 kg

Speed: Approx Mach 2.5 at burn-out

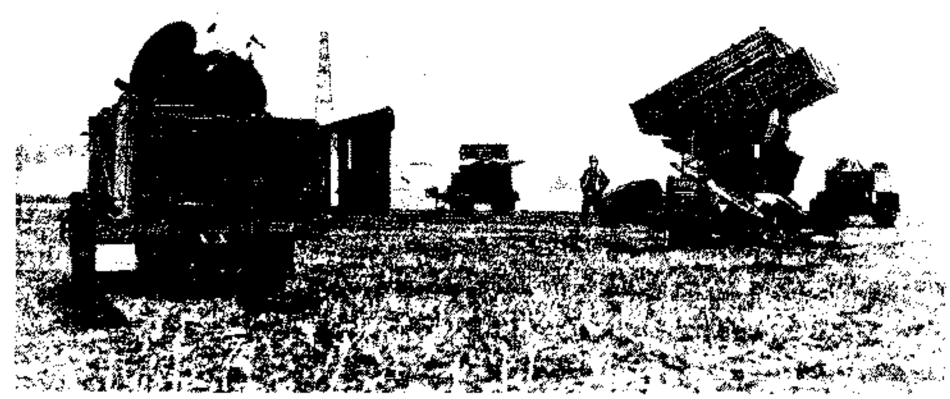
Range: Approx 10 km slant range

Ceiling: Approx 5,000 metres

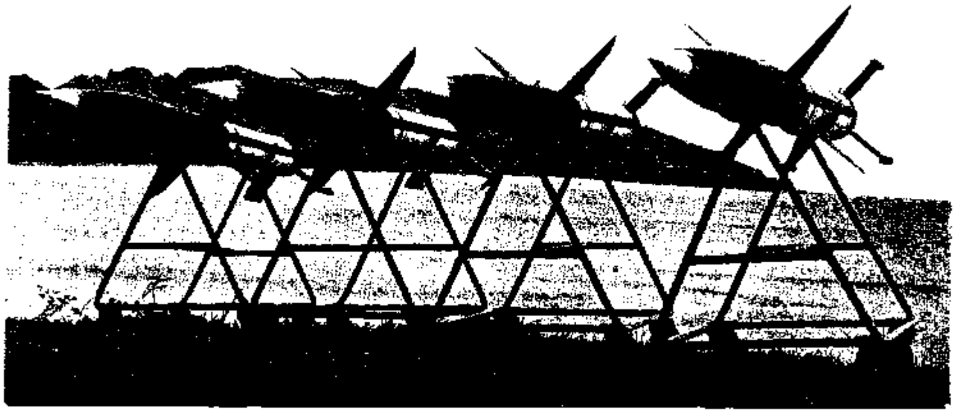
Reaction Time: 6 seconds

OPERATION

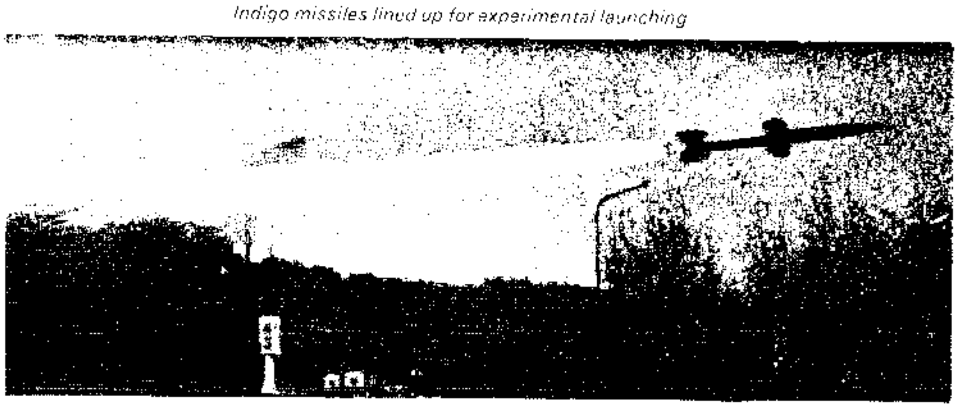
Operation of the missile is similar in principle to that of the Sistel Sea Killer Mk 1 and 2 missiles described elsewhere in this section (**2240.221** and **2253.221**). Primarily intended as a beam-riding system, the missile can also be controlled over the radio command guidance link with optical and infra-red tracking if the beam-riding function is rendered inoperative by jamming or



Indigo weapon system deployment



Indigo missiles lined up for experimental launching



Indigo missile in flight

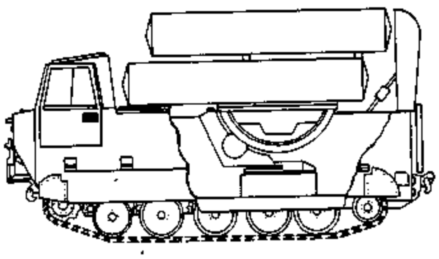
otherwise. Unlike the Sea Killers, however, there is no radio altimeter in the system.

DEVELOPMENT:
Development of the system was initiated by Contraves Italiana SpA in 1962 and the first prototype was completed in 1963. In 1969 the project was taken over by Sistel SpA.

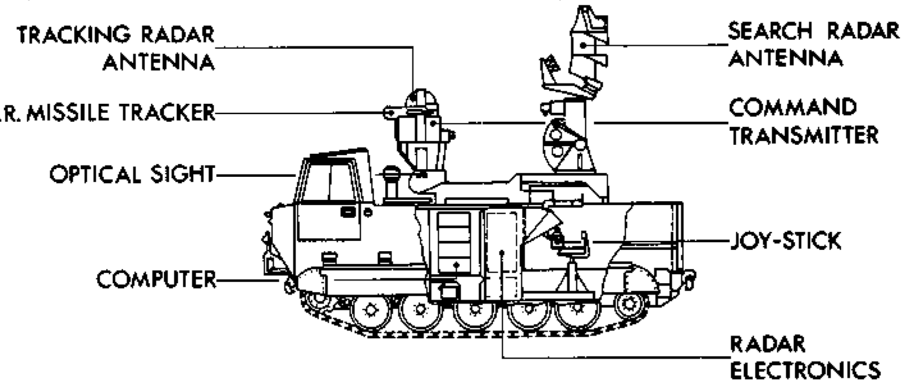
STATUS:
Towed System – operational.
SP System – in development.

MANUFACTURERS:
The missile is manufactured by Sistel SpA, Via Tiburtina 1210, 00131 Rome.
Test and training equipment is manufactured by Sistel and by Contraves Italiana SpA respectively.
Fire control system by Contraves Italiana SpA, (towed system) or Officine Galileo, Italy (SP system).
Acquisition radars by Contraves Italiana (towed system) or Thomson-CSF, France (SP system).
Proximity fuse by Hawker Siddeley Dynamics, England.
Launcher (both systems) by DEA, Italy.

Sextuple launcher for Indigo



Launcher unit of mobile Indigo system



Radar unit of mobile Indigo system

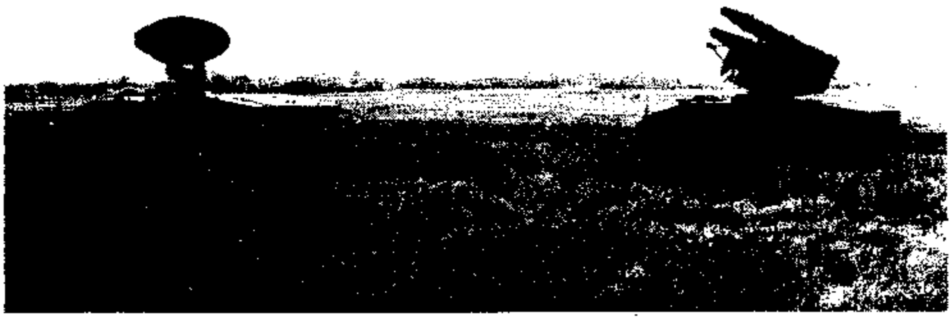
SOUTH AFRICA

2341.131
CACTUS

Cactus is the name given to the version of the French Crotale land-mobile surface-to-air guided weapon system which is in service with the South African Air Force.

Crotale is described elsewhere in this section (**2074.131**) and indeed it was primarily for South Africa that the development was originally started. Apart from the change of name, no details of differences between Cactus and Crotale have been released; but comments from usually well-informed sources suggest that it is "a version" of Crotale that is being supplied to South Africa. The Crotale system has undergone some changes in the course of development, and it may well be that the system in service in South Africa is rather different from that which has been supplied elsewhere.

It is interesting to note that the Cactus units in South Africa are linked directly to the early warning radar network which covers the North-East and North-West approaches to the Republic and which has its headquarters at Devon in the Eastern Transvaal. A Mirage interceptor squadron is also linked to the network.



Units of the Crotale / Cactus system

THE UNITED KINGDOM

2406.131
BLOODHOUND Mk 2 SURFACE-TO-AIR WEAPON SYSTEM

DESCRIPTION:

Bloodhound Mk 2 is a second-generation mobile anti-aircraft guided weapon sub-system suitable for incorporation in a comprehensive air defence system. The basic unit – a missile section – typically comprises four guided missiles and their launchers, a target illuminating radar (TIR) and a launch control post (LCP). The guidance principle is semi-active homing – the missile detecting and homing on the radiation reflected by the target when illuminated by the TIR.

Basic input required by the missile section is target location information from a surveillance radar which may be directly associated with the Bloodhound sub-system or may be part of the central equipment of a larger complex. This information is supplied to the TIR, which then searches for, acquires and automatically tracks and illuminates the target. Simultaneously, it interrogates the target for positive identification and transmits the appropriate information to the LCP.

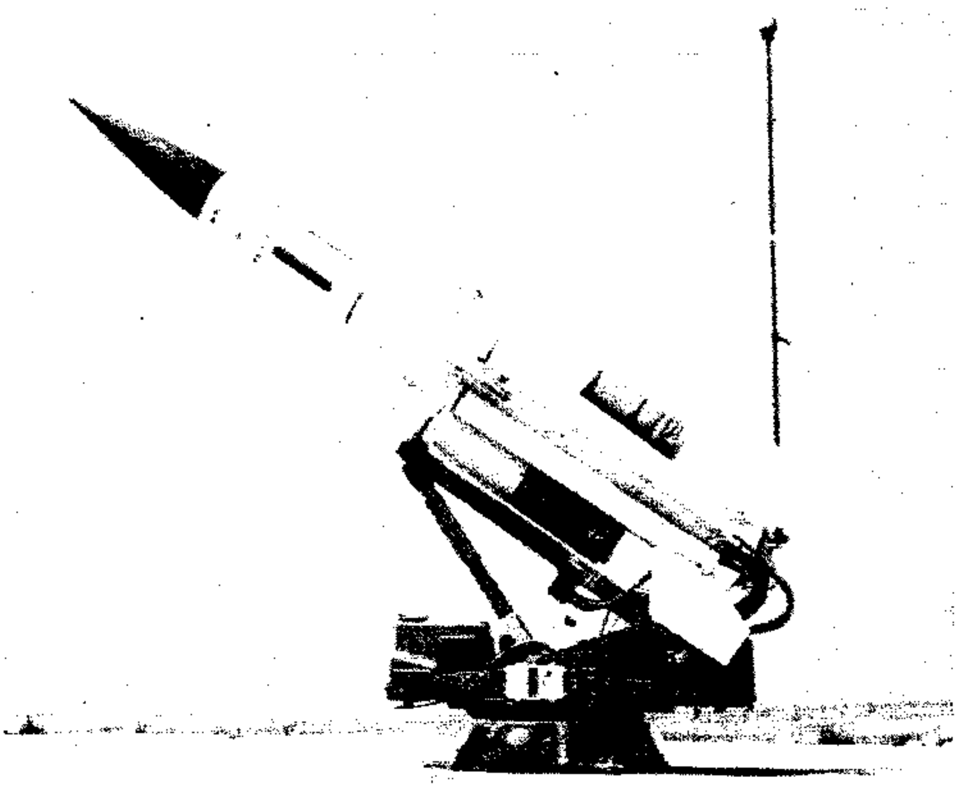
At the LCP, which is the control centre of the missile section, sits the Engagement Controller assisted by a Technical Supervisor. A high-capacity computer in the LCP processes the output data from the TIR to determine the optimum conditions for target engagement. This computer also performs routine tasks concerned with the state of readiness of the system; both the Engagement Controller and the Technical Supervisor are provided with displays and communications equipment to enable the former to take rapid operational decisions and the latter to maintain maximum equipment serviceability.

In the mobile role for which it was first designed, the Bloodhound missile section is normally equipped with the Firelight TIR (**2413.153**) which is readily mobile and air-transportable. The whole equipment is contained in a single cabin and the aerials are mounted on a retractable pedestal on the roof. For static operations – or where system mobility is not a prime consideration – there is an alternative TIR, the Scorpion (**2428.153**), which is a larger radar giving a longer range. It can be broken down into transportable units but cannot be brought into or taken out of operation as quickly as the Firelight. Both radars are X-band CW Doppler equipments having good performance in the presence of natural or ECM interference.

CHARACTERISTICS:

Type: Surface-to-air land-based GW system. Land-mobile. Air-transportable

Guidance Principle: Semi-active homing. Receiver in missile nose detects and follows radiation reflected by target when illuminated by TIR



Bloodhound deployed at Paramali, Cyprus (RAF Photograph)

Guidance Method: Twist-and-steer by pivoting wings

Propulsion: Ramjet with solid-propellant boosters

Warhead: High-explosive, with proximity fuse

Launch Control: From LCP by computer using data from TIR

Radar: Choice of two TIR's – Firelight or Scorpion

Range: Better than 80 km

DEVELOPMENT HISTORY:

Bloodhound Mk 2 is the successor to Bloodhound Mk 1 which first went into service with the RAF in 1958; development having been started by the Bristol Aeroplane Co Ltd and Ferranti Ltd in 1949. The first design study for the Mk2 version was started in 1958; the new version went into service with the RAF in 1964. In the same year the equipment also went into service with the defence forces of Sweden and Switzerland. The system has also been exported in substantial numbers to Australia and late in 1969 BAC were awarded a £10 million contract from the Singapore Government for the refurbishing and maintenance of the Bloodhound system previously operated by the RAF in that area.

Bloodhound-equipped RAF units are currently deployed as part of the NATO air defence of Western Europe.

MANUFACTURERS:

The following manufacturers are known to have been associated with the system.

Overall system, missile airframe etc. (consortium leader): British Aircraft Corporation (Guided Weapons Division), Stevenage, Herts.

Overall electronic system, missile homing system, LCP Computer etc., Firelight TIR: Ferranti Ltd., Edinburgh (TIR) and Wythenshawe (remainder).

Ramjet propulsion system: Rolls-Royce Ltd.

Missile fuse: EMI Ltd.

Scorpion TIR: GEC Electronics Ltd.

TEST AND TRAINING EQUIPMENT:

Engagement controller's simulator: Ferranti Ltd., Wythenshawe.

Homing head test equipment: Ferranti Ltd., Wythenshawe.

Fuse test equipment: EMI Ltd.

Ramjet propulsion system test equipment: Rolls Royce Ltd.

2424.131
RAPIER MOBILE LOW-LEVEL ANTI-AIRCRAFT MISSILE SYSTEM

DESCRIPTION:

Rapier is a lightweight highly-mobile surface-to-air guided weapon system in which a supersonic, direct-hitting missile is automatically, commanded to follow an optically established sightline to the target.

Main operational units of the system are a Fire Unit, an optical Tracker and a Power Unit. These three units can be disposed in any convenient manner, according to terrain, interconnection being by cable. Once the Fire Unit has been loaded with its four missiles (a two-man job) it can be left unattended and the system operated by one man at the Tracker until the missiles have all been fired. No cranes or mechanical handling equipment are required.

In addition to the missile launch mechanism, the Firing Unit contains a search and acquisition radar (**2425.153**) which works in conjunction with an IFF interrogator-responser, a microwave command transmitter and a computer which serves all parts of the system. When the surveillance radar detects a target the IFF automatically interrogates it to determine whether it is friendly or hostile. If the target is friendly all data on it is cancelled and the radar continues its search; if it is hostile the Tracker operator is alerted, the radar data is used to direct the Tracker towards the target and the operator will see it in his optical sight.

After acquiring the target optically the operator takes over from the radar and tracks it using a joystick control – thus generating an output from the tracker that is fed to the fire unit computer. When the operator considers he is tracking smoothly and after receiving a signal from the computer that the target is engageable the operator fires a missile – the launcher having been automatically aligned so that the missile will fly on the line of sight to the target.

While the missile flies towards the target the operator continues tracking. A television camera in the Tracker collimated to the tracking telescope detects flares mounted in the missile tail and measures any deviation from the sightline. These measurements are then fed to the fire unit computer which then causes the command transmitter to transmit correction signals to the missile.

Rapier is intended primarily for defence against fast (Mach 1 +) manoeuvring low-flying targets. It has the fast reaction time necessary for the successful engagement of such targets which may appear suddenly, over terrain screening, at short range. It can also, however, be used successfully against aircraft flying at heights of some thousands of metres

As already noted, Rapier is a direct-hitting system and it has demonstrated its capability in this respect in repeated trials. For this reason it is fitted with an impact fuse. It has been reported, however, that the Norden Division of United Aircraft (who have been collaborating with BAC in US Rapier trials) is developing a proximity fuse for the missile. It has also been reported that they, in conjunction with BAC and the Royal Radar Establishment have set up a mathematical model to explore the effectiveness of Rapier against manoeuvring targets.

In normal operational use the Fire Unit is towed by a long-wheelbase Land Rover which also carries the optical tracker and four missiles in sealed containers; a second Land Rover tows a missile re-supply trailer which carries more additional missiles in identical sealed containers. For continuous operation the normal detachment strength is five men: but three can deploy and man the system and, as already noted, only one man at a time is needed to operate it after loading. A complete system can thus be transported in a Chinook helicopter. Since the system components are small, however, they can be mounted in various other ways – eg on tracked vehicles – to suit special operational requirements.

One such special mounting, illustrated here by an artist's impression is on a general-purpose FMC M-548 tracked vehicle. The basic weapon system, pallet-mounted for convenience of fitment, can be carried on a single vehicle: for the system with blindfire radar (see below) a second vehicle is required. Trials of the tracked system are scheduled for late 1974.

Characteristics: (System with optical tracking)

Type: Surface-to-air land-or vehicle-based GW system
Land-mobile. Air-transportable

Guidance Principle: Command to line-of-sight

Guidance Method: Optical target tracking. Electro-optical missile tracking. Computer calculates course corrections for transmission over command link. Hot gas servos actuate missile fins

Propulsion: Two-stage solid-propellant motor

Warhead: High-explosive with crush fuse

Launch Control: By operator when cleared to fire by computer

Tactical Control: In primary design role as fast-reaction system, none. May be integrated with larger systems

Launch Weight: Not released. Probably about 65 kg

Speed: Not released. Evidently high supersonic

Range: Not released. Ceiling believed 5,000 m

Development History and Prospect:

Developed to satisfy a British Defence Ministry requirement for a low-cost system to combat low-level aircraft attacks, Rapier was the subject of a design study in 1963. It is currently in production, having been ordered by the British Army, the RAF and the Imperial Iranian defence forces. Several more overseas orders are pending and the system was fully evaluated by the US Army in 1972.

Blindfire Development:

The basic Rapier system was designed to combat the daylight/good visibility low-level threat posed by the very large numbers of ground attack aircraft and helicopters which are currently operational. The number of aircraft that can attack at low level by night or in conditions of low visibility is very much smaller, but extension of the system capability to combat this threat was considered necessary as a second priority.

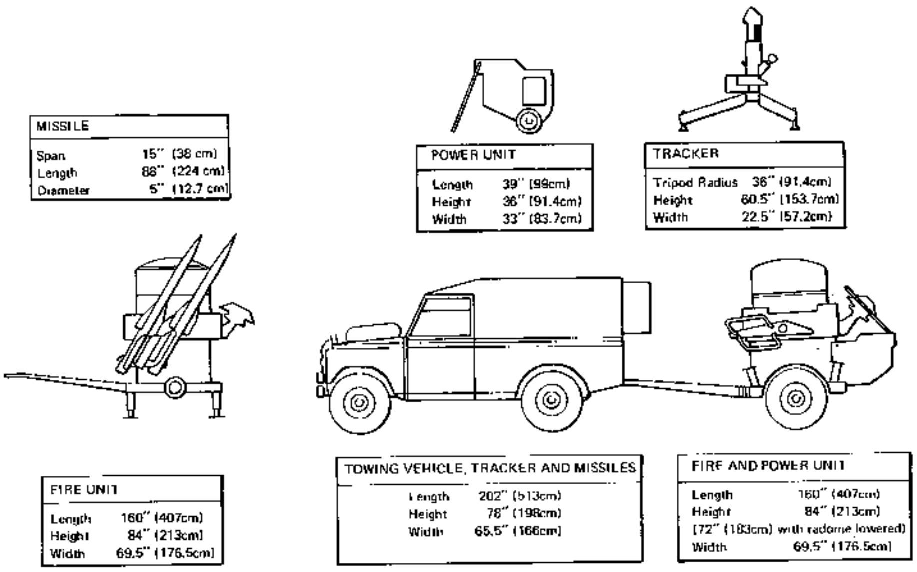
To provide this added capability, BAC have developed, in conjunction with Marconi Space and Defence Systems, an add-on radar **(2439,153)** which provides guidance when optical tracking is impossible.

This "Blindfire Attachment" as the new radar is called, is mounted on the same type of trailer as is used for the Fire Unit. No other details of its construction or performance have been released for publication but a mock-up of the radar was exhibited at Farnborough in 1970 and what appeared to be a fully-engineered model was on show there in 1972 – but with the aerial feed masked as it is in the accompanying illustration.

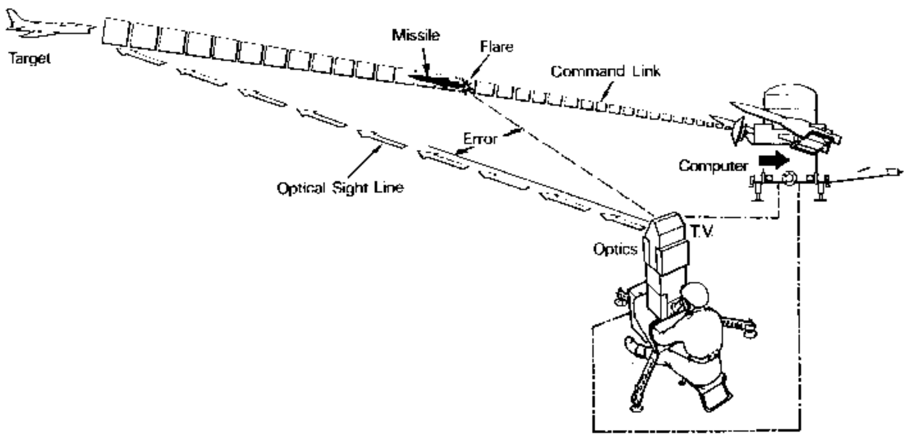
Firing trials of the "Blindfire" system have been conducted, and at the very first attempt the target – a Meteor drone flying at Mach 0.6 at a height of 600 metres – was destroyed by a direct hit. The manufacturers believe that this degree of success in combining a direct-hitting missile with radar tracking is unequalled elsewhere

In daylight conditions, the addition of the "Blindfire" radar to the system gives the operator the option of optical or radar engagement – an

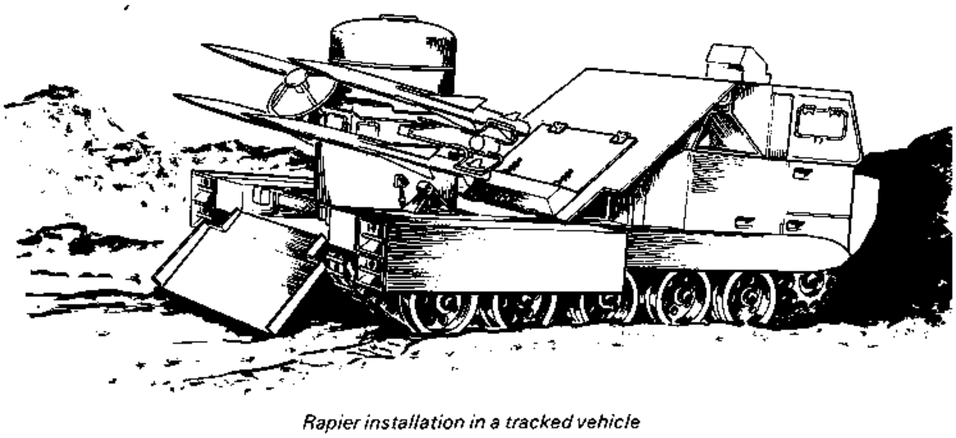
Fire Unit of Rapier low-level anti-aircraft weapon system being readied for action



Rapier dimensions



Rapier guidance system



Rapier installation in a tracked vehicle option which need not be exercised until after the acquisition radar has indicated the presence of a target and, through a remote control link, has enabled the tracker to acquire the target.

A UK production order for the blindfire radar has been placed and Iran has purchased some of these radars for its Rapier systems.

SIMPLIFIED FIRE UNIT

For certain special applications, BAC has proposed and demonstrated a less elaborate Fire Unit from which the search and acquisition radar and the relevant sections of the computer have been removed. Such a unit could provide an inexpensive way of increasing the fire power of a battery between reloadings, since the radar in one complete fire unit could seek out targets for other, incomplete, fire units. Alternatively the simple fire unit could be used as a visual system independent of radar using a simple printing sight to programme the tracker with target angular coordinates plus an estimate of range.

MANUFACTURERS:

The following manufacturers are known to have been associated with the system.

Weapon System: British Aircraft Corporation Ltd, (Guided Weapons Division), Stevenage.

Safety and Arming System: Marconi Space and Defence Systems Ltd.

Primary Radar: Decca Radar Ltd.

Secondary Radar (IFF): Cossor Electronics Ltd.

Servo-Optical Tracking System: Barr & Stroud Ltd.

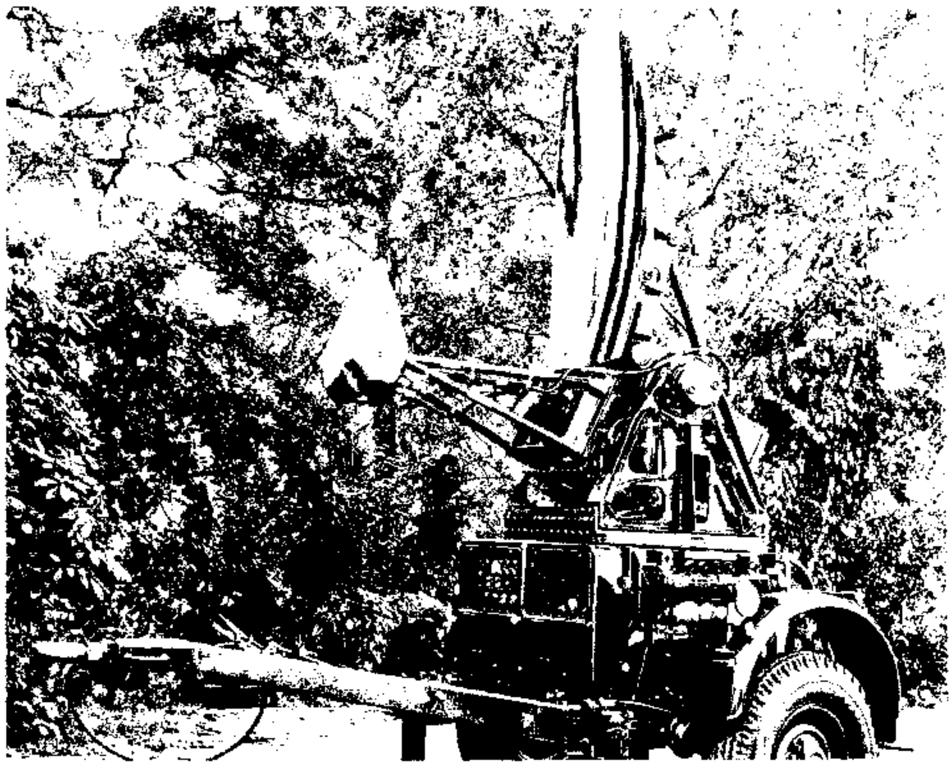
Command Link: Decca Radar Ltd.

"Blindfire" Radar Attachment: Marconi Space and Defence Systems Ltd.

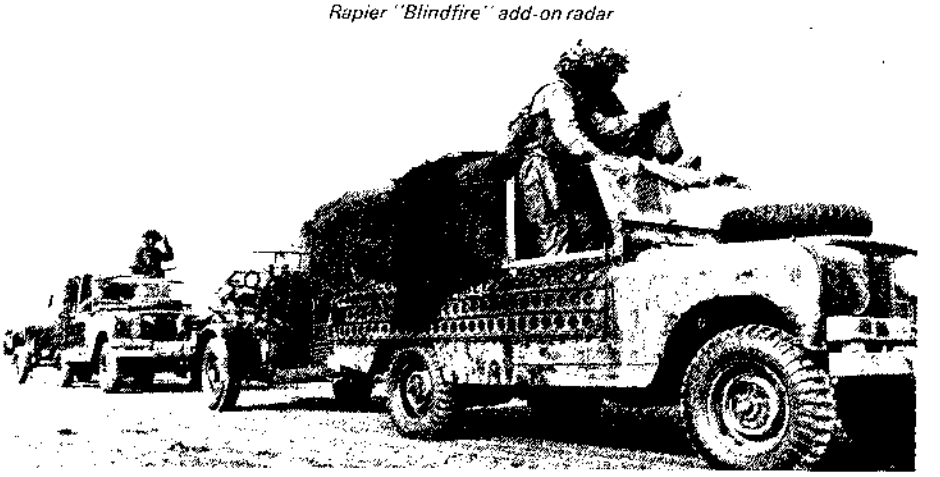
Missile Rocket Motor: Imperial Metal Industries Ltd.

TRAINING AND MAINTENANCE:

BAC make a special simulator for operator training. They also supply a range of specially equipped repair vehicles for maintaining the system. One of these, the Forward Repair Test Vehicle, is a Land-Rover equipped with automatic test equipment suitable for all first line testing. Two larger vehicles are available for second line work – one for the electrical and electronic equipment and the other for the optics and hydraulics.



Rapier "Blindfire" add-on radar



Complete Rapier system on the move

Rapier system deployed

2460.131
THUNDERBIRD 2 SURFACE-TO-AIR MISSILE SYSTEM

DESCRIPTION:

Thunderbird 2 is a versatile mobile medium-to-high level anti-aircraft guided weapon system capable either of being operated independently as a self-contained system or of being integrated into a larger air defence complex. The system description that follows relates primarily to its use as an autonomous firing unit, but some of the larger configurations of which it forms a part are described elsewhere in this section.

Fully land-mobile – including cross-country driving and rail transport in standard wagons – and air transportable Thunderbird 2 is a rugged system designed for use in any climate from unprepared sites; it is claimed that targets can be engaged in 2¼ hours from arrival at such a site.

When organized for autonomous operation the basic system unit is the missile battery. This is subdivided into missile firing units each of which has a group of missile launchers and a Launch Control Post (LCP) and a Target Illuminating Radar (TIR). Controlling the operations of these sections through the LCP's is the Battery Command Post (BCP) with which is associated, in the minimal configuration, a Tactical Control Radar (TCR) and a Height-Finding Radar (HFR). If the weapon system is organised on a regimental basis or as a part of a larger defence complex, a central group of radars – that may include long-range surveillance, gap-filling and height-finding radars – may serve several BCP's but the basic principle of operation remains the same.

Radar data, from whatever source, on targets in the operational area is supplied to the BCP as also is missile state-of-readiness information from the LCPs. Display and computer facilities at the BCP permit the presentation of all relevant tactical information to the officer in charge and for the storage of target tracks. Targets are allocated to the firing units from the BCP and the target data is passed by digital link in a form that enables the TIR of each firing unit to search for and acquire its selected target.

When the target has been acquired the TIR automatically tracks it, transferring data to the LCP, where facilities are provided for carrying out an automatic pre-launch preparation sequence and where there is also a comprehensive communication network linking the LCP to the BCP, TIR and launcher sites.

After missile launch the TIR continues to track the target, and the radiation reflected from the target is used by the semi-active equipment in the nose of the missile to guide it to a close approach. The missile carries a high-explosive warhead which is detonated by a proximity fuse.

Standard equipment for mobile Thunderbird 2 systems is the Firelight TIR (**2413.153**). This is a CW X-band Doppler radar; the advantage of using CW being its good performance in the presence of ground clutter or ECM interference.

DEVELOPMENT HISTORY:

Thunderbird 2 is the successor to Thunderbird 1 which first went into service with the British Army in 1960. The design study for the second-generation equipment was started in 1956 and the new equipment went into British Army Service in 1965. Thunderbird 1 was supplied to the Defence Forces of Saudi-Arabia in 1966.

CHARACTERISTICS:

Type: Surface-to-air land-based GW system. Land-mobile. Air-transportable
Guidance Principle: Semi-active radar homing
Guidance Method: By pivoting tail surfaces
Propulsion: Solid-propellant sustainer with four solid-propellant boosters
Warhead: High-explosive, with proximity fuse
Tactical Control: From BCP by digital link to LCP
Launch Control: From LCP to launcher sites using TIR data
Missile Length: 6.40 m
Body Diameter: 0.54 m
Span: 1.63 m
Range: Not released. Probably in excess of 75 km

MANUFACTURERS:

The following manufacturers are known to have been associated with the system.

Main System Contractor: British Aircraft Corporation (Guided Weapons Division)

Battery Command Post: Marconi Radar Systems Ltd., Cossor Electronics Ltd., Ferranti Ltd.

Tactical Control Radars: Marconi Radar Systems Ltd., Cossor Electronics Ltd.

Target Illuminating Radar: Ferranti Ltd. (Edinburgh)

Digital Data Links: Ferranti Ltd., (Bracknell)

Fuse: EMI Ltd.

Test & Training Equipment:

Sensitivity Test Set: BAC

Missile Test Set: BAC

Firing Troop Trainer: Sperry Gyroscope Co Ltd.

Thunderbird 2 missile

2465.131
TIGERCAT CLOSE RANGE AIR DEFENCE SYSTEM

DESCRIPTION:

Tigercat is a land-based version of Short Bros.' highly successful SEACAT and is a ground-to-air guided missile system for low-level close-range air defence.

In the design of both Seacat and Tigercat the policy has been to create a simple guided weapon capable of instant readiness. With any kind of radar warning system there is always the possibility of aircraft approach without detection to a range that permits little time for firing sequences. With Tigercat no prefiring sequences are required on the launcher; and auxiliary power services within the missile are activated at launch. The system is thus capable of engaging and destroying at close range even rapidly manoeuvring targets.

SYSTEM DESCRIPTION:

Tigercat is compact and mobile and has cross-country capability. The basic fire-unit comprises a director trailer, a launcher trailer, and two towing vehicles. These vehicles carry the fire-unit crew of five men, generating equipment, missiles and miscellaneous items. Power supplies are obtained from the generator or from public supply. The launcher trailer consists of a two-wheel chassis integral with a three-missile launcher. For operational use the chassis is supported and levelled on three jacks and the road wheels removed. The Director trailer also has an integral two-wheel chassis which is levelled and supported on three jacks. The Director incorporates an adjustable seat for the aimer and an auxiliary rotating structure on which is pivoted the sight arm carrying the aimer's binocular sight, flight controller and missile firing trigger. The control officer's console is a fixed box structure built on to the rear end of the trailer chassis. A door at the rear opens upward to provide access to the equipment within the console and together with a nylon windbreak forms a shelter for the launch control N.C.O.

The principle of operation is that after a target is acquired by the aimer the missile is launched into the aimer's field of view. The aimer then directs the missile to fly along the line of sight to the target by manipulating a thumb-operated flight controller which applies up, down, left and right commands to the missile by means of a radio link. Flares at the rear of the missile help the aimer to keep it in sight. As with Seacat the system is also suitable for operation using either radar or television guidance.

The Marconi ST850 radar has been designed to function as an integral part of Tigercat and provide

Tigercat launch

both dark-fire and blind-fire capabilities. It is an X-band target tracking equipment with good range performances. The magnetron pulse-transmitter, with a typical peak power output of 180 kW is tunable to counter ECM and a low selection of operating frequencies to prevent mutual interference when a number of similar systems are operating in the same area. Digital MTI is used to minimise ground returns and allow tracking of low flying aircraft. The sequence of radar operations is carried out automatically under control of a master programming unit.

The television camera is aligned to the radar boresight and provides optical information on the target being tracked by the radar. The system comprises both a conventional camera and display and a data processing system which permits automatic gathering of the Tigercat missile to the target sight line.

The ST850 is contained in a mobile air-conditioned cabin with the radar director on its roof. The system is simple to use, flexible in operation and can be speedily deployed.

When the ST850 system is added the aimer sits at the ST850 control console in the cabin instead of in the Tigercat visual director, and is presented with optical information from the television system in a manner similar to that presented on the binocular sight, and he has a similar type of flight controller. The duties of target tracking are taken over by the radar which acquires and tracks automatically.

CHARACTERISTICS:

Type: Surface-to-air close-range tactical guided missile

Guidance Principle: Command link with optical or radar/TV tracking

Guidance Method: Aerodynamic by movable wings

Propulsion: Two-stage solid-propellant motor

Warhead: High explosive

Missile Length: 1.48 metres

Missile Diameter: 19 cm

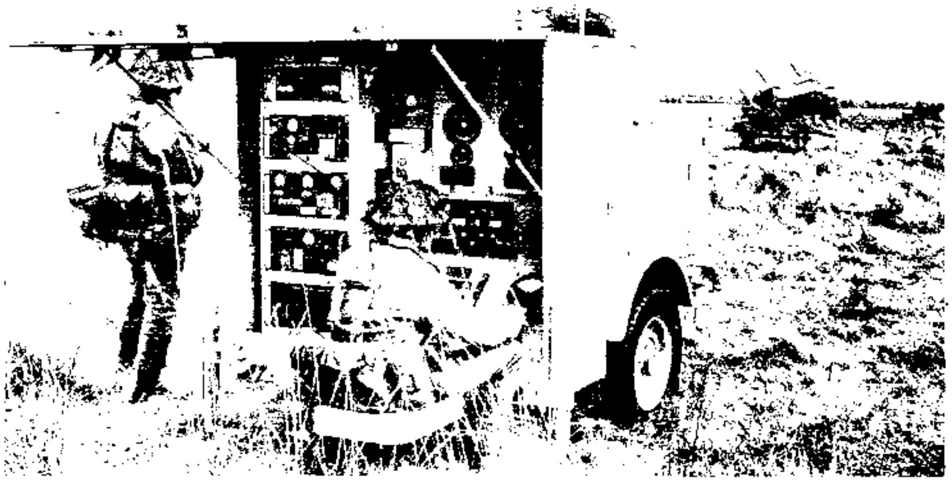
Launch Weight: 63 kg

DEVELOPMENT HISTORY:

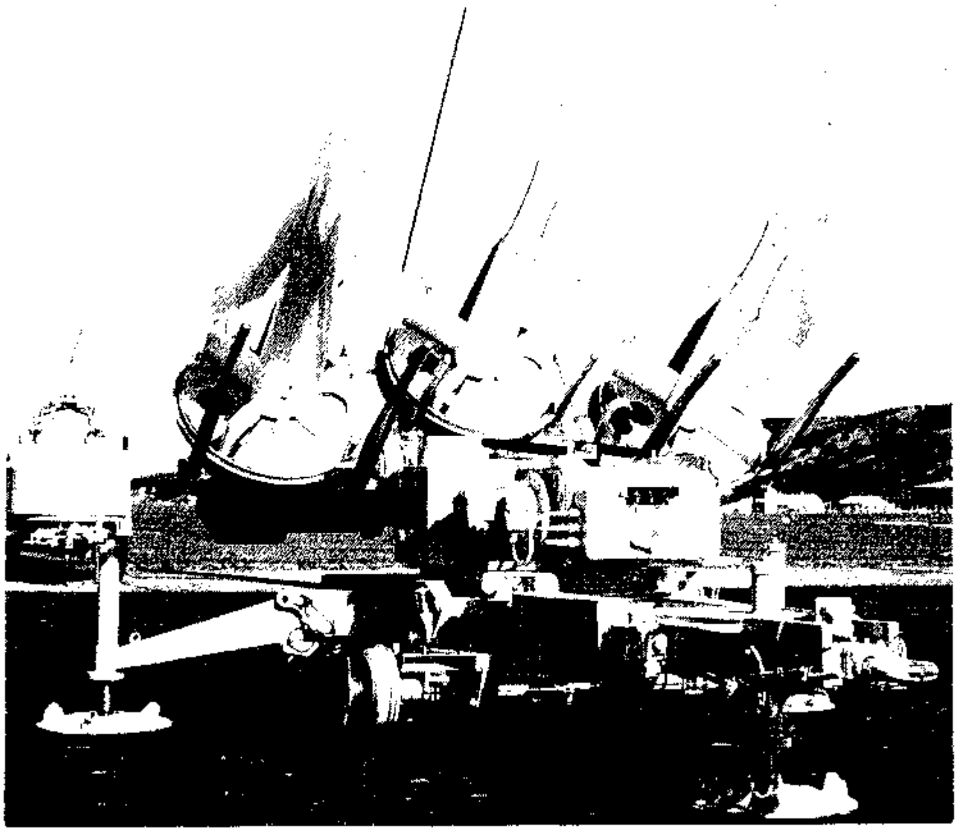
The manufacturers were awarded a British Government contract for Seacat in 1958 but the development of Tigercat was a company initiative. The weapon system is now in production, is in service with the RAF Regiment and the Imperial Iranian Air Force, and is in service with or has been ordered by several other overseas countries including Argentina, Jordan and Qatar.

MANUFACTURERS

Short Brothers & Harland Ltd, Belfast, Northern Ireland make the complete system including special test and training equipment. Other manufacturers known to be associated with the system are IMI Ltd who make the rocket motor and EMI Ltd who make the fuse.



The Tigercat director trailer housing the missile aimer and control equipment



Opposite view showing Tigercat launcher with director unit in the background

THE UNITED STATES OF AMERICA

2542.131
CHAPARRAL SURFACE-TO-AIR WEAPON SYSTEM

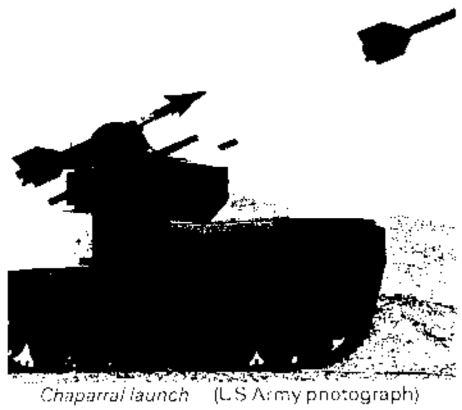
DESCRIPTION

Chaparral is a ground-to-air infra-red heat-seeking missile system which has been developed to meet U.S. Army requirements for a low-altitude air defence weapon.

The system consists of a launch and control assembly, vehicle and missile. The missiles are carried on and fired from a turret mounting four launch rails. Additional missiles are stored for ready access in the pallet. The gunner in the turret mount aims the missile at the target using an optical sight. Once locked-on to the target and fired, the missile guides itself to the target's heat source automatically. The Chaparral missile is a US Navy developed Sidewinder 1C, which has been modified for ground to air rather than air to air launch as now used by the Navy. The Navy supplies missiles for Army use.

The launch and control assembly is a self-sustaining unit, capable of operation independent of the carrier vehicle in a ground emplacement mode. For missions requiring full-tracked mobility the fire unit is mounted on an M-730, self-propelled tracked vehicle. It is amphibious when a "swim kit" is used, will carry a five-man crew, and can travel up to 64 kilometres per hour on the road.

One of the operational configurations is the association of Chaparral with the Vulcan air defence gun system (**2850.131**), the latter being a six-barrelled 20 mm Gatling gun adapted for ground use and mounted on a modified M-113 personnel carrier. Forward area alert radar (FAAR **1526.153**) can be deployed with Chaparral/Vulcan to provide early warning and IFF identification



Chaparral launch (US Army photograph)

within the detection area.

CHARACTERISTICS:

US Army Designation: M-48
Type: Land-mobile surface-to-air guided missile system
Guidance: Infra-red homing after optical aiming
Missile Designation: MIM-72A
Propulsion: Solid-propellant rocket motor
Warhead: High-explosive
Missile Length: 2.91 metres
Missile Diameter: 13 cm
Span: 64 cm
Launch Weight: Approx 84 kg
Speed: Supersonic

DEVELOPMENT:

Development was started in 1965 by the Aeronutronic Division of Philco-Ford on a contract from the U.S. Army Missile Command. Trial firings began in July 1965 from prototype fire units: an initial tooling and production contract followed in April 1966 and by early 1968 a total of 154 systems were reported to be on order.

It is understood that the US Army have plans for the further development of Chaparral to improve daytime target acquisition and tracking and night operations. The proposal is to refit the Chaparral/Vulcan combination with an integrated optical subsystem comprising a laser range finder and a forward-looking infra-red sensor, both being aligned on a common tracking mount. In the FY 1975 Defence Budget proposals provision was made for retrospective modifications to increase the reliability and maintainability of the missile fuse, improve warhead lethality and "provide a forward aspect engagement capability" – the last item presumably relating to the IR sensor.

STATUS:

Operational. Production of current version was completed in the Autumn of 1971. Modification programme noted above.

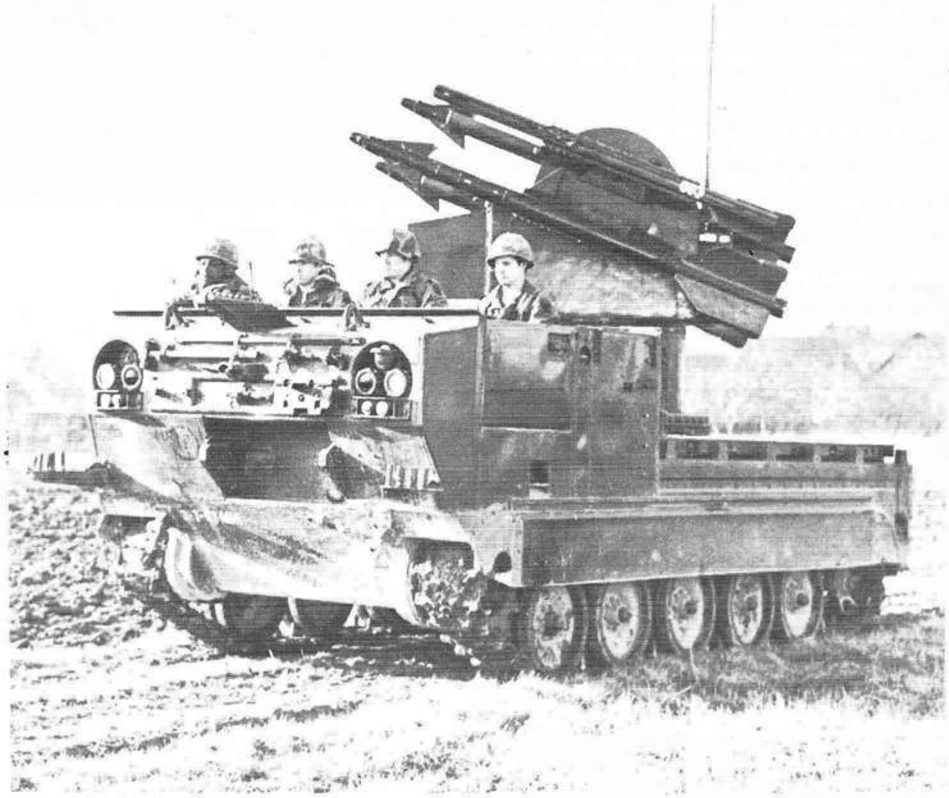
As noted above, further development of Chaparral is a possibility, but the US Army is considering, in parallel with this possibility, that of purchasing an existing system as a Chaparral replacement. To this end the Army has been evaluating Crotale (**2074.131**), Rapier (**2424.131**) and Roland II (**2218.131**).

MANUFACTURERS:

Complete System: Aeronutronic Division, Philco-Ford Corporation, Newport Beach, California 92663.

Missile Guidance and Control: Raytheon Company Missile Systems Division, Bedford, Massachusetts 01730.

Vehicle: FMC Corporation, San Jose, California.



Chaparral surface-to-air weapon system in its mobile role

2640.131
HAWK SURFACE-TO-AIR WEAPON SYSTEM

DESCRIPTION:

HAWK (homing-all-the-way-killer) is a surface-to-air missile designed primarily to engage low-level supersonic targets but capable of intercepting such targets at altitudes ranging from 30 to 11,000 metres.

The missile also has anti-missile capability – indeed the first known kill of one supersonic missile by another was achieved in January 1960 when a Hawk destroyed an Honest John battlefield missile.

SP Hawk launcher

CHARACTERISTICS:

US Army Designation: MIM-23A
Type: Mobile surface-to-air guided weapon system
Guidance: Semi-active homing
Propulsion: Two-stage solid-propellant motor
Warhead: High-explosive, blast fragmentation type
Missile Length: 5.12 metres
Missile Diameter: 35 cm
Span: 1.22 metres
Weight: Approx 580 kg
Speed: Supersonic
Engagement Altitude Limits: From less than 30 metres to more than 11,000 metres

Details of the functions of the units of the complete system are given below. In certain circumstances it may be necessary to bring missiles into action with less support equipment, and some notes on the way in which this can be done will be found later in this entry.

Battery Control Centre

Control of the battery is exercised by five operators in the battery control centre.

A Tactical Control Officer (TCO) makes all decisions to engage targets. He has an assistant to aid in detection, identification, evaluation and coordination with higher commands. The tactical control console gives these operators the necessary target and battery status information and the required controls. A second assistant has the sole mission of detecting low altitude targets from the separate CW acquisition radar display.

Targets selected by the TCO for engagement are assigned to the Fire Control Operators (FCO). Each operator has his own display and control console to perform rapidly the functions of target acquisition, missile launching, and intercept evaluation.

The electronic equipment and operating personnel of the battery control centre are housed in an air-conditioned, lightweight shelter that can be transported by truck, helicopter, or, for short distances, on its own dolly.

PULSE ACQUISITION RADAR:

Volume radar coverage around the battery is provided by the Pulse Acquisition Radar. This is mounted on a pallet which can be separated from the trailer on which it is normally mounted, so that radar and trailer can be separately lifted by helicopter.

CW ACQUISITION RADAR:

This radar provides for the earliest possible detection of low-altitude targets by employing continuous wave techniques. The rotation of its antenna assembly is synchronised with that of the pulse acquisition radar, so that the target data from both radars can be presented on composite displays for ease of correlation.

RANGE-ONLY RADAR:

Operating in a different frequency band from the other acquisition radars, this is a quick-response range-measuring radar that is capable of being slaved in angle to either of the two target illuminators on demand. Target information from this radar is sent to the BCC where it is used by the FCO to generate range and range rate information for the illuminator.

Guidance Group

The guidance group consists of the CW illuminator and the CW semi-active homing missile.

Continuous wave radar provides the clutter discrimination necessary for low altitude operation. The CW illuminator acquires, tracks, and illuminates targets. It searches automatically at the designated target azimuth until acquisition, and then automatically tracks the target as long as required. In addition, the illuminator also supplies a reference signal for the missile.

The missile contains a radar receiver with a tracking seeker antenna and a closed loop autopilot. Information obtained from received energy is used to direct the missile to home to intercept and to detonate the warhead at the closest approach to the target.

ILLUMINATOR:

Primary functions of the illuminator are to illuminate the target and provide a reference signal to the missile. To do this it can search a designated sector for targets, lock onto the reflected energy and track the target in speed and angle. Aiming the launcher and providing target information to the battery control centre are secondary functions. Functionally identical illuminators of two radiated power levels have been developed. With the high power illuminator the range capability of both the missile and the illuminator are significantly increased in addition to providing a basic capability against targets of much smaller radar cross-section.

Launching and Handling Group

The complete missile is received by the firing battery in a single tactical container. It is removed from the container by the tracked loader operating as a crane and placed on the storage and transportation pallet or on the launcher. The fully trainable launcher activates, aims and launches the missile upon a command from the BCC. When a launcher becomes depleted of missiles during a firing engagement, the loader brings ready missiles from the storage area and reloads the launcher, and can do this with sufficient speed to enable a high firing rate to be maintained.

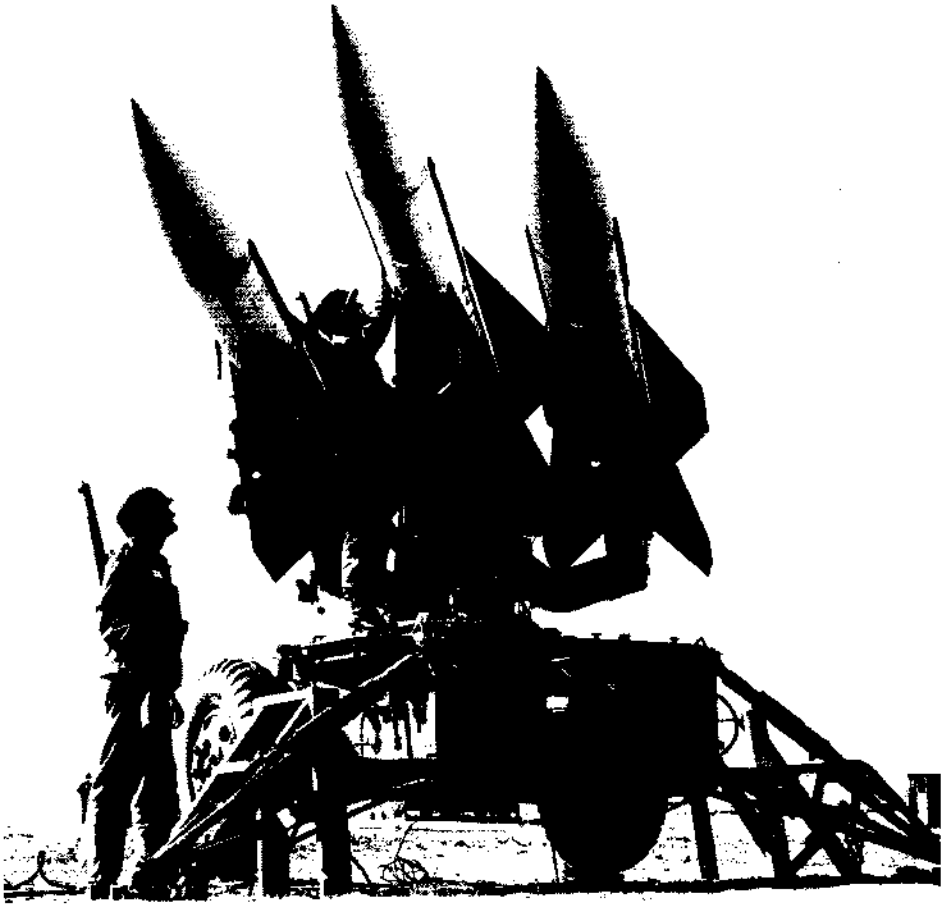
LAUNCHER:

The launcher carries three missiles and is trainable in azimuth and elevation. After illuminator lock, it is slaved to the illuminator in angle to aim the missile at the target. Upon receipt of a fire command from the battery control centre, the launcher selects a ready missile, activates the missile power supplies, enables stabilisation of the missile antenna, and slews to the lead angle commanded by the illuminator. After the lead angle is inserted, the missile rocket motor is ignited and the missile is launched.

Assault Phase

In certain mobile operational circumstances – for example when establishing a beach-head in enemy territory – it may be necessary to bring the missile into action in less time and with less equipment than is necessary to set up the complete battery installation.

To meet this requirement an Assault Fire Command Console has been developed. This is a lightweight fire control unit capable of controlling a firing section, and a CW acquisition radar if available. For minimum equipment deployment, however, the acquisition radar may be omitted and the illuminator programmed to search a designated sector for targets. The minimum equipment configuration, therefore known as an Assault Phase Firing Unit, comprises a single



Hawk missiles loaded on the triple launcher

launcher, an illuminator, a generator, a loader and pallet, the assault fire command console and a supply of missiles. Once the missiles have been loaded onto the launcher the whole of this minimum system can be controlled by one man.

As the tactical situation allows, this minimum unit can be progressively augmented up to full battery strength: alternatively a series of such units can be "leap-frogged" to provide continuous air defence for an advancing army.

SP Hawk

Mobility of the Hawk system has been further increased by the introduction of the SP Hawk, a self-propelled system with the equipment mounted on XM-727 full-tracked vehicles. A self-propelled Hawk platoon comprises three such vehicles each with three ready missiles on a launcher and each towing a piece of ground support equipment.

DEVELOPMENT HISTORY:

Development of the Hawk began in 1954 and the system first became operational in 1959, the programme having been under the technical control of the US Army Missile Command. Engineering of the system was performed at Raytheon's laboratories at Bedford and Wayland, Massachussetts, and at White Sands, New Mexico. US production of the missile and radar-equipment has been principally at Andover and Waltham, Massachusetts.

For European manufacture of the system a five-nation group of companies formed the Société Européene de Téléguidage (SETEL) in 1959. SETEL has acted as prime contractor for the project and coordinated the activities of five individual companies (see below). The system is also manufactured under licence by Mitsubishi in Japan.

Hawk has been extensively deployed by the US forces – both the Army and the Marine Corps – in Europe, Vietnam and other theatres. It has been sold or supplied on grant aid programmes to Israel, Japan, Korea, Saudi Arabia, Spain, Sweden and Taiwan as well as to many NATO countries.

Improved Hawk

This recent development has a new guidance package, a larger warhead and an improved solid propellant. Other improvements include increased ECM protection and the introduction of the 'certified round' procedure whereby missiles are delivered ready to fire without field maintenance or testing. In trials against Firebee drones in the Autumn of 1971, 16 hits were scored out of 17 trials with the improved missile. This was an improvement on the results achieved earlier in the year, and the trials were followed by Standard A approval in December 1971 and full production approval in January 1972. Improved Hawk is currently in production: the first Basic Hawk battalion was converted to Improved Hawk in November 1972 in USAREUR / Seventh Army.

STATUS:

Hawk is expected to remain operational for several years. US Army and Marine Corps units are currently re-equipping with Improved Hawk: Army procurement (90 batteries) is expected to be complete in FY 1977 and USMC procurement (14 batteries) in FY 1976. It is still intended that Hawk should be replaced by SAM-D (**2800.131**) in the 1980s – at which time the Hawk units will probably be transferred to the US Army Reserve and National Guard forces – but in the meantime there is a need for a more mobile and more quickly deployed tactical air defence system than Hawk and this is the rationale of the US SHORADS programme (**2793.131**).

Another programme which until recently had low priority but which is now being re-examined is one referred to as **Hawk 3**. This involves the introduction of a new missile with a different shape and internal arrangement of components. Status of this programme is still experimental, however.

Countries which have Hawk in their military inventories (including these supplied by SETEL) are Belgium, Denmark, France, Israel, Italy, Japan, Netherlands, Saudi Arabia, South Korea, Spain, Sweden, Taiwan and West Germany.

Hawk production by SETEL is complete (but see **2213.231**) but Mitsubishi is expected to continue manufacture for the JGSDF until 1977.

MANUFACTURERS:

Complete System and US Production: Raytheon Company, Lexington, Massachusetts.

Sub Contractors:
Rocket Motors: Aerojet General Corporation, El Monte, California.
Wings and elevons: Northrop Corporation, Beverley Hills, California.
Warheads: Iowa Ordnance Depot.
SETEL Consortium:
Belgium: ACEC
France: CFTH
France: Thomson-CSF
Italy: Finmeccanica
Netherlands: Philips
West Germany: Telefunken
Japanese Manufacture:
Mitsubishi.

2800.131
SAM-D TACTICAL AIR-DEFENCE SYSTEM

Description

SAM-D (Surface-to-Air Missile Development) is the name given to an advanced guided weapon system conceived as a replacement for the Hawk and Nike-Hercules systems in the 1970's. Serious questions as to the missile's cost and desirability raised by Congressional critics led to speculation in 1969 that the project might be cancelled or postponed. However, the US Secretary of the Army announced in the spring of 1970 that an intensive review of the programme had found that SAM-D would provide a better defence with one-third of the manpower and at less than half the annual operating costs of the Hawk and Nike-Hercules systems.

Since then development has continued: in March 1974 the US Defence Secretary said that after an intensive review of the status of the programme it had been decided to emphasise austerity in the programme and ensure adequate testing of the radar and guidance systems before proceeding with engineering development. From this and other speeches made at the time it seems reasonable to infer that the US authorities are confident of the success of the development but are determined to avoid the excessive cost that might result from over-hasty decisions.

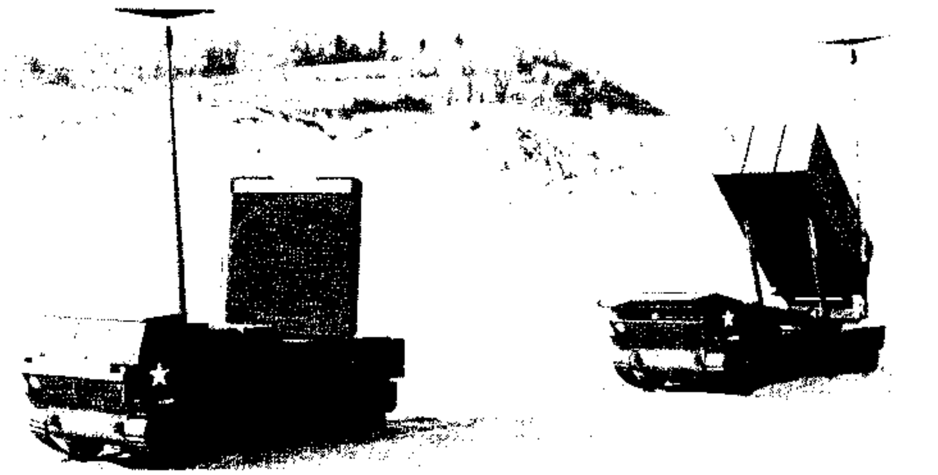
SAM-D can be deployed as a battery to provide circular defensive coverage or as a fire section to provide coverage over a sector. A fire section will consist of one fire control group and one or more (normally two) launcher groups, and may be detached from the major control elements for autonomous operations. A SAM-D battery will normally include four firing sections, and each launcher group will contain six missiles, thus giving each battery a total of 48 missiles. Such a field battery would be mounted on approximately twelve vehicles and would include three main elements: fire control, launchers, battery control and communications groups.

The fire control group will contain the phased array radar, a radar/weapons control computer, communications and prime power equipment mounted on a single tracked or wheeled vehicle. It will also house the operators, controls and displays for the firing section. The radar/weapons control computer will control the phased array radar in its search, acquisition, track and engage functions. It will also assess the threat and determine the best engagement procedure. The phased array radar antenna will have an eight-foot diameter face made up of 5,240 phase shifters. This radar will be capable of performing all the functions for which several radars are needed in some other systems – notably, of course, Hawk (**2640.131**) which can use four radars at a time and Nike Hercules (**2723.131**) which can use five.

The battery control group will coordinate firings within a battery and serve as a communications centre. It will house a computer for handling high data-rates and processes and will coordinate information between radars and pass on fire-control information.

Also mounted on a tracked or wheeled vehicle, the launcher group will consist of six missiles in launching-shipping containers. The missile is cradled within the canister or container supported by teflon-coated launch rails. At launch, the motor blast shatters the rear plastic cover and the missile breaks through the forward plastic cover. The system is capable of firing missiles from their canisters either singly or in close sequence salvoes at selectable azimuths and elevations.

The missile, controlled by four aerodynamic tail fins powered by control actuators, can carry either a high explosive or nuclear warhead. It is segmented into nose, guidance, warhead, motor and control sections.



Models of the units comprising the minimum fire unit of the SAM-D surface-to-air guided missile system – shown here in the operational mode

Minimum fire unit of SAM-D in transit

SAM-D Battery control group model

As a field army weapons system, SAM-D will be designed to destroy FB-111-type aircraft carrying nuclear or non-nuclear weapons and having good low altitude performance and high manoeuvrability. It will also be capable of defeating tactical ballistic missiles, air to surface missiles and submarine-launched cruise missiles. It has also been stated that the system will maintain its effectiveness despite intense electronic jamming.

An Army SAM-D air defence missile is launched successfully during a controlled flight test at White Sands Missile Range, New Mexico

Characteristics

Type: Land-mobile, surface-to-air guided weapon system

Guidance Principle: Command guidance and semi-active homing

Guidance Method: By control of four aerodynamic control surfaces

Propulsion: Single-stage solid propellant rocket motor TX 486

Missile Length: 5.2 metres

Missile Diameter: 40 cm

Warhead: Nuclear or high-explosive

Speed: Supersonic

DEVELOPMENT HISTORY:

SAM-D is the successor to two earlier study programmes managed by the US Army Missile Command's Research and Development Directorate. These studies were concerned with systems known as the Field Army Ballistic Missile Defence System (FABMDS) and the Army Air Defence System for the 1970's (AADS-70s).

In January 1965 the SAM-D requirement was specified and a study was directed towards defence against high-performance aircraft – at all altitudes – and short-range missiles. At the same time two independent organisations went to work on a component verification programme and conducted concept formulation studies.

SAM-D was placed under project management at the US Army Missile Command in August 1965; and shortly thereafter the contract definition process was initiated by the Department of Defence. On the results of this letter contract was awarded to Raytheon in May 1967.

In February 1970 the missile successfully completed its first launch environmental test. The full-scale, flight-weight missile was fired from a non-tactical canister and launcher to prove out the "bazooka" launch technique to be employed with the tactical system.

The US Army planned to begin engineering development in Fiscal Year 1971, but the missile flight test part of advanced development was not completed until April 1971 with the last of ten flight tests and the remainder of the advanced development phase was not completed until March 1972 when engineering development started.

STATUS:

Following the programme review announced by the Defence Secretary (see above) the programme now calls for a system demonstration test comprising sixteen missile firings at difficult targets and extending over a twelve-month period ending in June 1975. At the time of writing the advanced development Fire Control Group has been converted into a demonstration fire section at White Sands Missile Range and tracking and control tests are being carried out in preparation for the system demonstration tests. A cost-effectiveness study is also being conducted with a view to reducing the hardware cost per fire section to a figure comparable with that of Improved Hawk.

Artist's impression of the towed version of SAM-D in action

MANUFACTURERS:

System: Raytheon Company, Bedford, Massachusetts.

Principal Sub-contractors: Martin Marietta Corporation, Orlando, Florida (missile and shipping/launching canister).

Thiokol Chemical Corporation, Huntsville, Alabama (propulsion unit).

2842.131
SHORADS/LOFADS AIR DEFENCE MISSILE SYSTEM

DESCRIPTION:

The two acronyms in the title of this entry appear to be competing with each other to become the agreed description of a single US project. LOFADS (or sometimes LOFAADS) stands for Low Altitude Forward Area (Air) Defence System(s) and SHORADS stands for Short Range Air Defence System(s).

The project relates to the US Army's need for a mobile all-weather anti-aircraft missile system which can be used in the defence of combat units against low-level attacks by high-speed aircraft.

Because the need is seen to be urgent; because no current US development project is aimed specifically at satisfying this need, or likely to be able to satisfy it in the near future; because there are in Europe three developed, tested systems all of which offer facilities which are broadly in line with the US requirement; and because the cost analysts have calculated that it would be cheaper for the US forces to buy one of these systems than to develop a new one, the authorities have taken the unprecedented step of evaluating these three guided missile systems against the US requirement.

The three systems are the French Crotale (**2074.131**), the British Rapier (**2424.131**) and the Franco-German Roland (**2218.131**). If one of these is selected to equip the US forces, the equipment will be manufactured in the USA – all three contestants having designated licensees for such manufacture before the evaluation trials started.

It should be noted that the Chaparral system (**2542.131**) is not yet wholly superseded by the new project. Although Chaperral cannot meet the full all-weather requirements, it still has an important role to play as a clear-weather system – especially when upgraded as recently proposed.

STATUS:

Basic evaluation complete. Decision awaited.

MANUFACTURERS:

None yet designated.

THE UNION OF SOVIET SOCIALIST REPUBLICS

2944.131
SA-1 (GUILD) SURFACE-TO-AIR MISSILE

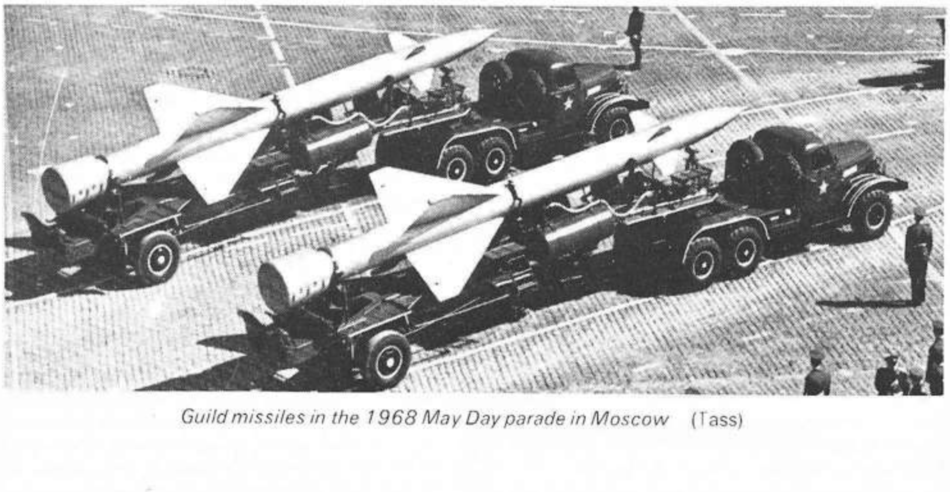
DESCRIPTION:

Guild is the NATO code name for an anti-aircraft guided missile system first shown in Moscow in 1960 and identified by the number SA-1 in the US alphanumeric code.

About 12 metres long and 70 cm in diameter, this missile has no booster stage and therefore probably has a dual-thrust solid-propellant motor. Movable cruciform fore-plane surfaces are another feature of the missile that distinguishes it from Guideline (SA-2, **2942.131**), which has movable tail surfaces but which is otherwise generally of much the same size as Guild.

STATUS:

Said to be operational but not known to have been supplied to any country outside the USSR. Presumably obsolescent.



Guild missiles in the 1968 May Day parade in Moscow (Tass)

2942.131
SA-2 (GUIDELINE) MEDIUM-RANGE SURFACE-TO-AIR MISSILE

DESCRIPTION

Guideline is the NATO code name for a medium range, anti-aircraft guided weapon system, known also by the US alphanumeric code SA-2, which is standard equipment in the Soviet forces and which has been exported in large numbers to many countries outside the Warsaw Pact territory, including Cuba, Egypt, Indonesia, Iraq, North Vietnam and Yugoslavia. Guideline missiles were used against US B-52 bombers during the bombing raids on North Vietnam prior to the peace settlement. Initially they scored a number of successes, but subsequently it appeared that the B-52 ECM equipment was more than a match for such ECCM equipment as the North Vietnamese had available.

The Soviet designation for the missile – or one version thereof – is believed to be V750VK and that of the complete weapon system – including radar and power supplies – V75SM. The system is land mobile, the missile being mounted on a Zil 157 cross-country semi-trailer transporter-erector.

Various models of the missile have been observed over the years exhibiting relatively minor changes in external appearances. The details given below relate to a type that was supplied to Egypt, but it is known that later versions exist. In particular, one that was seen in Moscow in 1967 is somewhat longer and has a larger warhead.

CHARACTERISTICS

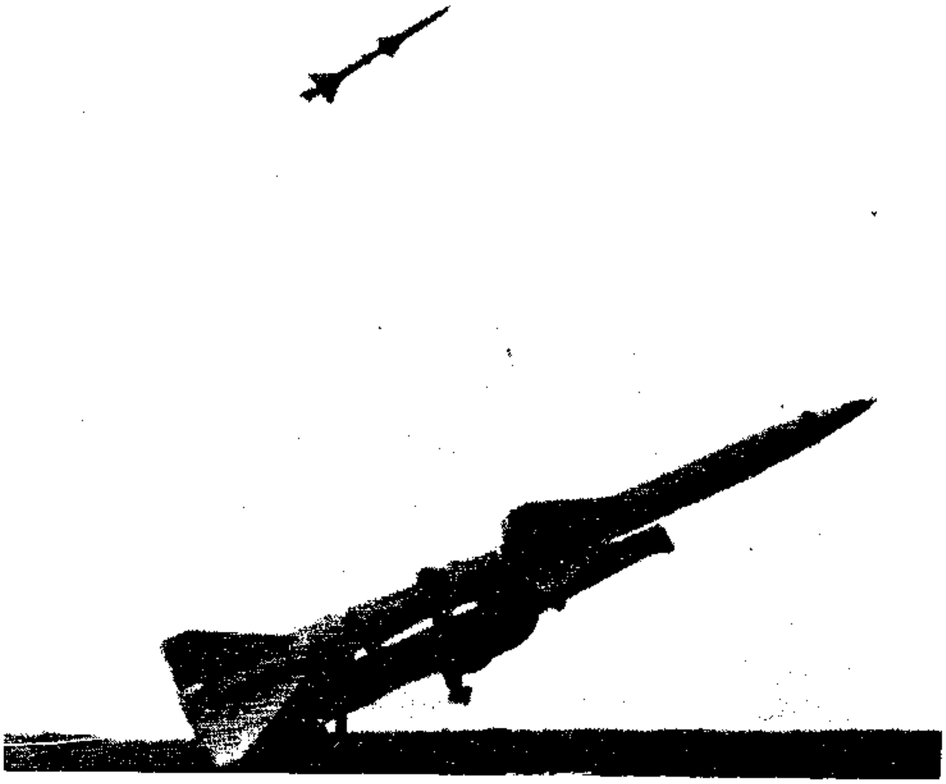
Type: Surface-to-air tactical guided missile
Guidance Principle: Radio command
Guidance Method: By control of movable tail surfaces
Propulsion: Solid-propellant booster with liquid propellant sustainer
Warhead: High-explosive 130 kg
Missile Length: 10.7 metres
Missile Diameter: Booster: 70 cm. Second stage: 50 cm
Launch Weight: About 2 300 kg
Slant Range: 40-50 km
Ceiling: 18,000 metres

OPERATION

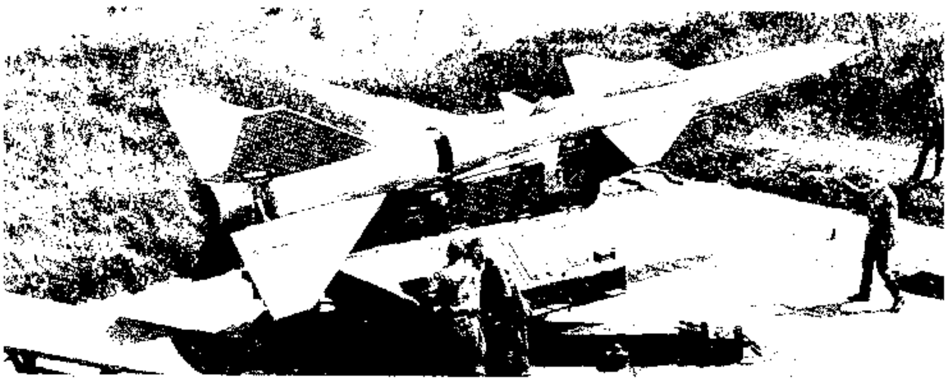
The radio command guidance system is believed to be quite straightforward. Targets are tracked by radar which feeds data to a computer; this in turn produces signals which modulate the output of the command transmitter. Two sets of four strip antennae are mounted fore and aft of the missile wings to receive these signals.

Radar used in conjunction with these missiles is generally that known to NATO as Fan Song (**2866-2868.153**). It is said that one problem with the fire control and guidance system is that the missile must be gathered to the radar beam in the first six seconds of flight or it will not be acquired at all.

According to reports published in the American press concerning Israeli experiences with Egyptian Guideline installations, it was at first found that Israeli ECM devices were adequate to deflect the beam-riding missiles. Subsequently, however, improved missiles were introduced having terminal guidance radar with a wider range of frequencies than the Israeli ECM could handle. They were, however, able to obtain improved ECM pods from the USA which they successfully used to jam the missile acquisition, tracking and guidance systems. When attacked by Egyptian surface-to-air missiles during the 1973 war, indeed, it was reported that the SA-2 and SA-3 missiles caused the Israelis few problems, their main difficulties were with the SA-6 (**2930.131**) and SA-7 (**2941.131**).



Guideline launch (Tass)



Guideline surface-to-air missile on launcher. Note the small nose fins and the control surfaces on the booster fins

Guideline missile with enlarged warhead first displayed in November 1967. Note the fin changes and the absence of control surfaces on booster fins

Various warhead and fuse arrangements have been reported. Most of the missiles have high-explosive warheads but contact proximity and command fuses have been reported. Furthermore, the larger version of the missile referred to above as having been first seen in 1967 is believed to have a nuclear warhead.

STATUS

Operational in the armed forces of the USSR and many other countries. Since the Russian authorities generally appear reluctant to discard from their inventory any weapon which continues to work reasonably well it is likely that Guideline will remain in service for some years yet. Despite various modifications however it is now technologically obsolescent and unlikely to be very effective against an enemy able to deploy reasonably sophisticated ECM equipment.

2938.131
SA-3 (GOA) SURFACE-TO-AIR MISSILE

DESCRIPTION

Goa is the NATO code name for an anti-aircraft guided missile for use both by the Soviet Army and by the Soviet Navy.

Small enough to be carried in pairs on the vehicle that is used as a tractor for the trailer transporters of both Guideline and Guild, Goa is a two-stage missile that is thought to have been intended for much the same operational role as the US Hawk – that is to say, short-range defence against low-flying targets.

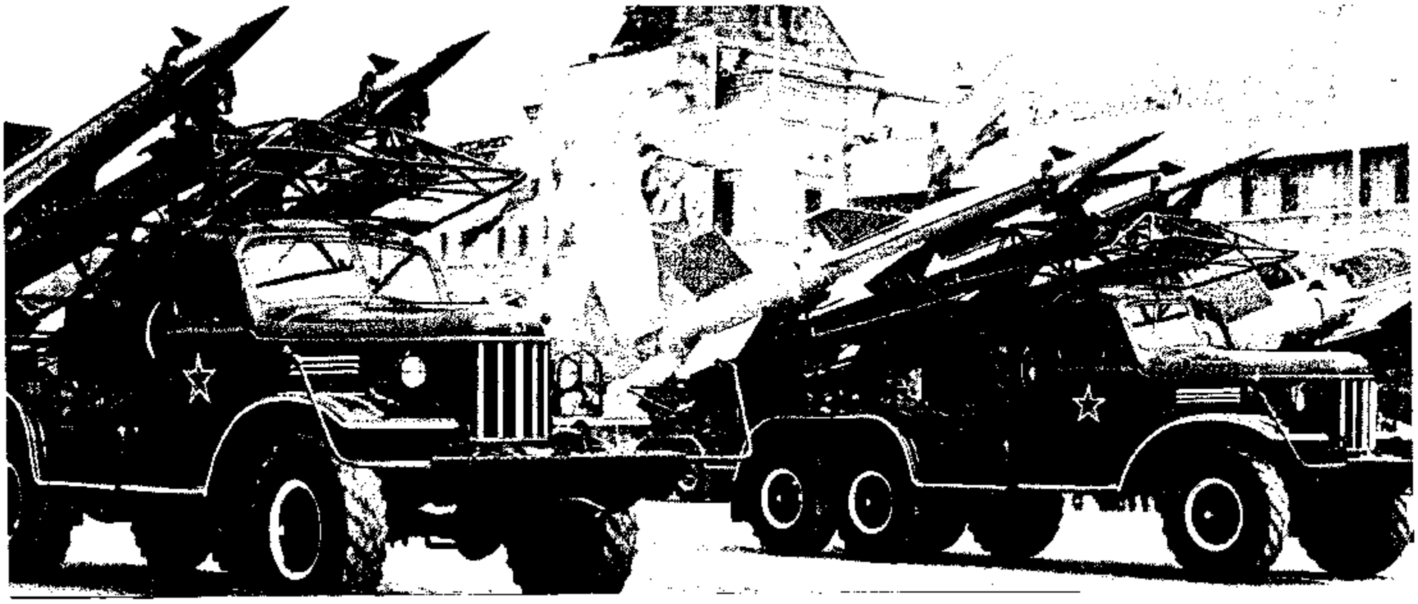
Control of the missile in flight is by movable foreplane surfaces, the rear mounted wings of the second stage being fixed. Considering the operational role suggested above it seems possible that the missile has some form of homing device in the nose; if so, the positioning of the control actuators in the same part of the missile would make a compact guidance package. Basically, however, it seems fairly definite that Goa is a command-guided weapon.

Recently the Goa missile has become much more widely known by its US alphanumerical code SA-3 (or SAM-3) particularly at the time when it was being extensively deployed in Egypt.

Goa is used in conjunction with an X-band fire control radar whose NATO code-name is Low Blow (**2884.153**) and is commonly associated with an acquisition radar code-named Flat Face (**2874.153**). In the linked installation of Goa and Guideline (SA-2, **2942.131**) missiles built by the Egyptians, with Russian assistance, near the Suez Canal in 1970, the Goa missiles were mounted on substantial trainable launchers, contrasting with the simple mobile ramps from which they are normally launched. Tracked vehicle mountings have also been seen.

In addition to its land-based uses Goa is extensively deployed on ships of the Soviet Navy. Further details can be found later in this section (**2939.231**)

CHARACTERISTICS:
Type: Shipborne or land-based surface-to-air guided missile
Guidance Principle: Probably command-guided but a homing system may be incorporated
Guidance Method: By control of movable fore-plane surfaces
Propulsion: Two-stage solid-propellant
Missile Length: 6.7 metres
Missile Diameter: Booster: 60 cm. Second stage: 45 cm
Range: 25-30 km



Goa two-stage surface to-air missile

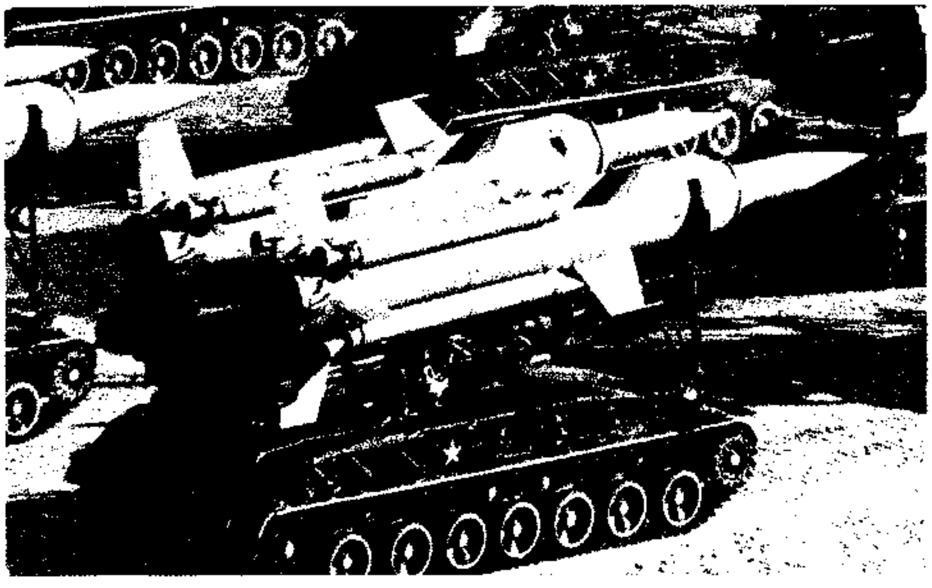
2934.131
SA-4 (GANEF) SURFACE-TO-AIR MISSILE

DESCRIPTION:

Ganef is the NATO code name for a surface-to-air missile launched from a tracked vehicle that was first seen in public in Moscow in 1964. Its US alphanumeric code is SA-4.

Two missiles are mounted on the armoured launcher from which they can be raised into the firing position. The system is thus highly mobile and can be brought into action rapidly: it can also be airlifted by such aircraft as the An-22 heavy freighter. The use of an armoured launcher suggests operation in forward areas and it is believed that the missile can also be used in a ground-to-ground role. For target acquisition and fire control a separately mounted C-band radar whose NATO code-name is Pat Hand (**2936.153**) is used Longer range surveillance is believed usually to be provided by Long Track radars (**2937.153**) which are also used with other mobile Russian missiles.

CHARACTERISTICS:
Type: Land-mobile surface-to-air tactical guided missile
Guidance Principle: Command guidance
Guidance Method: By control of moving wings on forepart
Propulsion: Ramjet sustainer with four solid-propellant boosters
Missile Length: 9.0 metres
Missile Diameter: 0.8 metres
Launch Weight: About 1,000 kg
Range: About 70 km



Ganef ramjet-powered surface-to-air missile (Tass)

STATUS:

Ganef is an operational missile widely deployed in Russia. It was also at one time deployed in Egypt; but since it appears not to have been used in the 1973 Arab-Israeli war it seems likely that the missiles have been withdrawn – possibly in exchange for the SA-6 Gainful missiles (**2930.131**) which were used in the war.

2930.131
SA-6 (GAINFUL) SURFACE-TO-AIR MISSILE

DESCRIPTION.

Gainful is the NATO code name for an anti-aircraft missile system known in the US alphanumeric code as SA-6 and first publicly shown in Moscow in 1967.

Until the 1973 Arab-Israeli war little was known about Gainful in the West. The missile system was, however, used extensively in that war – this being, so far as is known, its first operational use – and scored a number of successes in the early phases of hostilities The Israelis, however, were able to capture some of the missiles more or less intact and some information on their construction and performance has become available.

Gainful is both a command guided and a homing missile and is fully mobile, both missile launchers and fire control radar systems being mounted on separate tracked vehicles. The fire control system is both sophisticated and, it would seem, effective. It comprises a primary search and acquisition radar, a target tracking and illuminating radar, a command link with secondary radar response for missile tracking and a missile-borne semi-active homing system. In ECM conditions some of the tracking functions can be performed optically.

The ground equipment of this complex is known by the NATO name Straight Flush (**2885.153**). Its limitation would appear to be a restricted search capability when operating without the support of other types of surveillance radar Precise data regarding frequencies used for the functions enumerated above have not reached us, but it seems fairly clear that the search/acquisition function is carried out in the 6 6 GHz band, the target tracking illuminating function in the 8 10 GHz band and the command guidance and beacon response is also in the 8 10 GHz band though obviously not on the same frequencies. This sort of C-band X-band combination is of course not unlike that used in some Western missile systems of similar age.

The missile is constructed as a single-stage body containing a dual-thrust integral rocket-ramjet propulsion system. In the boost phase the missile is powered by a solid propellant rocket motor which accelerates it at about 20 g to about Mach 1.5. With the completion of this rocket burn the tail cone of the missile, which contains the booster nozzle is jettisoned and the rocket propellant chamber becomes the combustion chamber for the ramjet, ram air being supplied through four intakes disposed symmetrically around the centre section of the missile. The ramjet takes the speed up to almost Mach 2.8.

Two sets of cruciform fins at the centre and tail of the missile provide stability and aerodynamic control, pitch and yaw being controlled at the centre and roll at the tail. The tail fins also carry the command link receiver aerial and the beacon transmitter aerial. The nose of the missile is an ogival radome for the homing head.

CHARACTERISTICS

Type: Surface-to-air tactical guided missile

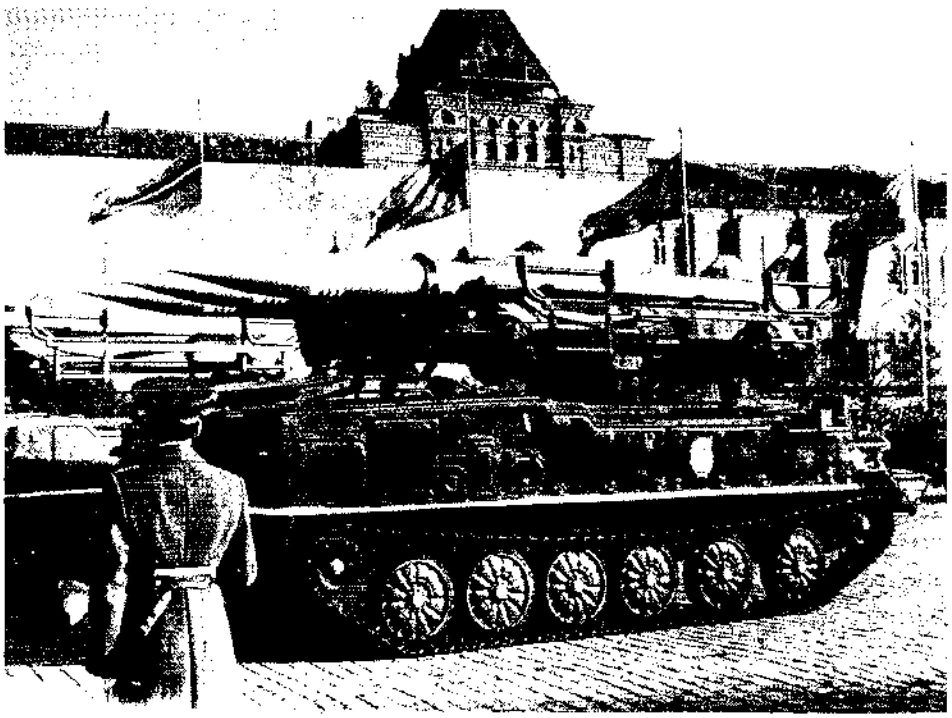
Guidance: Ground command plus semi-active radar homing. Aerodynamic control

Propulsion: Integral rocket-ramjet

Warhead: High explosive, probably 80 kg total with 40 kg HE

Fuse: Proximity and impact; possibly also command

Missile lengths: 6.2 m including tail cone, 6.0 m without



SA-6 Gainful missiles (Tass)

Diameter: 33.5 cm

Tail Span: 124 cm

Launch Weight: about 550 kg

Ranges: Maximum, high-altitude possibly 60 km, low altitude probably 30 km. Maximum altitude about 18 km. Minimum engagement about 4 km. Minimum altitude about 100 m by radar or perhaps 50 m with optical tracking

STATUS

Operational. Warsaw Pact countries and Egypt.

2964.131
SA-9/10 SURFACE-TO-AIR MISSILE SYSTEMS

Information from US sources contains references to two new surface-to-air missile developments in the USSR.

Virtually no details are available apart from the statement that one of the missiles (SA 9 ?) is designed specifically for low-altitude interceptors and has an active radar homing system and the speculation that the other might be intended to fill the range-altitude gap between Gainful and Ganef (**2930.131** and **2934.131**).

It is understood that the US alphanumerical code numbers SA 9 and SA 10 have been allotted to the two new developments. It will be observed that this means that the number SA-8 has apparently been omitted from the sequence, and we have no further information that will explain this omission.

STATUS:

Presumably advanced development.

MOBILE GUN AND ROCKET SYSTEMS

FRANCE

2110.131
JAVELOT SURFACE-TO-AIR WEAPON SYSTEM

DESCRIPTION:

Javelot is a mobile anti-aircraft multitube rocket firing system currently being developed by Thomson-CSF in collaboration with Thomson-Brandt.

Two versions of the system are proposed – Javelot for mounting on tanks or other armoured vehicles and Catulle for mounting kill on small or medium-sized warships. Each system comprises a multitube gun effect rocket launcher capable of firing salvoes of rockets with predetermined dispersion, an acquisition radar, a fire control radar and a digital computer.

PROPOSED CHARACTERISTICS:

Function: Anti-aircraft protection of AFV's or motorised units

Surveillance element: Coherent pulse-Doppler surveillance and target acquisition radar

Tracking element: Auto-follow pulse-Doppler fire control radar

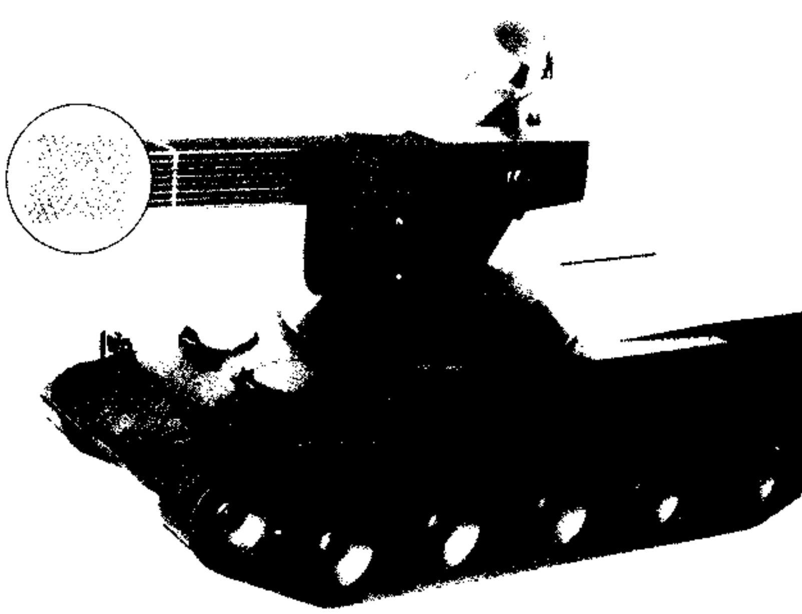
Weapon Aiming: Digital computer processing radar data

Weapon: Multitube gun launcher firing 40 mm rockets

Efficiency: 70% kill probability at 1500 metres

Reaction time: 2-4 seconds interval between target engagements

General: Large fire capacity without reloading Light weight – suitable for mounting on light AFT's or medium tanks



Model of Javelot system with, inset, a diagram of the launching tube pattern

STATUS:

Work is proceeding on a contract awarded to Thomson-CSF and Thomson-Brandt by the D.T.A.T. for the study of Javelot. The project is financed jointly by the French and US Governments and has been studied in the USA.

MANUFACTURER:

Principal: Thomson-CSF, 1 rue des Mathurins, 92222-Bagneux.

2164.131
M3 – VDA AA GUN SYSTEM

DESCRIPTION:

This Panhard/EMD system combines the firepower of many heavier SP AA gunsystems with the low cost lightness and high mobility of the Panhard M3 vehicle. It comprises a one-man gun turret mounted on the specially-adapted M3 and carrying a pair of HSS 820 SL guns; a weapon control system with a display for the vehicle commander; and the vehicle itself which is driven by the third member of the crew.

The weapon control system comprises a radar (or alternatively an optical observation system), a computer sight and high-speed controls for the twin guns and feed system.

The EMD radar is an X-band pulse doppler surveillance/acquisition device with a detection range of about 8 km (2 sq m target) and a rotation rate of 40 rev/min. Targets are displayed on the commander's console; and in target designation the radar feeds target bearing to the optical sighting system and range and target velocity to the Galileo computer sight. The gunner keeps the optical sight trained on the target and the computer calculates lead angle and favourable engagement conditions.

For the simpler (and cheaper) version of the equipment the radar is replaced by two optical observation posts, one for the commander and one for the gunner, with overlapping arcs of observation to give full 360° coverage. When one or other observer is tracking a target the tracking movement generates signals from which the computer calculates lead angle and engagement data as before. The absence of direct range and velocity measurements, of course, makes smooth tracking essential if reasonable accuracy is to be achieved and to this extent the non-radar version is more demanding than the other.

CHARACTERISTICS:

Vehicle characteristics: Generally similar to the M3-VTT (5022.102)

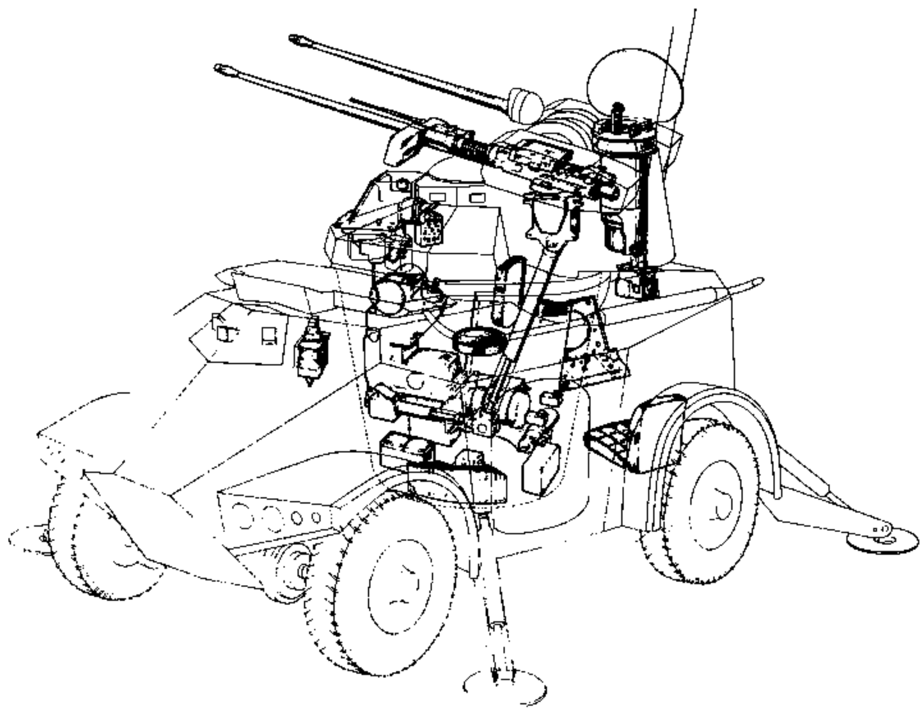
Combat Weight: 6,300 kg

Road speed/Range: 90 km/h/1,000 km

Armament: 2 HSS 820 SL or similar 20 mm cannon. HSS weapon has MV 300 m/sec slant range 2,000 m maximum engagement altitude 1,500 m. Rate of fire 800-1050 rounds/min. 600 rounds (2 × 300 belts) carried

Radar: EMD pulse doppler

Computer Sight: P56-Galileo



Layout of M3-VDA units

STATUS:

Prototype. Exhibited at Satory in 1973. Versions in larger Panhard vehicles are contemplated.

MANUFACTURERS:

System: Société de Constructions Mécaniques Panhard et Levassor, 18 Avenue d'Ivry, 75013-Paris, France.

Radar: Electronique Marcel Dassault.

Computer: Officine Galileo.

2138.131
SELF-PROPELLED 30 mm TWIN-GUN ANTI-AIRCRAFT WEAPON SYSTEM

DESCRIPTION:
This is one of several systems that have been developed in recent years in which an AA gun turret is mounted on a tank chassis and provided with its own fire control radar, the whole being used for the defence of forward (and especially armoured) units against attack by low flying aircraft.

DESCRIPTION:
The system comprises a SAMM (Société d' Applications des Machines Motrices) gun turret Type S401A with twin Hispano 30mm guns mounted on an AMX30 tank chassis. At the rear of the turret is mounted the aerial of a Thomson-CSF Oeil Noir radar, the electronics of which are contained within the turret. The aerial, is mounted on a bracket that allows it to be folded down when not in use to reduce the height of the system. The turret is fitted with optical sights and the guns can be laid and fired with these alone if the radar is inoperative.

OPERATION:
In its surveillance mode the radar scans continuously in azimuth, threat evaluation techniques being used to help the operator to select the most dangerous target (see description of Oeil Noir radar **2129.153** (Section 3 below). On selecting a target the turret is brought to the correct bearing and the gunner engages it visually using range data supplied by the radar.


SP 30 mm Twin-gun AA system on AMX-30 chassis

DEVELOPMENT:
Development was initiated by DTAT, and a version of the system mounted on an AMX-13 chassis has been in service with the French Army since 1965. The new version mounted on an AMX-30 chassis, is an improvement in terms both of utility and of mobility. In particular, mounting the system on the AMX-30 makes possible of a larger supply of ammunition; and the tank's self-contained power supplies are valuable for the watchkeeping role.

MANUFACTURERS:
Design Authority: DTAT (Direction Technique des Armements Terrestres).
Project Leader: GIAT (Groupement Industriel des Armements Terrestres), Caserne Sully, 10 place Georges Clemenceau, 92211 Saint-Cloud, France.
Turret Type S401A: Société d'Applications des Machines Motrices, 224 Quai de Stalingrad, 92130-Issy-les-Moulineaux, France.
Guns Type 831A or 831 SL/75 Cal 30 mm: Hispano-Oerlikon, 110 Route de Lyon, Geneva, Switzerland.
Radar Type DR-VC-IA (Oeil Noir): Thomson-CSF, 1 rue des Mathurins, 92222-Bagneux, France.

GERMANY (FEDERAL REPUBLIC)

2182.131
20 mm TWIN-GUN ANTI-AIRCRAFT SYSTEM

DESCRIPTION:
The AA 20 mm Twin Gun is a light highly mobile automatic system for the engagement of low-flying aircraft. It can also be used to engage ground targets.

Comprising two automatic rapid-fire guns with an analogue computer sight mounted on a transportable chassis that incorporates the gunner's seat, the system is suitable for rapid deployment in forward areas. The system is operated by a single gunner: to replenish ammunition two men are required and to bring the equipment into or out of action a third man is necessary.

A two-wheel trailer is used to transport the system and can be towed by any vehicle capable of handling an unbraked-trailer weighing 2500 kg. The trailer is detached when the equipment is brought into action, the system then being supported by a sturdy carriage with levelling outriggers. To this lower carriage is fixed an upper carriage that carries the laying mechanism, the gun cradle and the gunner's seat.

The laying mechanism is mounted over the rear bearings of the upper carriage. It carries the laying mechanism with its laying devices and consists of the following items:

- air cooled, two-stroke petrol engine with a centrifugal clutch.
- hydrostatic drives for elevation and traverse powered by an axial piston pump and motor.
- the housing, with integrally-cast cooling fins, serving as an oil tank.
- hydraulic dampers for extremes of elevation swing.
- control elements and transmission linkages.
- hydraulic systems.

Ample power is available so that the control elements can be made very sensitive. The laying mechanism thus facilitates very rapid acquisition of a target and smooth tracking.

During action against ground targets, or in anti-aircraft operation should the hydraulic system fail, the equipment can be laid manually. There is a changeover switch from normal to manual operation and handwheels are used to elevate and traverse the guns.

The fire control equipment is mounted on the laying mechanism and a shield is fitted to protect the gunner against pointed steel-core armour-piercing bullets.

The equipment consists of a lead computer of high accuracy, the target tracking device, the optic and the drive for the lead marks in the optical AA sight. At the start of the engagement the gunner calculates and manually sets the estimated target speed and the probable or ordered range to crossing point on the lead computer. As soon as tracking begins true information is mechanically fed into the lead computer which calculates the data used for controlling the lead marks in the monocular AA sight.

The upper reticle has an aiming mark in the form of a bar which pivots on one end and represents the apparent direction of flight. The lower reticle has a slightly curved spiral arranged to rotate about its optical axis.

It is the gunner's job to bring the point of intersection of the aiming bar and the spiral into coincidence with the target. Thereafter the gunner uses his knee to switch on the tracking aid. The tracking rates, determined by the lead computer, are transferred to the gears directly below the joystick and from there almost error free, through the gunner's controlling hands to the joystick and hence back again into the fire control system. To acquire the target the sight mounted on the gun shield is used.

A second eyepiece on the fire control equipment is the telescopic sight for ground targets. It operates as soon as the mask has been switched over the aperture of the AA sight. Ranges for ground targets of up to 4000 metres can be set on the ground sight.

A valuable feature of the fire control system is the programmed "taboo" facility. This is a safety device to prevent friendly targets from being accidentally engaged. It essentially consists of an electronic control mechanism, an azimuth and elevation coder, and a switch box which also includes a switch for storage and erasure of the data obtained.

The taboo facility divides the field of fire into a combat zone and a neutral zone. Below the boundary between combat and neutral zone the guns cannot be fired. Fire is reliably interrupted if the guns are swung into the neutral zone while tracking a target.

To programme the taboo interlock the gunner tracks along the boundary line delineating the area not to be engaged. The limits in elevation lie between −5° and +40° i.e. −90 to +700 mils and laterally all round. He tracks with the optical sight while the taboo interlock records electronically the limits of the neutral zone. Should sudden action against ground targets be necessary the taboo interlock can be temporarily bypassed without delay.

The guns used in the system are the Rheinmetall Rh 202 20 mm rapid-fire guns (**5600.103**). These are precision weapons that have a very high rate of fire (600-1000 rounds per barrel per minute) and a low recoil force. Both gun and ammunition feed are gas operated and independent of weapon and breech movement. In the AA weapon system cartridges can be fed selectively so that either or both guns can be employed during an engagement.

CHARACTERISTICS:

Guns:

Type: 2 Mk 20 Rh 202 rapid-firing guns

Calibre: 20 mm

Cyclic rate of fire: abt 1000 rpm per barrel

Length: 2610 mm

Weight: 76.5 kg

Barrel Centres: 230 mm

Weapon:

Cocking Device: Hydraulic, manually operated, simultaneously cocks both guns

Fire Mechanism: Pedal actuated electro-mechanical (firing solenoid); Mechanical emergency firing

Methods of Fire: Single shot or sustained

Types of Fire: By use of the electrical firing mechanism, right gun, both guns simultaneously, left gun

Supply of Ammunition: 270 rounds belted per gun in ammunition box and the feed mechanism 10 rounds belted per clip

Taboo Facility: Programmable for neutral zone of any shape

Fire Control Equipment: Analogue computer

Estimated Data Input: Target velocity 60 to 350 metres per second slant range to crossing point 200 to 1400 metres

Laying Mechanism (Hydrostatic):

Laying Speeds per sec: Traverse 0° to 100° i.e. 0 to 1830 mils. Elevation 0° to 55° i.e. 0 to 1000 mils

Field of Fire: Traverse unlimited Elevation −5 to 83° i.e. −90 to +1520 mils

AA Gun ready for the road:

Overall Length: 4.500 mm

Overall Width: 2.370 mm

Overall Height: 1.910 mm

Trailer Track Width: 2.080 mm

Weights:

AA 20 mm twin guns ready for firing with 540 rounds of ammunition: 1.450 kg

Chassis: 650 kg

Total weight of AA twin gun and trailer ready for the road: 2.100 kg

Crew:

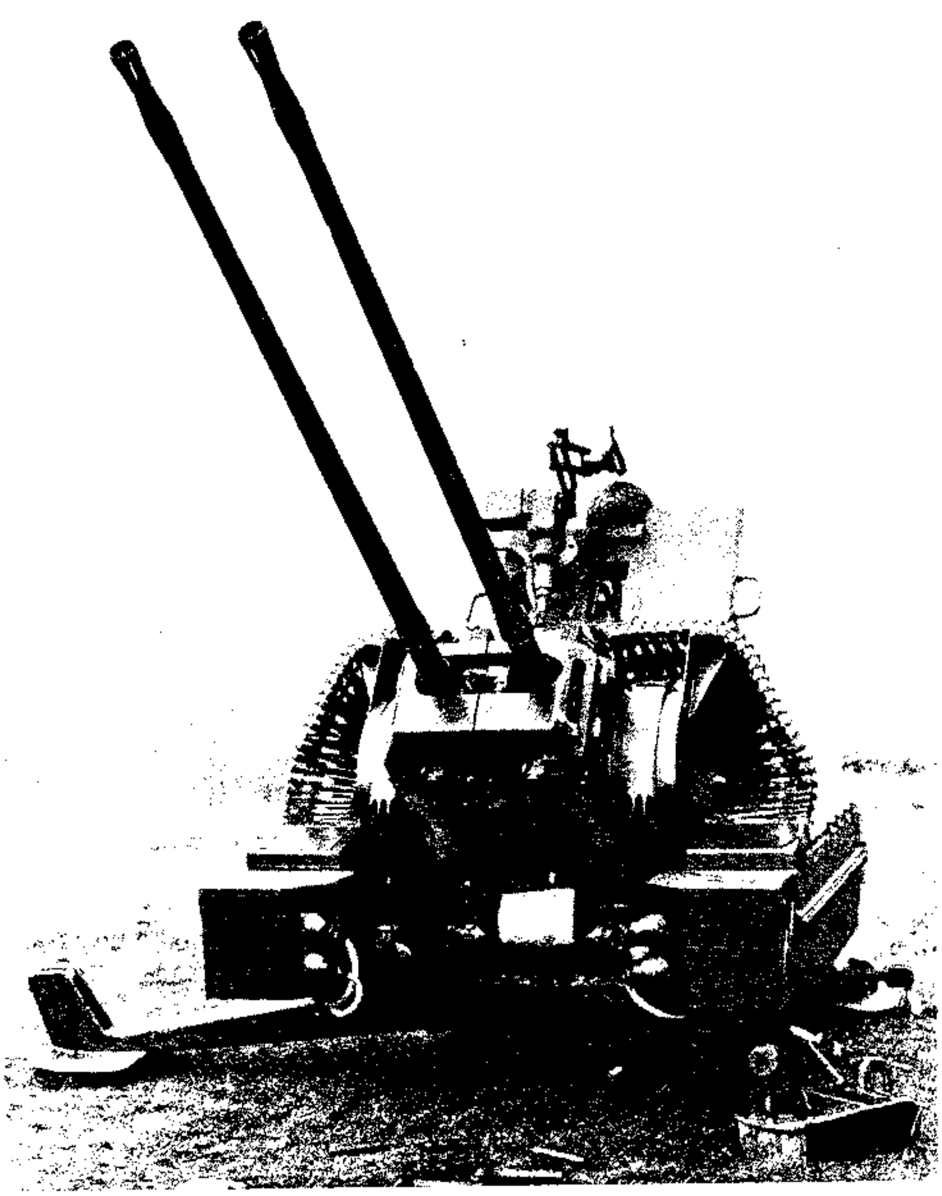
For Firing: One man

For replenishing ammunition: Two men

Coming in and out of action: Three men

DEVELOPMENT

The AA 20 mm Twin Gun system was commissioned by the German Federal Department of Military Technology and Procurement (Bundesamt für Wehrtechnik und Beschaffung) in Koblenz and has been developed and produced by Rheinmetall GmbH in Dusseldorf.



The Rheinmetall 20 mm Twin Gun AA system in firing position

Typical gun-missile layout using the 20 mm Twin Gun. The picture indicates the way in which the "taboo" facility can be used

MANUFACTURER:
Rheinmetall GmbH, 4 Dusseldorf 1, Germany.

SWEDEN

2349.131
BOFORS 40 mm ANTI-AIRCRAFT SYSTEM 75

DESCRIPTION:

Based on the Bofors mobile 40 mm L/70 gun (**5528.103**) this new system incorporates a new optronic fire control equipment known as BOFI (**2378.151**), which is integrated with the gun and a new proximity-fused shell. The gun carriage, in addition to the modifications necessary to accommodate the BOFI unit, also incorporates a power supply unit and associated apparatus.

An optical target indication device, separately mounted but carried with and connected to the mobile gun, is a standard part of the system: data from a separate search radar can also be used as an input to the system.

Principal characteristics of the system are:

1. Short deployment time of 3-5 minutes;
2. Effective fire resulting from the accurate, optronic target tracking and integrated construction, together with the use of proxi mity-fused ammunition;
3. Excellent anti-jamming properties resulting from the combination of manual, optical target tracking and gate controlled laser range finding;
4. Night combat properties provided by a light-amplification sight in BOFI;
5. Easy maintenance.

STATUS:

The gun has been in production for several years, and has been supplied to many countries.

Testing of the fire-control equipment was completed during 1972. This equipment is now operational.

Development of the proximity-fused ammunition was completed during 1974.

MANUFACTURER:

AB Bofors, S-690 20 Bofors, Sweden.

Anti-aircraft system 75, which is based on the Bofors 40 mm L/70 gun. New optronic fire control equipment is incorporated in this system. Note the diagram of a new proximity-fused shell at the top of the picture.

SWITZERLAND

2374.131
ANTI-AIRCRAFT FIELD SYSTEM 35 mm TYPE 2 ZLa/353 MK

DESCRIPTION:

The 35 mm twin gun Oerlikon-Contraves anti-aircraft system is fully automatic, and radar-controlled.

The system comprises the 35 mm twin gun, newly developed from basic requirements by Oerlikon-Bührle Ltd with the well proven Super-Fledermaus fire control equipment of Contraves Ltd. The electro-hydraulic system of the gun mounting enables a three man crew to change over from travelling to fire position – including levelling – in only 1½ minutes. The destructive effect of the 35 mm shell is the same as that of the 40 mm Bofors L 70 shell.

CHARACTERISTICS:

Calibre: 35 mm
Muzzle Velocity: 1,175 m/sec
Rate of fire per barrel: 550 rds/min
Rate of fire of gun: 1,100 rds/min
Tactical range: up to 4,000 m
Aiming speed:
Elevation: min 0.05°/sec, max 56°/sec
Traverse: min 0.05°/sec, max 112°/sec
Traverse and elevation drive:
- electric, by remote control
- electric, by gunner using joystick and auxiliary sight
- manual drive, by gunner in case of emergency

STATUS:

In production and already supplied to more than 10 countries.

MANUFACTURER:

System: Machine Tool Works Oerlikon-Bührle Ltd, Birchstrasse 155, Zurich.

Gun mounting of the Oerlikon twin 35 mm anti-aircraft gun system

2370.131
ANTI-AIRCRAFT TANK SYSTEMS

These systems had their origin in some basic studies carried out by a working partnership consisting of Siemens-Albis, Contraves and Oerlikon-Bührle Machine Tool Works. The object of the studies was the specification of a mobile, armoured anti-aircraft weapon system that could operate effectively in forward areas to provide protection for combat zone troops from low-level air attack.

It was recognised that the satisfactory performance of this function necessarily involved all-weather capability, fast reaction time, relative immunity to ECM, a high degree of reliability, coupled with the ability to carry sufficient ammunition to enable the system to remain in operation for long periods, and arrangements both to protect the crew from attack and to enable them to defend themselves against ground forces.

DESCRIPTION:

The basic component functions seen to be necessary were, first, an armoured tracked vehicle to carry the system; secondly, an anti-aircraft gun arrangement of adequate fire-power and range; thirdly, a fire control system with associated optical and tracking radar sensors; and, finally, a surveillance radar to detect targets and put the rest of the system on target.

So far, three significantly different systems have been designed – the 5PFZ-A, 5PFZ-B and 5PFZ-C – and the second and third have been modified as a result of further development, following exhaustive technical and user trials, to the latest versions – 5PFZ-B2 and 5PFZ-CA.

Original 5PFZ-A arrangement

5PFZ-A

Development of this version started in 1966, and a contract was placed in that year by the Federal Republic of Germany for two prototypes. Main components of this system were a *Leopard* battle tank chassis by Kraus-Maffei; a 35-mm twin-barrelled gun system by Oerlikon; a fire control system by Contraves; a tracking radar by Siemens-Albis and a search radar with MTI by B.V. Hollandse Signaalapparaten. This last radar was developed on a direct contract to the Netherlands.

The first prototype was delivered in 1968 and the second in 1969. Firing trials and other technical tests carried out in 1969-70 were very successful and were followed by user trials.

5PFZ-CA system

5PFZ-B2 (Flakpanzer 1 – Gepard)

Successor to the 5PFZ-A this model, embodies advanced radar and other electronic techniques. It uses the Siemens MPDR-12 pulse-doppler surveillance radar with integrated MSR400 IFF equipment. The Siemens-Albis tracking radar is of the monopulse-doppler type.

This version has been ordered in quantity to equip the armed forces of the Federal Republic of Germany and Belgium. Deliveries from the Kraus-Maffei assembly line of a series of 420 Gepard tanks for the FRG will start by the middle of 1976.

5PFZ-CA

Second offspring of the 5PFZ-A and preceded by the prototype 5PFZ-C, this model uses an integrated MTI/monopulse-doppler search and tracking radar. A special sharp beam is incorporated in the tracking radar section. Apart from the MSR400 IFF the whole radar is supplied by Signaal.

This version has been ordered in quantity by the Royal Netherlands Armed Forces.

OPERATION (5PFZ-B & C):

Targets are detected and identified by the surveillance radar and IFF – both of which continue to scan throughout an engagement. On detection the crew is automatically alerted; and on target designation the tracking radar automatically acquires it – the mounting of the tracking radar aerial in the turret being such as to give it a target acquisition arc of some 200 degrees without slewing the turret.

Data from the tracking radar enables the fire control computer to calculate the lead angle for the guns (which are fitted with MV measuring equipment, the output of which is also fed to the computer) and to determine the optimum point for engagement. The guns are belt-fed and have a rate of fire of 550 rounds/minute each and an MV of 1,175 m/sec. 680 rounds of ammunition are carried on the vehicle.

Both commander and gunner have periscopes that can be used when necessary for optical target acquisition and tracking, combat zone observation and gun-laying for ground targets. To enable these functions to be performed while the vehicle is on the move, the optical lines of sight are stabilised by rate gyros.

The miniaturised, transistorised computer, the radars and other electronic units are fitted with self-testing equipment whereby the fire control unit can be checked out. An emergency computer is also fitted to which the crew can switch in the event of failure of the main computer.

5PFZ-B prototype system

MANUFACTURERS:

System designers: Siemens-Albis, Contraves Oerlikon (Zurich, Switzerland).

Tank Chassis: Kraus Maffei (West Germany).

Guns: Oerlikon.

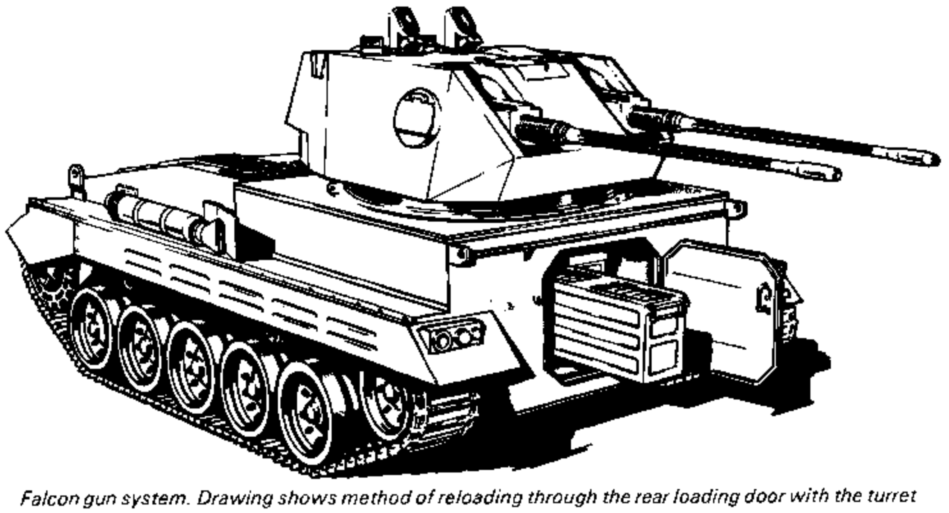
Fire Control System: Contraves.

Tracking Radars: Signaal (Netherlands), Siemens-Albis.

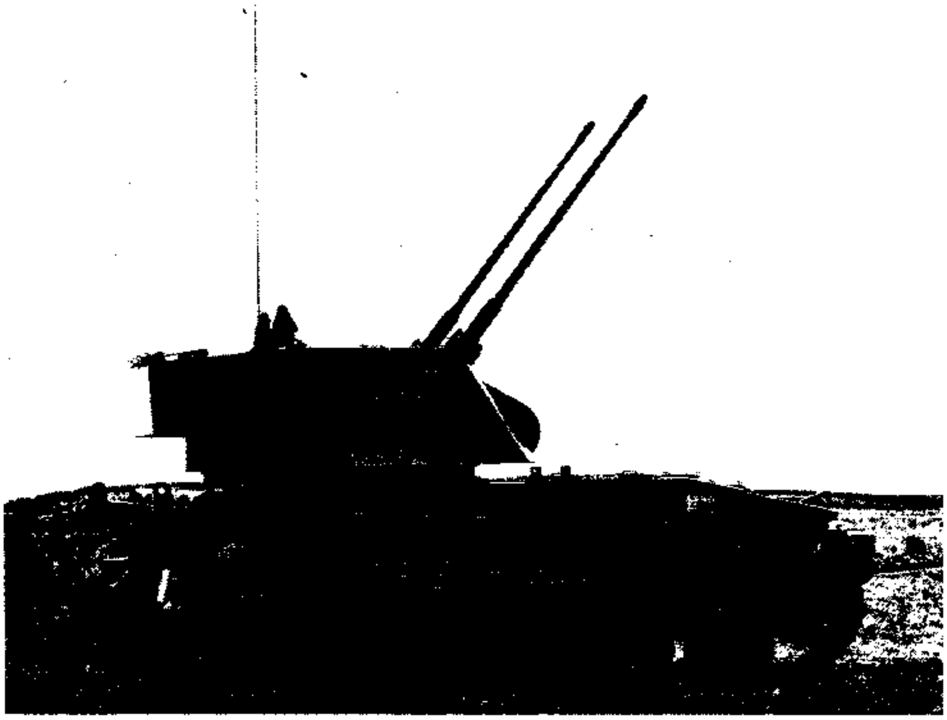
Surveillance Radars: Siemens (West Germany), Signaal.

IFF: Siemens.

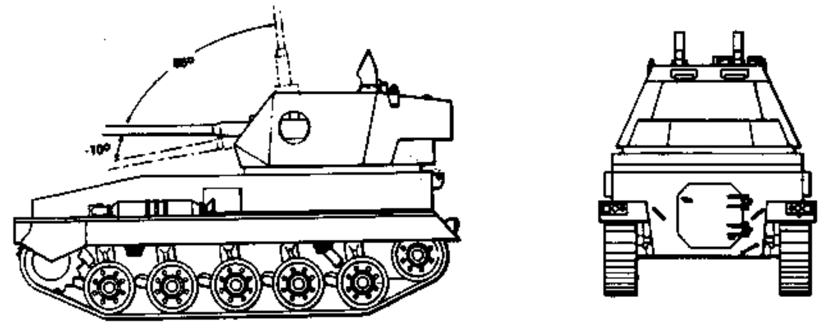
THE UNITED KINGDOM

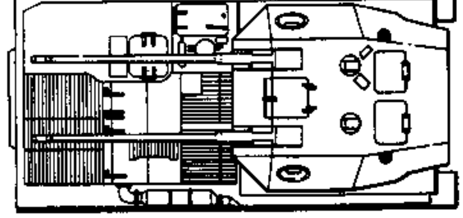


Falcon gun system. Drawing shows method of reloading through the rear loading door with the turret reversed



Falcon 30 mm AA gun system





Three-view drawing of Falcon.

2407.131
FALCON SP 30 mm ANTI-AIRCRAFT WEAPON SYSTEM

DESCRIPTION:

Falcon is one of several mobile anti-aircraft systems that have been built or proposed in recent years as solutions to the problem of defending military formations on the move from attack by low-flying aircraft or by lightly-armoured highly mobile ground forces.

Most of these systems, whether based on guns or on surface-to-air missiles are dependent for their operation on the use at least of surveillance radar capable of detecting low-level targets and often of tracking radar as well. Falcon marks an interesting departure from this trend in that it has no radar (although the possibility that someone might wish to fit radar to it is recognised) but instead depends on a highly sophisticated visual aiming system.

The arguments in favour of such a system are that it is not vulnerable to ECM and that it is significantly cheaper than a radar-equipped system. The manufacturers argue, however, that it is nevertheless as effective operationally as radar-equipped systems using the same basic weapons.

DESCRIPTION:

Major components of the system are the Vickers Abbot chassis, a specially-designed turret, Hispano Suiza 30 mm guns and a specially-designed fire control system built round a periscope optical sight.

The Abbot armoured chassis is described in Section 3 (**5503.103**) and all that need be said here is that it is a firmly established design that gives good off-road mobility – including a useful wading capability – air transportability and operational simplicity. On it is mounted a specially-designed turret which is fabricated in steel armour plate and gives protection against shell splinters and small arms fire.

Access to the crew compartment is through two hatches in the roof, above the commander's and gunner's seating positions. These are side-by-side adjustable seats. The commander's seat is designed to allow him to sit in the 'head out' position. The crew compartment is sealed from the gun and ammunition compartment thereby assuring an atmosphere free from fumes, and reducing the noise threshold when firing the weapons.

The weapons installed are the Hispano Suiza 30 mm calibre Type 831L. These are mounted in coupled gun cradles which are externally of armoured steel. Access for mounting and dismounting the guns for maintenance is simplified by the provision of a front cover on each cradle and the fact that the gun barrel is bayonet fitted into its gun body.

Ammunition is fed to the guns from boxes located in the base of the turret through chutes into belt feed mechanisms operated by gun recoil. Empty cartridge cases and the belt links are ejected sideways through the elevation trunnion bearings.

The guns are cocked and fired electrically, single shot and automatic fire from both or either gun being selectable. They fire at a rate of 650 rounds per minute from each barrel: this high rate of fire being one of the essential reasons for the attainment of the high hitting probability of the system.

The power control system controls and drives the turret in traverse and the twin gun in elevation, providing high speed slewing and maintaining accuracy of aim, even with one gun firing. The gun is also stabilised against vehicle movement. The system is similar to those developed by GEC-AEI (Electronics) Limited, for use in the Centurion and Chieftain tanks, and the Vickers Main Battle Tank.

The gunner tracks the target by operating a two-motion joy-stick which is energised when a foot pedal is depressed. The commander has a similar joy-stick which can override the gunner's.

The power control system is all-electric. Signals from the joysticks are compared with the outputs from rate gyro units mounted on the gun cradle, the resultant error signal being processed in amplifier channels to optimise the response and convert it into a suitable signal for controlling rotating amplifiers (metadynes). The metadyne outputs control servo motors which drive the turret and twin guns through gearboxes.

The gunner is provided with a periscope gunsight with dual optical systems – one of X1 magnification and a 50 degree field of view for anti-aircraft use and the other of X6 magnification with a 10 degree field of view for accurate laying on ground targets.

Superimposed on the anti-aircraft field of view is a moving circle, the displacement of which from the optical centre line is the lead angle for maximum hit probability. This lead angle is computed by automatically feeding the rate of tracking speed into a simple computer and multiplying this by a factor representing the present range of the target. In practice the guns would be intentionally fired at a range longer than the manually set range, and firing continued until the actual range is shorter than the manual set range. In this way it can be assured that any normal error in estimating the range of the target is covered by the bracketed range of fire. In short the use of the sight will be identical to the gyroscopic gunsights used for many years, but the periscopic gunsight as installed enables the turret to be used with complete cover for the crew.

The commander has a similar periscopic gunsight but without the moving lead angle display. Both the gunner's and commander's sights have emergency fixed graticules. Both sights are also provided with a ground target ballistic graticule which has the following features:

1. It gives the variation in tangent elevation (gravity drop) for different ranges.
2. The length of the graticule marks at each range are calculated to be identical to the width of a typical APC. This feature gives a form of stadiametric ranging.
3. Lateral deflection is possible by graticule marking at 5 milli-rad intervals.

These facilities are in the X6 magnification periscopic sight, and additional observation periscopes are provided for the commander.

Maximum engagement range is 3,000 metres.

MANUFACTURERS:

System – Vickers Ltd. Armament Division, Elswick Works, Newcastle-upon-Tyne, NE99 1CP, England.

Guns – Hispano Suiza.

Turret – British Manufacture and Research Co. Ltd.

Metadyne System – GEC-AEI (Electronics) Ltd.

Sights – Avimo Ltd.

THE UNITED STATES OF AMERICA

2843.131

AVADS – AUTOMATIC VULCAN AIR DEFENCE SYSTEM

DESCRIPTION:

AVADS is the acronym for an "automatic" version of the established Vulcan Air Defence System (**2850.131**). The principal feature of the automation of the system is the replacement of the radar/optical tracking system of the VADS by a system relying primarily on an auto-tracking radar – the range-only radar of the earlier system having been modified to give it an angle tracking capability (see **2844.153**).

Associated with this modification are the replacement of the gyro lead-computing sight by a helmet sight, which greatly speeds target acquisition, the addition of a solid-state analogue computer for fire control and the incorporation of a self-test unit. The whole is mounted in a M-113 APC (as is one version of the VADS) and solid-state electronic turret drives have been added. Total weight of the whole system is now some 2,350 kg.

OPERATION:

The system can be operated in any one of five modes:

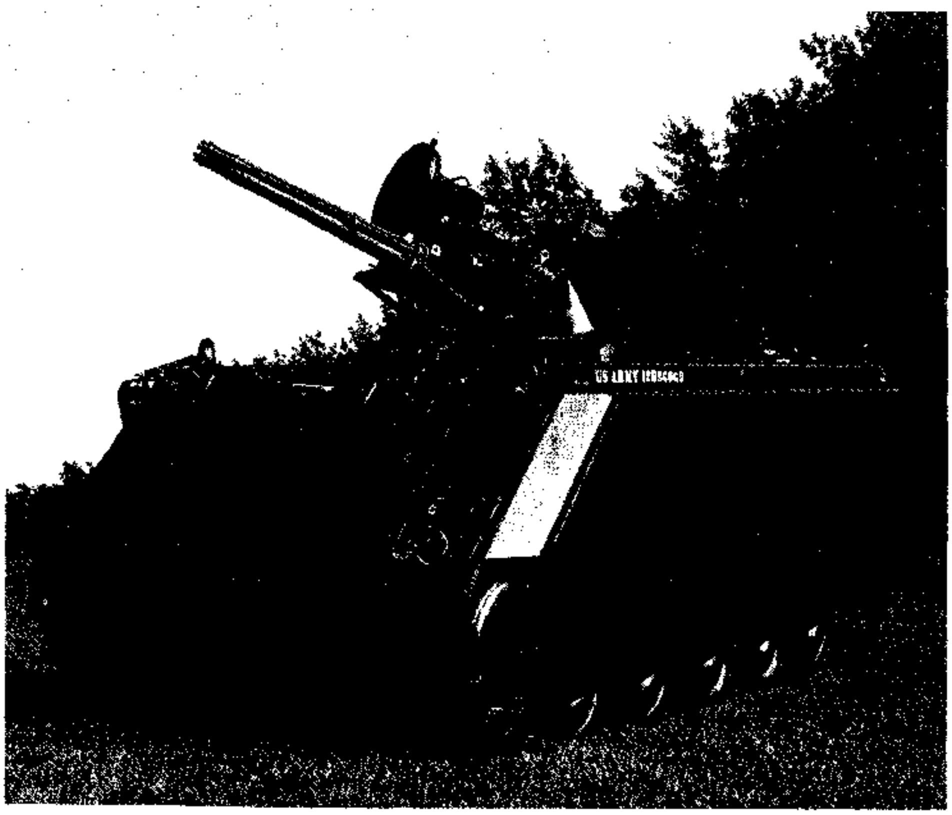
1. Helmet sight acquisition/automatic track
2. Ring sight acquisition/automatic track
3. Helmet sight track/range-only radar
4. Helmet sight track/estimated range and range rate
5. Ground mode.

The first of these modes is the most fully automated. As the gunner, aided by his helmet sight, searches for the target, the radar aerial (not radiating) and the turret (in low gain mode) follow his line of sight. When the gunner has acquired the target optically he operates the trigger – which then transfers control of the engagement to the automatics. The radar radiates, locks on and tracks the target; the computer calculates the correct lead angle and directs the turret appropriately; on being signalled that the gun is laid 'on' and when the radar indicates that the target is 'within' engagement range, the computer commands the firing of 2-second bursts until the gunner releases the trigger.

CHARACTERISTICS:

Gun: M-168, 20-mm Vulcan

Weight:
Feed System: 545 kg
Mount: 1,400 kg
Gun: 136 kg
Ammunition: 282 kg
Total: 2,363 kg



Automatic Vulcan Air Defence System

Firing Rate: 1,000/3,000 spm
Ammunition Capacity: 1,100 rds
Feed System: Linkless, single-ended
Drive System: Electric
Power Requirements: On-station batteries require 500 watts standby
Ammunition: M-50 series
Barrel Life (Per set): 20,000 rounds
Slewing Rates: Azimuth: 80°/second. Elevation: 60°/second
Train/Azimuth Limits: None, 360° continuous
Elevation Limits: +80 degrees, −5 degrees
Diameter of Main Bearing: 1,016 mm
Recoil Force (Average):
At 3000 spm: 818 kg
At 1000 spm: 273 kg
Fire Control:
Radar: X-band, pulse-doppler tracks in range and angle. 200-5,000 metre range.
Computer: Linear straight line prediction, solid-state, provides ballistics for 5 different projectiles.
Helmet sight: Electro-mechanical, used for acquisition, allows gunner to perform 360° search

STATUS:

Army evaluation relative to such competing systems as the naval Phalanx system (**2543.231**), the 30 mm gun project GLADS (**2544.131**) and the French Javelot (**2110.131**). Basic fact-finding evaluation is believed to be complete but no news of a decision has been received.

MANUFACTURER:

Systems prime contractor: General Electric Company, Lakeside Avenue, Burlington, Vermont 05401, USA.

2544.131

GLADS LOW-ALTITUDE DEFENCE SYSTEM

DESCRIPTION:

GLADS (or GLAADS), an acronym for Gun Low-Altitude (Air) Defence System, is the name given to a point or area defence system now being considered by the US Army.

Aimed at producing a system to combat low flying aircraft, the concept has much in common with the established Vulcan air defence system (**2850.131**) but is built around a larger-calibre gun than the General Electric 20 mm weapon used with Vulcan.

Envisaged as a self-propelled system GLADS will have, probably, either a 25 mm or 30 mm gun, an improved fire control sensor and a digital processor. A laser rangefinder is likely to be incorporated as also is a forward-looking infra-red (FLIR) imaging device. Possible suppliers of the gun are General Electric and Philco-Ford, both of whom have multi-barrel weapons of appropriate calibre in hand for other projects.

STATUS:

Project. A decision on its future will depend on the US Army assessment of its potential relative to the AVADS system (**2843.131**) a version of the Phalanx system (**2543.231**) and the French (American-assisted) Javelot system (**2110.131**).

2850.131
VULCAN AIR DEFENCE SYSTEM

DESCRIPTION:

This is an anti-aircraft weapon system based on the Vulcan 20 mm six-barrel gun. The gun was originally designed for aircraft use but has lent itself readily to integration in a sophisticated light anti-aircraft system.

For different operational purposes the weapon system can be made available on a variety of platforms – as a towed trailer, on a self-propelled land vehicle or mounted permanently on a ship or in a static air defence gun emplacement. The main functional units are the same in each case, however, and the description that follows relates to the towed trailer version of the system.

The system comprises the Vulcan gun, a linked ammunition feed sub-system and a fire control sub-system all mounted in an electrically-powered turret. The fire control sub-system consists of a range-only radar and a lead-computing gunsight with its associated current generator. The towed VADS system contains its own batteries and is equipped with a petrol-driven generator for recharging; and the whole system is mounted on a gun carriage.

THE GUN:

The Vulcan gun, previously used as aircraft armament at rates as high as 6,000 shots per minute, has been modified for the air defence application to provide alternative firing rates of 1,000 and 3,000 shots per minute. Because of the weapon's six-barrel design, its dispersion pattern can be optimised by a suitable choice of muzzle adapter. The adapter chosen causes the pattern to be spread, which results in a higher hit probability.

AMMUNITION FEED:

In the towed system a conventional belt feed is used for ammunition, the belted rounds being fed from a 300-round container. In other systems where more space is available a linkless feed system can be used and this has a capacity of 1,100 rounds.

TURRET AND CONTROL:

The turret is electrically driven and its drive is controlled by three solid-state servo amplifiers. Both the amplifiers and the DC motors they control are interchangeable and readily replaced. Despite the high slew rates attainable the turret motion is smooth.

FIRE CONTROL:

The fire control system consists of a gyro lead-computing gunsight and a sight current generator. The gunner visually acquires and tracks the target with the gyro lead-computing gunsight. The antenna axis of the radar is servoed to the optical line-of-sight, and the radar supplies target range and range-rate data to the sight current generator. These inputs are then processed to provide outputs that are used to control the gunsight.

With inputs of range, range rate, and angular tracking of the optical line-of-sight (measured by a freely gimballed gyro), the sight automatically computes the future target position and adds the required super-elevation to hit the target.

Turret fire control is a disturbed line-of-sight system. The sight case and gun bore are physically fixed in alignment, but the sight reticle, which defines the optical line-of-sight, is positioned by the gyro and is displaced from the gun bore as the gunner tracks the target, thereby establishing the

Vulcan Air Defence System. XM-167 towed version

proper lead angle. The amount of optical line-of-sight displacement is dependent on the range and range rate inputs to the sight, and the required tracking time to establish the lead angle is about one second.

The range-only-radar, developed by the Lockheed Electronic Company, is a coherent doppler, moving target indicator (MTI) radar. It will acquire targets up to 5,000 metres away.

A green light appears in the sight optics signalling that the radar has acquired the target and that the target is within the effective range of the turret system: so that the gunner simply acquires the target in the sight reticle, tracks the target, and fires after the green light appears.

ALTERNATIVE MODE:

When desired, the gunner may switch to a manual mode of fire control. In this mode he must estimate target range and speed and set the estimates on indicator dials on the control panel. The gyro lead-computing gunsight then computes the lead angle based on these estimates.

Trained gunners can achieve good results using the manual mode of fire control, as was demonstrated during the Military Potential Tests conducted by the US Army.

SYSTEM POWER:

Power for the turret is supplied by 24-volt nickel-cadmium batteries within the turret. One battery furnishes power to the turret power control and fire control system; a second drives the Vulcan gun with conventional linked ammunition, but a third battery is required when the linkless feed system is used. Batteries can be charged by an on-vehicle generator or a portable auxiliary power unit. The turret can remain in standby condition over long periods of time without significant power drain.

CHARACTERISTICS (TOWED TYPE):

Type: Land-mobile, air-transportable, light anti-aircraft weapon system

Control: Radar ranging, optical aiming, automatic lead computation

Fire Power: 6 × 20 mm guns. 3,000 spm high rate of fire. 1,000 spm low rate of fire

Radar Range: 5,000 metres

Weapon Coverage: Azimuth 360 deg. Elevation:- 5 deg to +80 deg

Turret Slewing rate: Azimuth 60 deg/sec. Elevation 45 deg/sec. Acceleration 160 deg/sec^2

Height on Wheels: 2.03 metres

Height Emplaced: 1.73 metres

Wheel Track: 1.77 metres

Weight: 1,360 kg

Standby Power Requirement: 500 W

DEPLOYMENT:

The US Army, after successful military potential tests in 1964 and 1965, selected the Vulcan Air Defence System to arm new Composite Air Defence Battalions. The Vulcan system is used in conjunction with the Chaparral missile system in the composite battalion.

The Army is using two VADS configurations; the M-163 Self-Propelled and the M-167 Towed. For the Self-Propelled M-163; the turret is mounted on a modified M113A1 armoured personnel carrier (designated M-741 for this application) and uses a linkless ammunition feed system. It maintains the swim capability of the M113.

For the towed M-167, the system is mounted on a lightweight, two-wheel gun carriage and uses conventional linked ammunition in a 300-round container. It is helicopter transportable and uses the M715, 1¼-ton truck as its prime mover.

STATUS:

In production for US and various other governments. A towed version without radar is in production for the Belgian Air Force. See also AVADS (**2843.131**)

MANUFACTURERS:

Complete System: Aircraft Equipment Division, General Electric Company, Burlington, Vermont.

Radar: Lockheed Electronics, Plainfield, New Jersey and American Electronic Lab. Philadelphia, Pa.

Vehicle: FMC Corporation, San Jose, California, USA

THE UNION OF SOVIET SOCIALIST REPUBLICS

5543.131
23 mm ZSU-23-4 SP AA VEHICLE

DESCRIPTION:

This SP vehicle system consists of four 23 mm AA guns mounted on a common mounting, and fired together. The result is a useful volume of fire and a greatly increased chance of a hit over what would be achieved with four independent guns.

The vehicle provides low level cover for the armoured and mechanised divisions of the Soviet army, and is organic to the AA battalions of these divisions. The fire control radar will provide the lay for guns, and compute the target speed and height. It is not known how the target is first acquired, nor how much ammunition is carried.

The hull and automotive components are the same as the PT-76 tank, the differences being in the superstructure and turret.

CHARACTERISTICS:

Estimated total weight: 15,000 kg

All main dimensions similar to PT76 tank:

Estimated height: 2.2 m

Guns: 23 mm automatic cannon

Range—anti-aircraft role: 1,200 m

Elevation: 0° to 85°

Traverse: 360°

Rate of fire—each gun: 1,000 r.p.m.

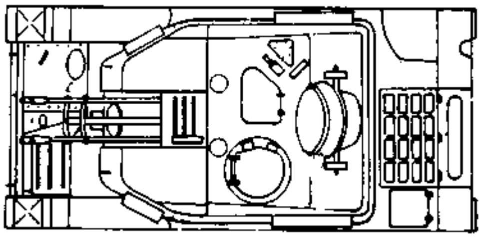
Total: 4,000 r.p.m.

STATUS:

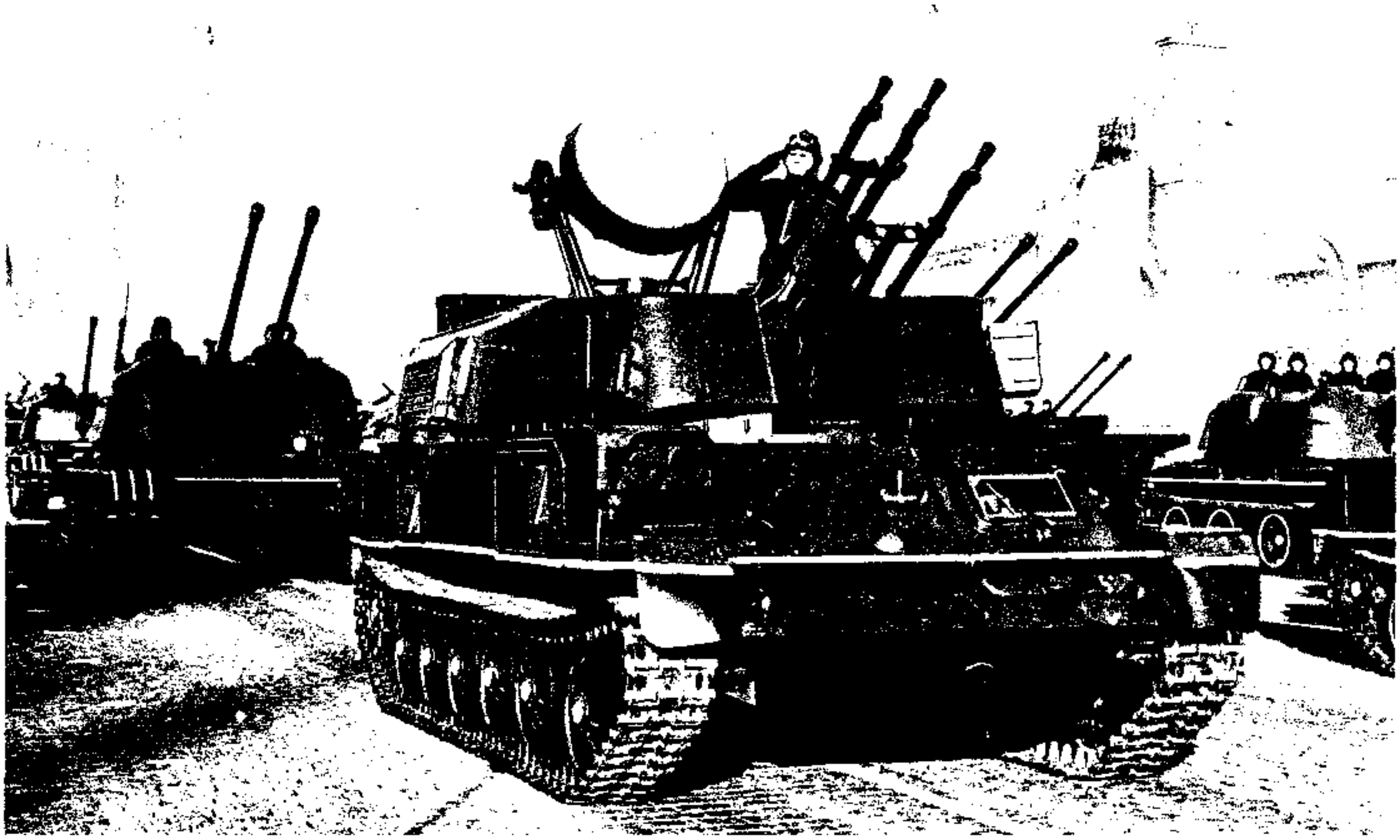
In service.

COUNTRIES SUPPLIED:

Warsaw Pact.



ZSU-23-4



ZSU-23-4 in Red Square. In the background is a ZSU-57 (Tass)

PORTABLE ANTI-AIRCRAFT GUIDED MISSILE SYSTEMS

SWEDEN

2348.131
RBS 70 ANTI-AIRCRAFT MISSILE SYSTEM
DESCRIPTION:

RBS 70 is a portable surface-to-air missile system operating on the optical beam-riding principle – which gives it substantial immunity to jamming. It is suitable for use against both fighter-bombers and helicopters, has a range of about 5 km and can be operated by one man – but for continuous firing a second man is needed.

The system is suitable for integration with other surface-to-air weapons or as a separate unit. Unlike many other portable anti-aircraft missile systems, RBS 70 can utilise precision target information from a search radar, and it is both possible and desirable to group several RBS 70 units with one or more search radars to form an anti-aircraft battery. RBS 70 is also designed to utilise IFF signals.

Three packs – stand, sight and missile in container – make up the complete firing unit which can be assembled and ready to fire in less than 30 seconds. The stand has three legs and forms the suspension device for the telescopic sight which has gyro-stabilised optics and which also contains the guidance beam transmitter.

To slew on to the target the operator uses coarse aiming, turning the whole sight housing in the required direction. For tracking, a thumb lever is used to operate the gyro-stabilised optics.

The missile is launched from a container which also serves for both storage and transport, the missile never being removed from the container except at the moment of firing. A starting motor ejects the missile from this launch container and separates from it at the mouth of the tube after which the missile sustainer takes over. The missile carries a receiver for the guide beam signals and a small computer to process them. The warhead has both proximity and percussion fuses but if desired the active optical proximity fuse can be paralysed before the missile is fired.

Among the items of test and training equipment supplied for use with the missile is a sight simulator for use in training operators.

CHARACTERISTICS:
Type: Man-portable surface-to-air guided missile system
Guidance: Optical beam riding on laser beam
Propulsion: Booster plus solid propellant sustainer
Warhead: High explosive with impact and proximity fuses

RBS-70 AA Weapon System

Weights:
Firing unit complete – about 80 kg
Missile in container – 22 kg
Container length: 1.6 m
Container diameter: 15 cm
Missile range: 5 km

STATUS:
Development started in 1969. Three series of firing trials have been held and development will be complete this year. Series production is planned to start in 1975.

MANUFACTURER:
AB Bofors, S-690 20 Bofors, Sweden.

THE UNITED KINGDOM

2409.131
BLOWPIPE PORTABLE ANTI-AIRCRAFT MISSILE SYSTEM

DESCRIPTION:
Blowpipe has been conceived primarily as a surface-to-air weapon for unit self defence in forward areas against close-range low-level air attack. In order to carry out this role effectively the equipment is compact, light and simple so that it can be both carried and operated by one man.

The weapon is suitable for use in world-wide extremes of climate with no maintenance needed during long periods in the field. It can be brought into action very rapidly, and reloading time is a few seconds. Blowpipe can be used against both attacking and receding fast aircraft and helicopter targets.

The Blowpipe weapon system is entirely self-contained with no external power requirements, and consists of two main components: the missile, sealed within its launching canister, and the aiming unit. The missile/canister combination is treated as a round of ammunition that can be taken out of store and fired with no preparation or testing. The aiming unit houses all the necessary equipment and controls to launch the missile and guide it towards the target.

CHARACTERISTICS:
Type: Man-portable, shoulder-fired surface-to-air (or surface) tactical guided missile
Guidance Principle: Radio command with optical tracking
Guidance Method: Twist and steer by nose-mounted control surfaces
Propulsion: Two-stage booster-accelerator solid-propellant rocket motor
Warhead: High-explosive with proximity fuse
Missile Length: 1.4 metres
Missile Diameter: 76 mm
System Weight: 18 kg with one missile

OPERATION:
To prepare the system for action all that is necessary is to clip the aiming unit to the canister, which only requires a few seconds, and the complete system, which weighs less than 40 lbs (18 kg), is lifted to the man's shoulder. The aimer acquires his target in his monocular sight, fires the missile and controls its flight to the target by means of a thumb-operated flight controller.

The act of pulling the trigger activates thermal batteries for power supplies in both the missile and canister (to supply the aiming unit). When these batteries have reached a sufficiently high voltage (in about 1 sec), the missile first stage motor ejects the missile from the canister. This motor is extinguished before the missile fully emerges and the missile coasts for a safe distance from the aimer before the second stage main motor ignites to boost the missile to supersonic speed.

The missile is fitted with flares which in the early stages of flight are detected by a sensor in the Aiming Unit to gather the missile to the centre of the aimer's field of view. From then on the aimer guides the missile to the target by means of the controller with up/down and left/right movements.

On arrival in the vicinity of the target a proximity fuse in the nose of the missile detonates the warhead.

Commands are transmitted to the missile over a radio link. Reception aerials in the missile pass these commands through the receiver and decoder to the missile control system. This works on "twist and steer" principles with one pair of nose mounted control surfaces working differentially to produce roll, and the other pair producing lateral movements.

British Army firing of Blowpipe missile

Blowpipe is fitted with a fully integrated identification (IFF) system which prevents friendly aircraft from being inadvertently engaged as a result of incorrect visual identification.

The missile has a slim, cylindrical body and ogival-nose cone. Cruciform delta-shape canard control surfaces are mounted on the nose cone and a unique type of cruciform delta-shape tail-fin assembly is used. This consists of a sliding ring structure which, in the launching canister, is positioned near the nose of the missile, enabling the diameter of the rear of the canister to be minimised. As the missile is launched, it passes through the tail-fin assembly which finally locks on the rear of the missile. The folded wing tips open to their full span as they emerge from the canister.

DEVELOPMENT HISTORY:
During 1966 the Royal Radar Establishment conducted feasibility studies with three contractors to investigate the design of a system to meet the requirements of the Naval and General Staff target for a man-portable all arms weapon for self-defence against low flying aircraft and surface targets. Following a complete analysis of the three competing proposals, the RRE recommendation was for a guided weapon system based on a private venture being pursued by Short Bros & Harland Ltd which had resulted in a test vehicle which they had christened "Blowpipe".

The feasibility study was succeeded by a one year project study for the complete weapon system, comprising contracts placed with all the participating contractors.

Close-up showing missile in its launcher

STATUS:
In production for the British Army the Royal Marines and the Canadian Armed Forces.

MANUFACTURERS:
The following manufacturers are known to have been associated with the development and manufacture of the system.
Main contractor: Short Bros & Harland Ltd, Belfast.
IFF System: Cossor Electronics Ltd.
Fuse: Marconi Space and Defence Systems Ltd.
Ignition, safety and arming unit: Royal Ordnance Factory, Blackburn.
Firing circuits: Pye Dynamics Ltd.
Thermal Batteries: Mine Safety Appliances Ltd.
The co-ordinating research and development authority is the Royal Radar Establishment.

THE UNITED STATES OF AMERICA

2841.131
ALTERNATE STINGER

DESCRIPTION:

Alternate Stinger is the rather unhappy title bestowed upon a projected portable anti-aircraft missile development aimed at producing a competitor in the US military market for the General Dynamics Stinger missile (**2805.131**).

The new development is understood to have been entrusted to Philco-Ford who are to produce 18 prototype and qualification models of the missile on a $5.2 million contract from the US Army Missile Command. It is further understood that the USAMC hopes to decide during the course of 1975 which of the two competing missiles it will adopt.

The principal known difference between the two missiles is in their guidance systems. Stinger utilises passive infra-red homing, the Philco-Ford missile will be guided by the reflected energy of a laser beam trained by the gunner on the target.

STATUS:

Development.

MANUFACTURER

Aeronutronic Division, Philco-Ford Corporation, Newport Beach, California 92063.

2784.131
REDEYE PORTABLE ANTI-AIRCRAFT MISSILE

DESCRIPTION:

Redeye is a shoulder-fired guided missile system designed to give a soldier an effective defence against low-flying aircraft. The missile's infra-red sensing device homes on the heat of an aircraft's engines. The Redeye carries a high-explosive conventional warhead and has a two-stage solid-propellant engine. The light launching tube is also a carrying case and can be borne through brush and over rough terrain. A shipping and storage container holds one missile and three battery / coolant units.

On sighting a hostile aircraft, the gunner tracks it in an optical sight. At the same time, he energises the missile guidance system. A buzzer located in the launch tube gripstock informs the gunner when the missile is ready to fire. Upon firing, the booster charge propels the missile out of the launch tube. When the missile has cleared the launch tube muzzle by a distance sufficient to protect the gunner from blast effect (about 6 m), the main rocket ignites and propels the missile the rest of the way to its target. The missile is stabilised in flight by cruciform tail fins and steered by two movable fins close to its nose.

CHARACTERISTICS:

Designation: MIM-43A
Type: Man-portable, shoulder fired, surface-to-air guided missile
Guidance: Optical aiming. Infra red homing
Propulsion: Solid-propellant booster and sustainer
Warhead: High-explosive
Missile Length: 1.22 metres
Diameter: 70 mm
Weight: 13 kg
Speed: Supersonic
Range: Not disclosed. Probably about 3 km
Crew: Normally two

TEST AND TRAINING EQUIPMENT:

Guided Missile Test Set AN / TSM-82 is provided for use at depots and ammunition supply points.

Guided Missile Training Set M76 simulates full launch procedure and enables an instructor to check correct gunner operation.

Field Handling Trainer M46 is for handling and sighting practice only.

Moving Target Simulator M87 gives full practice to gunner.

DEVELOPMENT HISTORY:

Development began in 1959 after a feasibility study in the previous year. An initial production contract was announced in 1964 and many thousands of the weapons have now been made. Extended trials have been carried out successfully both in tropical areas and in "forty-below" conditions in Alaska.

STATUS:

Redeye is employed in the forward battle area to protect combat troops against low-level aircraft. In the US Army the weapon is issued to Redeye teams, each made up of a gunner and assistant gunner. From four to six of these teams are assigned to a Redeye section at infantry battalion level.

Procurement of Redeye was completed in Fiscal Year 1970. It is used by the USMC as well as the US Army and has been supplied also to the Australian and Swedish armed forces.

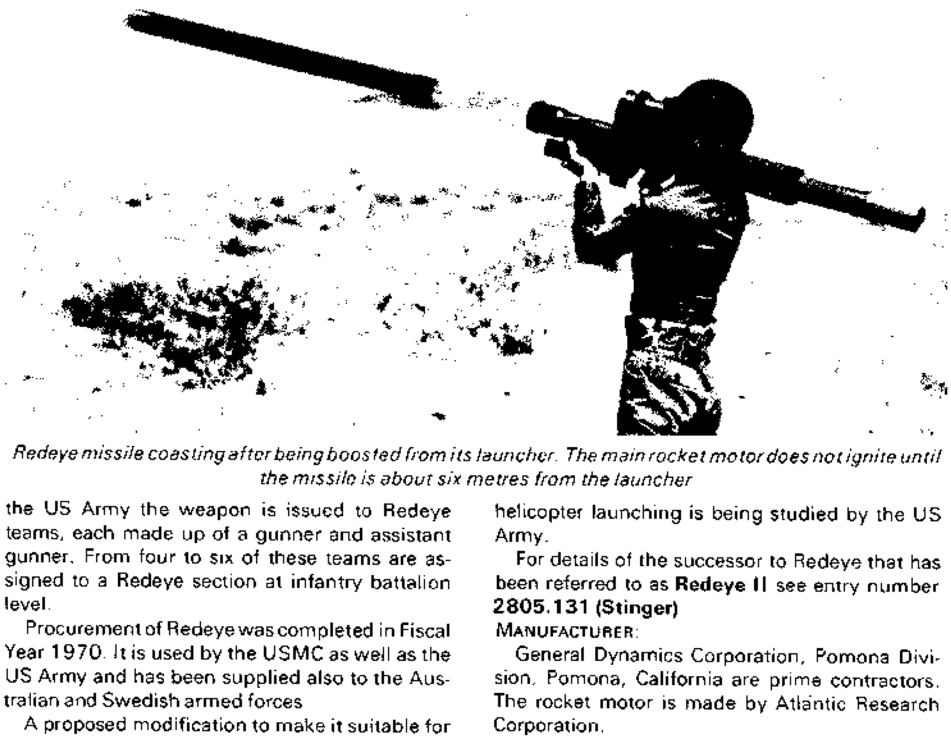
A proposed modification to make it suitable for helicopter launching is being studied by the US Army.

For details of the successor to Redeye that has been referred to as **Redeye II** see entry number **2805.131 (Stinger)**

MANUFACTURER:

General Dynamics Corporation, Pomona Division, Pomona, California are prime contractors. The rocket motor is made by Atlantic Research Corporation.

A gunner being instructed in the use of the Redeye weapon (US Army photograph)



Redeye missile coasting after being boosted from its launcher. The main rocket motor does not ignite until the missile is about six metres from the launcher

2805.131
STINGER PORTABLE ANTI-AIRCRAFT MISSILE – XFIM-92A

DESCRIPTION:

Previously known as Redeye II, Stinger will be Redeye's successor and has been under development for about four years as part of the US Army's Manportable Air Defense System (MANPADS).

In announcing the new name, the Army said that Stinger would incorporate a high-performance propulsion system, improved infra-red devices and an advanced guidance technique which will give the weapon a greater range and velocity.

As so far developed, Stinger is a slightly larger weapon than Redeye: its overall length of some 152 cm is about 20% greater than that of Redeye and it weighs about 6% more – about 13.4 kg.

Stinger also uses passive infra-red homing; but its sensor works at a considerably shorter wavelength (4.1-4.4 microns) than Redeye and can thus home on the relatively high intensity exhaust plume of an aircraft engine.

In parallel with the original development programme which is still continuing the US Army Missile Command's Stinger Project Office is implementing a programme known as **Stingthrift** aimed at reducing the manufacturing cost of the weapon without sacrificing Army performance requirements. The USAMC office is working closely with General Dynamics on this exercise.

STATUS:

Development. In 1973 laboratory and range tests of elements of the system were carried out. In January 1974 the first guided test was successfully carried out: the test vehicle, fired from a fixed platform scored a direct hit on a target drone.

Reference should also be made to the competing project known as Alternate Stinger **(2841.131)**.

MANUFACTURER:

System contractor: General Dynamics Corporation, Pomona Division, Pomona, California.

Stinger AA missile system

THE UNION OF SOVIET SOCIALIST REPUBLICS

2941.131

SA-7 (GRAIL) MAN-PORTABLE ANTI-AIRCRAFT MISSILE

DESCRIPTION:

During the later stages of the war in Vietnam it was found that North Vietnamese forces were using a shoulder-launched man-portable anti-aircraft missile system similar in general principle to the American Redeye missile **(2784.131)** or the British Blowpipe **(2375.131)**.

These missiles were found to be of Russian design and manufacture and it was said that the missile's Russian name was Strela ("arrow") but this has not since been confirmed. The missile is now known as SA-7 in the US alphanumeric code, however, and its NATO code-name is believed to be Grail.

During 1973 it was reported that BRDM-2 vehicles **(5036.102)** had been seen equipped with multiple SA-7 launchers: vehicle-mounted multiple launchers were also encountered during the 1973 Arab Israeli war.

Information on the weapon system is still in short supply but it appears that the missile is about 125 cm long, about 7 cm in diameter, has a range of about 3,500 metres, can engage targets at heights between 50 and 1,500 metres, has a passive infra-red homing guidance system and carries a high-explosive warhead. Sighting seems to be simpler than it is on its Western equivalents.

STATUS:

Operational. It is not known when the weapon was first introduced but, in addition to its use in Vietnam and Egypt it is known also to have been used by rebel forces in Angola – in its shoulder-fired role.

SA-7 anti-aircraft missile system

SHIPBORNE SURFACE TO AIR WEAPONS

CANADA

2036.231
CANADIAN SEA SPARROW MISSILE SYSTEM

DESCRIPTION:

This shipborne missile system which is intended for use in both surface-to-surface and surface-to-air engagements, has been developed for the Canadian Government by Raytheon Canada working in close collaboration with N.V. Hollandse Signaalapparaten in the Netherlands, the latter having been responsible for the fire control system.

The system comprises four sub-systems – the Sparrow III missile, a Guided Missile Launching System (GMLS) a Gun/Missile Fire Control System (GMFCS) and a Control and Interface Group. There are two standard installations – a single installation forward giving an arc of fire that lies mainly in the forward direction (about 190 degrees) and a dual port/starboard installation that gives all-round coverage. In the dual installation the GMLS and GMFCS are duplicated and cross-linked to provide maximum operational flexibility.

Basic weapon of the system, the AIM-7E2 version of the Sparrow III missile (**1106.331**), is in operational use in other systems in various countries. In the GMLS it is carried on a four-missile support pylon (**2714.293**) on an extendible cantilever beam. The launcher head rotates automatically about horizontal and vertical axes under the control of the GMFCS. Missiles can be fired singly or in rapid succession, automatic pre-launch commands being supplied to the missile electrically. Semi-automatic power loading provides rapid recycling and launching of missiles from each launcher.

The Signaal M22/6 GMFCS (**1359.281**) provides simultaneous early warning, air target tracking and surface target tracking and can control both the missiles and the ship's guns in simultaneous operation against air and surface targets. Electronically of compact solid-state design, it comprises a fire-control radar, an emergency back-up optical sight and a combined display, control and computer unit. Both optical sight and radar aerial systems are fully stabilised.

The radar (**1590.253**), which can track air and surface targets simultaneously, features monopulse air tracking track-while-scan facilities, MTI search, pulse-doppler tracking, extensive ECCM facilities and a missile guidance capability, a digital computer for system control tracking and weapon prediction. Search radar data are presented on a PPI, air tracking data on an A-scope and surface tracking and splash spotting data on a B-scope.

In the Control and Interface Unit, radar and other input data is processed to determine target status and future position; and information thus generated is passed to the ship's tactical data system, to the GMFCS as target designations and to the GMLS and missiles as pre-launch and steering commands. The sub-system also provides for missile status checking and for control of the missile pre-flight warm-up.

Three operators are required to man a single installation and only four for a dual installation. All-up weight of a dual installation, including missiles, is about 37,000 kg.

STATUS:

The four DDH 280, "Iroquois" Class destroyers of the Canadian Armed Forces have been fitted and following initial trials in 1973, the four ships are carrying out full firing sea trials during 1974. The two replenishment ships, *Preserver* and *Protector*, have simpler Canadian Sea Sparrow installations which employ a single launcher.

MANUFACTURERS:

System generally – Raytheon Canada Ltd, Waterloo, Ontario, Canada.

Fire Control System – N.V. Hollandse Signaalapparaten, Hengelo (O.), Netherlands.

FRANCE

2114.231
CATULLE SURFACE-TO-AIR WEAPON SYSTEM

DESCRIPTION:

Catulle is the name given to a naval version of the Javelot land-mobile weapon system (**2110.131**) and is a controlled-dispersion multiple rocket system which fires salvoes of 40 mm projectiles with proximity fuses from a 96-tube launcher.

Intended for defence against low-flying aircraft or cruise missiles, Catulle would complement existing shipborne weapon systems and would help to fill the gaps that exist between rapid-fire anti-aircraft guns and surface-to-air guided missiles. The concept is indeed not unlike that of the American Vulcan/Phalanx system (**2543.231**) but the method of realisation is different.

STATUS:

System study on behalf of the French Navy. Apparent lack of activity over a considerable period suggests that this project may have been overtaken by events and allowed to lapse.

MANUFACTURERS:

Thomson-CSF, 1 rue des Mathurins, 92222-Bagneux.

2122.231
HIRONDELLE SURFACE-TO-AIR WEAPON SYSTEMS

DESCRIPTION:

Based on the Matra Super 530 air-to-air missile (**1349.331**), the Hirondelle surface-to-air missile system is intended especially for naval use and particularly on small fighting ships such as the fast patrol boat *La Combattante II*.

Mounted on such a vessel, a multi-missile launcher (typically 4-chambered) would provide a measure of short-range protection against very low-altitude attacks by aircraft or cruise missiles. The Super 530 missile has an X-band semi-active radar homing head which would be used in conjunction with a tracking radar on the ship. The proposed missile launcher is trainable and would be remotely-controlled.

See also entry (**1353.231**) in the Naval Fire Control and Action Data Automation section.

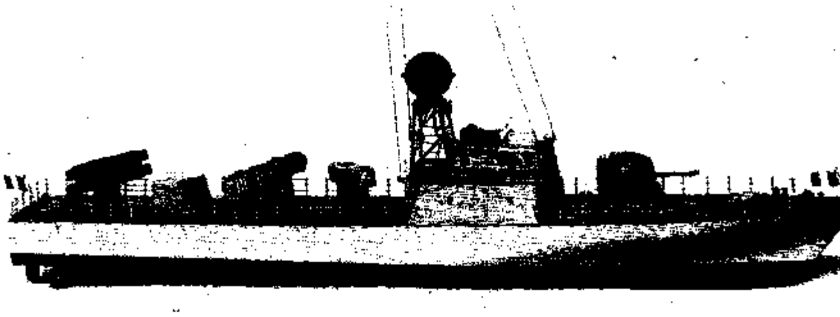
STATUS:

Project. The missile is due to become operational in 1977. No details of Hirondelle installations have been obtained.

MANUFACTURER:

System: Electronique Marcel Dassault, 55 Quai Carnot, 92-St Cloud, France.

Missile: Engins Matra, Avenue Louis-Breguet, 78 Velizy Villacoublay, France.



Model showing Hirondelle system (aft) fitted to a Combattante II*-class fast patrol boat*

1177.231
MASURCA SURFACE-TO-AIR MISSILE SYSTEM

DESCRIPTION:

Masurca is the name given to a surface-to-air missile system which forms the main anti-aircraft armament of the French frigates *Duquesne* and *Suffren*, whose principal role is that of escort to the aircraft carriers *Foch* and *Clemenceau*. Masurca also has armed the AA Cruiser *Colbert* since 1973 when her modernization was completed. Each of the Masurca ships is equipped with an elaborate and comprehensive three-dimensional surveillance radar, two independent Fire Control Systems and a twin launcher. Supersonic targets can be intercepted at ranges of 40 km or more.

The main characteristics of the missile are length (with booster) 8.6 m, (without booster) 5.29 m, diameter 41 cm, span of booster fins 150 cm, weight (with booster) 1,850 kg, (without booster) 840 kg. A proximity-fused high-explosive warhead is carried, and both boosters and sustainer motors are solid-fuel units.

Two types of guidance system are employed: the Mk 2 Mod 2 uses radio command, and the Mk 2 Mod 3 is equipped with a semi-active radar homing head. Externally the two versions are virtually identical, and the ship installation is designed to handle mixed salvoes of the two types simultaneously.

In addition to the missiles themselves, the Masurca weapon system contains the following main elements.

(1) A missile twin launcher
(2) Two storage and handling equipments
(3) Two remote-control directors, each linked with a tracking radar for radio command missiles and a target illuminator radar for the homing version
(4) Two test equipments for checking missiles

The DRBR 51 tracking radar has three main functions:

(1) Whichever type of missile is used, it continuously follows the target.
(2) In the case of the homing version (Mk 2 Mod 3), it controls the painting of the target illuminator radar.
(3) In the case of the radio command version (Mk 2 Mod 2), it measures missile displacement from the line of sight to the target.

OPERATION:

Radio Command Missile: A two-axis director is slaved to the DRBR 51 scanners and a TV camera, and is used for the initial alignment of the latter in the direction of the target, following target designation by the DRBI 23. The DRBR 51 has three aerials, the main one of which is used for tracking the target and measuring angular displacement of the missile relative to the line of sight to the target. (This unit is also used for target illumination when firing the homing Mk 2 Mod 3 Masurca). The second aerial is a wide-angled, broad-beam unit which is used for gathering the missile after launch, and the third is also a broad-beam system which illuminates radio command missiles during their gathering phase and is used for the transmission of command signals.

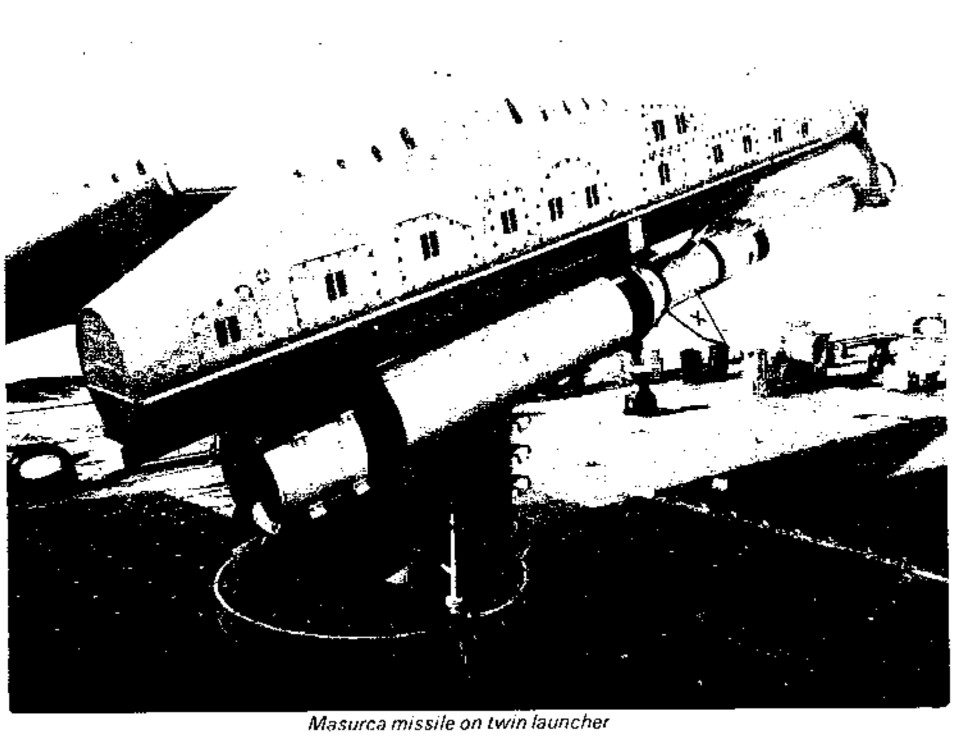
Command signals for the missiles are transmitted in the 7 cm waveband, and can provide guidance signals for two missiles simultaneously. There are two 5 cm radar tracking channels, 'Blue' and 'Yellow', one for each missile, and each radio command missile is equipped with a 5 cm transponder to increase long-range performance.

Semi-active Radar Homing Missile: Target pointing of the director and launcher ramp is similar to that for the launching of radio command missiles. The DRBR 51 main aerial operates as an X-band target illuminator radar. The missile is equipped with two aerial systems, one at the front of the vehicle, and twin horns at the rear. The latter are used to receive the illuminating radar signals direct, to provide a reference signal which can be compared with the signals reflected from the target that are collected by the forward missile aerial. This enables a doppler component to be extracted, which is used in the on-board computation of a proportional navigation interception course to the target.

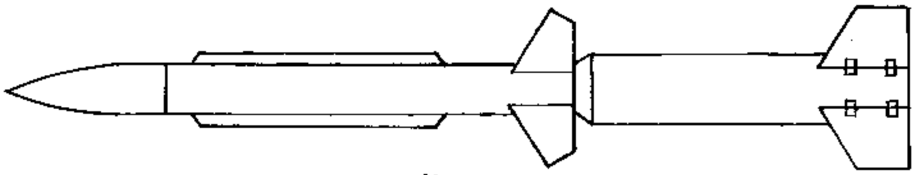
DEVELOPMENT:

Development of the Musurca missile has been the responsibility of the French Naval Arsenal "Etablissement des Constructions et Armes Navales de Ruelle". The Engins Matra firm has been cooperating with the "ecan de ruelle" in completing the development and meeting the required production programme of the homing version.

Fire control radars, missile homing head and proximity fuse, have been developed by Thomson-CSF and fire control system computer by IBM France. The launching, storage and handling equipments have been designed and developed by the "Etablissement des Constructions et Armes Navales de Ruelle".



Masurca missile on twin launcher



Masurca

The guided missile frigate Suffren *with Masurca missiles* (ECP-Armées)

STATUS:

Both versions of Masurca are fully operational.

MANUFACTURERS:

Direction Techniques des Constructions Navales, 2, rue Royale, Paris 1, France.

2111.231
NAVAL CROTALE SURFACE-TO-AIR WEAPON SYSTEM

DESCRIPTION:

Formerly known as Murène in the Murène/Mureca system, Naval Crotale is a proposal for a relatively straightforward adaptation of the land-mobile Crotale weapon system (**2074.131**) for naval use.

Full details of the most recent proposals have not been made available, but it appears that the intention is to mount the weapon system firing unit (launcher turret and monopulse tracking radar) in much the same way as it is mounted on its vehicle in the land-based version but with certain mechanical differences appropriate to a shipborne structure. The complete structure, however, would be roll-stabilised.

Surveillance and target designation functions would be performed by the ship's radars instead of by a separate track-while-scan radar as in the land-mobile system. The only other likely difference of any consequence between the two systems is the probable provision of a reloading facility.

STATUS:

Not definitely known. It seems that there is a definite requirement for a system of this type; but a strong competitor for a French contract in this area must be the naval version of Roland II (**2217.231**) and any contract is quite likely to be awarded on the strength of the results of a competitive evaluation of the two systems in their land-mobile form. Based solely on published promotional material, it appears that Marine Roland II is the preferred candidate.

MANUFACTURERS:

System: Thomson-CSF, Division Systèmes Electronique, 1, rue des Mathurins, 92222-Bagneux, France.

Missile: Engins Matra, Départment Missiles, Avenue Louis-Breguet, 78-Velizy, Villacoublay, France.

INTERNATIONAL

2217.231
MARINE ROLLAND II SHIPBORNE SURFACE-TO-AIR WEAPON SYSTEM

DESCRIPTION:

The shipborne Roland II M is a proposal based on a 'packaged' version of the all-weather variant of the tank-mounted land-mobile Roland weapon system (2218.131). Since its introduction in the early 1970s, it has undergone a series of changes of configuration, evidenced by the variations in drawings and models made public at successive exhibitions. The latest of these configurations is shown in the accompanying photographs of a cut-away model of a self-contained Roland II M system for shipboard installation. This arrangement suggests a completely autonomous system within a single unit comprising, launcher/radar assembly, magazine and reload system, and operators fire control console. All but radar and launcher are below deck.

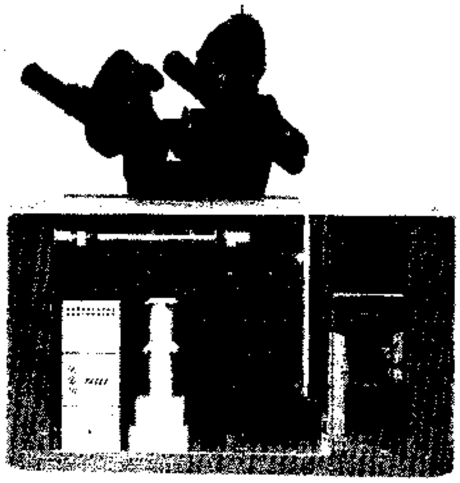
STATUS:

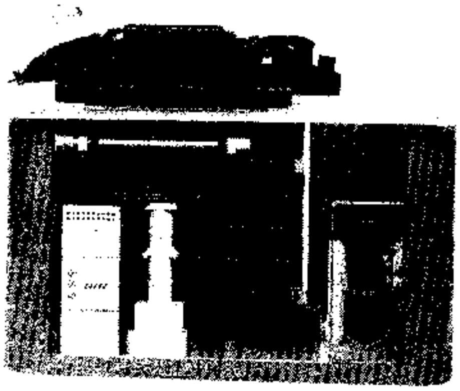
The French Government is known to be interested in the Roland II M project but no details of programme status have been obtained.

MANUFACTURERS:

Aérospatiale, 92-Chatillon, France.

Messerschmitt-Bölkow-Blohm, Munich, Germany.





Model of Roland II M shipborne version of Roland anti-aircraft missile system, showing folding radar and magazine with fire control console on right of unit

ITALY

2228.231
ALBATROS SURFACE-TO-AIR MISSILE SYSTEM

DESCRIPTION:

Albatros is an all-weather missile and gun shipborne weapon system designed for short-range air defence against aircraft and anti-ship missiles, including those flying at very low altitudes or having high angles of dive. The system can be installed in any type of vessel down to small escort units of some hundred tons displacement.

The complete weapon system includes the following major sub-systems:

—a missile and gun fire control system—a missile launching system and up to three groups of guns among which there may be two different ballistics.

—the Sparrow III (RIM-7H) or Aspide missiles.

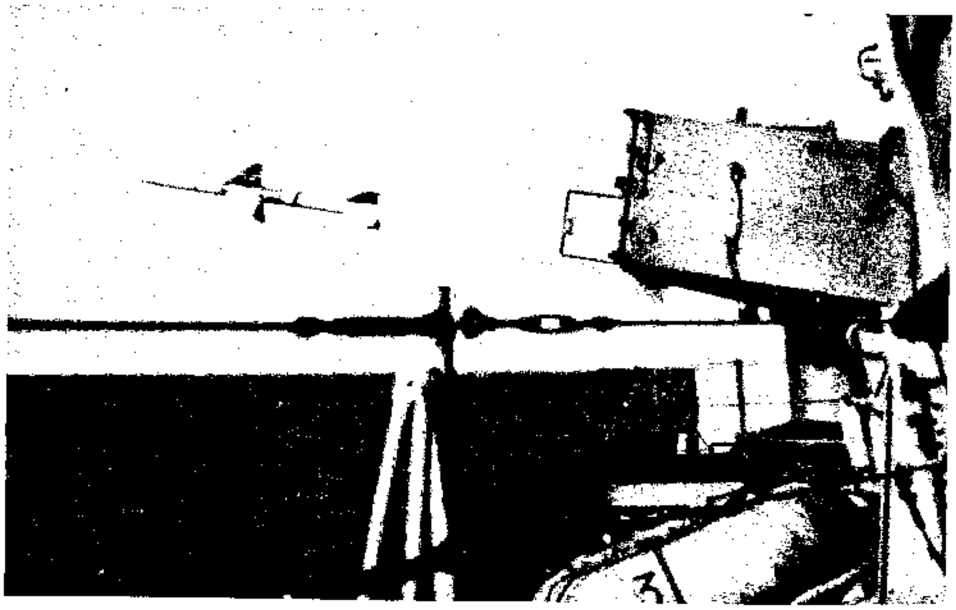
DESCRIPTION:

Details of this inter-relationship between these sub-systems and of the operation of the complete system can be found under entry number **1551.281** in the Naval Fire Control and Action Data Automation section.

STATUS:

Trials were carried out by the Italian Navy during 1973 off the Sardinia missile test range from the proving ship *Aviere* on which a prototype system was installed. The trials included launches against remote controlled air targets simulating anti-ship missiles; against surface targets; measurements of the system's ability to detect and counter air attacks under severe conditions; and checks of ECCM facilities.

A contract for the provision of about ten Albatros systems for installation on a number of major and medium-class ships of the Italian Navy was negotiated in 1973 with installations following in 1974.



Sparrow III missile launched from Albatros launcher in September 1972

MANUFACTURER:

Main contractor for the system: Selenia Industrie Elettroniche Associate SpA, via Tiburtina Km 12,4 Rome, Italy.

7022.231
SEA INDIGO SHIPBORNE ANTI-AIRCRAFT WEAPON SYSTEM

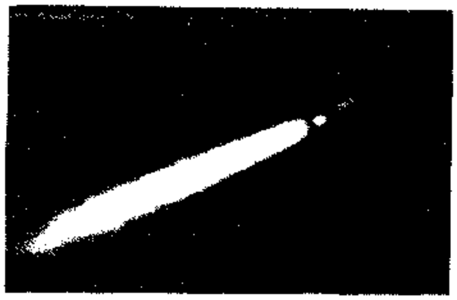
DESCRIPTION:

Sea Indigo is a shipborne version of the Indigo (**2235.131**) land-based surface-to-air tactical guided missile. The missile and its operational characteristics are substantially the same as those given in the entry for Indigo; the principal difference being the substitution of the Sea Hunter fire control system - also used for the surface-to-surface Sea Killer Mk 1 (**2240.221**) and Mk 2 (**2253.221**) missiles for the modified Super-Fledermaus fire control system.

For installations on naval craft of less than 500 tons displacement it is intended that manual reloading of the missile launcher shall be used. For installations on larger vessels automatic reloading is proposed; and one such installation, for both Sea Indigo and Sea Killer Mk 2 (Vulcano) missiles, is described elsewhere in this section (Combined Sea Indigo/Sea Killer Mk 2 Weapon System **2371.231**).

CHARACTERISTICS:

Type: Shipborne surface-to-air tactical guided missile

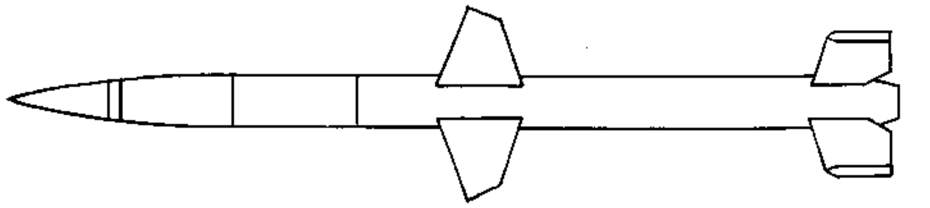


Sea Indigo missile in flight

Guidance Principle: Beam-riding with stand-by radio command guidance and infra-red tracking
Guidance Method: By control of movable cruciform control surfaces at centre of missile. Stabilisation by cruciform tail fins
Propulsion: Solid-propellant rocket motor. 3,800 kg st for 2.5 sec.
Warhead: High-explosive (21 kg) fragmentation type with infra-red proximity fuse
Missile Length: 3.32 metres
Missile Diameter: Body 19.5 cm. Span 86 cm
Launch Weight: Approx 121 kg
Speed: Approx Mach 2.5 at burn-out
Range: Approx 10 km slant range
Ceiling: Approx 6,000 metres

OPERATION:

The missile is armed with both direct action and proximity fuses, so that both direct hits and near misses are effective. It is launched from a quadruple missile launcher, and a simple arrangement is provided for reloading of missiles on board ship.



Sea Indigo

The primary method of guidance is beam riding combined with command signals from the Sea Hunter fire control system. A secondary method of guidance is provided for use in conditions of radar jamming or interference, using an infra-red camera on the aerial mounting. All necessary equipment is engineered in combination with the Sea Hunter system, the missile checkout and fire guidance controls being centralised in the missile control console.

DEVELOPMENT:

Development was initiated by Contraves Italiana SpA in 1963 following hard on the heels of the development of the land-based Indigo missile. The first prototype was completed in 1964.

Sistel SpA took over the project from Contraves in 1969.

MANUFACTURERS:

Sistel SpA Via Tiburtina 1210, 00136 Rome. Other manufacturers as for Indigo.

THE UNITED KINGDOM

1019.231
SEACAT SHIPBORNE SURFACE-TO-AIR MISSILE

DESCRIPTION:

Seacat is a close range, shipborne, guided missile system for anti-aircraft defence which may also be used against surface targets within visual range. The system has been designed to provide a simple and low-cost anti-aircraft capability, and represents a very cost-effective system. The guidance system is based on the use of optical tracking and a radio command link, but the system is capable of various degrees of sophistication and this has in fact been undertaken in a number of instances. Generally, such improvements take the form of integrating Seacat with ships' fire control systems. An advantage of this is that disablement of the fire control radars, or other part of that system, still leaves the option of the optically guided mode.

OPERATION:

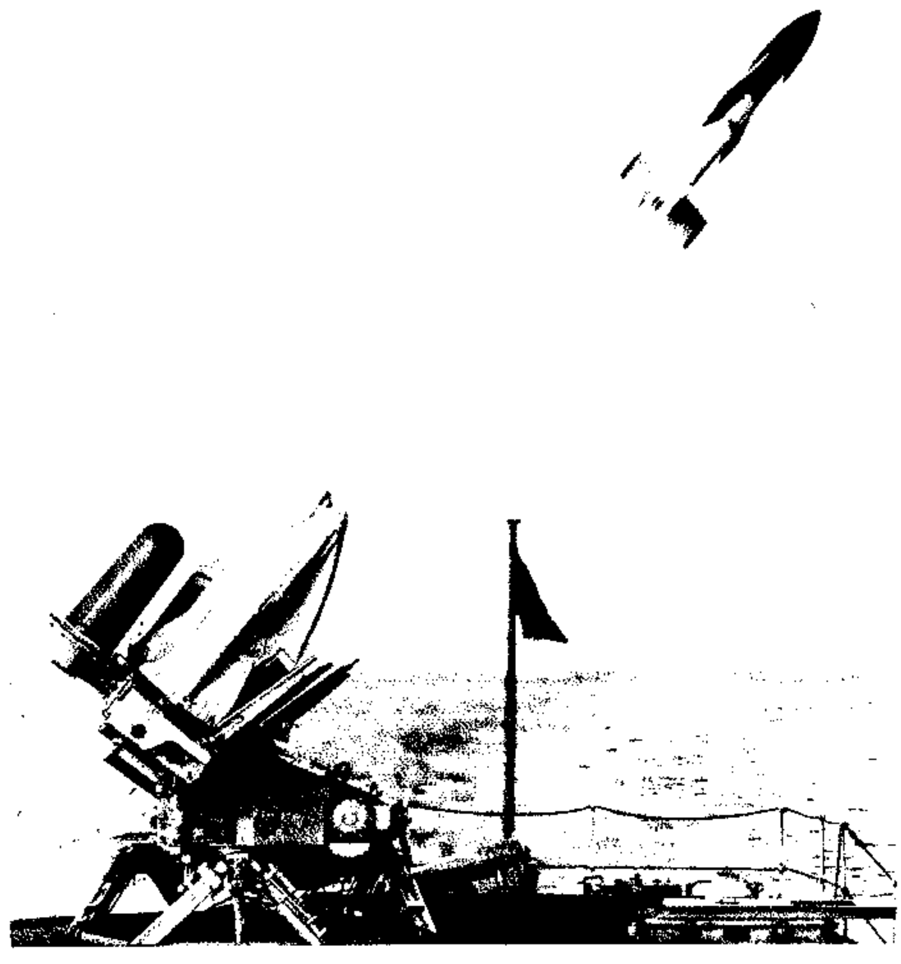
The basic form of the system, introduced into the Royal Navy as Guided Weapons System Mk 20 (GWS 20), consists of separate launcher and operator mounts, the latter carrying sighting binoculars with which the aimer first 'gathers' the missile after launch and subsequently tracks it to the target. A thumb joy-stick control is provided for missile guidance. Movements of the joystick are converted into command signals which are transmitted to the missile from a unit on the launcher mounting to maintain the missile on the line of sight to the target.

Seacat has since been deployed with the RN GWS 22 (**1242.281** and **1563.253**) fire control system in which a lock and follow tracking radar is linked to the aimer's binocular sight. Subsequent operation is the same as for the GWS 20 system. It has also been combined with Contraves Sea Hunter, San Giorgio NA9, and Signaal M 40 series fire control systems. A later development is a system that replaces the optical sighting binocular with a CCTV (Closed Circuit Television) system produced by Marconi-Elliott Avionic Systems as the 323 Series (**1021.293**). This enables the aimer to be placed in a much less vulnerable position and also results in important improvements in efficiency. The missile gathering phase has been reduced from about 7 seconds (conventional optical technique) to 6 seconds or less with the aid of CCTV.

Seacat, under the Swedish designation RbO7, is used with the Hollandse/Signaalapparaten M4-1 fire control system.

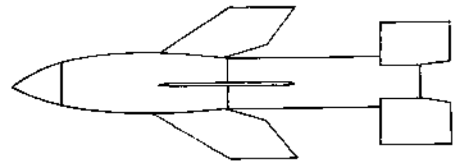
A lightweight version of Seacat has been developed for installation in such vessels as 30-metre fast patrol boats and inshore mine-sweepers, giving them guided-weapon defence against low-flying aircraft. It is in service with the Imperial Iranian Navy, and has attracted interest from other navies, some of which already have the standard Seacat system.

It employs a new three-round launcher (based on the Short Tigercat launcher) which weighs only 2,007 kg with all its ancillaries instead of the 4,700 kg of the standard four-round Mk 20

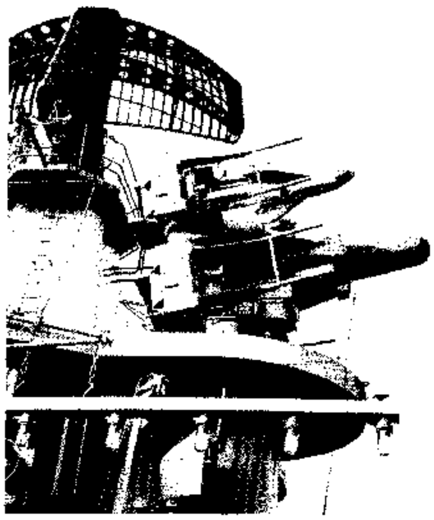


Seacat launch from the three-round launcher of the lightweight system

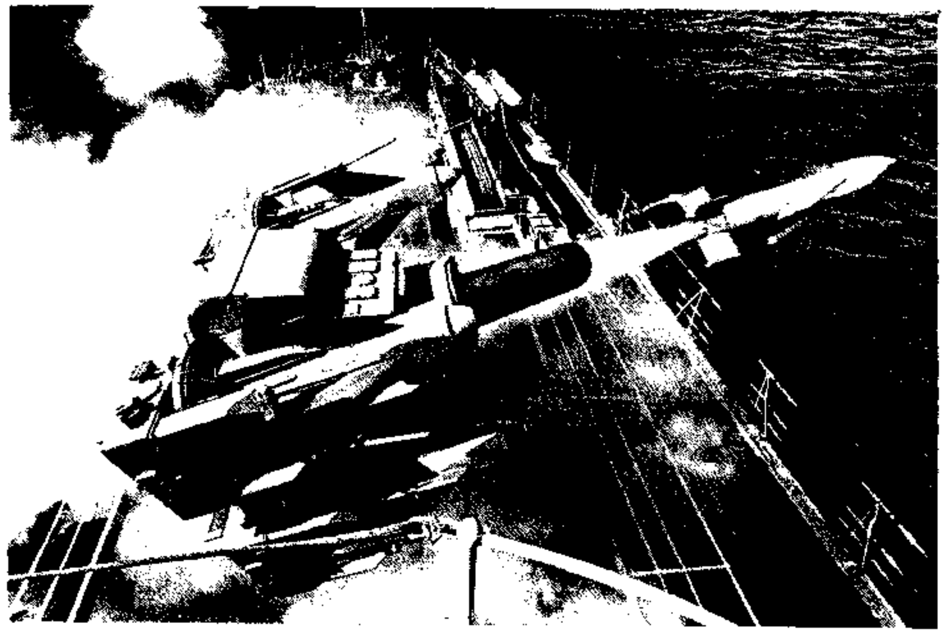
Close-up of the Seacat visual director



Seacat



Standard 4-round Seacat launcher on a Royal Netherlands Navy Ship



Seacat launch from the standard four-round launcher

launcher. Binoculars mounted on the head of a single manually operated pedestal director form a combined director and missile aiming sight.

MAIN CHARACTERISTICS:

Maximum effective range approx 4,750 metres. Warhead – high explosive. Solid fuel motor. Length 1.48 m, max span 65 cm, estimated weight 63 kg.

DEVELOPMENT:

Development work started in the late 1950s and the first sea trials took place on HMS *Decoy* in 1962. The basic system has proved itself adaptable to other roles and a land-based version has been developed as the Tigercat (**2465.131**).

STATUS:

In addition to the RN, Seacat has been ordered by 14 other navies: Argentina, Australia, Brazil, Chile, West Germany, India, Iran, Malaysia, Netherlands, New Zealand, Sweden, Libya, Thailand, and Venezuela.

MANUFACTURERS:

Short Brothers & Harland Ltd, Castle-reagh, Belfast BT6 9HN, Northern Ireland.

6004.231
SEA DART SURFACE-TO-AIR MISSILE

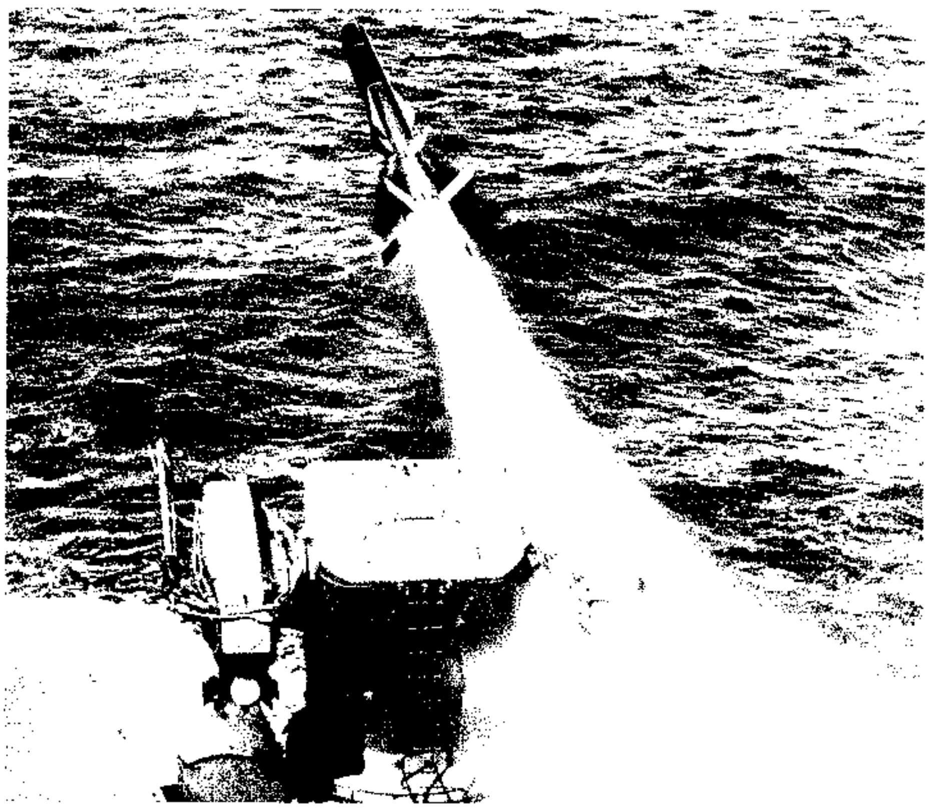
DESCRIPTION:

Sea Dart is a third-generation area defence weapon system, capable of intercepting aircraft, at both very high and extremely low altitudes, and air and surface launched missiles. It is also effective against surface vessels. Launch rate is rapid and the weapon system is capable of dealing simultaneously with many targets. Despite all this the system can be installed in a variety of fighting ships from small frigates upwards – including some vessels that would be too small to accept, for example, Seaslug (**6003.231**).

The missile is launched from a twin launcher. Performance data are classified and only the linear dimensions have been released for publication: other data in the accompanying table are taken from published unofficial estimates.

The missile is virtually a thick walled cylinder built around the Rolls-Royce (1971) Ltd. Odin ramjet engine. The guidance equipment (Marconi Space and Defence Systems), the proximity fuse (EMI), the control system (Sperry Gyroscope division of Sperry Rand Ltd.) and the fuel tanks and engine controls are all wrapped around the cylinder.

The guidance system is one of a semi-active 'homing all the way' nature. It uses a proportional navigation law which can be changed during flight. The ramjet engine enables the missile to fly at controlled speeds throughout its flight envelope. The guidance system will detect very small changes in target movement. This capability combined with very fast control responses enables very small miss distances to be achieved.



Sea Dart leaving twin launcher during trials

CHARACTERISTICS:

Designation: CF299

Type: Shipborne area defence, surface-to-air, surface-to-surface and anti-missile guided weapon system

Guidance Principle: Radar guidance and semi-active homing using Tracker Illuminator Radar type 909

Guidance Method: By control of movable tail surfaces

Propulsion: Solid-propellant booster and ramjet sustainer

Warhead: Presumably high-explosive

Length: 4.36 m

Body Diameter: 42 cm

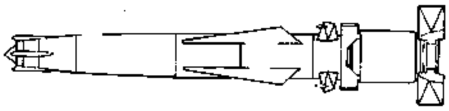
Span: 91 cm

Launch Weight: 550 kg

Range: At least 30 km

OPERATION:

Fully automatic magazine handling and loading arrangements. Mssiles are stowed vertically in magazine and are hoisted through an intermediate-stage to the electrically driven twin launcher. Targets are designated to the system in



Sea Dart

three co-ordinates by radar. The system automatically tracks the target and points the launcher. Radar illuminates the target to provide the missile with the RF signal for self guidance onto the target. The Type 909 target tracking and illuminating radar (**1559.253**) produced by Marconi Radar Systems has been developed from the equipment used with certain Bloodhound and Thunderbird missile systems. The missile is boosted to speed by a solid fuel tandem boost and speed is sustained by an Odin ram jet burning a liquid fuel.

DEVELOPMENT.

Development started August 1962. Test firings began in 1965 and the first production order was announced in November 1967.

STATUS

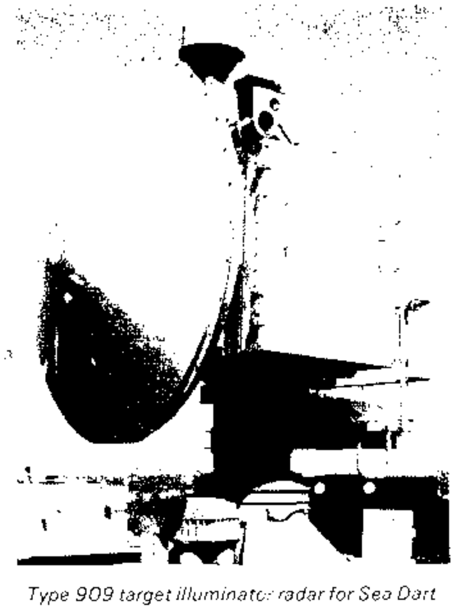
Development is complete and the first system is at sea in HMS Bristol. HMS Sheffield, the first of six Type 42 destroyers ordered by the Royal Navy, will be in operation in 1974. Sea Dart will also be installed in the two Type 42 destroyers ordered by the Armada Republica Argentina, and will provide area defence for HMS Invincible, the first through deck cruiser at present being built for the Royal Navy.

MANUFACTURERS:

System contractor is Hawker Siddeley Dynamics Ltd., Manor Road, Hatfield, Herts, AL10 9LL, England. Other contractors associated with the system include:

Marconi Space and Defence Systems Ltd. – Guidance: Rolls Royce (1971) Ltd. – Odin Ramjet: Sperry Gyroscope division of Sperry Rand Ltd. – Missile Control. EMI – Fuse: Vickers Engineering Ltd. – Launcher Magazine and Handling Equipment. Marconi Radar Systems, Ltd. – Type 909 Tracker Illuminator Radar: Ferranti Ltd. – Computer and Data Handling: Plessey Radar Ltd. – Operations Room Equipment.

Sea Dart launch



Type 909 target illuminator radar for Sea Dart

6003.231
SEASLUG SURFACE-TO-AIR MISSILE

DESCRIPTION.

Seaslug is a long-range beam-riding shipborne surface-to-air guided missile system.

Targets are detected at long range by radar (3-D or surveillance plus heightfinder) and their coordinates are supplied to the missile system control which commands the launcher. A twin ramp launcher is used and is reloaded from a between-decks magazine.

There are two versions of the missile, the Mark 2 having a rather longer range and better performance against low-flying aircraft. Both missiles have a surface-to-surface capability, but again that of the Mark 2 is better than that of the Mark 1.

CHARACTERISTICS.

Type: Shipborne surface-to-air tactical guided missile
Surface-to-surface capability

Guidance Principle: Beam-riding using type 901 M shipborne radar with coded transmissions

Guidance Method: By control of tail surfaces

Propulsion: Solid-propellant sustainer with four wrap-around solid-propellant boosters

Warhead: High-explosive with proximity fuse

Missile Length: 6 metres

Missile Diameter: 41 cm

Range: Probably better than 45 km. Targets engaged at heights above 15,000 metres in trials

OPERATION

Fully automatic magazine handling and loading arrangements. Electrically driven twin launcher. Targets are designated to the system in three coordinates by radar. The system automatically tracks the target and points the launcher. When the target comes within range the missile is fired and intercepts the target using beam-riding guidance techniques. Typical radars are the RN Type 965 (**1560.253**) for primary long-range surveillance, Type 277 for height finding and the Type 901 which is the Seaslug tracking and illuminating radar. HE warhead with DA and proximity fuses. Four wrap round boosters.

DEVELOPMENT:

Development started in the early nineteen fifties. Prototype trials carried out in HMS *Girdleness* during late fifties. First fitted in County Class Destroyers in 1961.

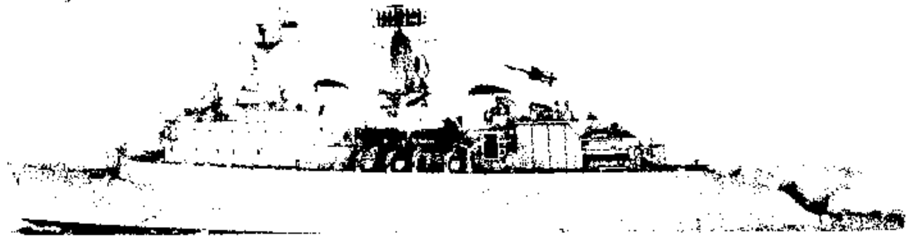
STATUS.

Mark 1 system fitted in HM Ships *Hampshire, Devonshire, Kent* and *London*. Mark 2 system fitted in HM Ships *Glamorgan, Fife, Norfolk* and *Antrim*.

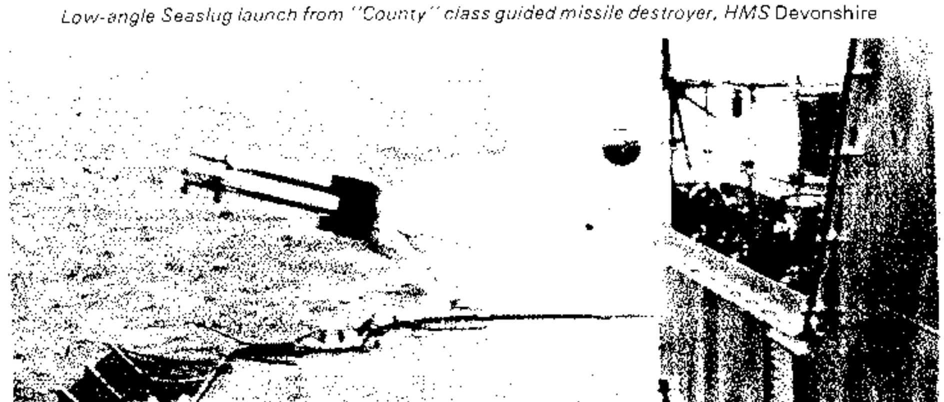
MANUFACTURERS

Hawker Siddeley Dynamics Ltd, Manor Road, Hatfield, Herts, AL10 9LL, England. Sub contractors include:

Sperry Gyroscope – flight controls. Marconi Space and Defence Systems – missile guidance, Vickers Engineering – magazine handling gear and launcher.



Low-angle Seaslug launch from "County" class guided missile destroyer, HMS Devonshire



Seaslug surface-to-air missile launch

2442.231
SEAWOLF SURFACE-TO-AIR MISSILE

DESCRIPTION:

Seawolf is the missile used in the Royal Navy's short-range self-defence missile system, GWS25. The system is designed to provide rapid reaction defence against both aircraft and anti-ship missiles. It is capable of installation in new and existing small escort vessels down to about 2,000 tons, full load, as well as in larger vessels. Lightweight derivatives of the GWS25 system, and known as Seawolf/Omega and Seawolf/Delta, have been studied for fitting in much smaller vessels of corvette size or possibly as little as 300 tons. Seawolf/Omega is a visually directed variant and Seawolf/Delta is a lightweight darkfire version.

The Seawolf missile employs line-of-sight guidance with radar differential tracking or television, both with radio command. Speed and manoeuvrability characteristics are suitable for the engagement of small Mach 2 missile and aircraft targets under severe weather conditions and sea states.

The complete GWS25 system comprises the following units:

—Air and low-air surveillance radars, Types 967 and 968
—Radar trackers, Type 910, and TV trackers
—Command transmitter
—Launcher and firing system
—Missile and handling frame
—Data handling
—Guidance Shaping Unit
—Operations Consoles
—Magazines

The Type 910 tracking radar is produced by Marconi and is described more fully in Section Three of this book (Entry No **1562.253**). The TV system is produced by Marconi-Elliott. The Type 967 and Type 968 surveillance radars provide both high and low cover, and also are produced by Marconi (Entry No **1561.253**). They are of modern design and incorporate features for air target detection up to high elevation angles as well as high performance against low-level and surface targets. Comprehensive precautions against sea and land clutter, as well as natural and man-made interference are incorporated.

The line-of-sight to a target is established by either the tracking radar or the TV system. Error signals proportional to Seawolf missile deviations from this datum are derived from the differential tracking radar or the TV system, and these signals are processed by a guidance shaping unit. Coded correction signals for missile guidance are produced and transmitted by microwave command link to bring the missile to the required flight path. In the GWS25 system the data processing required to interpret the tracking data and calculate the correction demand signals is based on the use of a Ferranti FM1600B computer (**1433.063**), which has been adopted as a standard.

A new multiple launcher developed by Vickers bears the designation Mark 25 Mod 0 and consists of six rectangular launch-tubes disposed in two banks of three, one on each side of an az/el mounting. Reloading is manual, presumably to avoid the complexity and particularly weight of an automatic system which might undesirably limit the number of ships which can carry the full Seawolf system. The launcher is separate from the tracking radar. High slewing rate and pointing accuracy are important features of the Seawolf launching which equipped for fully automatic firing sequence, with command override.

The Seawolf missile is about two metres in length and has four fixed wings (which may fold) and four moving tail fins. A solid booster motor is stated to give minimal launch drop and speed is quoted as being in excess of Mach 2. Successful techniques employed in Rapier (**2424.131**) have been incorporated, and no on-board test or repair facilities for missiles are called for. The HE warhead is provided with both proximity and contact fusing.

Operational Function:

Seawolf is being developed in such a way as to make it easy to fit the system into new and existing escort vessels. It is understood that it is planned to equip many Royal Navy ships with Seawolf in the mid-1970s.

For the successful interception of an incoming anti-ship missile great accuracy and an extremely short reaction time are required of the system. To achieve this it is being arranged that, once a target has been identified as hostile, all subsequent phases of the launch and guidance operation will be carried out automatically and without further manual control.

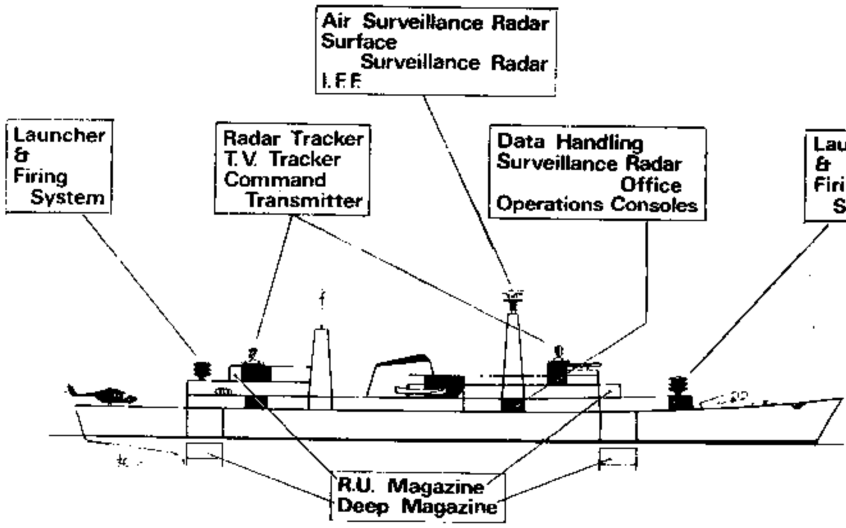
Other relevant features include the ability to fire salvoes, immediate readiness capability maintained over long periods, and extremely fast data handling facilities in all parts of the system.

Automatic radar and guidance is the normal operating mode, with TV tracking by an aimer for low angle of sight and surface target engagement.

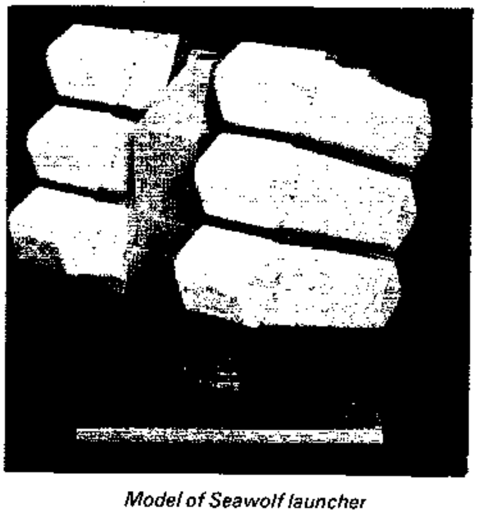
Development and Manufacture:

In June 1967, the British Aircraft Corporation's Guided Weapons Division received a contract to develop the PX430 missile – which was subsequently given the name Seawolf. Development of the complete electronics system has been entrusted to the Marconi Company, whose responsibilities therefore include surveillance radars, target tracking radar, television, data handling equipment – a major part of which has been subcontracted to Ferranti – display equipment and guidance communications equipment. Marconi Radar Systems are also responsible for coordination of the complete shipborne system; and their Control Engineering department has the contract for the remote power control system.

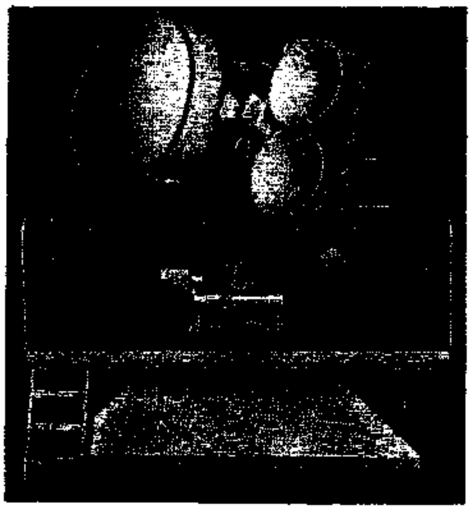
"Not to scale" model of Seawolf missile



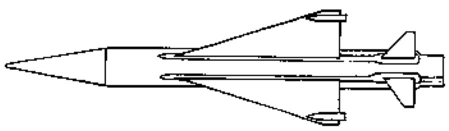
Suggested layout of Seawolf installation in a frigate



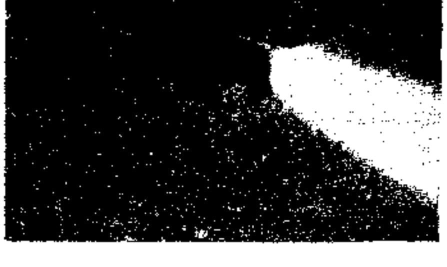
Model of Seawolf launcher



Model of Seawolf radar tracker and command guidance complex. Tracking data from this equipment could also be used for gun fire control purposes, or for other missiles



Seawolf (Provisional)



Seawolf in flight

STATUS:
Development of Seawolf is currently at an advanced stage and several test firings have been carried out. First ships to be fitted are currently planned to be the later Type 21 and the Type 22 frigates.
The development programme has recently been the subject of public criticisms, however, because cost and time estimates have been exceeded. It has indeed been suggested that the programme may be cancelled, but this is an unofficial view: the official reply to criticisms has been that having regard to the new ground being broken in the development, the cost-time overruns are not surprising.

MANUFACTURERS:
Missile: British Aircraft Corporation Guided Weapons Division.
Radar: Marconi Radar Systems Ltd.
Television: Marconi-Elliott Avionic System Ltd.
Computer: Ferranti Ltd.
Launcher: Vickers Engineering Ltd.

2446.231
SLAM CLOSE RANGE WEAPON SYSTEM

DESCRIPTION:
The initials SLAM stand for Submarine (or Surface) Launched Air Missile system. This system has been developed by Vickers to meet the need of submarines and light surface craft for an effective short range defence against other surface craft and helicopters.
For target engagement the system uses the Blowpipe (**2409.131**) missile for which a special multiple launcher is provided. This carries six missiles clustered around a central electronics enclosure which contains part of the missile control equipment, television camera and gyro sub-system for launcher stabilisation.
Control room equipment consists of an operator's display console, electronics cubicle which houses the power supplies and launcher control electronics, and a control unit for the CCTV system. An additional feature is a trainer/simulator which can be plugged into the display console to give the operator at sea training against simulated targets. Built-in test facilities are provided to enable routine servicing and rapid system checks to be carried out without the need for specialist personnel.

OPERATION:
In the submarine application one operator is required. Target acquisition is by means of the attack periscope, the launcher being automatically aligned with the target in azimuth when the launcher mast is raised. The operator then seeks the target's elevation and tracks it on his TV screen, controlling the launcher system by means of a thumb button controller which enables him to maintain the target in the screen centre. He then selects and fires the missile. When the missile is fired, the thumb button controller is disconnected from the launcher control circuits. The missile is automatically gathered on the line of sight and appears on the TV screen, at which point the operator controls its flight with the same thumb button controller. The launcher is able to continue tracking the target by means of a rate memory circuit which is built into the launcher control loop.
Missile range is at least 3,000 metres and may be greater against slow moving or stationary targets because less energy is required for manoeuvring. The warhead weighs 2.2 kg and is detonated by impact or proximity fuses.

DEVELOPMENT:
The system has been developed by Vickers initially to be suitable for use on the Oberon-class submarines but can be adapted for use in other types of submarine. SLAM can be fitted in new construction submarines or retrospectively.
Studies have been completed for fitting a surface version of SLAM to patrol boats, hovercraft and other coastal craft.

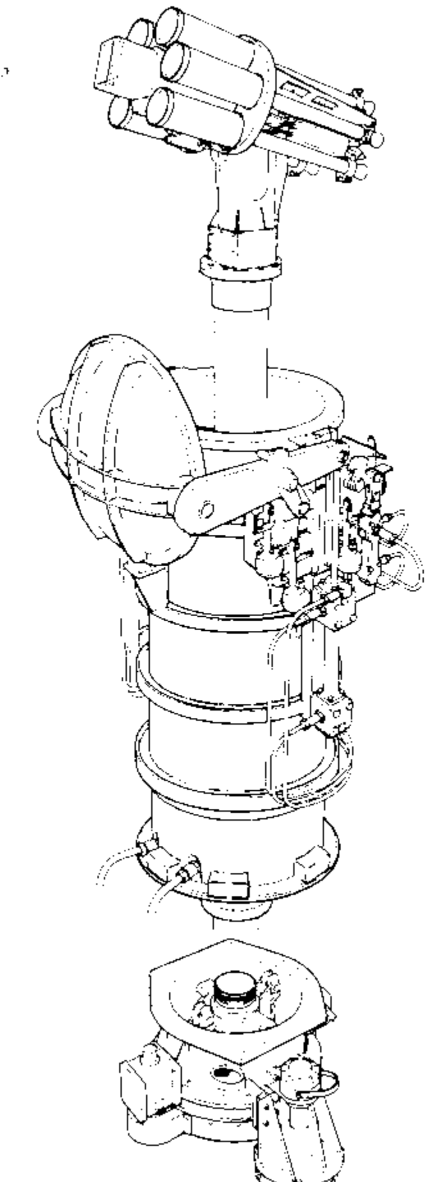
STATUS:
Sea trials on HM Submarine *Aeneas* were successfully concluded in November 1972 and established the accuracy and effectiveness of the system.

MANUFACTURERS:
SYSTEM

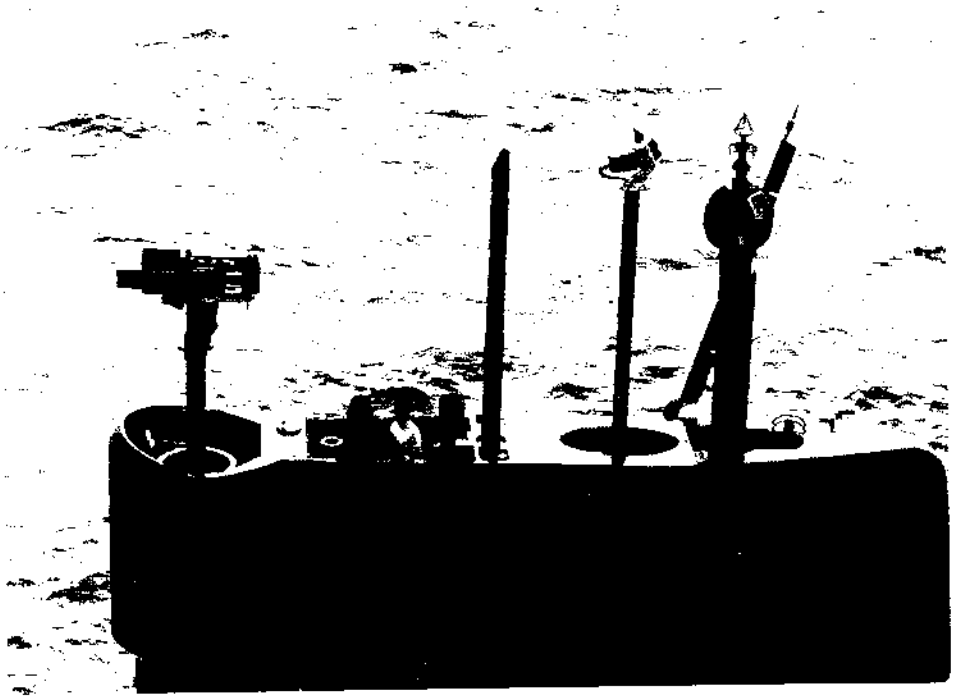
Vickers Ltd., Ship-building Group Barrow Shipbuilding Works, PO Box No 6 Barrow-in-Furness, Lancashire.

MISSILE

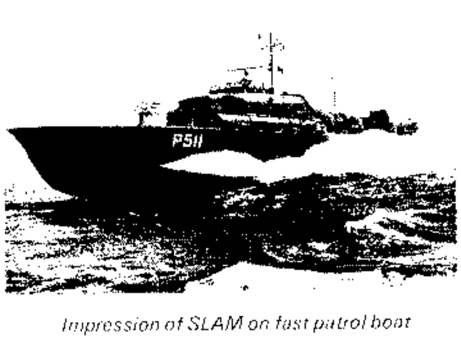
Short Brothers & Harland Ltd., Belfast



SLAM launcher, pressure vessel and training drive assembly



Bridge fin modified to take SLAM for sea trials only. The system will normally be installed within the existing fin structure



Impression of SLAM on fast patrol boat

1764.231
NAVAL BLOWPIPE MISSILE SYSTEM
DESCRIPTION:

Four different container fits for ship-board application of the successful Short Brothers & Harland Blowpipe anti-aircraft missile (**2409.131**) were announced at the Royal Navy Equipment Exhibition at Greenwich in September 1973. Originally developed as a man-portable defence system for the use of infantry against air and ground targets, subsequently adopted for the SLAM submarine defence system (**2446.231**) described above, the Blowpipe missile system has been developed by Shorts into a range of systems specifically for ship installation. Low weight and minimal launching effect permit its use on virtually any class of surface craft. The four versions range in both size and sophistication, but all are designed as compact container fits for direct deck mounting. The systems are:

(1) Manually Operated Twin-Launcher:

The simplest of the Blowpipe container fits, this system is independent of all ship's power supplies and is suitable for installation on the smallest vessels. It includes a manually-aimed twin-launcher and a 10-missile ready-use locker, all mounted on a rigid platform 1.68 × 2.87 m.

(2) Pedestal Director Sight System:

This system is based on the 10-missile Blowpipe launcher, controlled by a Seacat Pedestal Director Sight, and it incorporates an equipment compartment below the sight platform. It can be integrated with a variety of fire-control systems. The complete system is mounted on a 1.83 × 3.66 rigid platform. Space is available to mount a 10-missile stowage locker behind the equipment compartment.

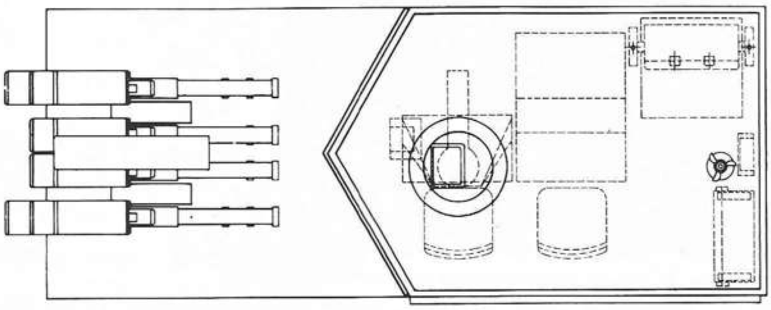
(3) Stabilised Periscope Director System:

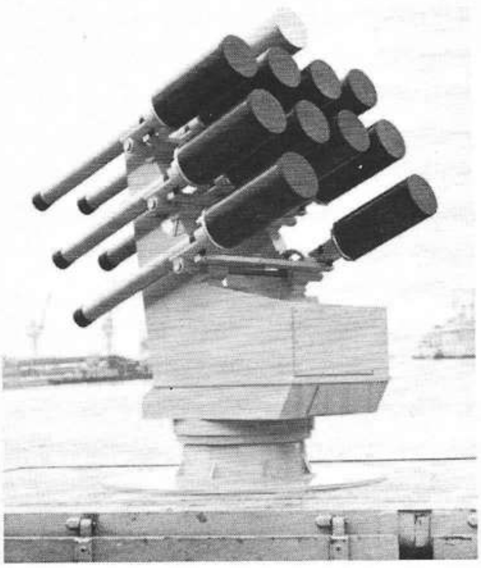
This Blowpipe container fit is based on the integration of the Kollmorgen Mark 35 gun director (**1666.261**) with the 10-missile Blowpipe launcher and CCTV aiming system. The complete container fit is mounted on a 1.83 × 4.5 m rigid platform. It is linked with ship's power supplies, communications and radar target information, and is operated by a crew of two.

(4) Automatic Target Tracking CCTV System:

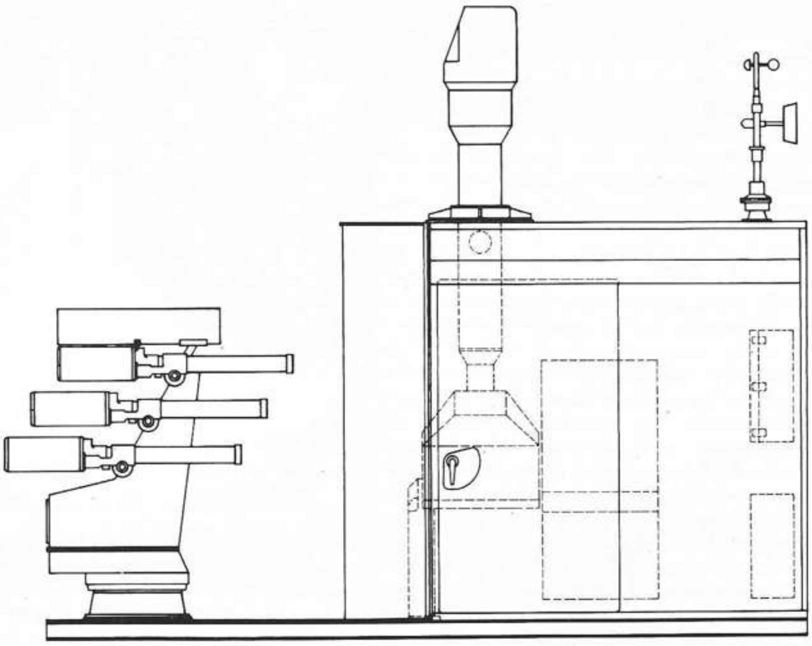
This TV auto-tracking system is the largest and most sophisticated of the Blowpipe container fits. It incorporates a modification of the Saab-Scania Aiming System, Type TVT 300/1 (Entry No **1231.383**) which has the ability to automatically track both surface and aircraft targets. It is a three-man operated system, the third man acts as

Smallest of the Blowpipe container fits, this twin-launcher/aimer installation can be bolted directly to the deck of any vessel





The 10-missile Blowpipe launcher used in the three larger container-fits



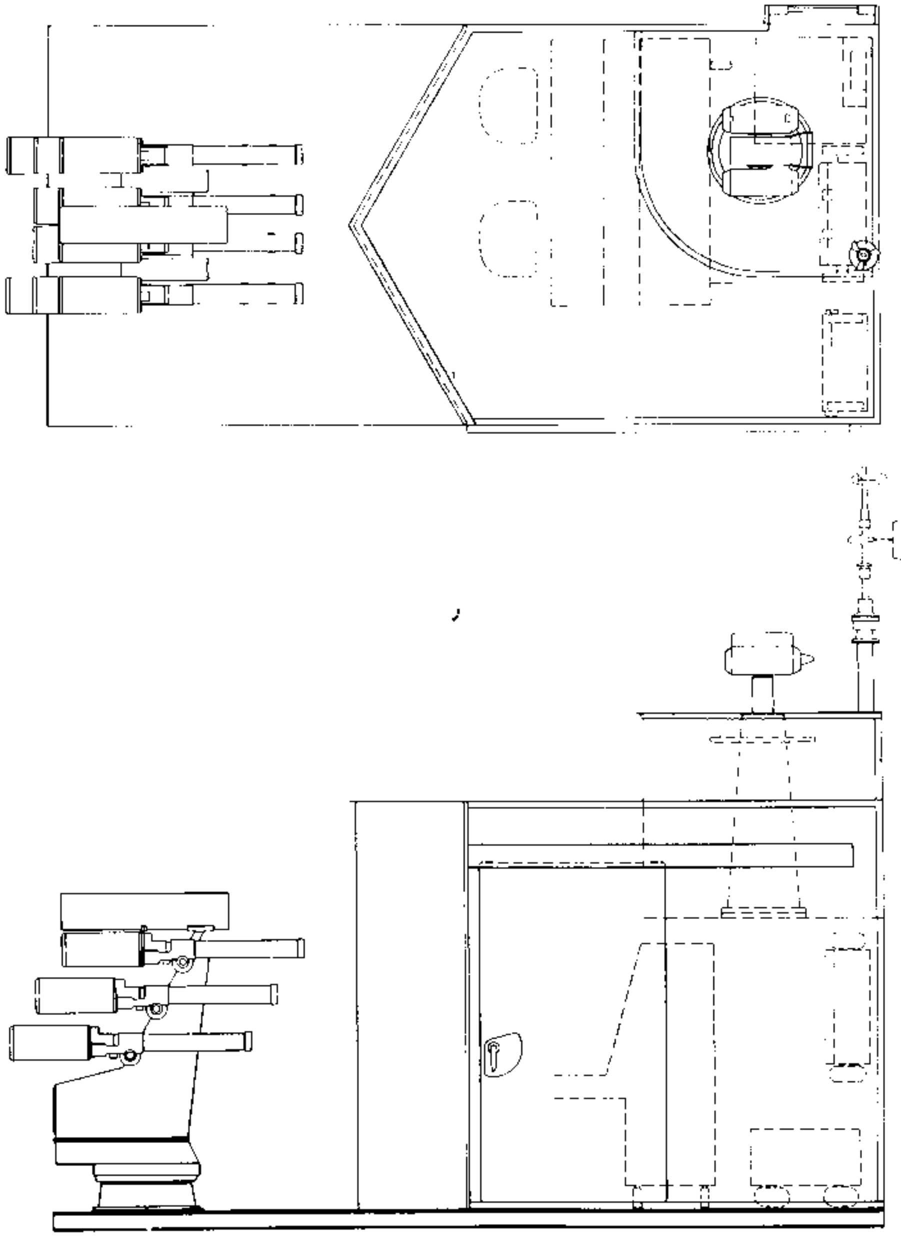
Layout of the Stabilised Periscope Director Blowpipe container-fit which uses the Kollmorgen Mk 35 director a look-out and can manually acquire the target in the TV sight. The sight can also automatically acquire the target from ship's radar target bearing indication. The complete system, with ten missile launcher, aiming system control console, launcher control unit and power supply unit, is mounted on a 2.44 × 5 m rigid platform.

STATUS:

No details of naval Blowpipe ship installation programmes had been notified at the time of closing for press.

MANUFACTURER:

Short Brothers & Harland Ltd., Missile Systems Division, Castlereagh, Belfast BT6 9HN, N. Ireland.



Layout of the TV tracking Blowpipe container fit, which uses the Saab Type TVT 300/1 aiming system

THE UNITED STATES OF AMERICA

2507.231
AEGIS SURFACE-TO-AIR WEAPON SYSTEM

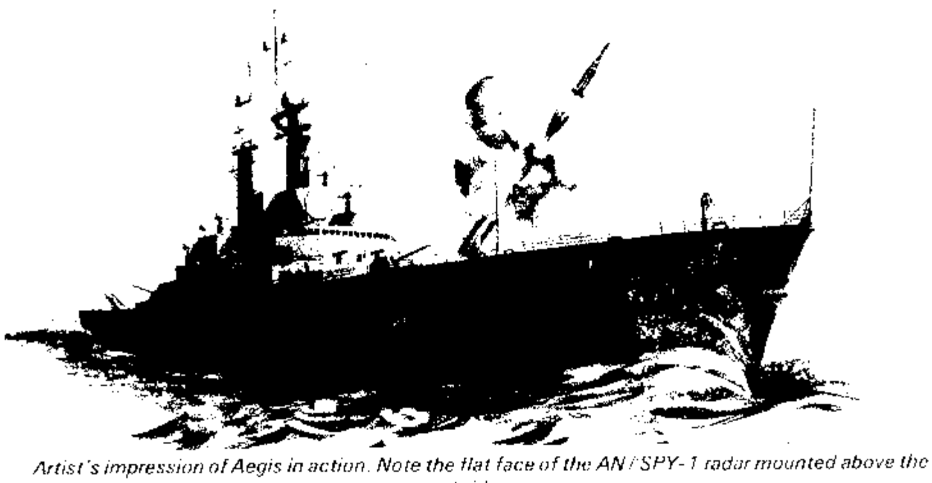
DESCRIPTION:

AEGIS, formerly designated the Advanced Surface Missile System (ASMS), is a surface-to-air weapons system primarily designed to defend against anti-ship cruise missiles. It is being developed as the US Navy's primary defensive missile system for the 1970s and 1980s. Present plans call for its installation aboard a new class of guided missile destroyers and frigates and possibly the "Nimitz"-class aircraft carriers, that will join the fleet beginning in Fiscal Year 1976. Aegis will be designed to destroy small, fast targets in hostile environments such as severe weather or countermeasure conditions. As an area defence system, Aegis will be capable of defending a task force which includes a carrier and several other types of ship. The system will complement and eventually replace the Tartar (**6006.231**) and Terrier (**6005.231**) missiles.

Major components of the Aegis system are the missile, its launching system, the fire control and weapon direction systems, the multi function array radar with its computer control, the system command and control and the operational readiness test system.

The missile to be used is the SM-2 modified Standard missile (**1122.231**). This is a semi-active radar homing weapon with provision for mid-course command guidance. It will be launched from the Mk 26 fully-automatic dual-purpose launcher which can also be used to launch Asroc (**6001.241**) anti-submarine missiles.

This launcher has a digital interface with the Mk 12 weapon direction system. One of the three computerised subsystems of Aegis, all of which use the AN/UYK-7 digital computer (**1467.063**), the Mk 12 system accepts weapon assignment commands and special threat criteria from the Mk 130 command and control system and tracking data from the multifunction radar. These inputs are processed to determine the possibility of



Artist's impression of Aegis in action. Note the flat face of the AN/SPY-1 radar mounted above the bridge engaging the target and then to generate commands for the Mk 26 launcher and pre-launch orders for the missile, commands for the Mk 99 fire control system for target illumination, commands to the multi-function radar, if mid-course guidance is required, and reports to the Mk 130 command and control system.

The function of the Mk 99 fire control system is to illuminate, and if necessary track, the target. To do this it uses either the Mk 90 (slaved) radar or the Mk 91 (tracking) radar. Inputs to the system come from the Mk 12 weapon direction system which, in the case of slaved radar operation is passing on data from the multifunction radar system.

The multifunction phased-array radar, the AN/SPY-1 (also known as the MFAR and described in entry **1570.253**) is a high-performance electronically-scanned equipment capable of surveillance and the simultaneous detection and tracking of multiple targets: it has been described as the heart of the Aegis system. Associated with it are four AN/UYK-7 computers and these equipments with ancillaries make up the Mk 110 radar control system. The primary function is, evidently, to search for and acquire targets and track them to whatever extent may be necessary. Beam scheduling for this and other tasks is organised by the computer. The system also handles the two-way link with the missile for mid-course guidance when requested by the Mk 12 weapon direction system. Certain special facilities can be provided such as a "burn-through" facility for use in ECM conditions or passive angle tracking. The system accepts general operational commands from the Mk 130 Aegis command and control system and mid-course guidance commands from the Mk 12 direction system; and its operational outputs are processed signals giving target detection data to the Mk 130 control system and target and missile track data to the Mk 12 director plus mid-course guidance commands to one or more missiles. Like all other operational subsystems in the Aegis system the radar control system is also connected to the Mk 545 operational readiness test system.

Together with the Mk 110 radar subsystem and the Mk 12 director, the Mk 130 command and control system make up the detection and decision loops of the Aegis system. The Mk 130 system is linked to the ship's command and control centre and targets enter the detection and decision loop from the AN/SPY-1 radar, from other ship's own sensors or from data supplied by other ships or aircraft. What happens next depends on which of the four Aegis operating modes has been selected. The modes are automatic special, automatic, semi-automatic and casualty; in the automatic special mode targets meeting certain predetermined threat criteria are automatically fired upon unless manual override is invoked; in all other modes positive human action to initiate firing is needed.

In these three modes the Mk 12 weapon direction system inserts targets into the engagement queue and schedules equipment for launching and terminal illumination. Trial intercepts are computed and a time to fire predicted. Resulting data are fed back to the Mk 130 command and control centre which is also receiving target detection data from the radar control system, operational readiness data from the Mk 545 operational readiness test system and electronic warfare and other data from the ship's command and control centre. Incorporated in the Mk 130 system is another AN/UYK-7 computer and a comprehensive display system; the AN/UYA-4. On the basis of all this data, threat evaluation and weapon assignment processes are carried out so that the engagement decision can be taken.

One of the eight AN/UYA-4 computer-controlled display consoles. This one provides missile fire control information to the Missile System Supervisor. The CRT shows a synthetic display with alpha-numeric labels and symbols. A smaller display above is used to present tabular information on a selective basis

Final major element of Aegis is the Mk 545 operational readiness test system (ORTS). This is linked to all the other major elements of the system and has the functions of continuously actively monitoring the state of readiness of each and of reporting the results of this process to the Mk 130 command and control centre.

Installation details so far available are meagre. There will probably be several kinds of Aegis installation, but it seems likely that the maximum installation – probably for the *Nimitz*-class aircraft carriers will have four AN/SPY-1 radar faces, about six tracking and illumination radars and two or three twin launchers.

DEVELOPMENT:

Initial planning for Aegis began in 1964, but further development was temporarily halted while a joint Army-Navy group was convened to study areas of possible commonality with the Army's SAM-D missile. Requests for Proposals were issued to defence contractors in June 1968, and the contract definition phase began on October 9 of the same year, when the Naval Ordnance Systems Command awarded contracts totalling \$18 million to the Boeing Company, General Dynamics Corporation, and Radio Corporation of America. RCA was awarded the engineering development contract for \$252,930,400 in December 1969.

STATUS:

At the end of April 1972 the US Navy and RCA jointly announced completion of the system design phase – including the critical design review and the initial testing of the AN/SPY-1 computer programs. Early in 1973, RCA announced satisfactory completion of the SPY-1 phased-array aerial tests, and prior to this successful tests of the SM-2 missile had been carried out including tests with mid-course guidance. In November 1973 the US Navy announced successful completion of land-based testing and the system was shipped and installed in USS *Norton Sound* for sea trials in mid-1974. On March 8, 1974, the AN/SPY-1 Phased Array Radar System simultaneously detected, automatically changed to tracking mode, and tracked more than 20 aircraft over the Pacific Ocean while operating in the US Navy test ship USS *Norton Sound*.

Installation is planned in a new DG-class ship of about 6,000 tons with a total ship cost of about \$125-million, and also in nuclear-powered DGN which has yet to be defined. Specific design and combat system integration efforts will be initiated in Fiscal Year 1975 to ensure a co-ordinated DG/DGN/Aegis development schedule. For these tasks the Fiscal Year 1975 Aegis funding allocation was \$67-million. In the same year \$32.2-million was allocated to the purchase of Standard SM-2 missiles for technical and operational evaluation.

MANUFACTURERS:

Prime Contractor: RCA Government and Commercial Systems, Moorestown, N.J. (Four major RCA divisions are engaged in the project.)

Parts of WDS Mk 12 and FCS Mk 99, Radar Type 90 and SPY-1 high-power transmitter: Raytheon Co.

AN/UYK-7 Computers: Univac Division of Sperry Rand.

Mk 26 Launcher: Northern Ordnance Division, FMC Corporation.

SM-2 Missile: General Dynamics Corporation, Pomona Division.

Computer Software: Computer Sciences Corporation.

Technical Advice to USN: The John Hopkins University, Applied Physics Laboratory.

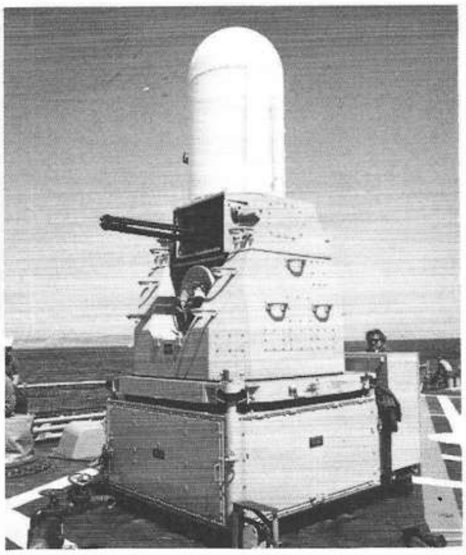
Also more than 600 other suppliers.

2543.231
CLOSE-IN WEAPON SYSTEM (VULCAN-PHALANX)

DESCRIPTION:

This system has been devised to provide a "last-ditch" defence against incoming missiles or high-speed low-level aircraft attacks. Based on the Vulcan (**2850.131**) low-level anti-aircraft system, the Close-in Weapon System (CIWS), or Vulcan/Phalanx as it is also known, depends for its chances of success on a fast automatic reaction to a threat and on the ability to put an intense barrage in the way of the incoming missile or aircraft.

An important feature of the CIWS is its fully automatic operation. The Vulcan gun will be associated with a search radar, a tracking radar and a fire-control computer (Phalanx), and the system will be so designed as to lock on an incoming target, evaluate the threat and, if the evaluation so



Close-up of Vulcan-Phalanx installation aboard USS King

indicates, *automatically* engage the target.

Characteristics of the Vulcan gun are described in entry number **2850.131** but it should be noted that the US Navy is proposing to use a new heavy bullet with great penetration capabilities.

Less well-defined is the possible associated missile element of the CIWS which is intended to complement the Vulcan gun in providing an inner zone defence against anti-ship missiles which have penetrated the longer-range defensive systems. In October 1973 it was announced that an improved version of the US Army's Chaparral air defence missile (**2542.131**) had been tested during the US Navy 'Hip Pocket-2' evaluation of ship defenses. The US Naval Weapons Centre system, called Chimp from Chaparral Improvement, uses the infra-red homing head of the AIM-9L Sidewinder on an existing standard Sidewinder. Another possibility is the so-called RAM, or 2.75-inch Dual-Mode Rolling Airframe Missile, a project which is linked with the US Army's Stinger development programme. The original infra-red seeker is retained but for the Navy project an RF head is added. This programme is being held at the advanced development stage until more practical information about the practical performance of missiles versus missiles has been obtained from operational tests which are planned for the coming year.

Trials installation of the Vulcan-Phalanx air defence weapon system on the helicopter deck of the USS King

In earlier Chaparral experiments the missile system was associated with a Ryan C-band coherent Doppler missile defence radar, capable of providing range bearing and velocity on target travelling at speeds between Mach 0.5 and Mach 2 with resolutions of 1 nm (1,850 m), 1 deg and 16 knots (30 km/h) respectively

A further development – and one which is common to the US Army Chaparral/Vulcan improvements – is the addition of a forward-looking infra-red (FLIR) system and a laser rangefinger to the weapon system to improve target acquisition in low-visibility or night conditions.

STATUS:

CIWS – being developed at high priority.

Sea Chaparral – experimental.

RAM – advanced development.

Fiscal Year 1975 funding for CIWS was $32.1-million, all for RDT&E.

MANUFACTURERS:

CIWS System contractor – General Dynamics/Pomona

—Vulcan Gun – General Electric

Sea Chaparral – Missile System – Philco-Ford/Aeronutronics

—C-band Radar – Ryan

—FLIR – Texas Instruments or Hughes Aircraft

RAM/Stinger – General Dynamics/Pomona

2770.231

POINT DEFENCE MISSILE SYSTEM (SEA SPARROW)

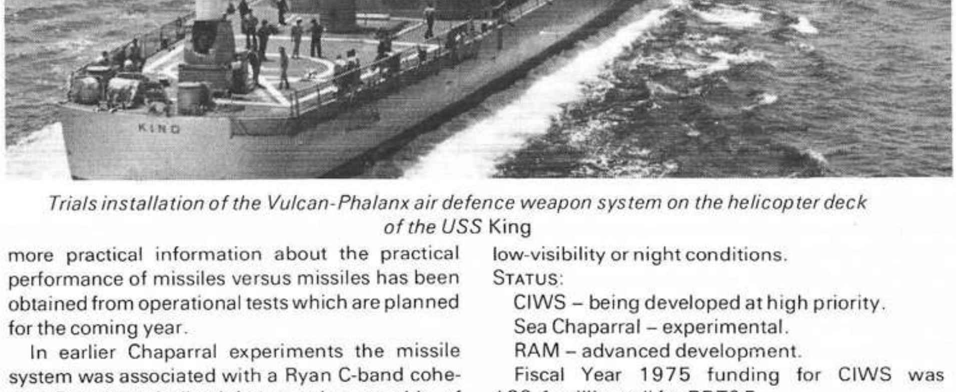
DESCRIPTION:

The Point Defence Missile System, also known as Sea Sparrow, is a close-in air defence system employing the AIM-7E Sparrow III missile (**1106.331**). The system, which is designed to counter the threat of enemy aircraft and anti-ship cruise missiles, consists of three parts; the Basic Point Defence Missile System, which became operational in 1969 and is now mounted on attack carriers, ocean escorts, an amphibious assault ship and the experimental ship USS Norton Sound; the Improved PDMS, currently in engineering development, and the Advanced PDMS, now in advanced development. The system is primarily designed for those ships which currently have no missile capability, including amphibious and auxiliary ships.

BASIC POINT DEFENCE MISSILE SYSTEM

The Basic Point Defence Missile System was assembled on an urgent basis from existing hardware. It features the Sparrow III missile launched from a modified eight-tube ASROC missile launcher. The launcher is housed on a modified 3-inch, 50 calibre automatic gun carriage. Total weight of the system is 17,690 kg.

A CW semi-active radar homing system is used. Target data from the Combat Information Centre are supplied to the manually-operated Mark 115 fire control system and the target is acquired and illuminated for homing guidance by a Mark 51 director/illuminator. This radar is trained and elevated manually by handlebar controls.



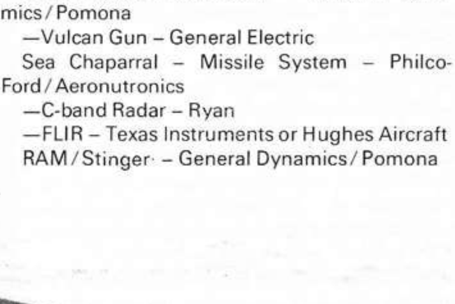
Basic Point Defence Missile System undergoing test on the USS Norton Sound

When target tracking begins, the launcher is fed train and elevation orders in synchronization with the director/illuminator. Pre-launch data and firing commands are relayed to the eight missiles housed in individual launcher cells. Weather doors open as each missile is launched and rear cell covers are either manually removed before launch or may be blown off by the rocket motor exhaust.

The missile is fired directly at the target but above the director-target line of sight. During flight the missile maintains a collision course with the target and at motor burnout is several hundred feet above the director-target line of sight and follows a downhill path against low-flying targets.

DEVELOPMENT:

BPDMS development began in 1964. In March 1972 an official US Navy statement revealed that



BPDMS missile (US NAVY PHOTOGRAPH)

80 BPDM System were "ready or in production" and that installation was scheduled for 30 ships in FY 1972. By May 1972 a total of 25 ships had been fitted and 16 of these installations had been made in FY 1972. Major contractors include Raytheon Corporation – Sparrow missile; General Electric – solid state power drive for fire control system, and Frequency Engineering Laboratories – fire control system.

IMPROVED POINT DEFENCE MISSILE SYSTEM

The Improved PDMS will incorporate a new lightweight eight-call launcher, a fire control system using digital computers, a Target Acquisition System (TAS) featuring a dual-mode sensor and a powered director/illuminator. The Sparrow missile family will still be used but in a modified form (RIM-7H). This version of the missile has folding fins which enable it to fit into a smaller launcher. The improved system will be produced as a co-operative effort by the US and five other NATO countries – Belgium, Denmark, Italy, Norway and the Netherlands. The participating countries will share development costs in relation to the number of subsystems each purchases. The US is expected to purchase approximately one-half of all systems produced.

The NATO Seasparrow programme, as the system is commonly called, was established by a Memorandum of Understanding in 1968 (the Netherlands joined the programme in May 1970). The contract definition phase began in 1968, and in September 1969 Raytheon Corporation was awarded a $23,109,600 engineering development contract calling for production of three engineering and development models. One system was to be tested by the US Navy, one sent to Norway for operational environment testing, and one to remain at Raytheon for systems evaluation.

The system is still in engineering development, but the US Navy requested $36 million to begin initial procurement in FY 1973. The first successful shipborne launch took place on March 31st 1972 when an IPDMS on the destroyer USS *Downes* acquired and tracked an incoming target and successfully fired its missile. Another prototype Sea Sparrow system was installed on board the Royal Norwegian Navy ship KNM *Bergen* in 1973. Pilot production of Sea Sparrow missiles for US and NATO was started by Raytheon in the latter half of 1973.

Sparrow missile launched from the development model hydrofoil Plainview *(AGEH-1). The launch was effected while the hydrofoil was foilborne*

Launch of Sparrow from the new type of launcher/canister which has been developed for this missile. The Sparrow is still resting on its foam launch pad, just before aerodynamic drag separates them. The launching cell from which the missile is fired is the same container as delivered to the ship, thus permitting a simplified and smaller construction than the conventional launcher cells seen on the left

ADVANCED POINT DEFENCE MISSILE SYSTEM

The third-generation Advanced PDMS will be developed by the US independently of the NATO effort on the Improved version. It will include a new missile of approximately the same dimensions as the Sparrow. This system is currently in the advanced development phase. Meanwhile Raytheon has completed the development of the AIM-7F Sparrow missile which has a longer-range radar seeker, a more powerful motor and more compact electronics.

DEVELOPMENT:

In November 1973 tests of a vertically launched version of Sparrow were carried out successfully at the US Naval Weapons Centre, China Lake, California. A modified AIM-7E2 missile, equipped with vanes of copper-impregnated tungsten which project into the rocket motor exhaust, was employed. The purpose of the vanes is to deflect the missile from its initial vertical path into a horizontal one directed towards the target. This pitch-over into the plane of the target is reported to occur within one second of motor ignition. The normal semi-active radar homing system is then responsible for guiding the missile to its target. For the China Lake tests the targets were Teledyne Ryan BQM-34A drones. This version of Sparrow is seen as a possible armament for large and small vessels for defence against anti-ship missiles.

VELARC

Experience gained with vertically-launched Sparrow experiments will be applied to another project known as Velarc (Vertical Ejection Launch Aero Reaction Control), which is a projected missile for use on hovercraft and hydrofoils at high speeds. The concept was initiated by Raytheon, and has subsequently gained USN support. The VELARC weapon will probably be of about half the volume of the AIM-7F air-to-air Sparrow III. In addition to its primary anti-ship missile intercept role, it will also have a surface-to-surface capability. A pre-charged pneumatic ejector is to be used to propel the missile from a below-deck launcher before the motor is ignited. Installations suitable for both large and small vessels are envisaged.

MANUFACTURERS:

Raytheon Company, Missile Systems Division, Bedford, Mass.

1122.231
STANDARD (RIM-66A & RIM-67A) SURFACE-TO-AIR MISSILE

DESCRIPTION:

The Standard ship-borne surface-to-air missile began life as a two-model range of anti-aircraft weapons, intended to gradually replace Terrier and Tartar with the US Fleet. The original two versions are the medium-range RIM-66A, and the extended-range RIM-67A. It was the first to be solid-state and is all electric with no pneumatic or hydraulically powered controls. Power for guidance and control is derived from a 'one-shot' battery which is activated just prior to missile launch. Use of a dry-storage battery is stated to ensure a reliable power supply even after the missile has been stored for long periods.

For both types, fully automatic magazine and loading facilities are provided for twin electrically driven launchers. The RIM-66A had a dual-thrust solid-propellant motor, and the RIM-67A used solid-propellant booster and sustainer rockets. Both versions are equipped with conventional high explosive warheads, with direct action or proximity fusing.

CHARACTERISTICS:

	(MR)	(ER)
Speed:	over Mach 2	over Mach 2.5
Ceiling:	over 20,000 m	over 20,000 m
Range:	greater than 18 km	greater than 55 km
Length:	4.57 metres	8.23 metres
Diameter:	30.5 cm	30.5 cm
Weight:	approx 590 kg	approx 1,060 kg

Subsequent developments have somewhat altered the original plan and versions of Standard have been or are in the process of development for surface-to-surface, air-to-surface and new surface-to-air applications. The following list is arranged in logical rather than chronological order.

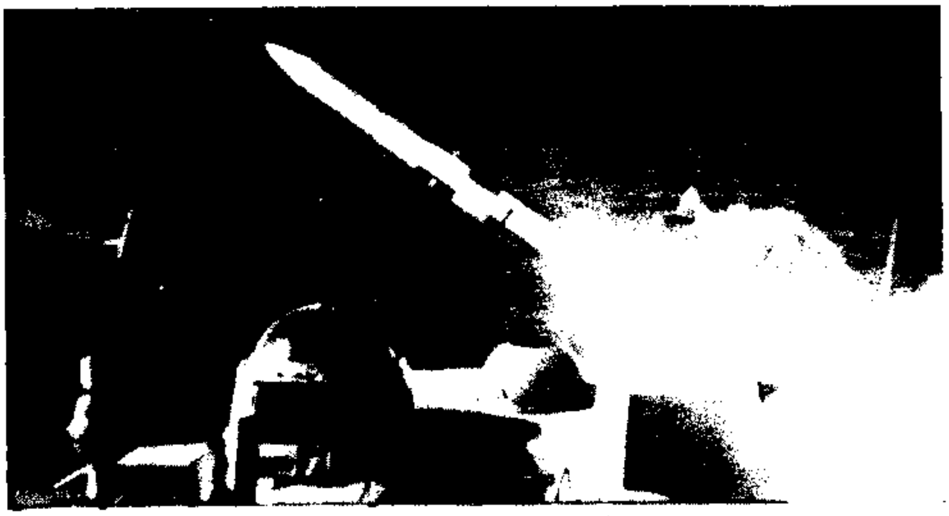
1. *Medium-Range and Extended Range*

All existing and most contemplated variants of the original missile can be made in either MR or ER versions. This possibility should therefore be borne in mind when examining the variants listed below.

2. *Standard 1 Missile (SM-1)*

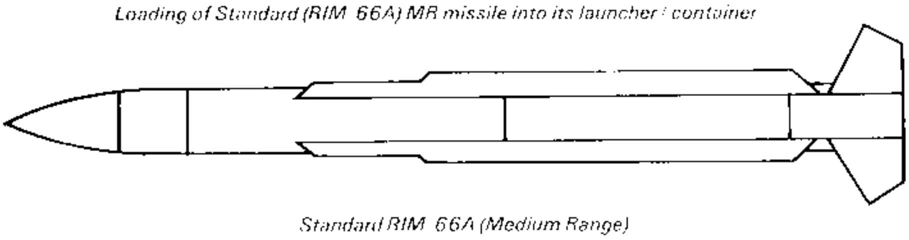
This is simply an improved version of the original missile and has superseded it. Its principal advantage over the earlier missile is that it has a (horizon-limited) surface-to-surface capability. It is expected to remain in production until 1975, is operational in over 70 missile ships and attack carriers and is one of the two missiles used in the Interim Surface-to-Surface Missile System (**2669.221**).

Procurement figures for the MR version in Fiscal Years 1973/4/5 are 340, 444, and 200, respectively at a total cost of $110.2 million. The comparable figures for the ER version are 100, 68 and nil, at a cost of $25.4 million.



Standard (RIM-66A) MR preparatory to loading

Loading of Standard (RIM 66A) MR missile into its launcher/container



Standard RIM 66A (Medium Range)

RIM-67A launch

3. *Standard 2 Missile (SM-2)*

At present this missile is still in development and is to be the missile used with the Aegis system (**2507.231**), at least when it is first deployed. In the MR version the SM-2 will have a range of over 48 km, while in ER form this will be doubled. Lengths of the two versions are 4.57 and 8.23 metres. An improved inertial reference will be provided, and to satisfy the requirements of the Aegis system the missile-born equipment has to be augmented by a two-way link for the mid-course command guidance. Fiscal Year 1975 funding for RDT&E amounted to $32.2 million.

4. *Standard ARM*

Essentially an airborne version (see entry number **1123.311**) this has also been adapted for use in a surface-to-surface role as part of the Interim Surface-to-Surface Missile System (**2669.221** and **2808.221**).

5. *Standard Active*

This is another development project which is aimed at producing operational missiles by 1975. The original intention was for this missile to serve as an interim anti-ship weapon until completion of Harpoon development, but delays with Active Standard have now made both missiles more or less contempories. The position at mid-1974 was that Active Standard would be maintained in development only until it was confirmed that it would no longer be required as a back-up to Harpoon. The missile will have an active homing head (radar seeker) and will be used as a surface-to-surface (presumably beyond-the-horizon) weapon.

OPERATION:

Details of the complex operational procedures of the Aegis system can be found under that system heading. The following description is appropriate to the use of the Standard missile as an anti-aircraft weapon with its own fire control system.

Targets are designated to the fire control system in three co-ordinates by surveillance radar. The tracker/illuminator radars, one per target and two per ship installation, automatically follow the targets and a digital computer provides data for the missile launcher pointing systems. Two missiles can be launched against separate targets within a period of a few seconds. The RIM-66A and the RIM-67A both use a semi-active radar homing guidance system.

DEVELOPMENT:

Development of the Standard missiles was started in December 1964 under a $13-million contract placed with General Dynamics. A further contract worth $23.8-million was awarded in July 1965 which covered continuted development work and production of an initial batch of 100 missiles. A full production contract, valued at over $120-million was placed in March 1967. Propulsion and warhead are the responsibility of the US Navy Ordnance System Command, and General Dynamics is providing guidance, control and fusing systems.

STATUS:

First ship fittings of the original missile types were made in 1968 and operational status was attained in 1969.

Progressive fleet fitting began in mid-1969 and by mid-1971 approximately 70 ships had been fitted, the installations being evenly divided between the MR and ER versions.

As noted above, the more recent Standard 1 version has now been extensively fitted and Standard 2 is in development. Several firing trials of the latter have now been carried out – including a mid-course guidance trial and a drone interception – all of which have been successful.

Standard 2 is expected to be in production in 1975 and to continue until 1977.

MANUFACTURERS:

General Dynamics Corporation, Pomona Division, 1675 West 5th Street, Pomona, California, USA.

1030.231
TALOS SURFACE-TO-AIR MISSILE

DESCRIPTION:

The Talos series of shipborne missiles is one of the most powerful in the US Navy inventory. Its main function is in the anti-aircraft role for fleet defence, but later versions are also capable of surface-to-surface operation. US military designations run from RIM-8A to RIM-8H.

The basic Talos missile is a beam-rider with a semi-active homing terminal phase. Propulsion is by solid booster and a ramjet sustainer motor. The latter burns a mixture of kerosene and naphtha, and total thrust is quoted as 20,000 lbs (9,070 kg).

CHARACTERISTICS:

Range: over 120 km
Ceiling: over 26,500 m
Speed: Mach 2.5
Length with booster: 9.53 m
Length less booster: 6.4 m
Body Diameter: 0.76 m
Span: 2.9 m
Firing weight with booster: 3,175 kg
Booster: Solid fuel
Sustainer: Liquid fuel ramjet

OPERATION:

Of the more recent variants in operational use the RIM-8F for high-altitude interception at long range employs beam riding mid-course guidance, with semi-active CW interferometer terminal guidance. A continuous rod warhead is carried. The RIM-8G is similar to the RIM-8E but with an improved homing system. The RIM-8H is provided with an anti-radiation homing head. This is probably the version intended for surface-to-surface missions.

Both HE and nuclear warheads are available with Talos missiles and in some ship installations there is provision for the remote selection of either type from the magazine for automatic loading onto the launcher.

STATUS:

The first US Navy vessel to be fitted with Talos was the guided missile light cruiser USS *Galveston*, from which the first firing at sea was made in February, 1959. At least six other USN cruisers have since been fitted.

Talos will probably eventually be replaced by the Aegis missile system (**2507.231**), but initially it will be the Tartar and Terrier missiles which will be replaced and Talos replacements will not start until Aegis has a longer-range missile than the SM-2: current plans call for Talos to remain operational until the early 1980s. The missile's standing in the US Navy was greatly enhanced when it was officially confirmed in the spring of 1970 that Talos missiles fired from the nuclear-powered cruiser USS *Long Beach* shot down two MiG jets over North Vietnam in May and September 1968. Both aircraft were flying at a distance in excess of 105 km from the cruiser when intercepted.

DEVELOPMENT:

Origins of Talos date back to the Bumble-bee programme of 1944, started by the Applied Physics Laboratory of Johns Hopkins University. Prime contractor for Talos is the Bendix Corporation's Missile Systems Division.

MANUFACTURERS:

Missile Systems Division, Bendix Corporation, Mishawaka, Indiana, USA.

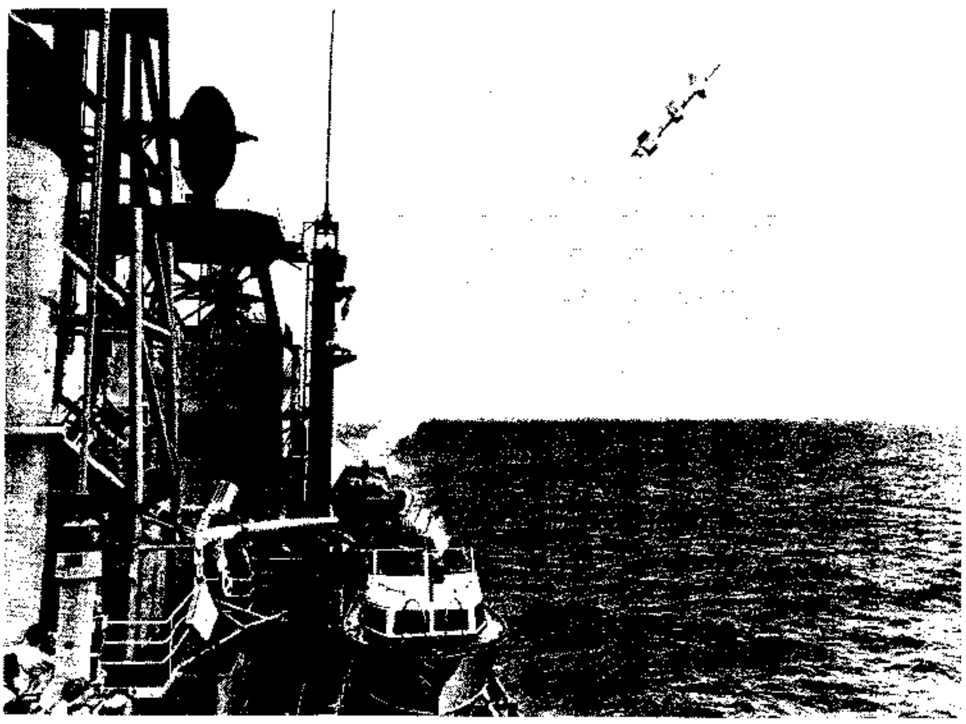
APL, Johns Hopkins University – Weapons system integration.

Vitro Corporation – system co-ordination.

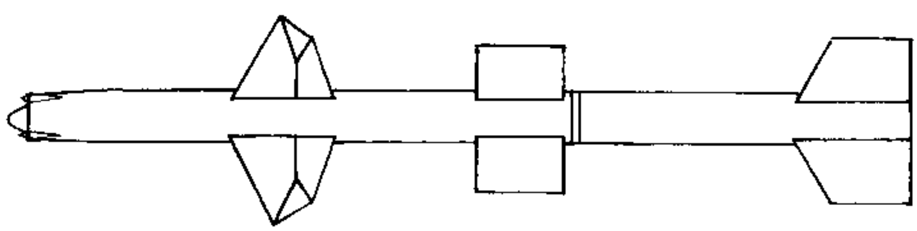
ASSOCIATED EQUIPMENT:

AN/SPG – 49 Target illuminating radar – Sperry

AN/SPG – 56 C-band tracking and guidance radar – Sperry



Talos long-range anti-aircraft missile launch from USS Oklahoma City, Flag Ship of the USN Seventh Fleet



Talos (RIM-8)

6006.231
TARTAR SURFACE-TO-AIR MISSILE (RIM-24)

DESCRIPTION:

Tartar is a medium-range, supersonic surface-to-air shipboard guided missile system. It provides primary air defence for US Navy destroyers and destroyer escorts and secondary air defence for cruisers. The missile booster and sustainer rockets are combined in a single solid-propellant motor, thus facilitating installation on smaller ships.

OPERATION:

Tartar employs a fully automatic magazine handling and loading system. Targets are designated to the system in two or three co-ordinates by radar. The tracker/illuminator radars automatically follows the targets and a computer provides missile launcher pointing orders. Guidance is semi-active homing probably operating in X-band. The missile carries a high explosive warhead with DA and proximity fuses.

The rocket motor has two levels of thrust to achieve rapid acceleration. The guidance system computes a collision course, then steers to intercept by means of four hydraulically actuated tail fins.

CHARACTERISTICS:

Range: More than 16 km
Speed: Mach 2
Length: 4.6 m
Diameter: 30 cm
Weight: 680 kg
Motor: Dual-thrust solid-propellant
Guidance: Semi-active homing

DEVELOPMENT:

Developed shortly after Terrier system and first entered USN service in 1961.

STATUS:

Tartar is no longer in production but is still operational in a large number of US Navy ships and French, Italian, Japanese and West German navies. Replacement by the Standard missile (**1122.231**) has begun. An order for Tartar missiles, worth $31.3 million, was placed as recently as September 1973 by the Japanese Navy.

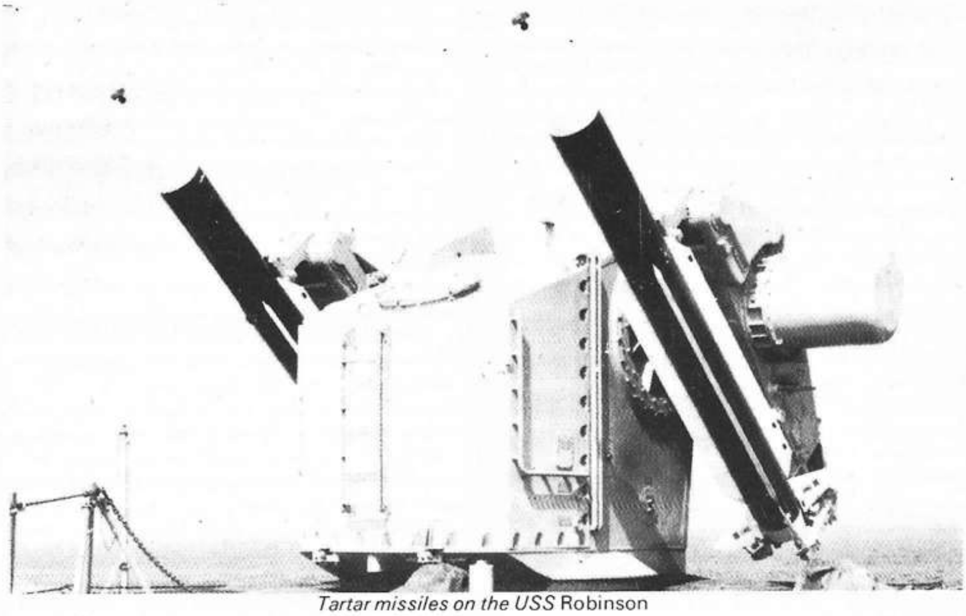
MANUFACTURERS:

General Dynamics, Pomona, for assembly and test. Vitro for systems co-ordination engineering. Target detection system Philco and Sperry Raytheon guidance.

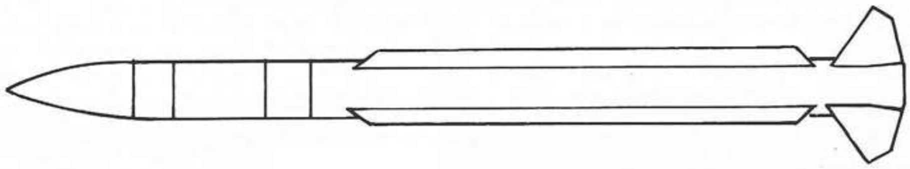
ASSOCIATED EQUIPMENT:

AN/SPG-51 (**1247.253**) Guidance radar – Raytheon

Gun and Guided Missile Director Mk 73 (**2632.281**).



Tartar missiles on the USS Robinson



Tartar (RIM-24)

6005.231
TERRIER SURFACE-TO-AIR MISSILE (RIM-2)

DESCRIPTION:

Surface-to-air anti-aircraft missile for shipboard use. The Terrier series of missiles has been operational since 1956 and since then it has been the subject of continued development and improvement. The US military designation is RIM-2 and successive models have been denoted by letter suffixes running from RIM-2A to the latest version, the RIM-2F. The latter is also known as the Advanced Terrier.

CHARACTERISTICS:

Range: 35 km (est)
Ceiling: over 20,000 m
Speed: Mach 2.5
Overall Length: 8 m
Length without booster: 4.6 m
Body Diameter: 30 cm
Weight: 1,400 kg (app)

OPERATION:

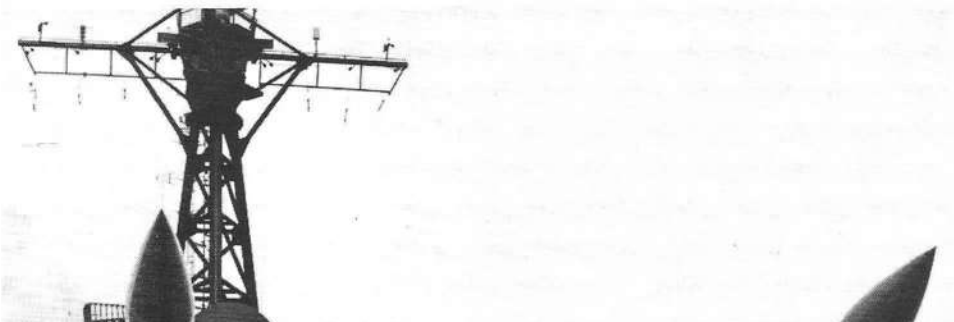
Beam-rider guidance with semi-active homing is employed to direct the missile against a target designated by the ship's tactical data system. A twin launcher is supported by automatic magazine and loading arrangements. Terrier is launched by a solid fuel rocket booster and propelled by a solid fuel sustainer.

The normal warhead is of the HE type with direct action or proximity fuse, but one version of Terrier (RIM-2D) has been produced with a nuclear head.

DEVELOPMENT:

Development started about 1951, under the former military designation SAM-N-7, and Terrier was based upon the experimental LARK vehicle. First Terrier became operational in 1956.

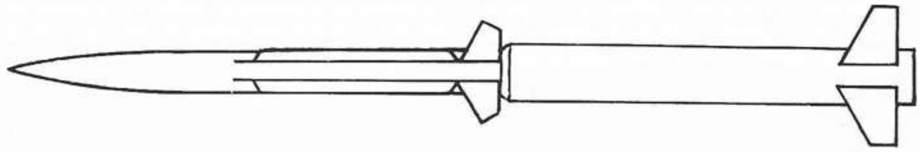
Advanced Terrier (RIM-2F) became operational in 1963 and is carried by US Navy cruisers, frigates and attack carriers. It has also been purchased by the Italian and Dutch navies. The system will eventually be replaced by the Standard missile system (**1122.231**).



Advanced Terrier missiles on twin launcher of Royal Netherlands Navy cruiser De Zeven Provincien. Note open reload hatch on left

MANUFACTURERS:
General Dynamics, Pomona – prime contractor.
Vitro Corpn – system co-ordination.

ASSOCIATED EQUIPMENT:
AN / SP – 44 CW target illumination radar – Raytheon
AN / SPG – 49 Guidance radar – Sperry
AN / SPG – 55 C-band fire control radar – Sperry
AN / SPQ – 5A Long-range tracking and guidance radar – Sperry

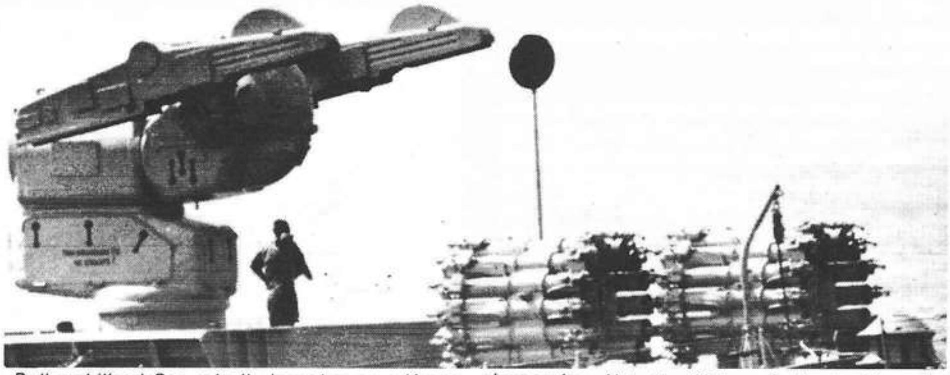


Terrier (RIM-2)

THE UNION OF SOVIET SOCIALIST REPUBLICS

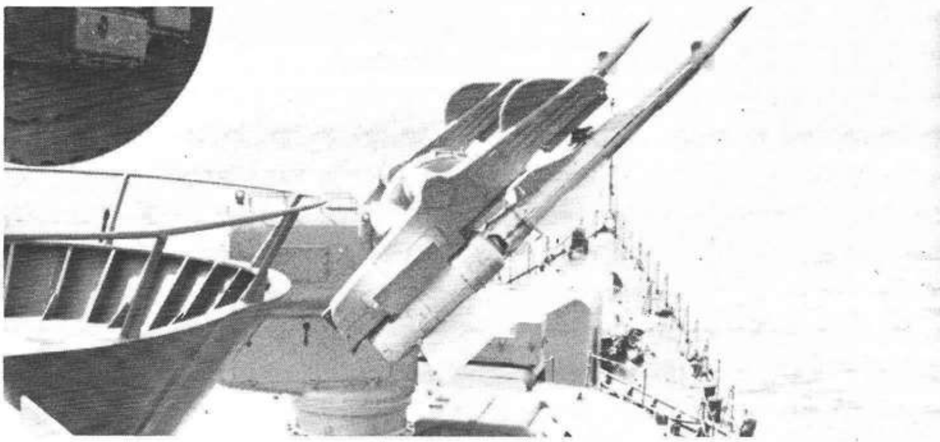
2939.231
GOA SHIPBORNE SURFACE-TO-AIR MISSILE (SAN-1)

DESCRIPTION:
Known also by the US alphanumeric code SAN-1 the missile whose NATO code-name is Goa is the principal surface-to-air missile of the Soviet Navy. It is fitted to the "Kanin", "Kashin", "Kotlin", "Kresta" and "Kynda" classes on scales ranging from one to four twin launchers.



Roll-stabilised Goa missile launcher on a Kresta *class cruiser. Note the 12-barrelled trainable anti-submarine rocket launchers*

The shipborne Goa missile is assumed to be identical with the ground-to-air missile (**2938.131**) but the equipment associated with it is very different. The standard launcher is clearly roll-stabilised as can be seen from the accompanying illustration. Rather different, and not obviously stabilised, launchers have also been observed, but these are most probably not for Goa. The launcher is mounted on top of the missile magazine and is reloaded vertically through small hatches.

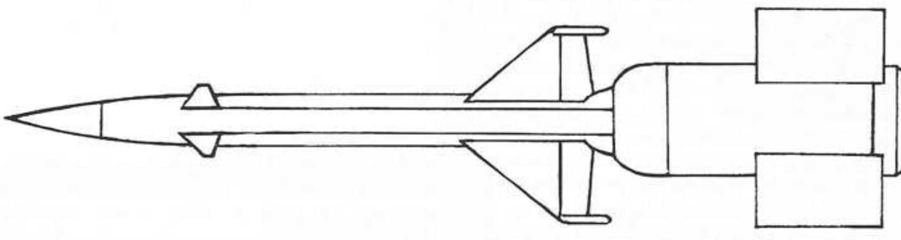


Goa shipborne anti-aircraft missiles on Kashin *class destroyer. Radar in the left foreground is probably a Tellerform-2 director for the guns forward of the missiles' launcher* (NOVOSTI)

Associated with the missile in all installations is a compound radar systm known by the NATO code-name Peel Group (**1323.253**) and described in the Naval Radar section.

There is, of course, no definite information on Goa's performance but it is generally taken to have maximum slant range of about 15 km and a ceiling of some 12,000 metres. Length is estimated at about 5.9 m and the maximum span at 1.2 m.

STATUS:
Entry into service with the Soviet Fleet was in 1961-62. According to the latest available figures, Soviet vessels are equipped with a total of 128 launchers. There are two on each of 8 SAM "Kotlin" class, 6 "Kanin" class, and 4 "Kynda" class ships; while 19 "Kashin" class, and 4 "Kresta I" class vessels each have four SAN-1 launchers.

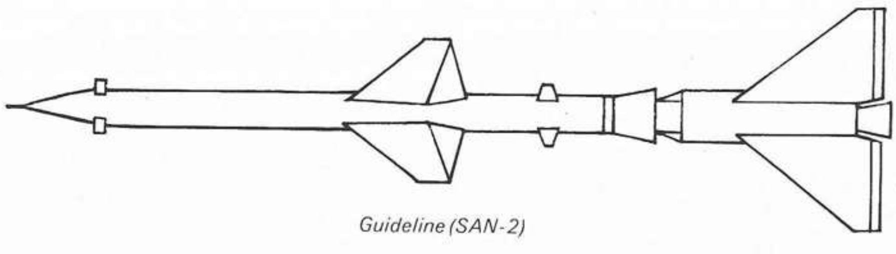


Goa (SAN-1)

2943.231
GUIDELINE SHIPBORNE SURFACE-TO-AIR MISSILE (SAN-2)

DESCRIPTION:
Guideline, also known, in its shipborne application, by the US alphanumeric code SAN-2, has been installed in only one Russian ship, so far as is known at present – the cruiser *Dzerjinski*.

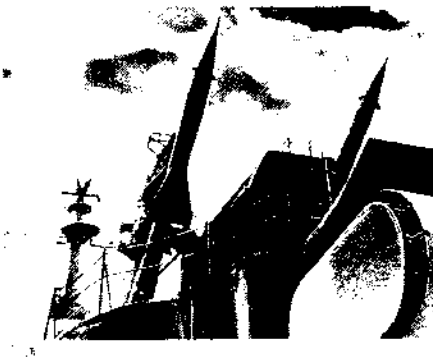
It has been suggested that one reason for this is



Guideline (SAN-2)

the difficulty of providing suitable stable platforms on smaller vessels for the flapping Fan Song (**2866.153**) radars used to guide these missiles. It could also be that the relative difficulty that there appears to be in gathering these missiles to the required flight path presents even more of a problem in shipborne installations than it does on the ground.

So far as is known the general performance of Guideline as a shipborne missile is substantially the same as that described in the entry for the ground-based version.



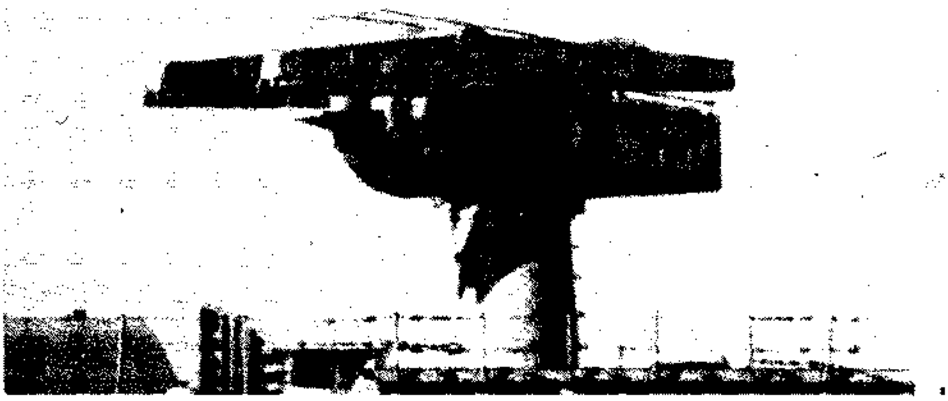
Guideline shipboard installation (NOVOSTI)

2947.231
GOBLET SHIPBORNE SURFACE-TO-AIR MISSILE (SAN-3)

DESCRIPTION:

The helicopter-carrier *Moskva* and the "Kresta-II" class cruisers are equipped with a surface-to-air missile that is similar in size to Goa (**2939.231**) but possibly larger and certainly launched from a different launcher and directed by a different radar complex.

Although there was confusion concerning this missile it now seems to be agreed that it is that classified in the American code as SAN-3: it is also widely believed – without, of course, any official confirmation – that its NATO code-name is Goblet.



SAN-3 missile launcher on Kresta II *class cruiser*

The launcher, illustrated here, does not appear to be roll-stabilised – suggesting that the missile gathering is efficient. The nature of the missile itself is unknown although various suggestions have been made. One suggestion, that appears to be consistent with the general Russian practice of making maximum use of any successful development, is that the missile is that known as Gainful (SA-6) (**2930.131**) and is a surface-to-air weapon of more modern design than Goa. Fire control radar has the NATO code "Head Lights" (**1328.253**). While the identification of Gainful with Goblet cannot be asserted, the suggestion has authoritative support.

STATUS:

Goblet-type launchers have been sighted on the two "Moskva" helicopter carriers, 6 "Kresta II" cruisers and on a "Kara" class ship. In all cases, each ship had four launchers, to make a total of 36.

2954.231
SAN-4 SHIPBORNE SURFACE-TO-AIR MISSILE

DESCRIPTION:

This designation (SAN-4) has been allocated to whatever missile system is concealed within the 'bin-type' launcher assemblies which first appeared on the Nanuckha missile boats and "Krivak" destroyers and spread fairly rapidly to a number of other classes of Soviet Navy ship. A form of retracting mechanism is involved so that a kind of 'pop-up' missile launching mode is possible, and a twin launcher is employed. Most reports assign a close-in air defence role to the SAN-4, with some observers stressing the anti-helicopter aspect. Each SAN-4 'bin' is associated with a fire control radar group of a new type (reportedly code-named "Pop Group"), and which the Soviet Navy has been to some pains to shield from Western eyes to date. As for the missile itself and its possible configuration and mode of guidance, the lid of its shipborne silo is totally inadequate evidence upon which to embark on any worthwhile conjecture.

STATUS:

According to the latest figures available, the Soviet Fleet has at least 31 SAN-4 launcher installations on five classes of vessel. Two converted Sverdlov cruisers have one each; the new "Kara" class of cruisers have two amidships; five "Krivak" class ships each have two; six Nanuchka missile boats have one each; and eleven "Grisha" class corvettes have a similar foredeck installation to the Nanuchkas.

A rare picture of the SAN-4 missile launcher outside its 'silo'. The associated Pop Group radar can be seen on the raised platform to the left; Drum Tilt radars are for gun fire control

SURFACE TO SUB-SURFACE WEAPON SYSTEMS

2293.241
INTRODUCTION – ANTI-SUBMARINE WARFARE

Classification of anti-submarine warfare systems and equipment in a manner compatible with the general arrangement of this book presents several difficulties – which, in general, have to be resolved in an arbitrary way. Torpedoes, for example, can be launched from tethered mines, submarines, surface ships, drones, helicopters and fixed-wing aircraft and can be aimed at either submarines or surface craft; and torpedoes of many types can be used in more than one of these roles. Because of this general and individual versatility we have grouped all kinds of torpedo together in the general area of sub-surface weapons.

Because of the complexities of the subject the reader may find it necessary to consult one or more of the following sections of the book in order to find the information he requires.

Section One
(a) This subsection – dealing with shipborne anti-submarine weapon systems
(b) Torpedoes
(c) Underwater Weapons (Subroc)
(d) Naval Fire Control and Action Data Automation Systems – for weapon control systems

Section Two
(a) Fighting Ships – for ASW vessels &c.
(b) Submarines – for hunter-killer submarines &c.
(c) Military Aircraft – for ASW aircraft

Section Three
(a) Shipborne Anti-Submarine Weapons – as distinct from systems (often an arbitrary decision)
(b) Sonar and Underwater Detection Equipment
(c) Data Processing Equipment
(d) Ancillary Equipment – Guns and Missiles
(e) Simulators and Trainers

AUSTRALIA

2018.241
ANTI-SUBMARINE MORTAR SYSTEM

DESCRIPTION:

An improved version of the AS Mk 10 (Limbo) anti-submarine mortar system (**6008.241**) has been developed in Australia. The design of the Limbo system dates from about 1955 and technological advances since then made it possible to overcome certain disadvantages of the system. In particular, the new development eliminates the use of rotating electric machinery in the pitch and roll servo loops – with consequent saving in power, deck-level weight and noise – to reduce the weight and noise level of the loading mechanisms (pneumatic for Limbo) and to eliminate the mechanical problems that can arise from the use of uniselectors in the fuse-setting system.

In the new design the metadyne servo control system for pitch and roll has been replaced by an electric system using silicon-controlled rectifiers to control the launcher drive motors; the pneumatic rammer has been replaced by a smaller and lighter electrical device; and the fuse setting system has been redesigned to use solid-state logic circuits with which have been incorporated additional supervisory circuits that permit checking of the setting before launch.

One effect of all these changes – apart from reduction in cost, weight and noise – is a manning reduction from seven to three.

STATUS:

Production equipments are being delivered to the Royal Australian Navy.

MANUFACTURERS:

Sponsoring Organisation: Department of Supply – Weapons Research Establishment, Salisbury, S.A., Australia.

Contractor: Hawker Siddeley Electronics Ltd., Brookvale, NSW.

6002.241
IKARA ANTI-SUBMARINE WEAPON SYSTEM

DESCRIPTION:

The concept of Ikara is the employment of a guided missile to deliver a homing torpedo to the target submarine. The missile is launched from a surface ship which uses a computer to calculate the torpedo dropping position, from information fed into the computer from the ship's sonar and other sources of information on the submarine's position.

The guidance system ensures that the missile flies to the continuously up-dated optimum dropping position, derived from target information fed into the computer during flight.

After release from the Ikara vehicle, the lightweight torpedo (such as the Mk 44) descends by parachute to the sea, where it searches for the target submarine and carries out a homing attack

The missile is about 310 cm long with a wing span of approximately 150 cm; propelled by a dual thrust solid fuel rocket motor, and carries a control system and autopilot to enable the vehicle to be steered in flight.

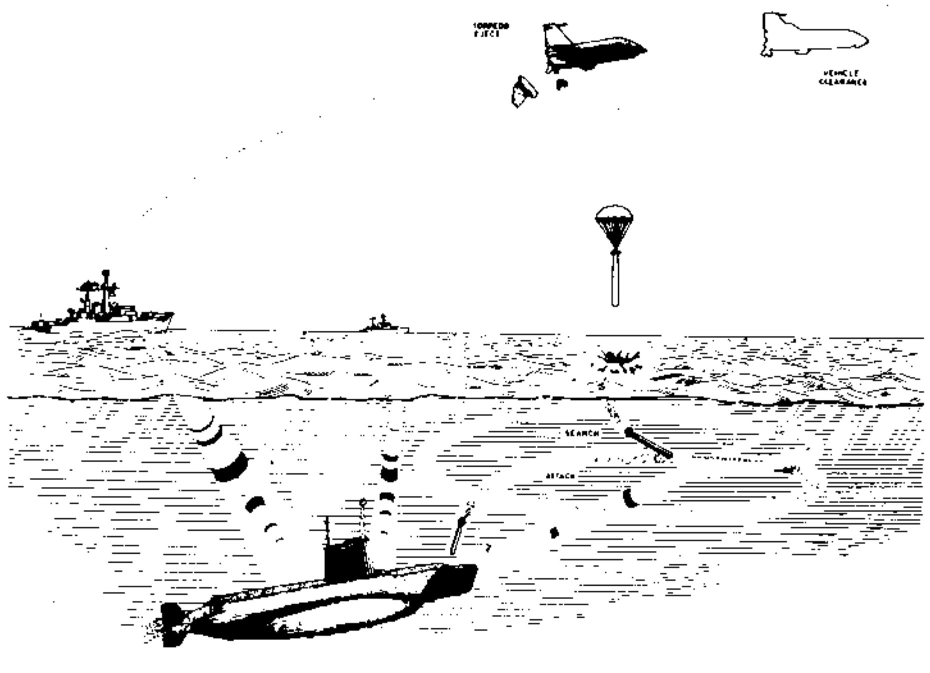
OPERATION:

Ikara is capable of attacking enemy submarines out to the maximum range of the ship's sonar regardless of the weather conditions.

In addition, an Ikara attack can be carried out on information received from another ship, or a helicopter equipped with dunking sonar. In this case target information is passed to the firing ship's computer, and an attack is carried out in the normal manner, even though the firing ship itself is not in contact with the target.

This mode of operating has been successfully proved in trials and considerably enhances the potential of Ikara to provide long range ASW capability.

In the self-contained mode of operation a ship mounted radio/radar system enables the missile to be accurately tracked and guided to the drop zone, where command signals initiate the torpedo release function



Attack sequence of Ikara ASW weapon system

Target information from the ship's long range sonar is fed into a computer which calculates the dropping position, taking into account such factors as ship's own course and speed, the prevailing wind, and target movement during time of flight. The outputs from the computer are passed to the missile via the guidance system.

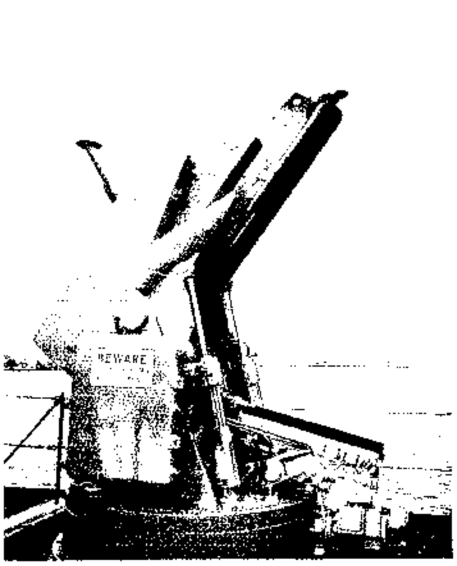
In the Australian version the computer is a digital system autonomous to the Ikara system. The Royal Navy version (specifically known as RN Ikara) takes computer service from the action data automation system (ADAS).

The Ikara launcher ensures that the missile takes up its correct flight path as quickly as possible, whilst the automatic handling system ensures rapid reloading from the magazine, where the missiles are stowed with their torpedoes attached.

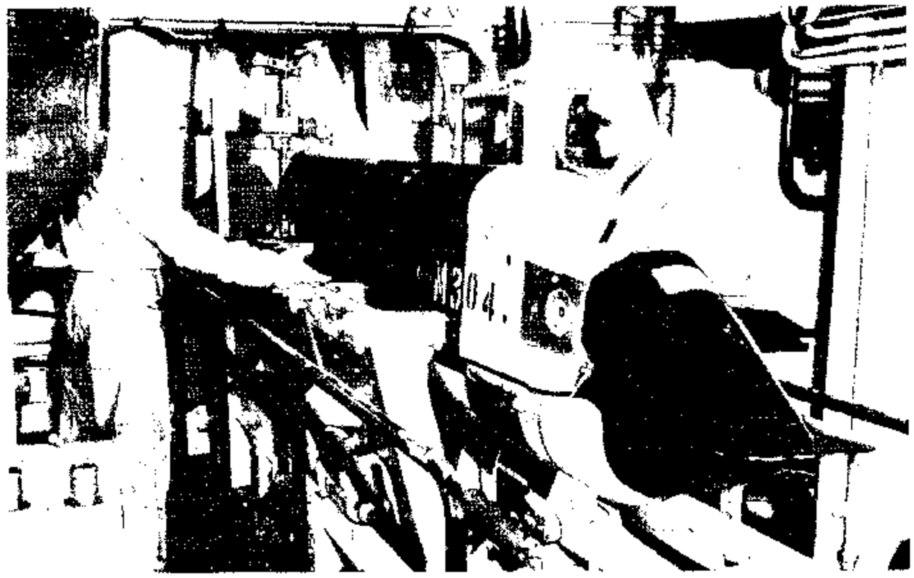
The layout of the magazine and handling area varies considerably between the classes of ships already fitted with Ikara, and designs are available to cater for the differing requirements of ships ranging from 1,500 tons upwards.

DEVELOPMENT:

Initial design was undertaken by the Australian Department of Supply and Department of the Navy. The modified version to meet Royal Navy requirements was subsequently embarked upon



Ikara missile on its launcher on board HMAS Perth



An Ikara anti submarine missile seen in the below-decks magazine and launch preparation area. An automatic handling and loading system ensures rapid reloading of the launcher

as a joint programme.

Branik

Even more recently, the requirement to fit Ikara to the Brazilian "Niteroi" class Mk 10 frigates has given rise to the development of a third version of the system. Known as "Branik", this version again differs from the Australian and RN versions in the way in which the launcher and missile obtain computer service. In the "Niteroi" weapon control system two fire-control computers (Ferranti FM 1600B **1433.063**) are used to control all the ship's weapons. The Branik system employs a special-purpose missile tracking and guidance system which is fully integrated with one of these computers. A lightweight semi-automated missile handling outfit is also incorporated in the new version.

Branik is the subject of a joint development programme by the Department of Supply, Vosper Thornycroft, Hawker Siddeley Dynamics and Ferranti.

STATUS

In service with the Royal Australian Navy and the Royal Navy. Ordered by the Brazilian Navy. Other orders pending.

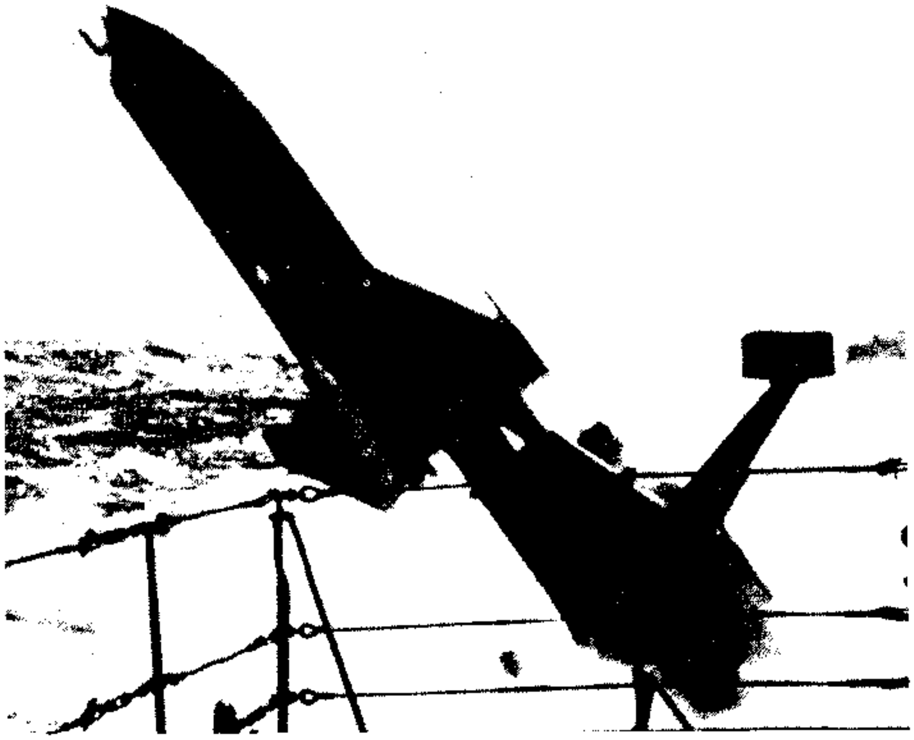
PRODUCTION

Department of Supply – Government Aircraft Factories, Melbourne, Victoria, Australia.

SALES

Hawker Siddeley Dynamics Ltd, Manor Road, Hatfield, Herts, England.

– Department of Supply, Canberra, ACT, Australia.



Ikara launch

FRANCE

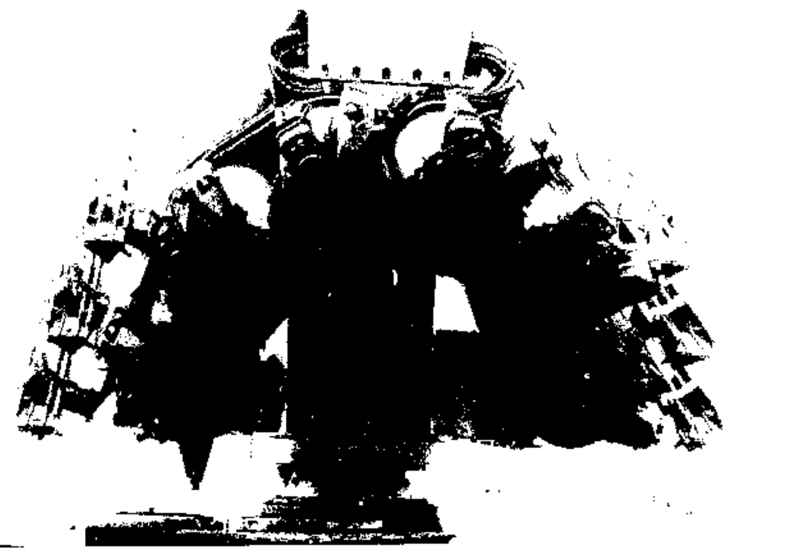
2057.241

ANTI-SUBMARINE WEAPON SYSTEM

DESCRIPTION:

This system comprises an anti-submarine rocket launcher associated with a sonar and a computer. The rocket launcher is remotely controlled, aiming and rocket fusing being determined by the computer, which in turn receives input data from the sonar.

The launcher is made by Creusot-Loire under licence from Bofors and is a 6-tube device with automatic reloading from a magazine. It fires single rockets or salvoes as required, and will accept any of the range of Bofors 375 mm rockets, thereby giving a choice of ranges from about 260 metres to about 3,600 metres. Rate of fire can be up to one round per second.



Rear view of the CAFL built sextuple rocket launcher

The computer is by Thomson-CSF and is of the type used by the French Navy. It calculates ballistic data for initial velocities of 70, 90, 100 and 130 metres/sec for the different rockets that may be used with the systems.

Input data from the Alcatel sonar comprise the location and rate of change of position of the target.

STATUS:

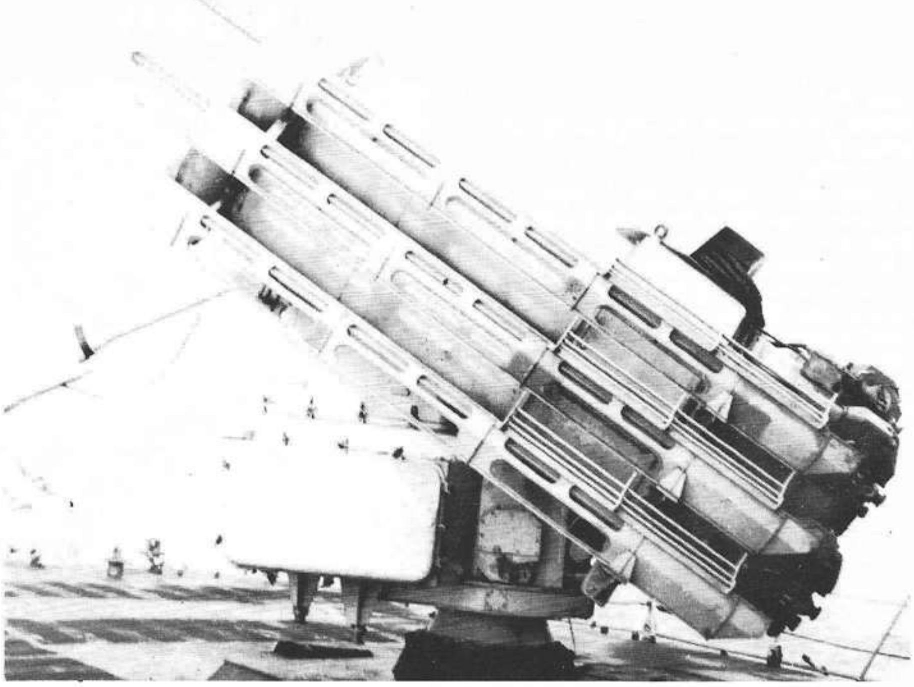
Development started in 1954 and three types of system have been produced – the latest of which went into service with the French Navy in 1967.

MANUFACTURERS:

Launcher: Creusot-Loire, 12, rue de La Rochefoucauld, -75- Paris 9e.

Computer: Thomson-CSF

Sonar: Alcatel.



Side view of launcher showing launchers for flare rockets

1179.241
MALAFON SURFACE TO SUB-SURFACE MISSILE

DESCRIPTION:

Naval weapon consisting of a radio command guided winged vehicle carrying a homing acoustic torpedo. Mainly intended for use from surface vessels against submarines, but may also be used to attack surface targets.

The Malafon missile has the appearance of a small conventional aircraft with short, unswept tapered wings, and a tailplane fitted with end-plate fins. Principal dimensions are: length 6.15 m, diameter 0.65 m, wing span 3.3 m, and the launch weight is 1,500 kg. Maximum range is about 13 km.

OPERATION:

The missile is ramp launched and propelled by two solid-fuel boosters for the first few seconds of flight. Subsequent flight is unpowered. A radio altimeter is fitted to the missile to maintain a flat trajectory at low-level. On reaching the target area, approximately 800 metres from the target's estimated position, a tail parachute is deployed to decelerate the missile. The homing torpedo is thus ejected from the remainder of the vehicle and enters the water to complete the terminal guidance phase of the attack by acoustic homing.

Target detection and designation in the case of submerged targets is by means of sonar and by radar in the case of surface targets. These sensors, as appropriate, are used during the flight of the missile to provide data on the target for the generation of command guidance signals which are sent via radio command link to guide the missile. Missile tracking is aided by flares attached to the wing tips.

DEVELOPMENT:

Development started in 1956 and by 1959 a total of 21 test launches had been made, 15 from the ground and six from an aircraft. The first sea launch and guidance test took place in 1962. Evaluation of the complete weapon system took place in 1964, during which time over 20 launches were made. Operational trials were carried out the following year.

STATUS:

It is understood that Malafon was deployed in an interim form on French Navy vessels, while full development trials were still in progress, these installations probably being up-dated as development continued. These fittings have been referred to as Malafon Mk 1 systems. Deployment of the latest versions includes installations in the guided weapons frigate *Suffren*, five modified T.47 class destroyers and five corvettes.

Malafon on its launcher   Note how the torpedo head projects from the fuselage

Malafon launch

MANUFACTURERS:

Société Industrielle d'Aviation Latecoere, 79 Avenue Marceau, Paris 16, France.

NORWAY

6022.241

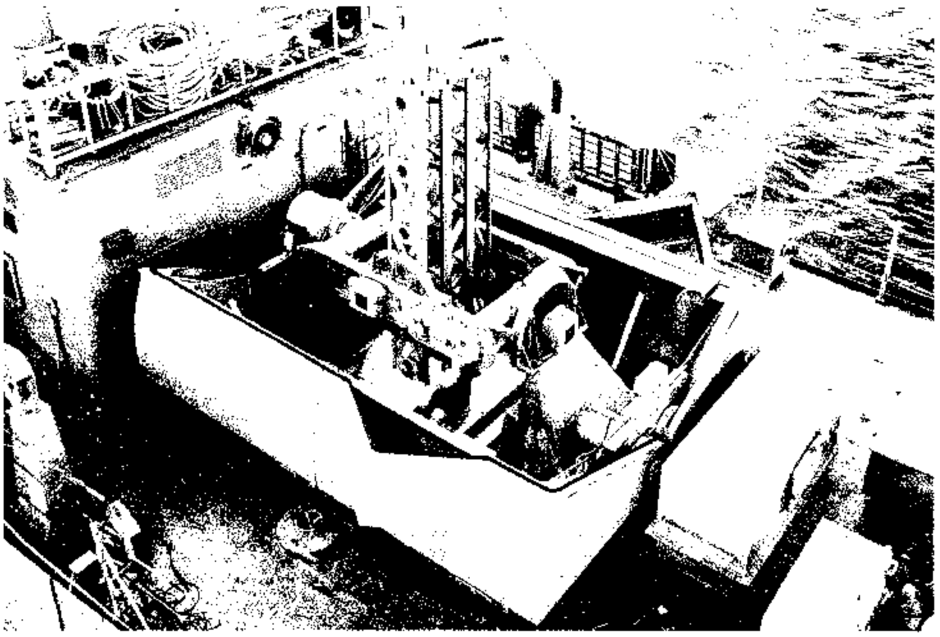
TERNE III SURFACE TO SUB-SURFACE MISSILE

DESCRIPTION:

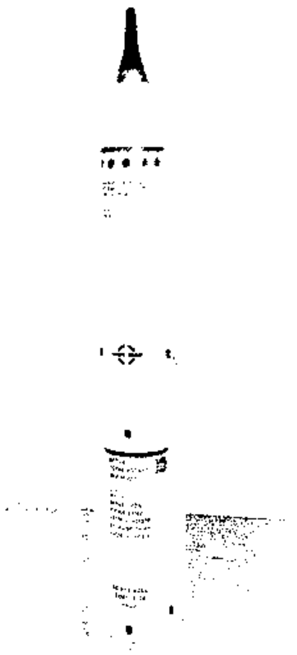
Shipborne medium/short range anti-submarine unguided multiple missile system.

OPERATION:

Ship's sonar provides submarine position for prediction of the Terne launcher elevation and bearing data. The six barrelled launcher can be used for firing single or multiple salvoes of solid fuelled rockets on an unguided trajectory. Hydrostatic fuses fire charges at predetermined depth. A six-missile salvo can be fired in 5 seconds. Reload time is 40 seconds, and is automatic.



Six-round launcher for Terne Mk 8



Terne MK 8 anti-submarine missile

CHARACTERISTICS:

Range: Probably about 3 km

Firing Sector: 360 degrees

Launcher: Sextuple remote-power-controlled. Automatic loading from manually loaded magazine hopper. Special launcher protection against ice and arctic conditions

Missiles: Length 2.0 metres. Diameter: 20 cm. Fusing: Hydrostatic and DA

DEVELOPMENT:

Development, by Kongsberg Vapenfabrik, started about 1960. The system is operational in ships of the Norwegian and US navies

STATUS:

Fitted in Royal Norwegian Navy and US Navy ships.

MANUFACTURERS:

Kongsberg Vapenfabrik, Postbox 25 N-3601, Kongsberg, Norway.

SWEDEN

6021.241

TYPE 375 SHIPBORNE ANTI-SUBMARINE MISSILE SYSTEM

DESCRIPTION:

Shipborne surface to sub-surface medium range anti-submarine unguided missile system.

OPERATION:

Ship's sonar provides submarine position for prediction of Bofors 375 launcher elevation and bearing data. The launcher has either two or four tubes and can fire single or multiple shot salvoes. A special design of missile nose ensures a predictable and accurate under-water trajectory. The launcher is reloaded by automatic means from the magazine which is disposed directly below the launcher. Bofors launchers are described in section 3GI (**2368.203** and **2369.203**).

Missiles have three types of rocket motor giving differing range brackets. The missile trajectory is flat thus giving a short time of flight to minimise target evasive action. Fuses are fitted with hydrostatic and DA devices. Rocket characteristics are:

M/50: weight 250 kg, range 300-830 m

Erika: weight 250 kg, range 600-1,600 m

Nell: weight 230 kg, range 1,520-3,600 m

DEVELOPMENT:

The initial version of the system, comprising the four tube launcher and the M/50 rocket, was developed in the early 1950s, and became operational about 1956. The two-tube launcher was developed in 1969-72 and the Nelli rocket in 1969-73. A version made in France by Creusot-Loire under licence from Bofors is described in **2057.241** above.

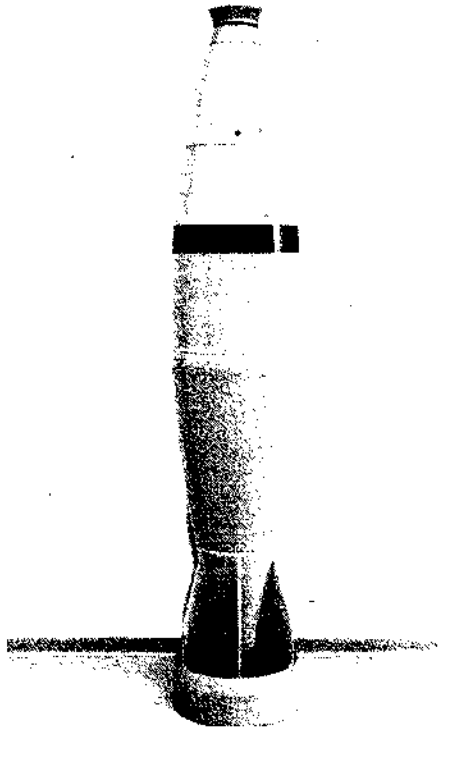
STATUS:

Fitted in Swedish Navy vessels and used by many other navies.

MANUFACTURERS.

Launcher and missile: Bofors AB, Bofors, Sweden.

Predictor system: Various – e.g. Philips Teleindustri, Sweden; Ferranti Ltd, England and N.V. Hollandse Signaalapparaten, Netherlands.



375 mm anti submarine rocket

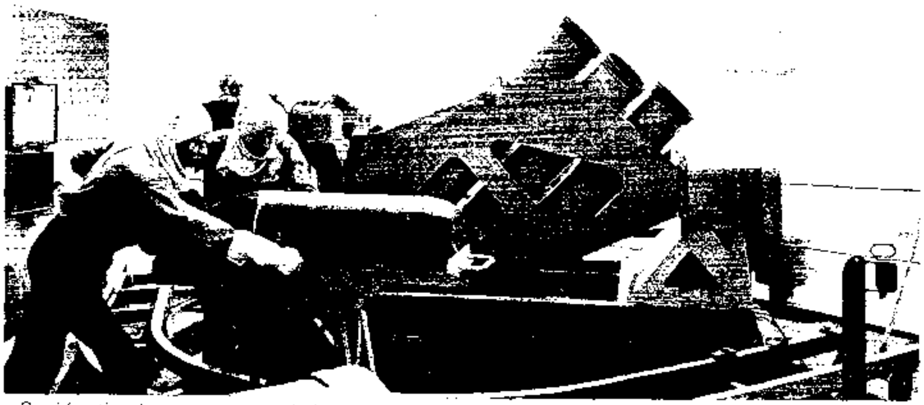
THE UNITED KINGDOM

6007.241
SQUID ANTI-SUBMARINE MORTAR SYSTEM

DESCRIPTION:
Shipborne surface-to-sub surface medium range anti-submarine mortar system.

OPERATION:
Ship's sonar provides submarine position data to a predictor which computes mortar aiming position. The triple-barrelled mortar fires a pattern of three mortar bombs which are programmed to give a three dimensional explosive pattern ahead of the target. The bombs can be set to explode at variable depths using hydrostatic fuses and are also fitted with DA fuses.
Weight of the projectile is about 200 kg and range is limited to about 400 metres.

DEVELOPMENT
Developed by the Admiralty Underwater Weapons Establishment in the nineteen-forties. Ship fitting started in about 1948



Squid anti-submarine mortars being loaded on board HMS Cambrian (Official MoD (Navy) photo)

STATUS
Operational in the Royal Navy and other Commonwealth navies. Must be considered as obsolescent

MANUFACTURERS:
Manufactured to MOD (Navy) designs by several contractors.

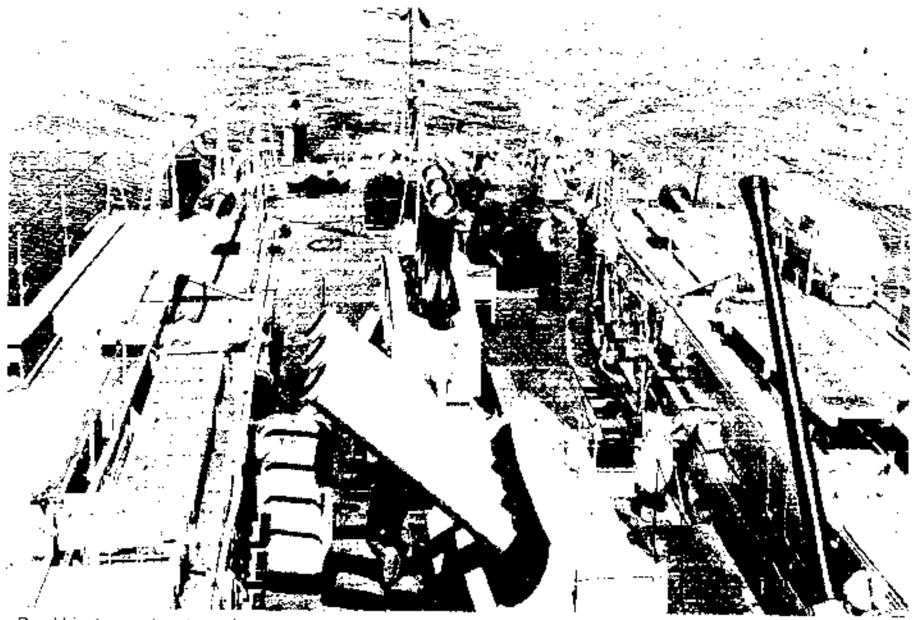
6008.241
LIMBO ANTI-SUBMARINE MORTAR SYSTEM (AS Mk 10)

DESCRIPTION:
Shipborne surface-to-subsurface medium-range anti-submarine mortar system. Mortars are stabilised in pitch and roll by a metadyne system referenced to the ship's stable platform.

OPERATION:
Ship's sonar provides submarine position data to a predictor which computes mortar elevation and lateral tilt. The triple-barrelled mortar fires a pattern of three mortar bombs which are programmed to give a three dimensional explosive pattern ahead of the firing ship. The bombs can be set to explode at variable depths using hydrostatic fuses and are also fitted with DA fuses. The fuse setting is by remote control through relays and uniselectors. Loading is accomplished by pneumatic power horizontal ramming from a magazine which is located alongside the mortar.
Weight of the projectile is about 200 kg and range is somewhere between 1,000 and 2,000 metres – estimates vary.

DEVELOPMENT
Developed by Admiralty Underwater Weapons Establishment during the nineteen-fifties. Ship fitted in the early nineteen-sixties.

STATUS.
Operational in British and Commonwealth destroyers and frigates and in many other vessels. See also entry number **2018.241** for modified Australian version



Dual Limbo anti-submarine mortar installations (Official MoD (Navy) photograph)

MANUFACTURERS:
Manufactured to MOD (Navy) designs by several contractors.

THE UNITED STATES OF AMERICA

6001.241
ASROC ANTI-SUBMARINE SYSTEM

DESCRIPTION:
ASROC (RUR-5A) is an all-weather, day or night, ship-launched ballistic missile carried as the primary anti-submarine warfare weapon aboard US Navy destroyers as well as some cruisers and frigates. The weapon consists of a Honeywell Mark 46 acoustic homing torpedo or a nuclear depth charge attached to a solid propellant rocket motor. It can be fired from an eight cell launcher, the Mk 46 launching system, or from the Mk 10 Terrier missile launcher (ASROC / Terrier system).
Other major components include a fire control computer and an underwater sonar detector. Honeywell Inc. is the prime contractor.

OPERATION:
After launch the weapon follows a ballistic trajectory. The rocket motor is jettisoned at a predetermined point and the payload continues toward the target. If the payload is a torpedo, it is lowered to the water by a parachute, where its homing mechanism is activated upon submersion. Depth charge payloads sink to a predetermined depth before detonating.
Range of the weapon is classified but has been estimated at from 2-10 km. The missile is 4.6 metres long, has a diameter of 32.5 cm and a span

Underwater explosion resulting from an ASROC missile fired from the destroyer USS Agerholm. *ASROC launcher can be seen between the destroyer's smokestacks* (Official US Navy photograph)

Modified ASROC missile on the Terrier launcher of the USS Belknap

ASROC launch from the guided missile escort ship USS Brooke (Official US Navy photograph)

of 84.5 cm. Launch weight is about 435 kg.

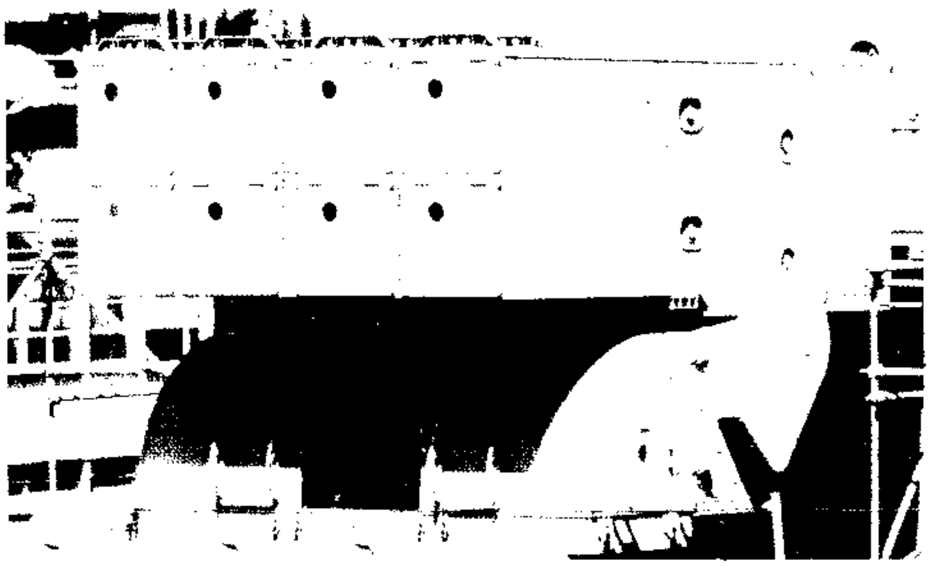
DEVELOPMENT:

ASROC has been in development since 1955. The first development contact was awarded to Honeywell in June of the following year. After a successful two-month evaluation aboard the USS *Norfolk* in 1960, the weapon became operational on four destroyers in 1961. It is now operational on eight Japanese destroyers, three West German destroyers, an Italian cruiser and seven Canadian destroyer escorts, as well as on cruisers, destroyers and escorts of the US Navy including the new "Spruance" class DD963 destroyers.

See also entry number **2507.231** for combined ASROC/Standard launcher in the Aegis system.

MANUFACTURER:

Prime Contractor: Honeywell Inc, 2701 Fourth Avenue, South Minneapolis, Minn. 55408.



ASROC eight-tube launcher (Official US Navy photograph)

THE UNION OF SOVIET SOCIALIST REPUBLICS

6097.241

RUSSIAN ANTI-SUBMARINE WEAPON SYSTEMS

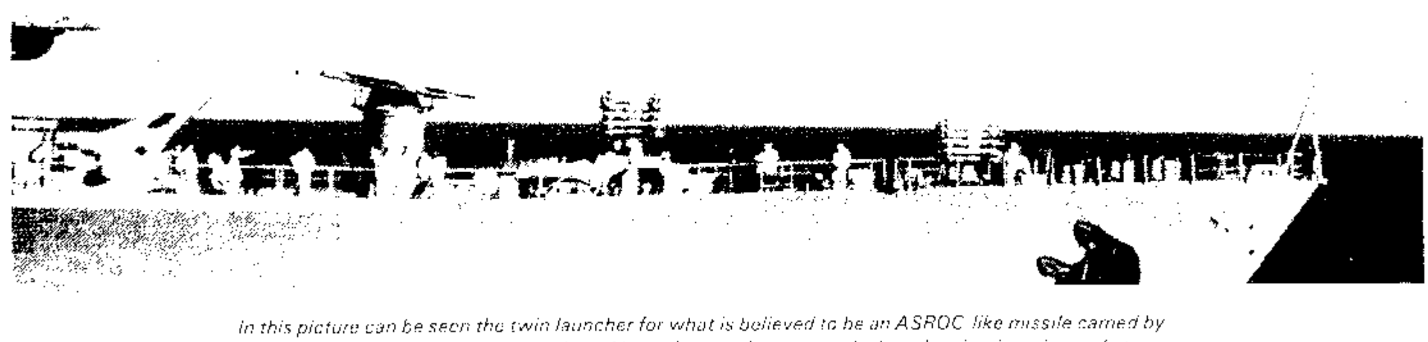
DESCRIPTION:

In general the development of anti-submarine weapon systems in the USSR closely parallels that which has occurred among Western nations. There has, however, been a time-lag between the two sets of developments, the Russians appear to have started serious developments of ASW systems other than simple depth charges only after the emergence of the nuclear-powered submarine in the West.

After making allowances for this phase-lag between the two programmes, the only major development of an ASW system for surface vessels that appears to have been omitted from the Russian programme is a drone torpedo system such as Ikara (**6002.241**) or Malafon (**1179.241**).

Some details of Russian anti-submarine mortars and rocket launchers will be found in Section 3 under entry number **6096.203**. It may be assumed with some confidence that these equipments are linked with sonars and fire control equipment to form a complete ASW system in much the same way as are the French or Swedish launchers (and others omitted from this section for lack of detailed information) described above (**2057.241** and **6021.241**).

Another system which is presumed to have a close Russian parallel is the American ASROC (**6001.241**). On the "Moskva" class helicopter carriers, there is a missile launcher forward of the two surface-to-air launchers (**2947.231**) which is widely believed to be for use with an anti-submarine missile of the ASROC type. No details are available.



In this picture can be seen the twin launcher for what is believed to be an ASROC like missile carried by the Moskva class helicopter carriers. Also to be seen here are multi-barrel anti submarine rocket launchers

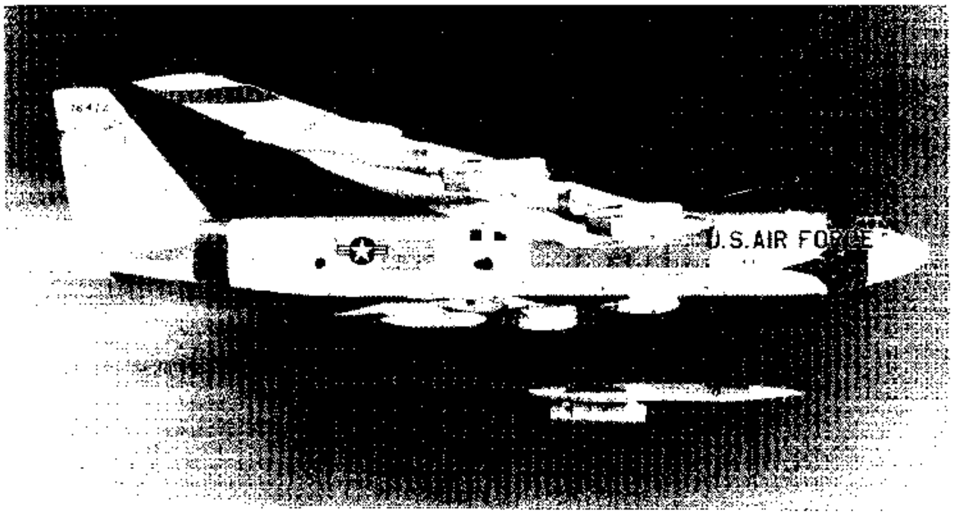
AIR-TO-SURFACE MISSILES—STRATEGIC

THE UNITED KINGDOM

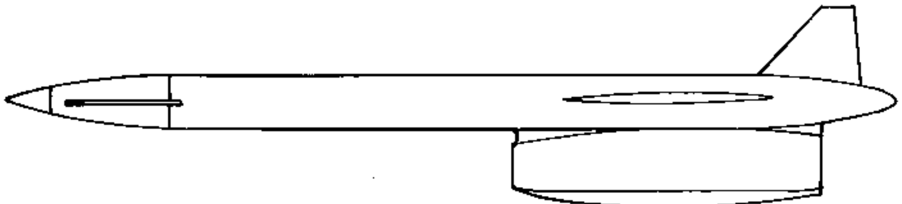
1078.311
BLUE STEEL STAND-OFF BOMB
DESCRIPTION:
Stand-off air-to-surface weapon designed for carriage as standard armament by the Mark 2 versions of the Vulcan and Victor aircraft of the Royal Air Force. It enables targets to be attacked from well outside the range of local defences. Its nuclear warhead is in the megaton range.
The missile has a rocket engine, using liquid propellants, which gives it a speed 'several times' the speed of sound at high altitude over very long ranges. After launching from the carrier aircraft it is guided to its target by an automatic built-in navigation system.
Blue Steel has small delta-shaped foreplanes for pitch control, a rear mounted delta wing with in-board ailerons, and a pair of stabilizing fins, the lower one of which folds sideways to give ground clearance.
Main dimensions of Blue Steel are: length 10.6 m, maximum diameter 1.72 m, wing-span 3.96 m, foreplane span 1.98 m. The airframe is mainly of stainless steel, and propulsion is by a two-chamber Bristol Siddeley Stentor liquid (HTP and kerosene) rocket motor. The inertial guidance system is by Elliott-Automation.
Range from release point has never been officially stated, but it is generally believed to be in the region of 320 km.
STATUS:
Entry into RAF service took place in the Summer of 1962, with Vulcan Mk2 aircraft of 617 Squadron. When the transfer of UK nuclear deterrent responsibility to the Royal Navy was announced, it was implied that Blue Steel was to be progressively withdrawn, but no subsequent official statement has been issued. It is assumed that some of these weapons are maintained on a 'care and maintenance' basis, and it has been reported that two squadrons of Vulcans are the only units still operating with this weapon.
MANUFACTURER:
Hawker Siddeley Dynamics Ltd, Manor Road, Hatfield, Herts, England.

THE UNITED STATES OF AMERICA

1093.311
HOUND DOG (AGM-28B AIR-TO-GROUND MISSILE
DESCRIPTION:
Long-range, stand-off air-to-ground strategic missile. Carried in pairs beneath the wings of USAF Strategic Air Command B-52 aircraft. Principal characteristics are: length 13 m, diameter 71 cm, height 2.83 m, span 3.66 m, range 960 km, speed slightly over Mach 2, weight 4,500 kg. It is powered by a Pratt & Whitney J52-P-3 turbojet air breathing engine, and the official ceiling is above 15,000 m. Nuclear warhead.
OPERATION:
The prime navigational mode of the Hound Dog missile from launch to target is an inertial navigation system INS developed by Rockwell International, Autonetics Division. Prior to launch, missile INS remain operative and are continuously updated by the navigation system of the parent B-52 and a Kollsman KS-140 astro tracking subsystem. The latter are housed in the pylon wing mount for each Hound Dog missile and their function is to provide continuous, high accuracy attitude and heading reference data for the missile inertial platforms.
The Hound Dog engines can be used to supplement those of the carrier B-52 to augment thrust at take-off or during cruise and the missile can be refuelled in the air from the aircraft tanks prior to release.
Missile targeting and mission profile can be varied by the B-52 crew in flight.
DEVELOPMENT:
Development was initiated by USAF Strategic Air Command in 1957, and the first launch took place in 1959. Entry into service under the original designation GAM-77A was in 1961. The AGM-28B (formerly GAM-77B) designation was allocated to an improved version, in which the principal modifications were aimed at increasing navigational reliability and accuracy. The programme was also known as Weapon System-131.
A project to incorporate a further navigational aid, TERCOM – Terrain Contour Matching – was subsequently dropped.



Hound Dog immediately after release from carrier B-52 strategic bomber


Hound Dog (AGM-28)

STATUS:
Hound Dog production ended in 1963. The USAF inventory of an estimated 600 missiles has since been the subject of refurbishing programmes under which Rockwell International has undertaken 'inspect and repair as necessary' action on large quantities. The AGM-28B is operational with USAF Strategic Air Command, and future deployment is dependent upon decisions taken by DoD concerning the future of the B-52 force and the development of other systems such as SRAM (which see). In March 1974 the US Secretary of Defence said that it had been decided to phase out Hound Dog with the B-52G/H force by Fiscal Year 1976.

MANUFACTURERS:
Rockwell International Corporation, 600 Grant Street, Pittsburgh, PA 15219, USA. Tulsa Division – prime contractor; Autonetics Division – inertial guidance system.
United Aircraft Corporation, Pratt & Whitney Aircraft Division, East Hartford, Connecticut, USA – engines.
Kollsman Instrument Company, Elmhurst 73, New York, USA – star tracker.

1766.311
ALCM AIR-LAUNCHED CRUISE MISSILE
DESCRIPTION:
The ALCM is the USAF portion of a joint endeavour with the US Navy to provide the former service with an advanced long-range strategic stand-off weapon and the Navy with a Submarine-Launched Cruise Missile. The latter would be produced in both tactical and strategic versions and is intended to be suitable for deployment on surface ships also. More details of the SLCM will be found in entry number **1759.411**.
The USAF will develop the ALCM as an adjunct to the strategic bomber force. The initial carrier will be the B-52 but ALCM will be used on the B-1 and could take advantage of that aircraft's improved pre-launch survivability characteristics. The ALCM programme will make maximum use of the now-cancelled SCAD (Subsonic Cruise Armed Decoy) engineering development programme for vehicle design and turbofan engine development. This design is particularly suited for launching from strategic bombers in that it can replace the SRAM (1107.311) on a one-for-one basis in both internal rotary racks and pylon mounts. This also suggests that the ALCM could be deployed with the FB-111 but official US defence sources have not named this aircraft as a possible carrier.
Both the ALCM and SLCM are seen as a major alternative approach to penetration of heavily defended Soviet targets. Cruise will be at sub-sonic speeds in the interests of maximum range. Guidance (overland) will be by the TERCOM (Terrain Comparison) technique which has been pioneered by the US Navy, and a terrain following system will be provided to enable penetration at a height

of a few hundred feet. It is anticipated that each missile will weigh about 2000 lb (900 kg).

DEVELOPMENT:

The USAF will concentrate on the development of a small turbo-fan engine for use on both the ALCM and SLCM. The USN will pursue development of the TERCOM guidance technology, which also will be common to both missiles. Present plans are that the USAF will commence engineering development of an ALCM in Fiscal Year 1975, and that this could be made available for initial deployment in the late 1970s. On this basis, the Fiscal Year 1975 Budget contained a sum of $80-million for the USAF RDT&E aspects of ALCM. For its part on the SLCM, the USN was allocated $45-million. Prime contractors nominated for the ALCM programme are the Boeing Aircraft Company for the airframe and carrier aircraft equipment, and Williams Research Corporation for the engine.

1767.311
AMX - AIRBORNE MISSILE X

DESCRIPTION:

Missile 'X' is the present designation given to a proposed USAF development for a new advanced mobile intercontinental ballistic missile system. Both land-based and airborne systems are being considered. Further information on the land-based and overall MX project will be found in entries **2707.111**, **2718.111**, and **2200.111** which precede this entry. The designation AMX refers to Airborne Missile X, which at this stage exists only as proposals put forward by industry. The salient features are outlined in the following paragraphs.

Boeing has suggested four approaches to the provision of a suitable airborne launch platform for the AMX. First is based on an adaptation of the Boeing 747 airliner, which would operate in conjunction with a tanker version of the same type of aircraft to provide the necessary payload/range characteristics. The carrier aircraft, MC-747 would have a missile payload of 180,000 kg in the form of four ICBMs of a new design and weighing about 45,000 kg each. An alternative load could be eight ICBMs of about half this size and weight. Boeing envisages a fleet of 36 MC-747s supported by 12 tanker 747s, with 25 MC-747s being at various stages of alert (including on station) at any one time. Launching would be by release from the aircraft followed by a stabilisation period, after which rocket ignition would take place to accelerate the missile into a ballistic trajectory to its target. Six methods of free-fall stabilisation have been studied: fins, an extendable skirt, nose ballast, canard surfaces, parachute(s) and thruster motors. The last two are apparently the most promising.

The other carrier aircraft possibilities put forward by Boeing are: (1) a new design four-engined land-based machine with a flight-refuelled performance of 15 hours with a 272,000 kg payload or 24 hours with 180,000 kg; (2) a land-based six-engined aircraft with wing-mounted missile pods to house the smaller version AMX and designed for long-endurance cruise; and (3) a high-wing amphibian with four engines and a payload of about 90,000 kg.

A major problem with the AMX concept is ensuring the high accuracy of navigational data, which is essential throughout the system if accuracy and reliability of delivery are to be assured. For the aircraft, inertial plus stellar, satellite, ground radio aids and area correlation for updating have been suggested, with inertial plus radio correction for AMX post-boost guidance and an unspecified form of terminal guidance.

STATUS:

The Fiscal Year 1974 allocation of funds to the MX project as a whole was $4.2 million, but in response to the appearance of the Soviet's four new ICBMs, SSX-16/17/18/19 and the SSN-8 SLBM, a big increase to $37.3 million for advanced studies and RDT&E was sought on behalf of MX in the Fiscal Year 1975 Budget.

1107.311
SRAM (AGM-69A) SHORT RANGE ATTACK MISSILE

DESCRIPTION

The Short Range Attack Missile (SRAM) is a supersonic air-to-surface nuclear weapon for the USAF, to complement and soon will replace the Hound Dog missile. It is being deployed with the B-52G and H, the FB-111, and the B-1 strategic bomber.

SRAM is designed to attack and neutralize enemy terminal defences, particularly the Soviet surface-to-air missile (SAM) defences. The weapon will have the capability of penetrating terminal defences and striking mission targets while the bombers stand off outside the range of enemy defences. It will also be able to attack enemy SAM and anti-aircraft sites so that bombers can strike primary targets with other SRAM or conventional bombs.

Other roles which have been considered include the use of the SRAM against airborne early warning and control aircraft, as an air-to-air missile, and as a defence against surface-to-air missiles. Boeing has said that the SRAM has the manoeuvre capability for air interception at relatively long range, and the General Dynamics anti-radiation detection and acquisition system for the standard ARM could be used in a version of SRAM.

The missile is 425 cm in length, 45 cm in diameter and weighs approximately 1000 kg. Range varies between 60 and 160 km, depending upon the flight profile employed, and a speed in excess of Mach 3 has been quoted.

The nuclear warhead carried is stated to be of the same size as that of the Minuteman 3.

An inertial guidance system is used, and the propulsion system is a two-pulse solid rocket motor developed by Lockheed. The first stage provides initial acceleration; the second stage is activated as the missile approaches its target. Trajectory can be changed in mid-flight, and the missile can be launched from any direction regardless of the bomber's flight path. The missile can be launched from either a high or low attack mode. The high mode is said to yield the greatest range but also increases the missile's vulnerability to enemy defences.

Four basic modes of flight trajectory can be employed: (1) semi-ballistic, (2) altimeter-controlled terrain following, (3) pull-up from behind radar screening terrain followed by inertial, and (4) a combination of inertial and terrain following. Lateral deviations in flight profile can also be programmed.

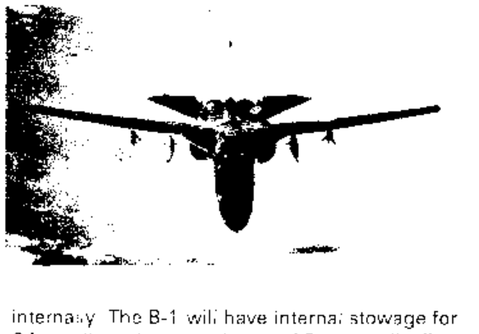
The B-52 carries twenty SRAMs, twelve of which are mounted in two clusters of three missiles on each wing, with eight more carried internally. The FB-111 can carry six missiles, four on individual pivoting pylons under the wings and two internally. The B-1 will have internal stowage for 24 missiles, plus a maximum of 8 externally. The rotary launcher to be used with SRAM on B-1 and B-52 aircraft will permit the launching of eight successive missiles at intervals of five seconds.

DEVELOPMENT:

Specific Operational Requirement 212 was de-

SRAM missile being launched from the internal weapons bay of an FB-111A aircraft at the White Sands Missile Range

SRAM (AGM-69)



FB-111A aircraft carrying SRAMs on wing pylons fined by the USAF in 1964, and requests for proposals were issued to manufacturers the following year. Boeing was selected as the prime contractor in October, 1966, for SRAM design, development and evaluation. The first dummy missile was dropped from a B-52 weapons bay on December 6, 1967. Missile guidance system tests were completed in February 1968. The first dummy drop from the FB-111 took place on November 19, 1968. B-52/SRAM navigation and guidance tests were conducted from Holloman Air Force Base Test Centre, and a simulated missile launch was accomplished in February 1969. By mid-1971 there had been sixteen launches from the FB-111, and flight tests were completed by July 1971, with the missile having exceeded specifications in range, accuracy, radar cross-section and reliability.

STATUS:

The first production SRAM was delivered to the USAF in March 1972. Contracts were placed for 101 missiles in Fiscal Year 1971, 465 in 1972, 480 in 1973 and 454 in 1974. Estimated unit costs for each batch are $760,000, $330,000, $268,000 and $209,000 respectively. It should be noted that these costs do not include the warheads, which are installed by the USAF. The USAF is to modify 282 B-52s and 72 FB-111 aircraft to carry SRAM, and deployment was started in the Summer of 1972 with deliveries of SRAMs to the 42nd Bomber Wing, Loring AFB, for SAC B-52s.

The 750th production missile was delivered in February 1974. The USAF has announced that by the end of 1975 a total of 1,500 would be produced. In March 1974 the US Secretary of Defence reported that acquisition of SRAM will be essentially completed with Fiscal Year 1974 funding and that the planned complement of operational missiles (1140) would be on hand by the mid-1970s.

MANUFACTURERS:

The Boeing Aerospace Company, PO Box 3999, Seattle, Washington 98124, USA – Main contractor.

Lockheed Propulsion Company, PO Box 111, Redlands, California 92373, USA – Solid-propellant motors.

Kearfott Division, General Precision, Inc., 1150 McBride Avenue, Little Falls, New Jersey 07424, USA – Inertial guidance sub-system (inertial platform, guidance and control electronics, guidance computer, power conditioner, rate gyros).

North American Rockwell Corporation, Autonetics Division – Aircraft computers, B-52, FB-111.

Litton Industries, Guidance and Controls Division – Inertial measurement unit B-52.

Delco Electronics – Missile computer.

Stewart-Warner, Electronics Division – Radar receivers/transmitter.

THE UNION OF SOVIET SOCIALIST REPUBLICS

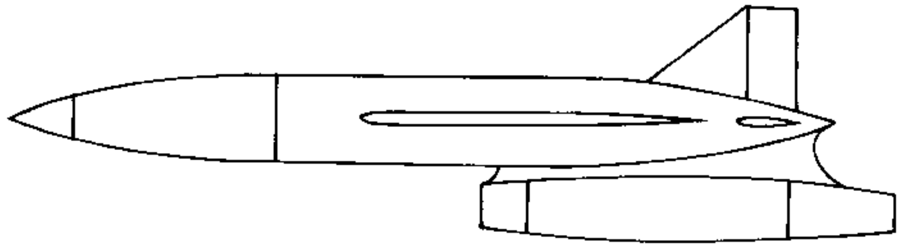
1150.311

KIPPER AIR-TO-SURFACE MISSILE (AS-2)

DESCRIPTION:

Kipper is the NATO code-name of another Soviet stand-off missile, which with Kangaroo (Entry No. **1147.311**) was first seen in 1961. Somewhat smaller, approximately 9.5 m in length and with a wing span of about 4.6 m, it also has an aircraft-like configuration with swept wing and tail surfaces. Propulsion is by a turbojet motor suspended beneath the missile fuselage. Most Western estimates of Kipper's range give a value of between 180 and 210 km. In general appearance Kipper resembles the American Hound Dog, AGM-28 (Entry No. **1093.311**), stand-off strategic bomber weapon.

Kipper is generally considered by observers in the West to be essentially an anti-shipping missile, but the possibility that it may be used for strategic bombing of land targets should not be completely discounted. The weapon is associated with the Tu-16 Badger-C bomber aircraft.



Kipper (AS-2) Provisional

Kipper stand-off missile mounted on Tu-16 Badger-B bomber aircraft

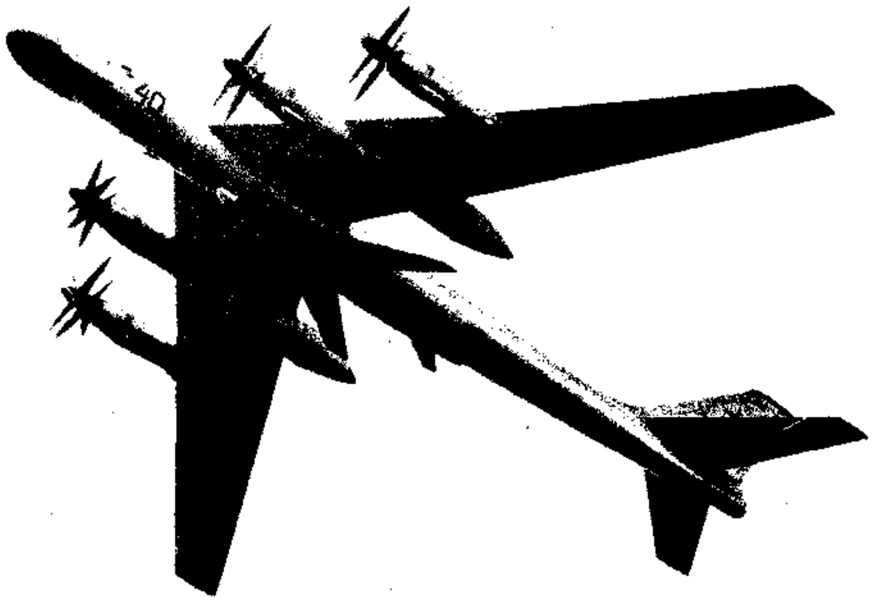
1147.311

KANGAROO AIR-TO-SURFACE MISSILE (AS-3)

DESCRIPTION:

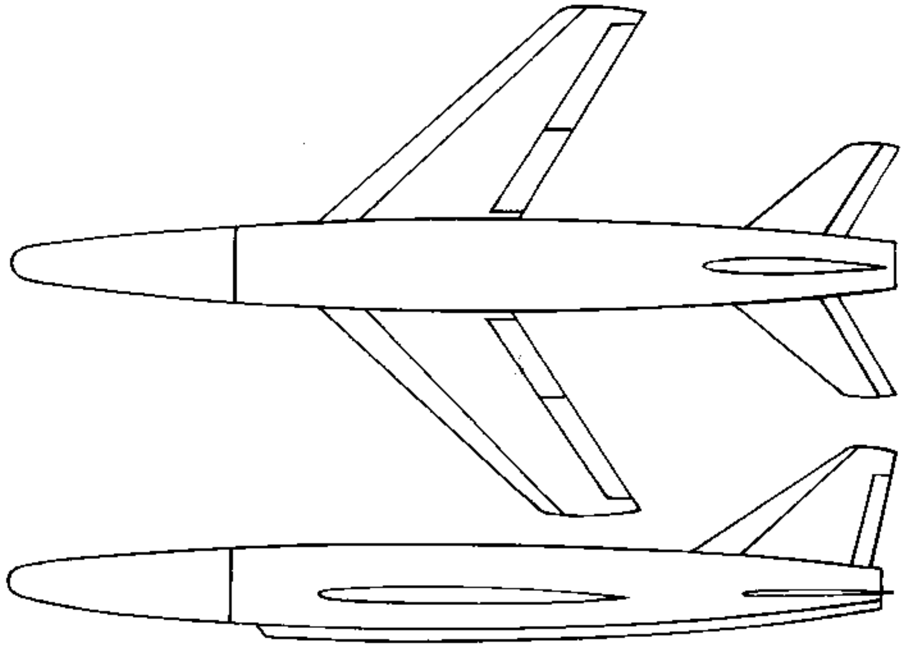
Kangaroo is the NATO code-name assigned to the largest Soviet air-to-surface missile so far revealed. First shown in public in 1961, it is associated with the Tu-95 Bear bomber aircraft and is generally assumed to have retained operational status though its operational importance has probably declined significantly as newer weapons have been deployed.

As the photograph shows, the Kangaroo has the configuration of a conventional swept-wing fighter aircraft and similar dimensions, approximately 15 m in length and with a span of 9 m. The propulsion used has not been confirmed but is probably a turbojet engine. There is no reliable information available as to the ratio in which the relatively large payload potential of Kangaroo is allocated between range and warhead, as is borne out by the wide variation in range estimates published by different specialist sources. These extend from 185 km to 650 km, and it is likely that all these ranges are possible but without access to trustworthy data of the type and weight of warhead,



Kangaroo stand-off missile beneath Tu-95 Bear bomber aircraft guidance method(s) and performance, the true range figure must remain conjecture.

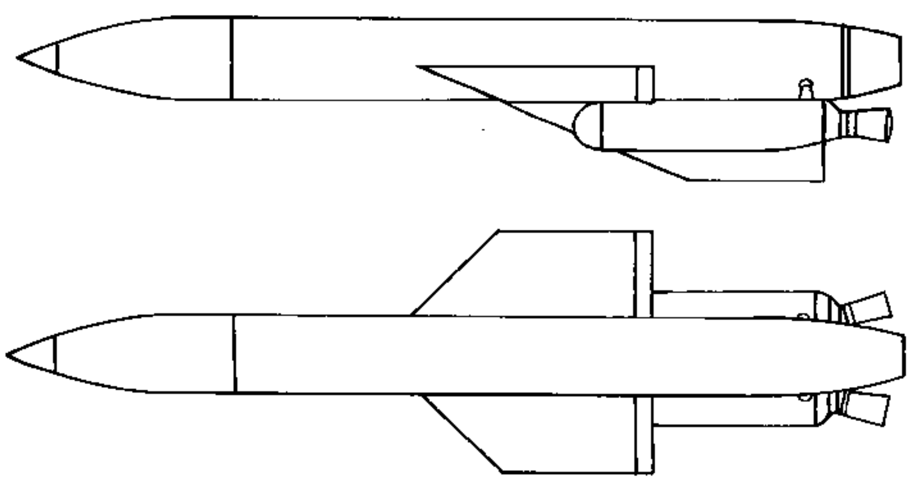
Similar considerations apply to Kangaroo's military function, but the most probable is that the weapon was designed as a medium/long-range stand-off nuclear weapon for use against 'area' targets, such as cities or industrial areas, rather than point targets.



Kangaroo (AS-3) Provisional

1151.311
KITCHEN AIR-TO-SURFACE MISSILE (AS-4)
DESCRIPTION:

Kitchen appears to be one of the most technically advanced Soviet air-to-surface missiles yet revealed. It has a fuselage about 11 metres long to which are attached a pair of delta platform wings and a cruciform tail assembly. Propulsion is by rocket motor, liquid-fuel burning according to American sources, and inertial guidance is assumed. Estimates of range vary widely from 300 km to 800 km, and the aerodynamic features of Kitchen suggest a high cruising speed. The only Soviet aircraft type known to be equipped to carry this weapon is the Tu-22 Blinder, beneath which it was first seen in 1967. The missile is carried in a partly enclosed position on the fuselage undersurface.



Kitchen (AS-4) Provisional

AIR-TO-SURFACE MISSILES—TACTICAL

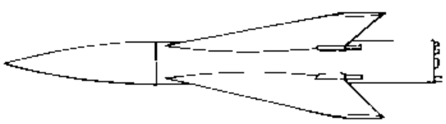
FRANCE

1170.311
AS.20 AIR-TO-SURFACE MISSILE
DESCRIPTION:

Supersonic air-to-surface tactical missile, powered by a two-stage (booster and sustainer) propulsion system. The AS-20 uses solid fuel motors. Principal characteristics are:– length 259 cm, diameter 25 cm, wing span 78 cm, weight 143 kg. A conventional high explosive warhead weighing 30 kg is carried, and a direct action fuse is fitted. The booster motor stage exhausts through two slightly divergent nozzles, and the sustainer uses a single nozzle which is fitted with vanes that enable the missile to be steered. Estimated speed is Mach 1.7 and the approximate flight time is 16 seconds.

OPERATION:

Radio command guidance is used to direct and steer the AS.20 to the target, and the rear of the missile carries twin flares to aid tracking. The same system of control that is used for the AS.30 missile (which see) can also be used for the AS.20, and the latter weapon is proposed by the manufacturers for use as a training round for AS.30 operation. A special adaptor is available to enable the AS.20 to be carried by aircraft normally equipped for the AS.30. Launch of the AS 20 is possible from any aircraft capable of a speed of Mach 0.7 or over.



AS.20

The standard fire control equipment for aircraft using the AS.20 consists of: command guidance installation, including control stick; command radio transmitter, with optional co-ordinate converter; ignition and power supply circuits; and missile launchers with three missile attachment points, mounted either under the fuselage or wing.

STATUS:

The AS.20 has been ordered in quantity by several armed forces, and it is estimated that at least 8,000 have already been supplied. Users include the French Air Force and Navy, the German and Italian Air Forces, and at least two other countries.

MANUFACTURERS:

Société Nationale Industrielle Aérospatiale, Division Engins Tactique, 2 rue Béranger, 92320-Chatillon, France.

1171.311
AS.30 AIR-TO-SURFACE MISSILE
DESCRIPTION:

Medium/heavy air-to-surface tactical missile. The AS.30 has been described as a scaled-up AS.20, and the general configuration and mode of operation are very similar. The AS.30 has a streamlined, cylindrical body with swept cruciform wings. Early versions of this missile appeared without any other surfaces, but current models also have four small fins very near the rear end of the missile and located between the exhaust tubes of the booster motor.

Principal characteristics of the AS.30 are:– length 390 cm, diameter 34 cm, wing span 1 m, weight 520 kg. Weight of the high explosive warhead is 230 kg. Speed at impact is 450-500 m/sec. and range is 10 to 12 km. Propulsion is by two-stage solid-fuel motors, booster and sustainer.

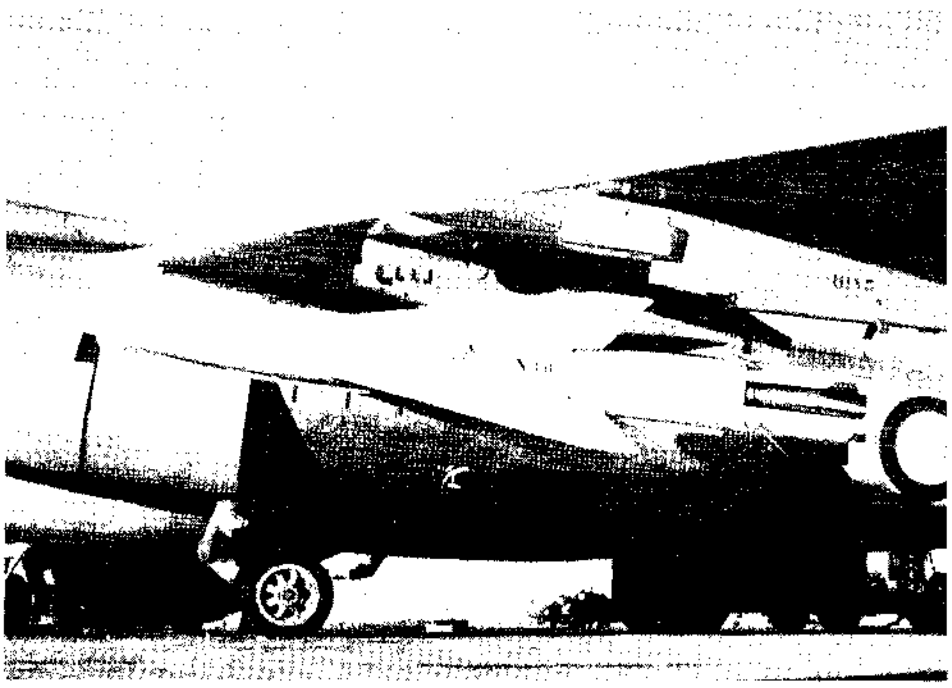
OPERATION:

Guidance is by radio command link, with two alternative methods of control from the launch aircraft. The simplest is the use of a control stick in the cockpit of the launching aircraft with which the operator controls the flight of the missile to the target by visual observation of its flight path. Flares are fitted to the missile to aid tracking. A later development uses a stabilised IR tracker on the aircraft and infra-red flares on the missile to provide a form of automatic guidance.

On the aircraft an infra-red tracker developed by Société Anonyme de Télécommunications provides continuous data on the missile position relative to the aircraft, while the pilot uses his attack sight to provide a continuous bearing to the target. This is accomplished by merely keeping the target centred on the aiming mark of the sight. An on-board computer unit uses these data to derive corrective command signals which are transmitted to the missile guidance system in the same way as for manually controlled firing of the AS.30.

The radio command link is of the progressive type, and in the normal (manual) mode of operation, it continuously transmits pitch and yaw demand signals which originate from movements of the two-degree-of-freedom control stick in the cockpit of the launching aircraft.

An ingenious operational mode possible with the AS.30 in tactical attack situations where the target is relatively large and a rather greater CEP can be accepted involves the use of two aircraft. The first approaches the target, followed by the second aircraft some kilometres astern, and launches the missile toward the target. The launch aircraft then immediately breaks off and takes evasive action, leaving the second aircraft to assume command of the missile from a safer distance. To meet this requirement, a three-position commutator switch is provided with positions for firing with guidance; firing without guidance, and guidance without firing. The first position corresponds with normal use of the missile by a single aircraft, and the second and third positions inhibit the command transmitter and the missile firing circuits, respectively.



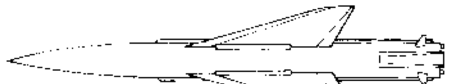
AS.30 air-to-surface missile

DEVELOPMENT:

The AS.30 was designed and developed to meet a specification by the French authorities which called for a minimum launch range from the target of 10 km and a further requirement that the aircraft would not need to come within 3 km of the target. A circular probability error of 10 m or less was also specified, and it is reported that these requirements have been exceeded in use. Compared with the AS.20, the larger AS.30 is capable of launch at a lower speed – Mach 0.45 compared with Mach 0.7.

STATUS:

The AS.30 is in full production and orders outstanding or completed are estimated to exceed 8,000. Users in addition to the French Forces include: The RAF, German, Indian, Israeli, Swiss and South African air forces.



AS.30

MANUFACTURERS:

Société Nationale Industrielle Aérospatiale, Division Engins Tactique, 2 rue Béranger, 92320-Chatillon, France.

1173.311

AS.11 AIR-TO-SURFACE MISSILE

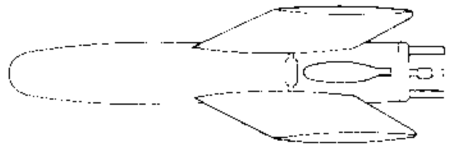
DESCRIPTION:

Wire-guided multi-purpose, lightweight air-to-surface missile. The SS-11 was originally conceived as a general-purpose battlefield weapon for deployment on surface vehicles, but it has been successfully adapted for use with helicopters, hovercraft and surface vessels. Designation of the former version is AS.11.

Principal characteristics are: length 1.2 m, diameter 16.4 cm, wing span 50 cm, weight 29.9 kg (approx). Average cruising speed is 160 m/sec, and time of flight 20 to 21 seconds. The maximum practical range is 3,000 m. The SS.11 B1 can be equipped with three types of warhead, anti-tank, a 'high-effect' high explosive warhead, or fragmentation type.

OPERATION:

Using a stabilised optical sight, the operator gathers the missile after launch (aided by tracer flares attached to the missile), and then uses a control stick to transmit command signals to the missile via wires to align the missile flight path with the target. Maintaining this alignment results in the missile hitting the target.



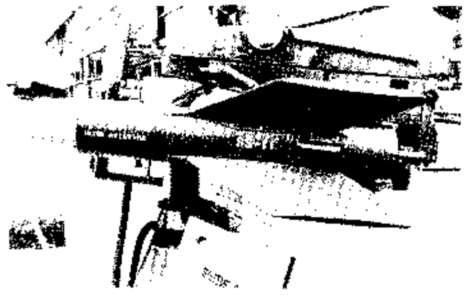
AS.11

STATUS:

Between 100,000 and 200,000 of the various versions of the SS.11 series have been supplied to 21 different countries.

MANUFACTURERS:

Société Nationale Industrielle Aérospatiale, Division Engins Tactique, 2 rue Béranger, 92320-Chatillon, France.



The SS.11 shown on a surface launch mounting. The airborne missile is virtually identical

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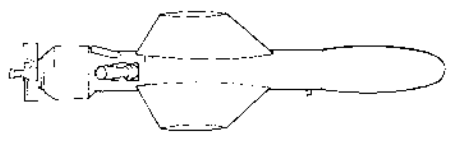
1174.311

AS.12 AIR-TO-SURFACE MISSILE

DESCRIPTION:

Airborne version of the SS.12 (which see) to provide an air-to-surface general-purpose lightweight missile. Principal characteristics are: length 187 cm, warhead diameter 21 cm, wing span 65 cm, launch weight 76 kg, weight of warhead 28.4 kg. The AS.12 can be equipped with a variety of different warheads to meet a range of operational requirements. The OP.3C has penetrating power sufficient to pierce over 40 mm of armour plate with a delayed action detonation, and other types include a powerful shaped charge, and a fragmentation head.



AS.12

OPERATION:

Guidance is by command signals fed to the

Close up of AS.12 missile

missile via wires, the missile operator in the aircraft usually being provided with a stabilised sighting system, and a control stick for steering the missile. Installed in a helicopter, the AS.12 is reported to be highly accurate when used with such a sight at ranges out to 6,000 m. Use of a sight of this type also permits the launch aircraft to manoeuvre during missile flight. Maximum range of the AS.12 when launched from an aircraft providing 200 knots forward speed is 8,000 m.

DEVELOPMENT:

While the SS.12 and AS.12 are based on the highly successful techniques employed in the earlier SS.11 series of missiles the former weapons have been designed with much greater versatility and kill power in view. Range is approximately doubled, and the warhead is stated to be four times as powerful as that of the SS.11. The SS.12 range of missiles is capable of being launched from the several types of launcher developed for the SS.11 missiles.

STATUS:

The AS.12 is in operational service with at least eight different types of aircraft, including the ASW Atlantic and Nimrod aircraft and RN Wasp and Wessex helicopters.

AS.12 air-to-surface missile carried by Wasp helicopter

MANUFACTURERS:

Société Nationale Industrielle Aérospatiale Division Engins Tactique, 2 rue Béranger, 92320-Chatillon, France.

1770.321
AIR-LAUNCH EXOCET (AM.38 & AM.39)

DESCRIPTION:

The successful MM.38 Exocet anti-ship missile has had its usefulness increased by the development of two air-launched versions, the AM.38 and AM.39. The former is a virtually standard Exocet missile slightly modified to enable it to be launched from beneath the Super-Frelon naval helicopter instead of from a launcher container as in the shipborne version (**1156.221**). The AM.39 model has slightly more extensive changes to permit its deployment on fixed-wing aircraft which may operate at greater altitudes than the Super-Frelon.

The Super-Frelon/Exocet weapon system comprises:

(1) An Omera ORB-31D search radar which incorporates facilities for the automatic transmission to the missile to be fired continuous target range and bearing data. The target is designated on the radar by the operator.

(2) A control panel for the insertion of operational information.

(3) A missile adaptor kit which provides for missile selection and also performs pre-launch navigation calculations for the selected missile.

(4) Two missile launchers located alongside the helicopter fuselage, ahead of the main landing wheels.

Equipped in this way the Super-Frelon can carry 5,000 litres of fuel, by means of extra tanks, enabling it to remain airborne for about six hours, or engage a target up to 350 nautical miles away. The main characteristics of the missile in this role are: range 28 nautical miles; inertial cruise followed by active radar homing; sea-skimming cruise, impact or proximity fuse. The missile is released from the helicopter inert, the motor being ignited 1.5 seconds later.

Super-Frelon carrying two AM.38 air-launch Exocet anti-ship missiles

The high-altitude, fixed-wing aircraft version of Exocet, AM.39, has been evolved with deployment on Atlantic and Super-Etendard aircraft in mind.

DEVELOPMENT:

Following the release of three inert models from a Super-Frelon, two Exocets were launched in June 1973 with motors that had had their burning time limited to reduce the distance covered by these test pieces. These tests were successful and were later followed by more elaborate trials involving the helicopter firing installation and the ORB-31-D radar.

STATUS:

The French Government is understood to have decided on procurement of the AM.38, but at May 1974 no decision on the AM.39 version had been disclosed.

MANUFACTURER:

Société Nationale Industrielle Aérospatiale, Division Engins Tactique, 2 rue Béranger, 92320-Chatillon, France.

GERMANY (FEDERAL REPUBLIC)

1180.321
KORMORAN AIR-TO-SURFACE ANTI-SHIPPING MISSILE

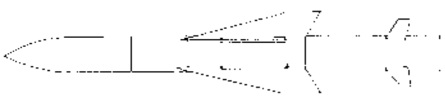
DESCRIPTION:

Kormoran (AS.34) is an advanced air-to-surface missile, designed principally for strikes against surface shipping. The guidance system employed provides a useful stand-off capability for the launch aircraft. Main characteristics of the missile are length 440 cm, diameter 34.2 cm, wing span 1 m, weight 580 kg, speed Mach 0.95, and range about 20 nm.

Propulsion is by solid-fuel motors, and a hybrid guidance system is employed. Cruciform, broad chord swept wings are located just aft of the cylindrical missile body midpoint, and these are followed by a set of four in line tail fins. A specially-developed high explosive warhead is carried.

OPERATION:

Several operational modes appear to be provided for by the guidance equipment developed for the Kormoran. The major portion of the trajectory is travelled under the guidance of an inertial system followed by a terminal homing phase on to the target. The latter phase can be performed by one of three methods, passive infra-red, active radar homing, or passive homing on to radiation from the target itself.



Kormoran (AS.34)

Target designation could be performed by either the radar of a surface vessel working in conjunction with the Kormoran carrying aircraft, or with the aid of the latter's forward radar. A completely blind attack also seems possible, provided the geographical co-ordinates of the target are known to reasonable accuracy.

Missile launch, according to information released at the 1969 Paris Air Show, is normally effected from a low level, with the aircraft flying in the general direction of the target. On release, the first of the two propellant motors burns for about one second to accelerate the missile, after which the single-nozzle sustainer motor takes over. There is presumably on-board computation equipment to relate the precise position of the aircraft at the time of launch with that of the target to enable the missile inertial navigation system to guide the missile toward the target at low level to remain beneath radar cover for as long as possible.

At a predetermined position, a climb is programmed to take the missile up to a height from which the target can be 'seen' to enable the homing equipment to take over for the terminal phase of the attack.

The radar homing head fitted is the RE 576 developed by Thomson-CSF. This is stated to be capable of either active or passive homing, and the assumed mode of operation is that when the missile has reached a height to bring it within line-of-sight range of the target, the radar receiver is switched on for an initial period during which it searches for radar signals emanating from the target. If such signals are received, the homing head will lock on and the missile will operate in a passive homing mode. In the absence of signals, the radar transmitter in the missile will be switched on and a target search, lock on and tracking sequence will follow to enable the missile to intercept the target.

The RE 576 head is an autonomous automatic search and track radar, providing range, bearing and elevation data from which control signals for the missile autopilot can be derived. An inverse-Cassegrain aerial system is used, with the feed passing through the centre of a ridged-plate main reflector. Energy from the feed is first directed to a semi-reflector situated in front of the gimballed reflector plate, before being returned to the latter which is responsible for focusing and steering the beam.

DEVELOPMENT:

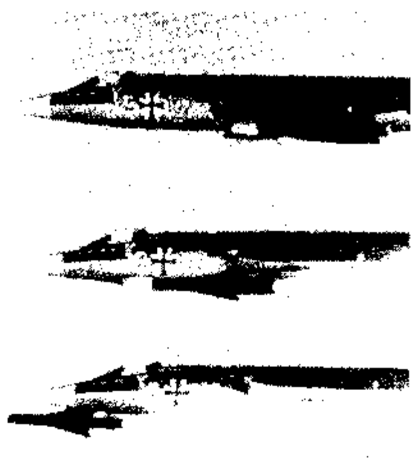
Kormoran is the largest missile project so far undertaken in West Germany, and was initiated in 1964 to meet a Navy requirement. Messerschmitt-Bolkow and SNIAS are working in collaboration on the project. The inertial navigation system is most probably the same as that flown in the Nord experimental AS.33 missile. The RE 576 was stated by the manufacturers to have achieved 120 experimental launches by June 1969, and the same unit is believed to be employed in the Swedish anti-shipping missile.

STATUS:

The first air launch, from an F-104G, took place successfully on March 19, 1970.

In May 1971 it was announced that the first of a series of fully equipped missiles had been successfully launched from an F-104G against a moving target 'many kilometres' away. The homing head successfully acquired and tracked the target. No warhead was used for this test.

Further prototype firings were followed by deliveries for armament evaluation tests by the West German Navy in the Summer of 1972. These trials had been completed successfully by early 1974 and preparations for serial manufacture were then in progress.



MBB Kormoran launch sequence from W German F-104G during operational tests over the Bay of Biscay. Hits were scored on a target ship at maximum range and with a head-on aspect

So far the West German Navy is the only named user for the Kormoran, but interest from the Italian Air Force has been reported, and use with the MRCA is another possibility.

MANUFACTURERS:

Messerschmitt-Bölkow-Blohm GmbH, Munich-Ottobrun, West Germany.

Société Nationale Industrielle Aérospatiale, Division Engins Tactique, 2 rue Béranger, 92320-Chatillon, France.

Thomson-CSF, Division des Matériels d'Avionique, 178 Boulevard Gabriel Peri, 92–Malakoff, France.

1532.311

JUMBO AIR-TO-SURFACE MISSILE

DESCRIPTION:

Jumbo is a large, long-range stand-off air-to-surface missile being developed by Messerschmitt-Bölkow-Blohm GmbH under contract to the Federal Ministry of Defence. It is intended for use against large or high-value surface targets, and it is proposed to deploy this missile with the MRCA and F-4 Phantom aircraft. Dimensions are: length 5.24m, diameter 50 cm, span 1.25m, and weight approximately 1150 kg. Guidance during the cruise phase will be by autopilot/inertial system, with TV target aquisition and homing for the terminal phase. The crew of the launching aircraft will be provided with a monitor screen for viewing the television pictures relayed via a telemetry link from the Jumbo missile.

The complete system consists of the missile itself and an electronics package which will be carried by the aircraft as an external store, thus eliminating the need of a large, permanent installation inside the aircraft. It also enables the Jumbo system to be adapted to various aircraft types.

DEVELOPMENT:

Jumbo is under development by MBB under a West German Ministry of Defence contract. There is a possibility that the programme may eventually become an international project according to MBB.

The first picture to be released of the MBB Jumbo stand-off missile.

MANUFACTURER:

Messerschmitt-Bölkow-Blohm GmbH, Munich-Ottobrun, West Germany.

1531.311

STREBO AIR-TO-SURFACE AREA WEAPONS

DESCRIPTION:

The STREBO designation has been given to studies by Messerschmitt-Bölkow-Blohm of weapon systems specifically to counter large-scale ground attacks by infantry and armour. Two versions had been identified by May 1972, Strebo I and Strebo II. The former is proposed for deployment on West German F-104G aircraft, while Strebo II is larger and is intended for carriage by the MRCA. The Strebo classification apparently refers to weapon dispensing systems and techniques rather than missiles. It is envisaged that bomblets (with and without delayed action fusing) and mines would both be employed, with distribution by 'seeding' and assisted dispersion methods. The latter would include rocket assistance to initially launch the weapons above the sending aircraft to ensure distribution over a greater area. The aircraft would operate at very low level. The weapons would be suitable for both anti-personnel and anti-tank use, and mixed payloads would be carried.

STATUS:

No official information has been released but it is reported that the first of these weapons could be ready by the mid-1970s.

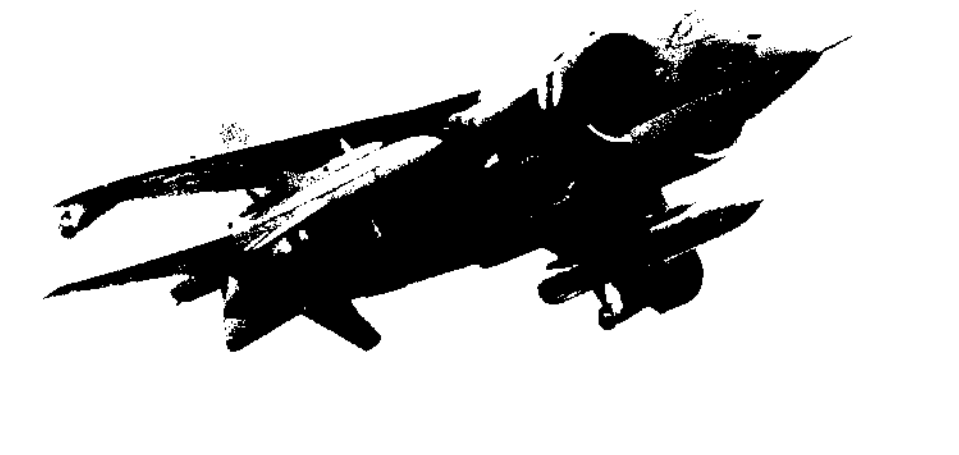
INTERNATIONAL

1022.311

MARTEL AS.37/AJ.168 AIR-TO-SURFACE MISSILE

DESCRIPTION:

Martel is an air-to-surface tactical missile with two alternative terminal guidance systems capable of offering a considerable stand-off capability. Both versions are designed to operate in an ECM environment, to which a high resistance is claimed. The two forms of terminal guidance are: passive homing onto electromagnetic radiation in the AS.37, anti-radar version; and visual guidance to a selected target by means of a nose-mounted TV camera and a data link over which both video and command signals are passed be-



Hawker Harrier carrying anti-radar versions of Martel missile tween aircraft and missile, in the AJ.168 variant. The Martel system is the product of a joint Anglo/French development programme with prime responsibility for the AS 37 resting with Engins Matra, and for the AJ.168 with Hawker Siddeley Dynamics.

General configuration of the missiles can be seen from the diagram and adjacent photographs. Length of the AJ.168 is 390 cm, and of the AS.37, 420 cm; body diameter and wingspan, respectively, for both versions are 40 cm and 120 cm. No details of performance have been revealed, but range has been officially stated both as 'several tens of miles' and several 'tens of kilometres'. This suggests a range of about 60 km although maximum range will be to some extent dependent upon the height of launch and subsequent trajectory.

OPERATION:

Both versions of Martel probably employ the same basic autopilot which provides guidance until either TV or radar homing systems assume control for the terminal guidance phase. There are some indications that the autopilot can be pre-programmed to provide several options of mission profile. A fundamental difference, in addition to the guidance system, is related to the two-stage propulsion assembly, which is adapted to the mission requirements specific to each version.

Martel AS 37. The Electronique Marcel Dassault AD.37 homing head is believed to use a movable receiver aerial, possibly of the inverse Cassegrain type, and this is used both prior and subsequent to launch from the aircraft. Prior to launch, the AD 37 provides data for the pilot for navigation to and determination of launch point. These data are presented via the aircraft equipment, and probably consist of initial warning of hostile radar signals, followed by information on their aspect relative to the aircraft. After launch, the AD.37 head locks onto the radar target and generates guidance signals for the auto-pilot to direct the missiles to the target. Missile control is by means of four moveable fins placed a short distance behind the cruciform wings.

Martel AJ.168. Where illumination by the opposing radar is necessary for the AS 37 version of Martel to operate, the TV-guided variant will most likely be deployed and operated to keep radar contact to a minimum, and for this reason it is more likely to be launched from a low altitude, preferably while the launch aircraft itself is still beyond radar range. Launch will be from a known geographical position and the weapon will be directed along a calculated track to the target.

A TV camera in the nose will produce pictures of the terrain over which it is flying, and these are transmitted back to the missile operator in the launch aircraft, which by this time can be on its way back to base. A monitor screen in the operator's cockpit will enable him to relate the missile track to the correct calculated path, enabling him to make corrections. He may be aided in this by a projected map display. When the designated target (or a target of opportunity) is sighted by the TV camera, the operator can use the radio command link to fly to it, completing the attack.

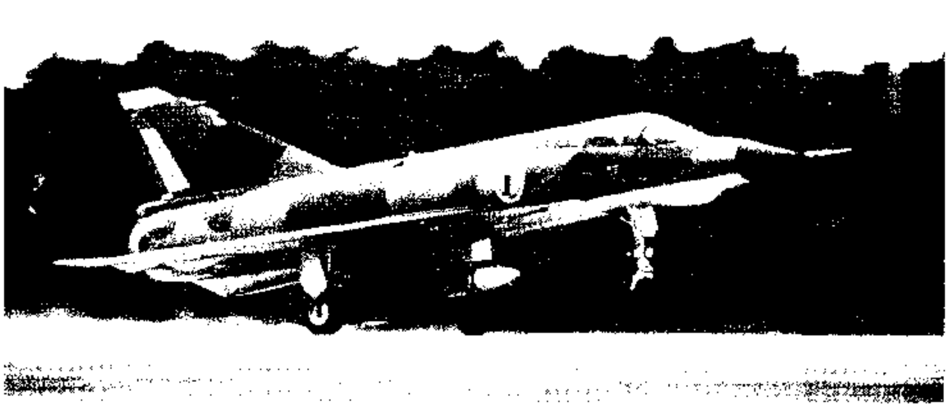
The TV Camera Control Unit and the Video and Command data link system have been developed by Marconi Elliott Avionic Systems Ltd.

DEVELOPMENT:

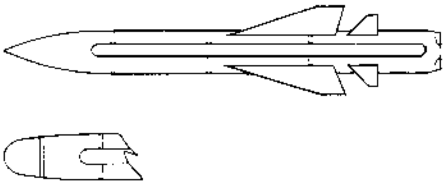
The UK and France entered into an agreement for the joint development and production of Martel in September, 1964, although related studies preceded this by possibly as much as four years. The first simulated firings and mock-up launchings took place in the Summer of 1964, and prototypes of both versions were completed in 1965-66. Evaluation trials have been completed for both variants.

STATUS:

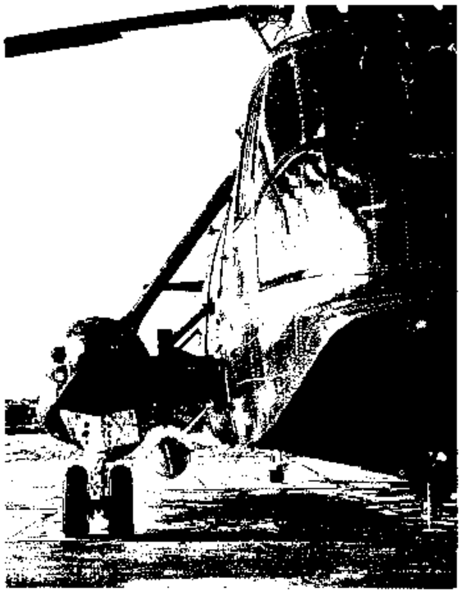
Production contracts were placed by the British and French Governments in December 1968 and production missiles and equipment are now being delivered to the British and French Services. The Martel system will be used on the Mirage III E, Jaguar, Atlantic, and Buccaneer Mk II.



Martel carried by Mirage III E



Martel (AS.37/AJ.168) showing alternative anti-radar and TV homing heads



Full-scale model of Martel missile on RN Sea King helicopter during trials

MANUFACTURERS:

Prime Contractors:

Hawker Siddeley Dynamics Ltd, Manor Road, Hatfield, Herts AL10 9LL, England.

Engins Matra, Ave. Louis Breuguet, 78-Velizy, France.

Marconi-Elliott Avionic Systems Ltd, Basildon Essex, England – TV guidance system.

Electronique Marcel Dassault, 55, Quai Carnot, Saint-Cloud, Paris, France – AD.37 homing head.

1338.321
OTOMAT ANTI-SHIP MISSILE (FRANCE/ITALY)

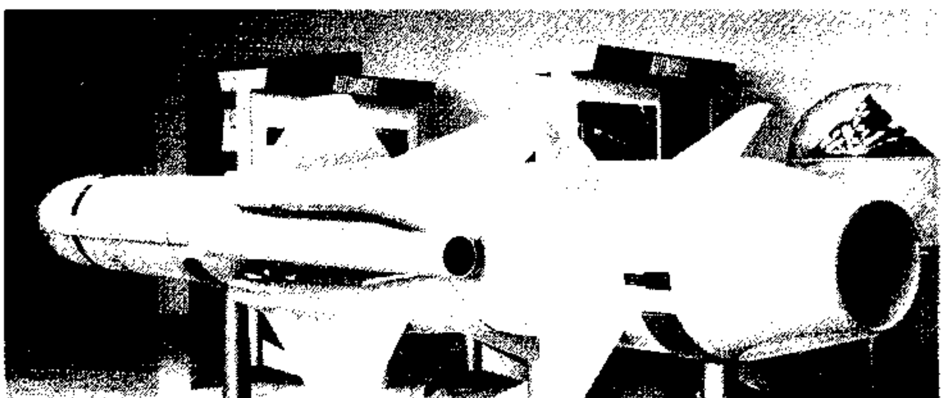
DESCRIPTION:

Otomat is the anti-surface version of an all-platforms anti-ship missile. Range is over 80 km, but with fuel capacity for greater ranges (200 km); speed is in the region of Mach 1. Inertial guidance plus a radio altimeter is used for the low-level cruise phase with a Thomson-CSF active homing head for terminal guidance. Two lateral boosters are employed for initial acceleration in the helicopter version but these are not always required for the aircraft version. A more detailed description appears in Entry No **1336.221**.

DEVELOPMENT:

Studies are underway for the adaptation of Otomat to other aircraft. A series of completely guided firings has been made so far to demonstrate and evaluate the long range capability, and the shape of the final attack pattern.

Development continued until 1974, will be followed by evaluation by the Italian Navy, which has already signed a contract for the surface-to-surface version.



Air-to-surface version of the Otomat anti-ship missile

STATUS:

The use of Otomat for its maritime patrol aircraft (Atlantic) and its strike aircraft (Super Etendard) is under consideration by the French Navy. The missile is also proposed for helicopters (SH-3D, and Superfrelon).

MANUFACTURERS:

Engins Matra, 78140 Vélizy, France.

Oto Melara, La Spezia, Italy.

1771.311
HOT AIR-TO-SURFACE MISSILE
DESCRIPTION:

The relatively recent increase in interest regarding the use of helicopters in a specifically anti-tank role has led to the development of a helicopter installation for the HOT anti-tank weapon. The basic HOT missile is described in Entry No. **2212.111** in an earlier section of this book, and the following refers to the helicopter version.

Depending upon the type of helicopter used, two, four or six launcher ramps to accept the HOT combined container-launch-tube can be fitted, and these are elevation-slaved to the line-of-sight. For helicopter operation a stabilised optical sighting system is used, this being derived from the APX334 sight described in Entry No. **7032.393** in Section Three of this book.

The guidance system includes a dual-field infra-red 'localizer', with a 12-degree acquisition field and a one-degree tracking field. The function of the infra-red localizer is to establish the position of the HOT missile relative to the line-of-sight (which normally will be maintained on target by the operator using his optical sight). Appropriate guidance signals are computed and transmitted via the command wire to maintain the missile on the line-of-sight to the target.

HOT Anti-Tank weapon system on BO 105 helicopter

MANUFACTURERS:

Management, sales and production responsibilities rest at: Euromissile, 37 Boulevard de Montmorency, 75016 Paris, France.

Aérospatiale, Division Engins Tactiques, 2-18 rue Béranger, 92-Châtillon, France.

Messerschmitt-Bölkow-Blohm, GmbH, Ottobrun, Munich, West Germany.

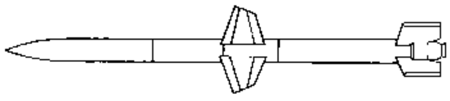
ITALY

1650.321
AIRTOS AIR-TO-SURFACE ANTI-SHIP MISSILE
DESCRIPTION:

Airtos is an aircraft-launched anti-ship missile for use at short to medium ranges and under all-weather conditions. The design provides for the engagement of high-speed (up to 90 knots) targets such as hydrofoils and hovercraft with considerable manoeuvring capabilities. The principal dimensions of Airtos are: length 3.9 m, body diameter 206 mm, wing span 857 mm, weight (at launch) 191 kg. The maximum speed is Mach 1.9, maximum launch range is 11 km, and the minimum range from an aircraft at 500 m is 3 km. A 35 kg fragmentation warhead is carried and impact and proximity fusing are provided. The solid propellant booster motor has a thrust of 2,000 kg and a burning time of five seconds. Aerodynamic control is by means of the four moveable cruciform in-line wings, and stability is assisted by a set of four tail fins. Active pulse radar guidance is used, assisted by a radio altimeter.

OPERATION:

The launching aircraft can use any means for surface target detection, after which the Airtos missile is directed towards the target by aircraft manoeuvres. When homing head lock-on to the target has been achieved (between 17km and 11 km) the operator is warned and the missile can be launched. After launch, no further guidance of Airtos is required from the aircraft which is then free to take avoiding action or engage other targets. Shortly after release from the aircraft the missile drops to a cruise altitude of about 10 metres which is maintained under radio altimeter control. At a preset distance from the target, altitude is further reduced to 2 to 5 metres for the final



Airtos

attack phase. Throughout the missile flight homing guidance is by means of the active radar homing system. This system has an antenna angular aperture of 30 degrees, and high resistance to sea and rain clutter.

DEVELOPMENT:

Development is believed to have started in 1969 and the Airtos system was still in development during 1974.

MANUFACTURER:

SISTEL – Sistemi Elettronici S.p.A., Via Tiburtina 1210, 00131 Rome, Italy.

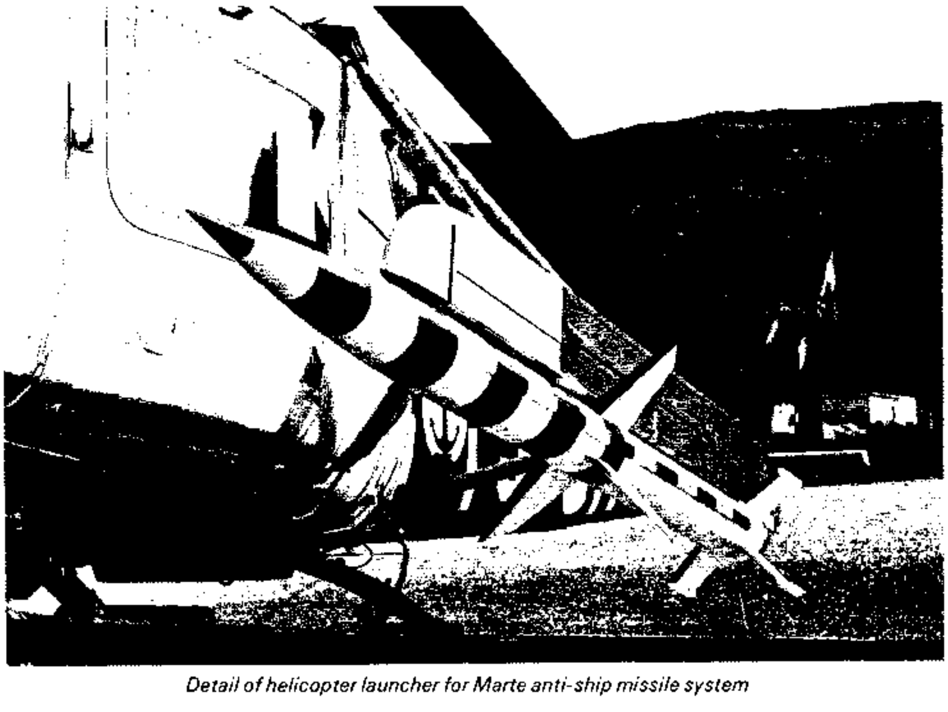
1651.321
MARTE HELICOPTER ANTI-SHIP MISSILE SYSTEM
DESCRIPTION:

The purpose of the Marte system is the destruction or disabling of naval craft in "all weather" conditions by means of Sea Killer missiles launched from helicopters in a stand-off position.

So far, the helicopter-borne missiles used in conjunction with the Marte Project are the Sea Killer Mk1 (10 km range with 35 kg warhead) and Sea Killer Mk2 (20 km range with 70 kg warhead for the Marte version). Easily operated and light equipment only need be carried on board the helicopter since the radar performs navigation search and track of the target as well as guidance of the missile in azimuth (the missiles are autonomous in altitude by means of SISTEL-designed radar altimeter).

Installation of the Marte Weapon System has been studied on helicopters ranging from a maximum TO weight of 3,000 kg up to 10,000 kg or more depending on the number of missiles carried and on the operational requirements which may call for simultaneous ASW and Surface Strike capability or not.

A typical installation is pictured in the nearby diagram: the SH3D helicopter shown, fully equipped for Surface Strike and anti-submarine surveillance plus autopilot for instrument flight.



Detail of helicopter launcher for Marte anti-ship missile system can be assigned to a 4.30 hour patrol mission, at a search speed of 100 knots (max. 130) with a crew of 4.

The Sea Killer Mk1 and Mk2 are sea-skimmer missiles, of a cruciform configuration and centre wing control, roll-stabilized, and based on the use of a combined radar (illumination) radio command/radio altimeter guidance system. For the configurations studied for the Italian Navy, two Sea Killer Mk1 missiles have been installed on light helicopters, and alternatively two Sea Killer Mk2 or four Sea Killer Mk1 on-board heavier ones, always allowing for at least a 4 hour endurance.

OPERATION:

Figure 2 shows the events occurring in the case of a helicopter attack on a naval target with a Sea Killer Mk2 missile. The helicopter discovers a target with a short radar exposure time: a few seconds. It may be assumed that detection occurs at the radar range limit; in these conditions the probability that the enemy recognizes the helicopter's radar interrogation is not absolutely certain; the helicopter, therefore, having discovered the target, shuts down its radar, reduces altitude to elude as far as possible the enemy's active search and, with dead reckoning or with a passive "homing" procedure on radar interception directs itself towards the target. At an estimated distance slightly above the missile range, it rises again to the launching height, re-acquires the target and launches the missile which takes slightly more than a minute to reach the target. It is not necessary for the helicopter, having launched the first missile, to proceed en route towards the target, it may as well hover or change course and altitude with the only limitation of the maximum range distance not to be exceeded.

As can be seen, in this manoeuvre the helicopter is exposed to detection by the enemy radar only during the launching phase of the missile.

In all modes of operation, the missile altitude is automatically controlled by a built-in altimeter. This enables precise control of altitude down to very low values (2 m or less). The missile flight height can be preset prior to launching, or changed during flight – choice depending upon the operational requirements, sea-state, etc. – either in accordance with a given programme or by means of a command signal transmitted to the missile, via the command link.

The missiles may be controlled in azimuth with two difnerent modes of operation: the radar mode, automatically in "all weather" conditions and the optical mode, a standby or "fair weather" system using an optical sight.

DEVELOPMENT:

In 1967 the Italian Navy began the preliminary studies required for strengthening the offensive capabilities of ground-based or ship-based helicopters by arming them with anti-ship missiles as a complement to the use of helicopters in antisubmarine warfare. Obvious requirements were those of ensuring the helicopter a high kill potential at stand-off ranges in its new surface role, as well as safe mission profiles. The solution adopted was the Sea Killer family of missiles.

The Italian Navy promoted a development programme known as the Marte project, with the firms SISTEL, as prime contractor, Agusta and SMA with the purpose of proposing a weapon system for installation on board helicopters of the Sea Killer missiles, which meanwhile had reached operational status in their ship-to-ship version. SISTEL was chosen because it had originated the Missiles, Agusta as the manufacturer of the helicopters while SMA specialises in radars.

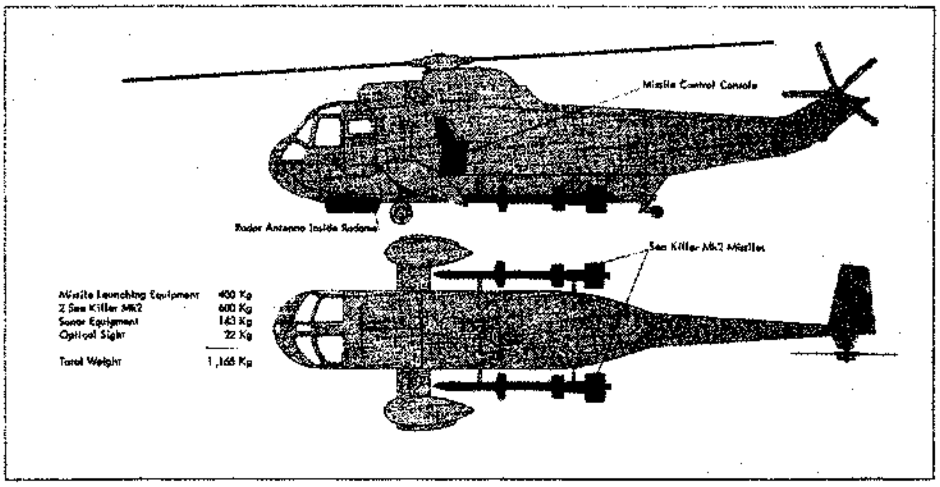


Figure 1

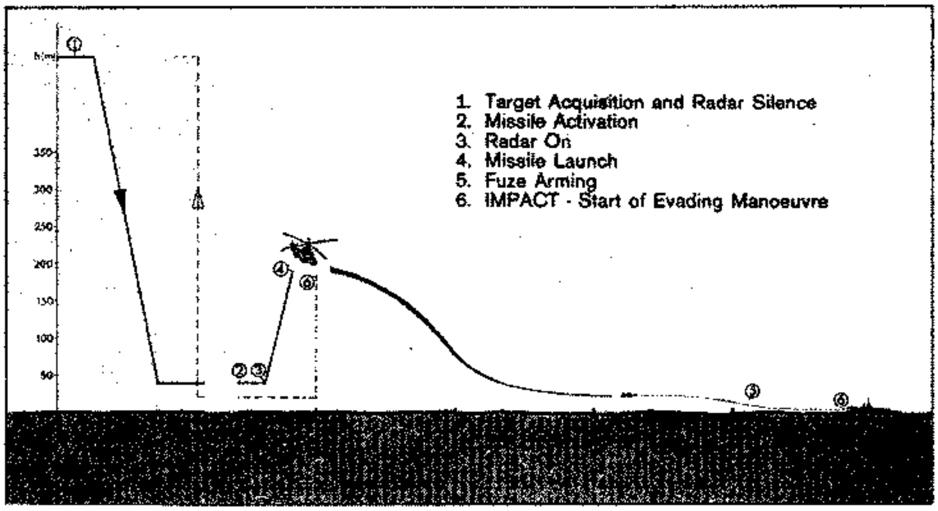
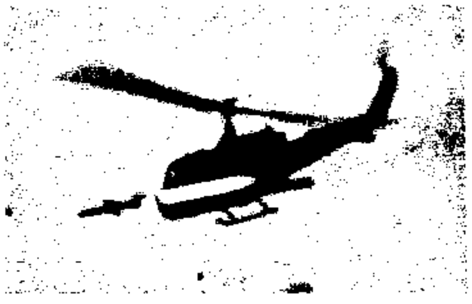


Figure 2



Marte anti-ship missile system launch from helicopter

STATUS:

Development has been in progress since 1969. Both ground and air firings have been made.

MANUFACTURER:

SISTEL – Sistemi Elettronici S.p.A., Via Tiburtina 1210, 00131 Rome, Italy.

JAPAN

1653.311
ASM-1 AIR-TO-SURFACE MISSILE

DESCRIPTION:

Under the designation ASM-1 the first Japanese tactical air-to-surface anti-ship missile is being developed for use with the Mitsubishi FS-T2 close-support aircraft. No official details have been obtained but provisional characteristics are range approximately 45 km, speed about Mach 1, and it has been reported that a 140 kg warhead will be carried. It has been officially stated that the ASM-1 will also be capable of ship or ground launching by the addition of a rocket booster motor. An inertial system will be used for mid-course guidance and an active radar seeker for terminal homing.

STATUS:

In November 1973 Mitsubishi Heavy Industries Ltd was selected as prime contractor for the development of the ASM-1.

MANUFACTURER:

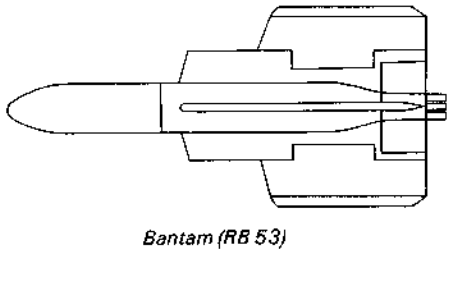
Mitsubishi Heavy Industries Ltd., 5-1 Marunouchi 2-chome, Chijoda-ku, Tokyo 100, Japan.

SWEDEN

1652.311
BANTAM (RB 53) AIR-TO-SURFACE ANTI-TANK MISSILE

DESCRIPTION:

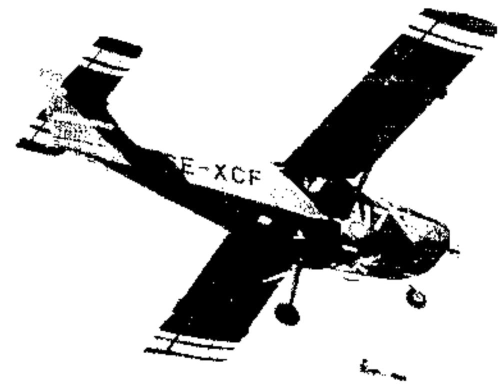
This is a helicopter version of the infantry anti-tank weapon system using the wire-guided Bantam missile. The Bantam has also been fired successfully from light aircraft like the Bulldog and Saab-MFI 17. The standard infantry control unit has been used with excellent scoring results. The missile itself is described more fully in Entry No. **2363.111.** Principal features are length 850 mm, body diameter 110 mm, span 400 mm, weight 7.5 kg. A two-stage solid-propellant motor is employed and a 1.9 kg hollow charge AP warhead is carried.



Bantam (RB 53)

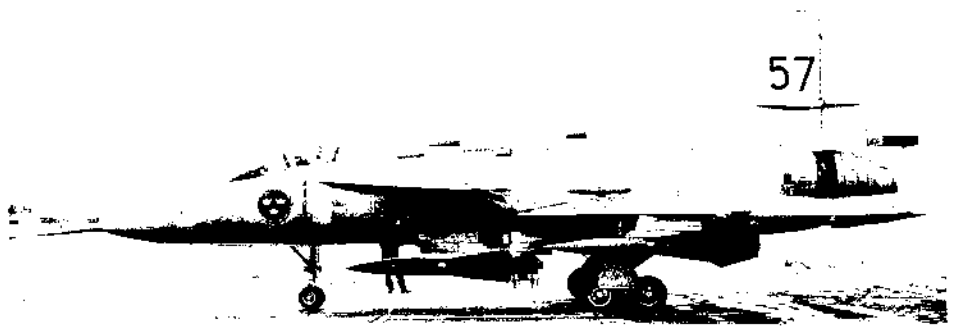
STATUS:
The land version of Bantam has been adopted as standard equipment by the Swedish and Swiss Armies.
MANUFACTURER:
AB Bofors, S 690 20 Bofors, Sweden.

Bofors Bantam anti tank missile firing from Bell 204B helicopter



Launch of Bantam from Saab-MFI 17

1190.311
Rb 05A AIR-TO-SURFACE MISSILE
DESCRIPTION:
The Rb 05A is a radio command guided manually controlled tactical air-to-surface missile. It is for use against both sea and land targets but may also be used in certain air-to-air roles. Principal characteristics are: wing span 80 cm, diameter 30 cm, length 360 cm, and total weight about 305 kg.

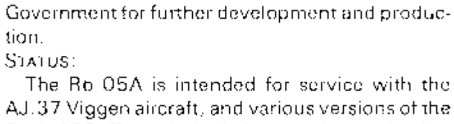


Saab Rb 05A air-to-surface missiles carried by AJ37 Viggen aircraft

The airframe of the Rb 05A is made of conventional aircraft materials and consists of a pointed cylindrical body with long-chord cruciform wings and aft-mounted cruciform control surfaces. A liquid rocket motor is centrally located and the motor casing forms part of the outer skin and load-carrying structure of the missile. The armament system is located in the nose and most of the control equipment at the rear of the missile. The VR 35 rocket motor is fitted with a tail-pipe which passes through the rear of the body. A pre-packaged liquid-propellant motor, supplied by Volvo Flygmotor AB, is used. The propellant tanks are placed around the centre of gravity to avoid CG-shift. Electrical power is supplied by a thermal battery, the battery remains unactivated until the time of firing the missile. Before launching some necessary electrical preheating of the missile is supplied from the aircraft. The hot gas for the control surface actuators is provided from a solid propellant gas generator. An effective proximity fused armament system is used, developed by the Swedish Research Institute of National Defence, and is manufactured under sub-contract by Förenade Fabriksverken.

The auxiliary airborne missile system equipment comprises a control stick, coding unit, transmitter and antenna. The control stick is designed to give good support to the hand even under severe conditions. In the coding unit conditioning of the control stick signals takes place prior to coding. The coded signal is fed to the microwave transmitter which transmits control signals in front of the aircraft by means of the antenna.

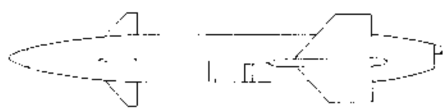
After launching the missile is guided manually by the pilot who visually lines up the missile track ing flares and the target. The control signals, indicated by the pilot through the special control stick, are transmitted over the radio link with the transmitter in the aircraft and the receiver in the missile aft section. The guidance transfer function, from control stick force to the missile's transverse acceleration, is specially designed to provide a high degree of guiding accuracy for both small and large off-set angles. The command link is difficult to jam because both coded signals and a very high transmitter output are used. Guidance signals received by the missile are converted by an autopilot to control surface deflections through the medium of four hot gas actuators. The autopilot initially guides the missile into the pilot's field of view.



RB 05A

DEVELOPMENT:
Developed by Saab-Scania on behalf of the Swedish Air Force, the system entered advanced testing in 1968/9. In June 1969, Saab was awarded a large contract by the Swedish Government for further development and production.
STATUS:
The Rb 05A is intended for service with the AJ.37 Viggen aircraft, and various versions of the Saab 105. The missile is in quantity production and has entered operational service at certain Swedish Air Force wings.
MANUFACTURERS:
Saab Scania Linköping, Sweden.

1189.321
ROBOT Rb 04 AIR-TO-SURFACE MISSILE
DESCRIPTION:
Air-to-surface missile developed principally for anti-shipping strikes. The version in current Royal Swedish Air Force service is the Rb 04D, but in mid-1968 it was revealed that an improved version under the designation Rb 04E was in development. Principal characteristics of the latter are as follows: length 445 cm, body diameter 50 cm, wing span 2 m and total weight about 600 kg. These figures are the same as for the earlier models, but the Rb 04E is stated to be technically very advanced. After launch, the missile acts in-



RB 04

dependently of the launch aircraft and is automatically guided to a low level altitude where target search and acquisition are performed at a high sub-sonic speed.

Guidance in the approach phase of an anti-shipping attack with the Rb 04E is probably by means of a high quality auto-pilot (perhaps based on an Aga platform) or a fixed course towards the target area. When within range of the missile's homing head, it will either use passive radar homing if the target is radiating, or active radar homing if the target is 'silent'.

DEVELOPMENT:

The Robot Rb 04 series of missiles was initiated by and developed by the Missile Bureau of the Swedish Air Force Board (now the Defence Material Administration – Missiles Directorate). This organisation was responsible for the development of the 04C and 04D versions, but subsequent R & D has been performed by Saab.

STATUS:

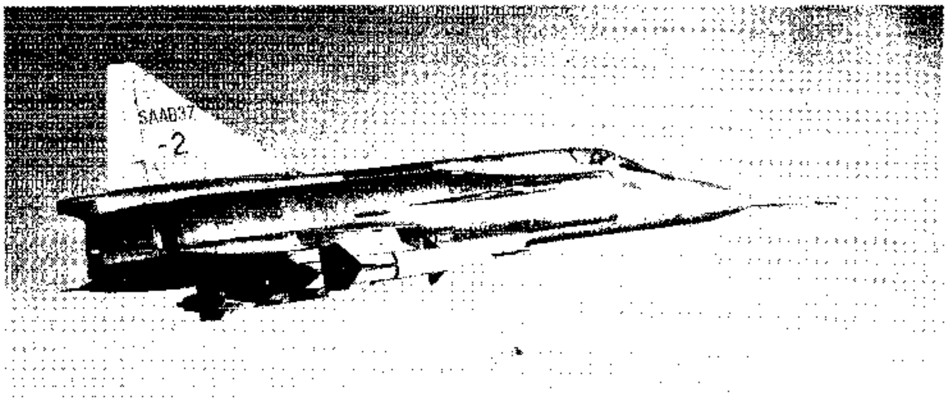
The Rb 04 was first introduced to the Swedish Air Force in 1959/60, and the C and D versions are standard weapon options for the A32A Lansen attack aircraft, which is capable of carrying two of these missiles.

Production of the Rb 04C ceased in 1964, and the Rb 04D entered operational service in 1971.

The Rb 04E is intended for use with the AJ37 Viggen all-weather attack aircraft, which can carry three missiles. The missile is in quantity production, this having started in 1973 following the award of a contract in 1969.

MANUFACTURERS:

Saab-Scania, Linkoping, Sweden.



Rb-04 air to surface missile carried by Viggen aircraft

THE UNITED KINGDOM

1654.311
HAWKSWING HELICOPTER ANTI-TANK MISSILE

DESCRIPTION:

Hawkswing is one name given to a proposed helicopter installation of the BAC Swingfire (Entry No **2450.111**) anti-tank missile. An alternative name is Airstrike Swingfire. At the 1972 Farnborough Air Show a typical installation on a Lynx helicopter was shown in model form. A total of six rounds, three on each side, are carried ready for firing from their containers, and a further six to permit re-loading without having to return to base can be carried inside the helicopter. A more detailed description of the Swingfire missile and its operation will be found in the anti-tank missile section of this edition.

Hawkswing launch from Scout helicopter during early development trials

1530.321
SEA SKUA CL 834 HELICOPTER AIR-TO-SURFACE MISSILE

DESCRIPTION:

The CL 834 Sea Skua is a new helicopter-launched anti-ship missile system, initially under development for RN Lynx helicopters but expected to be more widely deployed in the future. The operational role of the weapon is to provide long-range self-defence for frigates against missile-carrying fast patrol boats, hydrofoils and hovercraft having a capability against frigates and larger vessels. It has been stated that the range of the missile itself will be great enough to provide the launching helicopter with a useful degree of 'stand-off' protection from return fire put up by the selected target. This, and the ability of the helicopter to operate at appreciable distances from its parent vessel, are intended to provide protection extending beyond the range of most surface-to-surface anti-ship missiles.

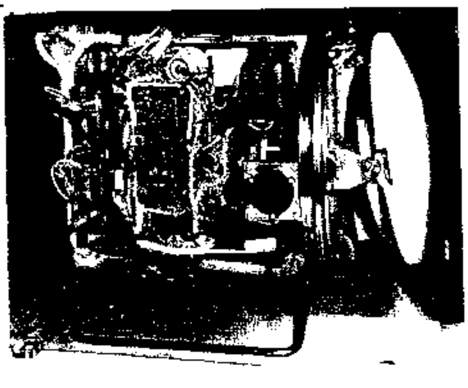
So far, the CL 834 has only been shown in model form, and no dimensions have been given officially. However, the model photograph indicates the missile configuration, and provisional dimensions are 2.83 m long, maximum body diameter 20 cm, span 60 cm, and weight approximately 210 kg. A high explosive warhead weighing about 20 kg is probable. A solid-propellant motor is used, and guidance is by semi-active radar homing, the target being illuminated by the Ferranti Seaspray radar in the Lynx helicopter. After launch, the CL 834 will reduce height to a few metres above wave level for the cruise phase of an attack. A pre-programmed or radio command instruction will bring the missile to target acquisition height for the terminal homing phase. An aircraft-launched version is understood to have been studied.

MANUFACTURERS:

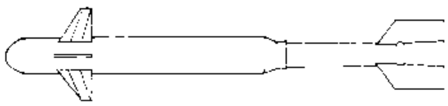
British Aircraft Corporation, Guided Weapons Division, Stevenage, Herts, UK – prime contractor

Marconi Space and Defence Systems Ltd, Chelmsford, Essex, UK – homing head.

Model of CL 834 Skua helicopter anti-ship missile showing general configuration



Homing head by Marconi Space and Defence Systems for CL 834



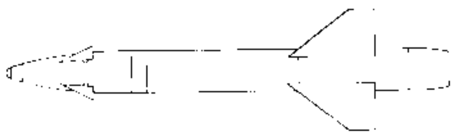
Sea Skua (CL 834)

THE UNITED STATES OF AMERICA

1655.311
BULLDOG (AGM-83A) AIR-TO-SURFACE TACTICAL MISSILE

DESCRIPTION:

Bulldog is a laser-guided missile developed for close air-support for the US Marine Corps and designed to make maximum use of existing hardware and technology. It was officially stated in March 1974 that further development and procurement had been suspended, but this entry has been retained both as illustrative of the state-of-the-art and because later re-instatement is a possibility. It uses the Bullpup airframe (Entry No **1280.311**) and a new design guidance control unit (Guidance Control Group AN/DSM-126) which embodies a high proportion of the Sidewinder missile (Entry No. **1103.331**) technology. Since Bulldog uses existing components from other systems wherever possible, a reasonably inexpensive missile has resulted. It has also been designed to be compatible with a variety of existing laser target designators, and can be used on



Bulldog (AGM-83A)

A-4, A-6 and A-7 aircraft.

The main characteristics of the missile are length 298 cm, diameter 30.5 cm, and weight 272 kg. Propulsion is by either an LR-58RM liquid-propellant motor or Mk 8 Mod 2 solid motor, and a Mk 19 Mod 0 warhead is carried.

OPERATION:

Unlike laser guided bombs, which require normal ballistic bomb delivery techniques, Bulldog has a large delivery envelope and can be fired at long range and low altitudes. The system performance and unit cost make it appropriate for the destruction of small ships, bridges, tanks, and similar stationary and mobile targets. A Forward Air Controller, either on the ground or airborne, is responsible for target selection and for transmitting radio instructions to the attack aircraft to bring it to the target area. The FAC then operates the laser designator and illuminates the selected target. When the pilot activates the seeker in the nose of the Bulldog missile, it scans until it acquires the laser designated target. At that point, a light on the control panel and an audio signal indicate to the pilot that the target has been acquired. He aims the missile by means of pointers on a Target Position Indicator instrument, and then initiates the launch. From that point Bulldog is directed to the target automatically by the laser-seeking homing head. The missile itself leaves no vapour trail, thus enhancing the surprise element.

DEVELOPMENT:

The Bulldog weapon system AGM-83A, was developed by the US Naval Weapons Centre, China Lake, California, in response to a US Marine Corps requirement for a close air support weapon. The new guidance control group was developed jointly by the Naval Weapons Centre and Texas Instruments, and a contract was awarded to the latter in late 1972 for pilot production of that component. During 1972 a variety of land and sea target situations were evaluated in 27 test launches, and a high success ratio was achieved.

US Marines loading Bulldog missile onto US Navy aircraft for trial at China Lake (US Navy Official Photograph)

STATUS:

Bulldog was in pilot production at the beginning of 1973. Despite the apparent success of the Bulldog programme, it was announced by the Director of Defence Research and Engineering in March 1974 that no funds were being requested in the Fiscal Year 1975 Defence Budget for continuation or procurement of Bulldog. He said, "Strong action has been taken to eliminate duplication in laser-guided missile developments. Our goal has been a common laser guided missile for fixed-wing aircraft of the Air Force, Navy and Marine Corps and a common seeker for all the Services. No funds are being requested to procure the Navy Bulldog because we are convinced that laser Maverick can meet the needs of the Air Force, Navy and Marine Corps. I am directing the Air Force to hold a competition to select a common multi-Service seeker".

MANUFACTURERS:

US Naval Weapons Centre, China Lake, California, USA.

Texas Instruments, Inc, Dallas, Texas, USA.

1280.311
BULLPUP (AGM-12) AIR-TO-SURFACE TACTICAL MISSILE

DESCRIPTION:

The Bullpup AGM-12 series of missiles embraces a range of air launched missiles for attacking tactical surface targets on land or sea. Guidance is by radio command link from the launching aircraft, with optical tracking to target, aided by flares attached to the missile.

Bullpup model designations run from AGM-12A to AGM-12E, and within this group quite considerable variations of payload (and hence dimensions) exist. There are also Bullpup trainer versions carrying ATM-12 designations. These are essentially inert rounds for pilot training.

Early versions of Bullpup employed a US Navy-developed solid fuel rocket motor, but all current models use pre packed liquid fuel motors (LR62/LR58, Thiokol Reaction Motors) which permit long storage time and rapid missile preparation.

The several variants of Bullpup carry either 250 lb (113.4 kg) or 1,000 lb (453.6 kg) conventional high explosive warheads, or a nuclear warhead. Maximum speed is variously quoted by the manufacturers and the USAF as: over Mach 2, Mach 1.8, and 1,400 mph. Range quotations also vary but are approximately 11 km and 17 km for the small and large versions, respectively.

Principal characteristics are as follows: Bullpup A (AGM-12B):

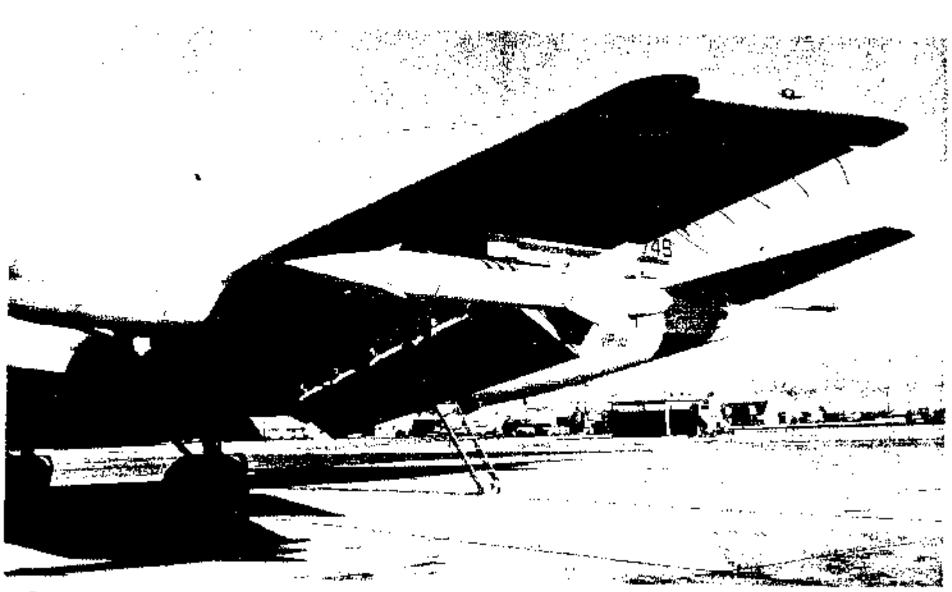
Length 3.2 m, diameter 30.5 cm, wing span 95.25 cm, launch weight 258 kg.

Bullpup B (AGM-12C)

Length 4.07 m, diameter 43.9 cm, wing span 117.76 cm, launch weight 812 kg.

OPERATION:

Bullpup is launched on the appropriate line of sight from the aircraft to the target, and is then visually tracked by the pilot who uses a radio command link to direct the missile to impact. Two high-intensity flares in the aft end of the missile aid tracking.



Bullpup air-to-surface missile on wing of US Navy P-3B Orion aircraft (US Navy Official Photograph)

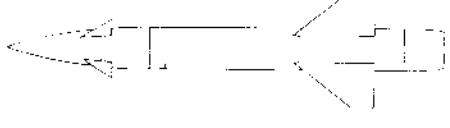
DEVELOPMENT:

Development originated in 1954, and the Martin Company and Maxson Electronics Corporation embarked on a long running programme involving production and continuous further development of the Bullpup system.

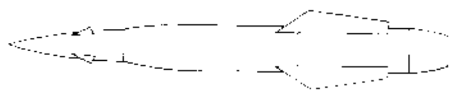
In March 1970 Texas Instruments was awarded a \$1.9 million contract by the US Navy to develop a laser guidance system for the Bulldog (1655.311, above) version of Bullpup.

STATUS:

Bullpup became operational in 1959 and is now in use by the US Navy, Air Force and Marine



Bullpup A (AGM-12B)



Bullpup B (AGM-12C)

Corps, and numerous NATO services.

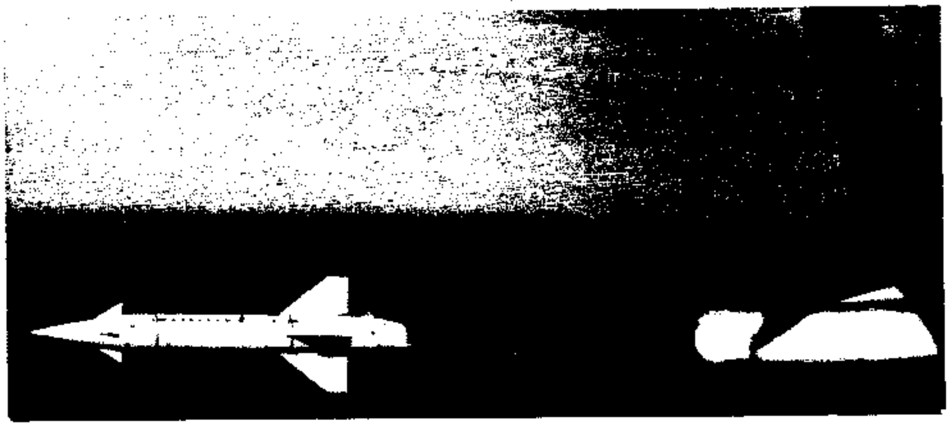
Foreign users include the Royal Navy which has selected the AGM-12B as standard strike armament for the Sea Vixen and Buccaneer aircraft. This version of Bullpup is manufactured under licence in Europe for the armed forces of Denmark, Norway, Turkey and the UK by a consortium headed by Kongsberg Vaapenfabrikk. American production has ceased.

MANUFACTURERS:

Martin Marietta Corporation, Orlando, Florida, USA.

Maxson Electronics Corporation, Sunrise Highway, Great River, Long Island, New York 11739, USA.

A/S Kongsberg Vaapenfabrikk, Norway – prime contractor for European consortium.



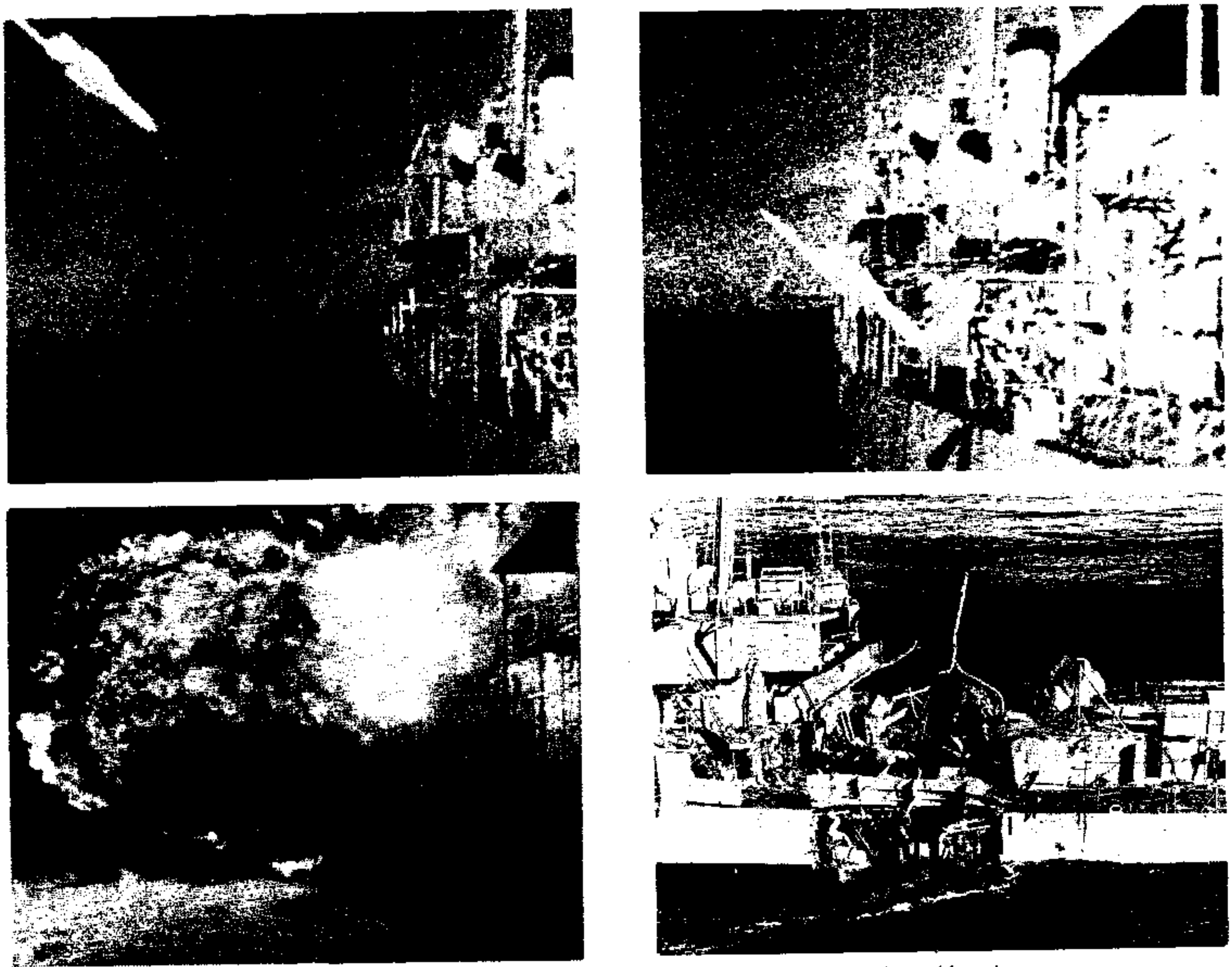
Bullpup firing from US Navy Orion maritime aircraft (US Navy Official Photograph)

1081.311
CONDOR (AGM-53A) AIR-TO-SURFACE TACTICAL MISSILE

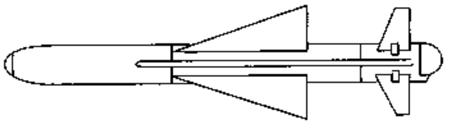
DESCRIPTION:

Condor is a medium-range, supersonic cruise missile using a TV remote guidance and control system to provide the US Navy a standoff capability against heavily defended, high value, surface targets. Principal characteristics are: length 1.67 m, diameter 43 cm, wing span 135 cm, launch weight 966 kg, warhead 286 kg. The range has been estimated at from 60 to 80 km. In addition to the missile itself, the Condor weapon system consists of a control system pod and the aircraft installation. The former contains the data link system, with fore and aft aerials; a special-purpose digital computer which performs automatic mid-course guidance as well as built-in test and pre-launch functions; a mission recorder; and space provision for an inertial navigation unit. The cockpit installation comprises a TV display, missile controller, and system controls. In tests in late 1971, in which a Condor was launched from an A-6A aircraft against a moored destroyer escort target vessel, a hit was scored at a range of 56 km.

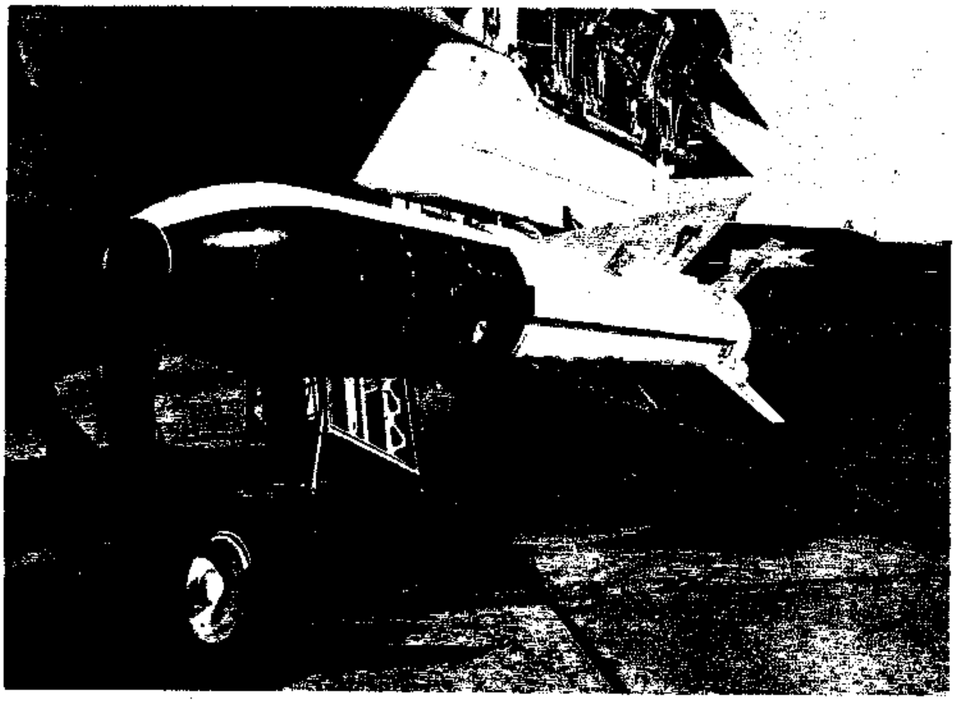
A conventional high explosive warhead is carried but it is believed that some consideration has been given to an alternative nuclear warhead. Since its inception in the mid-1960s, the Condor system has been the subject of a number of studies relating to alternative guidance and propulsion methods and it seems probably that this weapon will ultimately be procured in more than one version. In addition to the possibility of an alternative nuclear warhead, mentioned above, other possibilities and changes which have been pursued are an extra, turbo-jet engine for longer range, a dual-mode (EO and radar) homing head, and a different data link.



This remarkable sequence of pictures, three of which are single frames from a filmed record from the target ship, show a Condor missile homing onto its target by electro-optical guidance and the ensuing explosion. The final picture shows the damage sustained. (US Navy Official photographs)



Condor (AGM-53A)



Condor (AGM-53A) air-to-surface missile

The original data link arrangement planned for Condor is a sophisticated equipment, designed to provide secure operation (eg. within a potentially hostile electromagnetic environment, from ECM etc) and simultaneous Condor launches from several carrier aircraft. The use of a 'non-secure' data link offers the chance of worthwhile cost reductions while remaining perfectly adequate for many operational applications, and work is in progress to adapt the Walleye II (**1129.311**) data link to Condor.

A complete new nose section for the missile is envisaged for the so-called 'dual-mode' Condor guidance system, and it is expected that this will be interchangeable with the standard TV homing head and guidance package. The standard Condor has daylight and "non-interfering" cloud cover capability only, which is taken to mean that cloud penetration under automatic flight control is possible, the Condor must emerge from cloud under conditions which will permit TV guidance to the target. Day and night all-weather operation is the eventual goal. The all-weather mid-course capability has been demonstrated, and Condors have been flown through clouds in the mid-course areas on the automatic mode to the terminal area using the data link and mid-course navigation.

For the full all-weather mode the TV system is supplemented by an active radar in the new-type nose guidance section of the missile mentioned above. This contains the EO (TV) section, chin mount and radar system, and it will add slightly to overall missile length.

In operation the following sequence takes place. After the launch phase there is a search mode, followed by a map-while-track (MWT) mode by which a radar terrain map obtained by the Condor's radar is returned by data to the launch aircraft for display. The television picture is returned also for simultaneous presentation, thereby permitting navigation and up-dating operations. During the terminal phase, the missile will be transmitting only video data. The radar will be operating in a monopulse tracking mode. Since there will be no radar picture generated, the TV data can be used to monitor the target approach up to the moment of impact. The all-weather Condor will be deployed on TRAM (Target Recognition and Attack Multi-sensor) fitted A-6E aircraft. By means of a modification kit costing about $50,000, Condor can be integrated with TRAM so that the latter system's TV and radar displays can be used for Condor guidance in addition to their original functions of presenting radar, TV, and infra-red data derived from sensors fitted to the A-6E aircraft and forming part of the overall TRAM installation.

DEVELOPMENT:

The requirement against which Condor is being developed originated in 1962. Requests for Proposals were issued in 1964, and Rockwell International was selected as Research Centre, in May 1972.

STATUS:

Condor has completed engineering development and is entering pilot production.

The first Condor powered launch was made on March 31 1970.

On February 4 1971, a Condor launched from an A-6 aircraft scored a direct hit against the former Navy destroyer escort, USS *Vammen*, off the California coast. The Navy said the test was the first live warhead test and third consecutive successful test flight and demonstrated the missile's ability to strike surface ships from beyond the range of their anti-aircraft defences.

In March 1974 the US Secretary of Defence reported that development of the basic missile was essentially complete, and that pilot production missiles are being procured with Fiscal Years 1973-74 funds for operational test and evaluations of Condor. Engineering development and flight testing of the dual mode radar and electro-optical seeker version of Condor will be carried out in Fiscal Years 1975-76. The Fiscal Year 1975 Budget includes $30.2 million for this programme; $10.2 million for continued development and $20 million for procurement of 35 pilot line missiles, the minimum possible to keep the line running pending a decision on full-scale production in early 1975. With this latest production increment, a total of 85 Condors have been procured over the past three years.

MANUFACTURERS:

Rockwell International, Missile Systems Division, Columbus, Ohio, USA – prime contractors.

Rockwell Autonetics Division, Anaheim, California, USA – digital computers.

Curtis-Wright Corporation – flight control system.

Hughes Aircraft Company – data link guidance.

Rockwell, Rocketdyne Division – solid rocket motor.

1129.311
WALLEYE (AGM-62A) AIR-TO-SURFACE MISSILE

DESCRIPTION:

The Walleye weapons family consists of three models of unpowered, guided bombs, designated Walleye Mks I and II and Extended Range, Data Link Walleye. Walleye I has the following main characteristics: length 344 cm, diameter 32.5 cm, wing span 116 cm, weight 499 kg. Conventional, Mark I Mod 0 850 lb (385 kg) high explosive warhead.

Walleye II, which has the USN designation Guided Weapon Mk 5, Mod 4, is a much larger missile than the AGM-62A Walleye. Length of Walleye II is 404 cm, body diameter 45.7 cm and weight 1,061 kg. A warhead in the 2,000 lb (907 kg) class is carried, and the weapon was designed for the destruction of large semi-hard targets such as bridges, air base facilities and ships.

The latest version is Extended Range, Data Link Walleye II (ER/DL WE II) which has the USN designation Mk 13 Mod 0. This is essentially a Walleye II fitted with larger wings to extend the glide range and data equipment. The data link was originally intended for single aircraft use of Walleye to enable earlier release (by virtue of the extended glide range) and remote acquisition and lock-on of the Walleye's EO homing system while the launch aircraft had already begun its escape manoeuvre. Experience in SE Asia led to a change in philosophy, by which the data link terminal (and control functions) were transferred to a companion aircraft which followed the Walleye carrier aircraft.

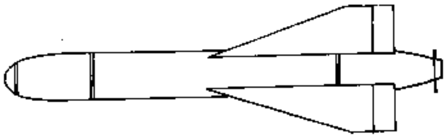
OPERATION:

A gyro-stabilised TV camera in the nose of the weapon is aligned with the target prior to launch by the pilot. He is aided in this by a CRT monitor screen, and for target acquisition either the Westinghouse AN/APQ-100 or APQ-109A fire control radar may be used. Modified displays have been produced by Texas Instruments for use in the

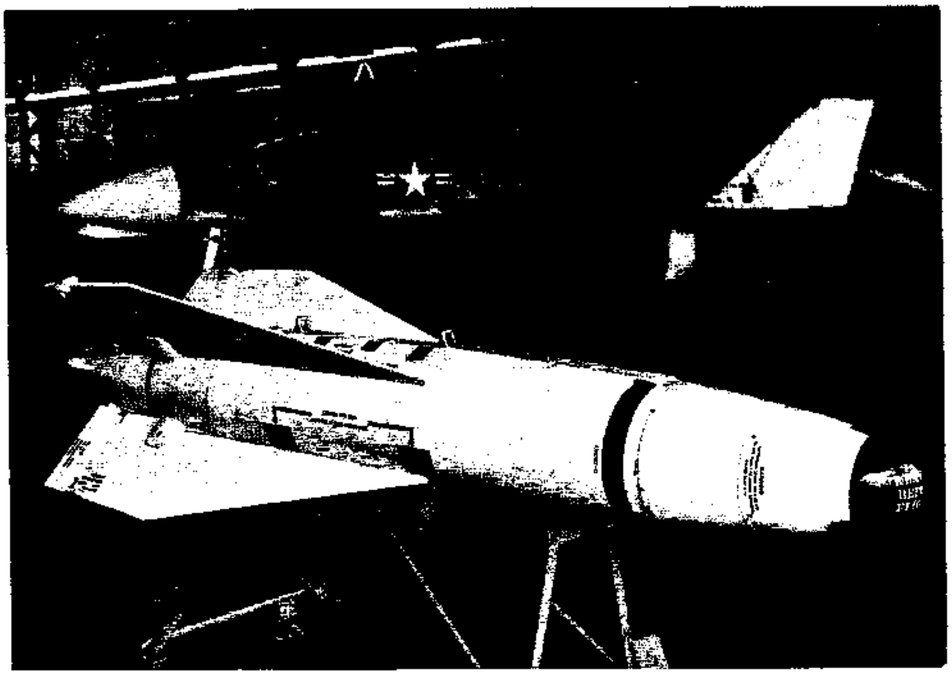
A-7 Corsair II aircraft carrying Walleye II during flight tests (US Navy Official Photograph)



Destruction of the Ninh Binh bridge in North Vietnam as recorded by the TV camera in the nose of the Walleye bomb (US Navy official Photographs)



Walleye II (AGM-62)



Walleye II air-to-surface glide weapon carrying 2,000 lb class warhead, awaiting loading onto aircraft for flight tests (US Navy Official photograph)

latter system.

When the target has been identified by the pilot, the missile TV camera is locked on and after release the missile guidance and control system uses signals from the TV head to produce control surface movements to direct the bomb to the target. The aircraft is thus free to quit the area immediately after releasing the weapon.

A Prestolite ram air turbine is used to drive a solid-state alternator which generates electrical power for the TV and control systems.

Development:

Initial development was performed by the US Naval Ordnance Test Station, China Lake, in 1963. The following year the Naval Avionics Facility entered the programme and in July 1964 requests for proposals were issued. Contract definition phase followed some months later in January 1965, when Hughes, North American and Martin-Orlando each received contracts. The last of these three concerns was nominated prime contractor in January 1966, and a $12.1 million contract was awarded which covered initial production. Later the same year the contract was increased by a further $11.1 million, and a $34.5 million contract followed in early 1967 covering production for the USN and USAF.

In November 1967 Hughes was designated as a second source prime contractor for the AGM-62A, and an award of $15.9-million was made to the company.

Moves to develop an improved version of Walleye took place in 1968 when a number of contracts were placed for the study and development of new components. Various designations attributed to this version are Fat Albert, Walleye II and Large Scale Walleye.

The US Naval Weapons Centre, China Lake, California, developed and tested Walleye II with assistance from Hughes Aircraft Company, Canoga Park. In March 1971 a pilot production contract for the warhead, wings and fins was awarded to Martin Mariette, Orlando, Florida. The Naval Avionics Facility, Indianapolis, modified Walleye I guidance and control sections for the Walleye II pilot production.

Status:

Walleye is widely deployed with the USN and USAF, and Walleye II is in production for the USN. Aircraft types that have, or which are projected to carry this weapon include F-4, A-4E/F and A-7A/B/C/E.

Manufacturers:

Martin Marietta Corporation, Orlando Division, PO Box 5837, Orlando, Florida 32805, USA.

Hughes Aircraft Company, Missile Division, Canoga Park, California, USA.

1102.311
SHRIKE (AGM-45A) AIR-TO-SURFACE MISSILE

Description:

Anti-radiation air-to-surface missile for the destruction of ground defensive radar installations. Official details include: length 304.8 cm, diameter 20 cm, wing span 91.4 cm, weight 177 kg, solid-propellant rocket motor. Estimated speed and range are: Mach 2 and 12 to 16 km.

Operation:

Initial warning of illumination of Shrike-carrying aircraft by ground defence radars is probably obtained from ECM receivers installed in the aircraft. When within appropriate range, the Shrike sensor heads are switched on and the missiles fired when target acquisition has been achieved. After release, the missile radar receiver continously senses the direction of arrival of radar radiation from the target and generates command signals for the missile guidance system to home it on to the radar.

Shrike guidance heads have been developed

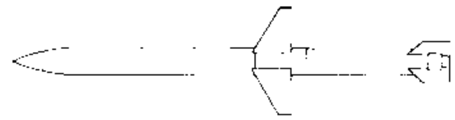
Shrike AGM-45A air-to-surface anti-radar missile prepared for flight testing at China Lake, US Naval Weapons Centre (US Navy Official Photograph) that provide for effectiveness against enemy early warning, ground control intercept and SAM guidance radars, each of which covers a different frequency range. The frequency range of a particular Shrike version is denoted by a suffix number to the AGM-45A designation, and there are at least 13 of these. The relationship between these numbers and the radar frequency bands is classified but a few other details are available. The -5 model was cancelled before production started. The -1, -1A and -2 models produced between 1963 and 1966 are thought to have covered the X and C-bands. The -3, -3A, and -3B were produced from 1963 to 1969 and may have an anti-ship radar role. The -4 was produced between 1965 and 1968, and the -6 has been used by USAF and USN from 1965 to 1970. The -7 is thought to cover one or more of the lower frequency bands. The -8 programme ran from 1967 to 1970/1 when it was cancelled in favour of HARM development. The -9 is for USAF and is in development, while the -10 is still under consideration by the USAF. Based upon the specific radar to be attacked, the operational commander selects the most appropriate weapon option. The USAF uses Shrike on modified F-105 and F-4 aircraft, termed WILD WEASEL aircraft, with special radar homing and warning equipment. The USN employs the missile on A-4, A-6 and A-7 aircraft.

DEVELOPMENT:

System Manager for the Shrike programme was the US Naval Weapons Centre, and development started in 1962. Production started in 1963, with operational deployment in 1964. Initial experience in Viet Nam was disappointing and a series of improvement programmes was instituted and these are now reported to have proved successful.

STATUS:

Production is continuing for use on both USN and USAF aircraft. The USAF is known to have procured 1,200 missiles in Fiscal Year 1969 and 300 in Fiscal Year 1970, both services were



Shrike (AGM-45A)

authorised funds in Fiscal Year 1971 for the purchase of guidance heads designed for use against the more advanced models of surface-to-air missile (SAM) guidance radars. Two-source procurement has been applied throughout most of the Shrike programme. Shrike procurement in Fiscal Years 1973, 1974 and 1975 amounts to 1972, 1660 and 1200 missiles, respectively, the combined cost of these being $118.3 million.

MANUFACTURERS

Joint prime contractors: Texas Instruments and Sperry Rand/Univac.

1097.311
HORNET (ZAGM-64A) AIR-TO-SURFACE MISSILE

DESCRIPTION

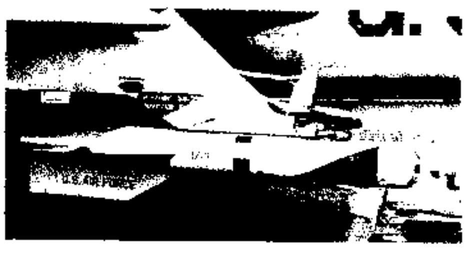
The origins of the ZAGM-64A lie in a USAF programme for the development by Rockwell International of an air-to-surface bombardment missile, following a private venture proposal by Rockwell for a missile known as Anti-Tank Guided Aircraft Rocket-ATGAR. The award of a contract in 1963 was followed by air firings from an F-100F in November 1964. Test and evaluation continued and various guidance methods, including magnetic and at least two electro-optical systems, were tried.

The ZAGM-64A programme, as such, is stated to have ended in March 1968.

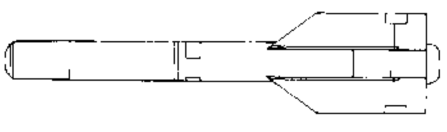
The Hornet was revived in 1970 as a test vehicle for a variety of guidance packages, mostly of electro-optical or laser types. A more powerful rocket motor and a cold-gas actuation system were subsequently incorporated, the former providing a booster-glide trajectory of more than four kilometres. A particularly successful series of test flights combining semi-active laser seekers with the Hornet missile were conducted in 1971 and 1972 by the US Army's Missile Command. These trials demonstrated terminal homing accuracies comparable with direct hit attacks on point targets. The laser Hornet programme is at present providing concept validation data to support the US Army Hellfire missile system. This work was combined with another programme initiated by a $14 million USAF contract awarded to Rockwell for the development of so-called 'smart' bombs (Entry No. **1579.331**). These are conventional bombs to which a guidance and control system had been added to yield greater accuracy by providing for modification of the trajectory after release. The combination of Hornet guidance elements with conventional bombs led to the HOBO concept. The term is sometimes translated as Homing Bomb System (HOBOS).

MANUFACTURER:

Rockwell International, Missile Systems Division, Columbus, Ohio, USA.



Hornet air-to-surface missile developed to demonstrate feasibility of TV-homing guidance



Hornet (ZAGM-64A)

1098.311
MAVERICK (AGM-65A) AIR-TO-SURFACE MISSILE

DESCRIPTION:

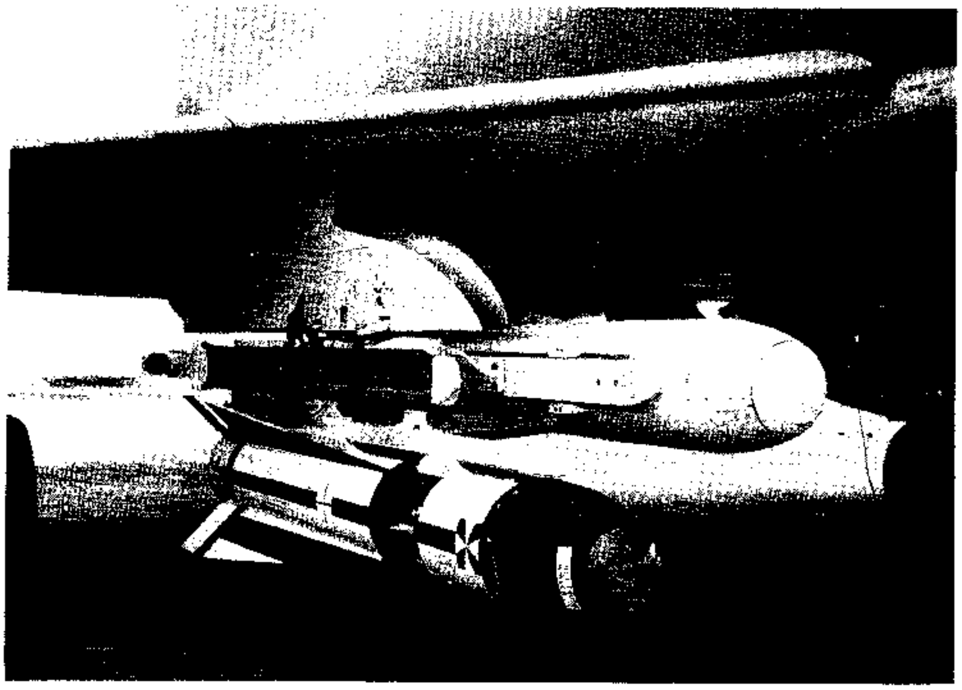
Maverick is a relatively small, television-guided tactical missile designed for use against small concentrated targets such as armoured vehicles, concrete field fortifications, revetments, gun positions, parked aircraft and communications vans. The missile, can be carried by F-4D and E and A-7D aircraft, is 246 cm long, 30 cm in diameter, has a 71 cm wingspan and weighs 209 kg. The warhead is a 59 kg high explosive conical-shaped charge, designed for high penetration. The weapon is powered by a Thiokol two-stage solid fuel rocket motor and will be mounted in clusters of three.

OPERATION

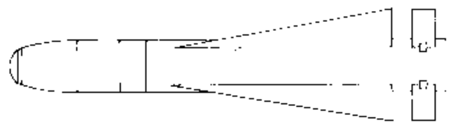
Maverick is guided by a miniature television homing system in the nose of the missile. On selecting a missile prior to engaging a target, gyro run-up is initiated and when this is completed (normally about three minutes) an indicator lamp is lit to tell the pilot he may uncage the gyro. This action releases a protective dome from the nose of the missile. The aircraft pilot picks up the target on a television monitor in the cockpit, locks the missile's electro-optical tracker onto the target (by either slewing the missile's nose-mounted TV camera, or changing the aircraft attitude) and launches the missile, which is automatically guided to the target by the television centroid tracker. The launch aircraft is free to take necessary evasive action once the missile is launched.

DEVELOPMENT:

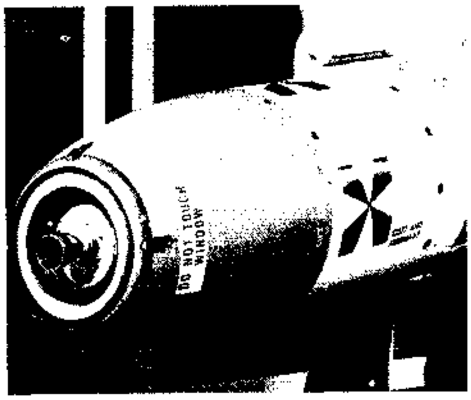
The Maverick development programme was approved by DoD in 1965 although related experimental work had been conducted earlier in the Hornet programme (which see). Requests for Proposals were issued in 1966, and Hughes was selected as prime contractor and awarded a $95 million fixed price incentive contract in June 1968. An alternative version of Maverick, using

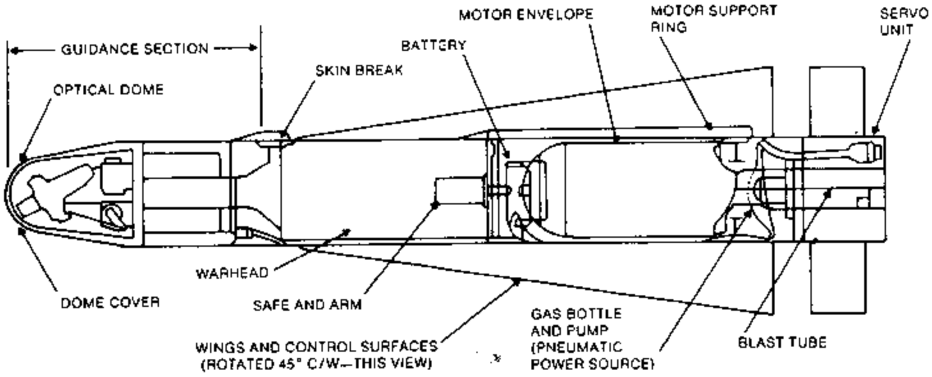


Maverick missile on triple launcher/adaptor



Maverick (AGM-65A)


Close up of Maverick optical guidance head



Internal arrangement of Maverick

laser-seeking guidance is under development in the Close Air Support Weapon System, described in Entry No. **1768.311**.

STATUS:

The initial production decision was to have been made in June 1970, but in March 1970 the USAF announced that funding constraints would force it to delay exercise of this option. The USAF requested $87 million to begin procurement in Fiscal Year 1972.

A production contract for 2,000 missiles valued at $69.9 million was awarded in September 1971, with first deliveries being made at the end of August 1972. In November of that year the USAF awarded a contract worth $47.7 million for a further 3,000 Maverick missiles. In Fiscal Year 1974 another batch of 3,000 was funded and the Fiscal Year 1975 procurement was doubled, to 6,000, to give a total of about 14,000 produced. The original total production envisaged was at least 17,000 missiles, and it seems possible that this number may be exceeded.

In addition to use by the US Forces, sales to Iran and Israel have been reported, the latter nation allegedly using Maverick to effect in the 1973 Middle East conflict.

MANUFACTURERS:

Hughes Aircraft Company, Culver City, California, USA.

1768.311
CLOSE AIR SUPPORT WEAPON SYSTEM (LASER MAVERICK)

DESCRIPTION:

The Close Air Support Weapon System (CASWS) will be a laser-guided Maverick to exploit the performance of that weapon and to derive maximum benefit from the broad production base which exists for Maverick. It is intended to provide a new day and night attack capability for countering armour and suppressing enemy air defences. Another, related objective is the ability to co-operate much more closely with the troops on the ground. An operational requirement of the system is that it should be possible for the launch aircraft to provide its own laser target designation facilities or for these to be provided by either a Forward Air Controller aircraft or by a ground laser marker. Provision for coding the laser illuminiation is required.

Modification to the Maverick missile (described in Entry No. **1098.311**) consists simply of substituting a laser-seeking homing head for the original TV homing head. This part of the project, selection of the laser seeker, relates to the so-called Tri-Service Seeker programme which has the objective of deciding upon a common laser seeker for use by all arms of the US Forces. It is also hoped that the USN, USAF and USMC will be provided with a common laser-guided missile for their fixed-wing aircraft.

DEVELOPMENT:

The programme started with a series of studies undertaken before 1970, and these were completed when initial industry studies confirmed the feasibility of meeting USAF requirements. In June 1971 there was a decision that Maverick could provide the appropriate platform for the project and advanced development was started in May 1972. Tests of various seekers, including examples from Texas Instruments and Rockwell (North American) were carried out later that year. RDT&E funding in Fiscal Years 1973 and 1974 was $4.4 million and $5.0 million, respectively. The Fiscal Year 1975 Budget sees a big increase for this programme, up to $20.0 million. No contractor had been named by May 1974.

1597.311
HOBO (EO) & LASER-GUIDED SMART BOMBS

DESCRIPTION:

There are two types of smart bombs currently in use by the USAF – the laser-guided bomb (Entries Nos. **1533.311** and **1534.311**) first introduced in Southeast Asia in May, 1968, and electro-optically (EO) or HOBO bombs which entered service in that theatre in February, 1969. The former type of munition is used in 500, 2,000 and 3,000 lb categories and the EO bomb is produced in 2,000 and 3,000 lb sizes.

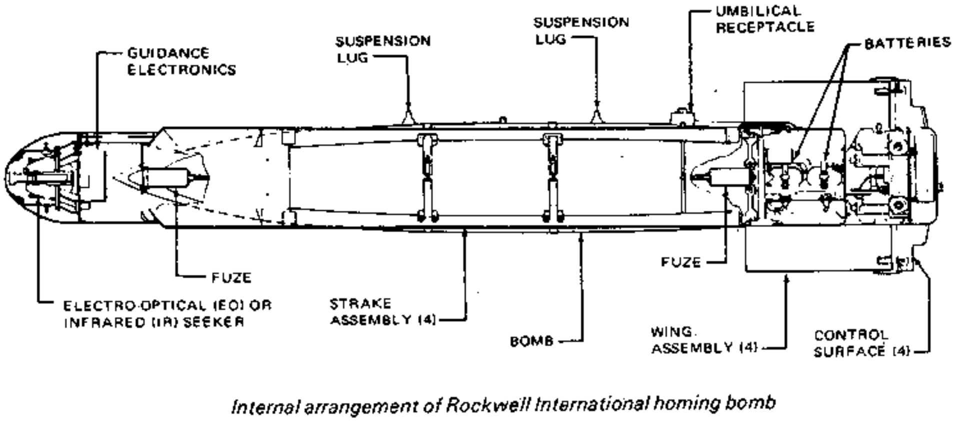
The laser-guided type consists of a conventional bomb to which are added stabiliser fins, a computerised directional package in place of the normal fuse, and a guidance module containing a laser seeker. The EO bomb has strakes running the length of the weapon and control surfaces at the rear, with a television guidance module at the front. A monitor in the aircraft is used by the crew for initial target acquisition, and after lock-on by the bomb's camera has been confirmed the weapon can be released, after which the guidance module steers the bomb to the target.

The laser-guided versions are reported to cost $3,100 each, and the EO versions $13,000 each. In both cases CEP errors are claimed to have been reduced to a few feet.

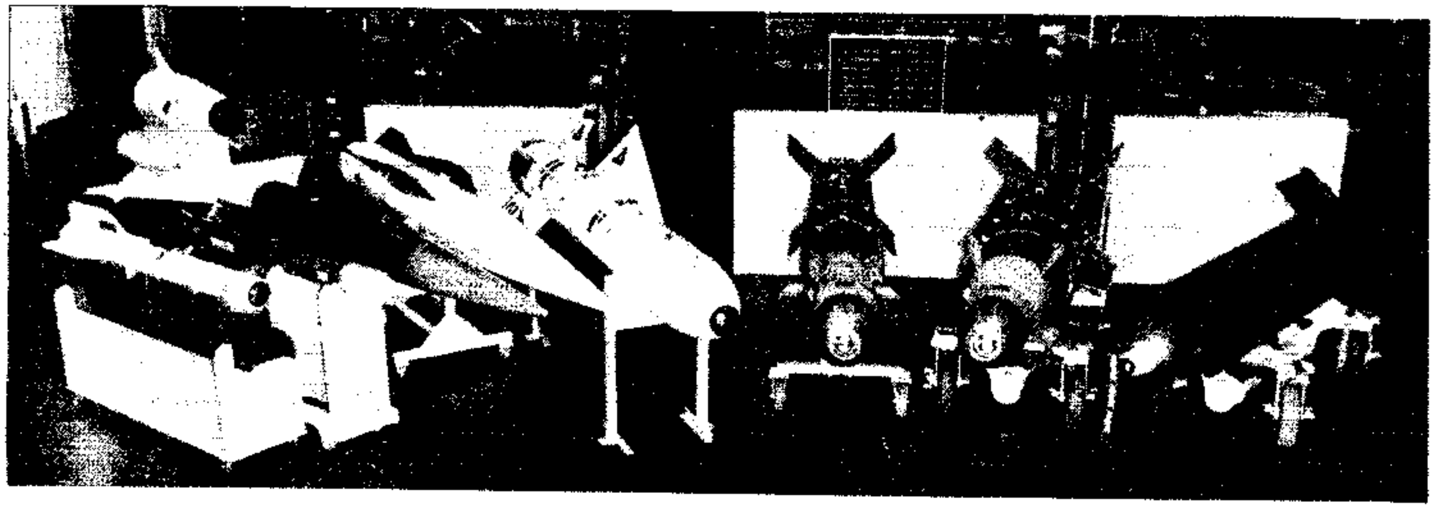
DEVELOPMENT:

In the latter half of 1972 the USAF, with industry, instituted studies of possible ways of further enhancing the smart bomb concept by the provision of blind attack facilities and extending the effective range to permit 'stand-off' operations. Because smart bombs EO or laser directed,


Laser-guided smart bombs



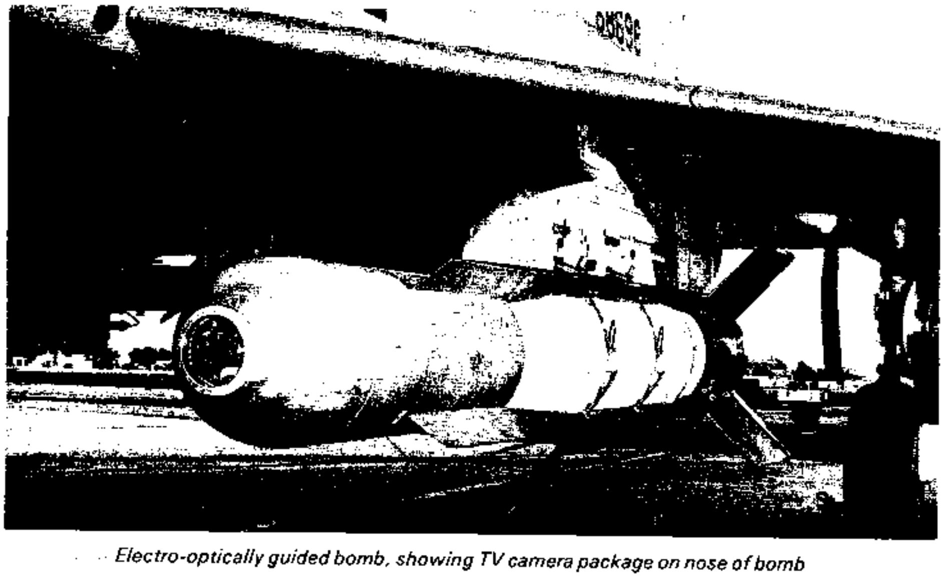
Internal arrangement of Rockwell International homing bomb



A selection of the latest US air-to-ground guided weapons, all developed by the Missile Systems Division of Rockwell International. Left to Right: *USAF Hornet anti-tank missile, US Army Terminal Homing flight, test vehicle, Redhead/Roadrunner target missile, Low-Altitude Short Range Missile (LASRM), Condor stand-off tactical missile, MK 84 EO smart bomb, M 118 EO bomb, and Mk. 84 infra-red guided bomb*

are capable of only modified-ballistic trajectories, effective stand-off ranges cannot be achieved under all conditions. The latest development overcomes this objection by providing the bomb with wings that are sprung into the flight position after the release from the parent aircraft. The bomb is thus given increased range by the ability to glide into the target area. The Celesco Industries modification kit includes, in addition to the wings, an autopilot to control the bomb until the terminal homing system takes over.

Bombs of this type have been designated Modular Guided Glide Bombs (MGGB) and Rockwell International has produced a number of these weapons based on the Mk 84 2,000 lb bomb. A variety of techniques for mid-course guidance are being studied and evaluated, the principal tactical objective of the system being the suppression of ground-based air defence installations. One method is for the missile operator in the parent aircraft to be equipped with a TV monitor which would display the video from the camera in the nose of the bomb, returned to the aircraft via data link. A link in the opposite direction would enable him to control the bomb's glide until target acquisition, after which the wings would be discarded and the terminal homing system would take over.



Electro-optically guided bomb, showing TV camera package on nose of bomb

A more sophisticated technique involves the provision of an on-board navigation system for the bomb, such as DME, Loran, or Omega, to enable it to navigate itself to a target area defined in co-ordinates determined by the release aircraft and/or co-operating aircraft. This method is appropriate to the engagement of radiating targets such as missile battery radars which might be located by TOA (Time-of-Arrival) Elint techniques.

Demonstration flights of the MGGB began in December 1972, and development is continuing, possibly at reduced speed since the disengagement from SE Asia by the USA.

In the UK, the Rockwell International E-O Seeker is under evaluation for the MoD by the Royal Aircraft Establishment and BAC as a possible air-to-surface weapon guidance system. Flight trials are taking place in a Hawker Siddeley Shackleton aircraft.

STATUS:

Modification kits have been produced by Rockwell International's Missile Systems Division for two standard US bombs, the 2,000 lb (900 kg) Mk 84 and the 3,000 lb (1,360 kg) M118E1. Kit designations are KMU-353A/B, KMU-390/B, and KMU-359/B, the first two being electro-optical and the last infra-red. Each kit consists of a guidance section for mounting on the nose of the bomb; a tail assembly with four stabilising vanes having control surfaces on their rear edges, and containing batteries; and a set of strakes and metal straps which serve to locate the guidance and control packages on the body of the bomb.

MANUFACTURER:

Rockwell International, Missile Systems Division, Columbus, Ohio, USA.

1534.311
PAVEWAY LASER GUIDED BOMBS

DESCRIPTION:

A family of bombs utilising a common laser guidance and control subassembly, with only the aerodynamic surfaces (control fins and aerofoil group) changed to match the particular size bomb. System allows standoff capability while providing precision weapon delivery against a wide spectrum of targets.

Present applications:

KMU-342/B	Conventional 750 lb M117 GP Bomb
KMU-351A/B	Conventional 2000 lb MK 84 GP Bomb (High and Low Speed Versions)
KMU-370B/B	Conventional 3000 lb M118 Demolition Bomb
KMU-388B/B	Conventional 500 lb MK82 GP Bomb (High and Low Speed Versions)
KMU-420/B	Conventional 500 lb MK20 MOD 2 (Rockeye) Cluster Munition
KMU-421/B	Conventional 2000 lb SUU-54/B (Pave Storm) Cluster Munition

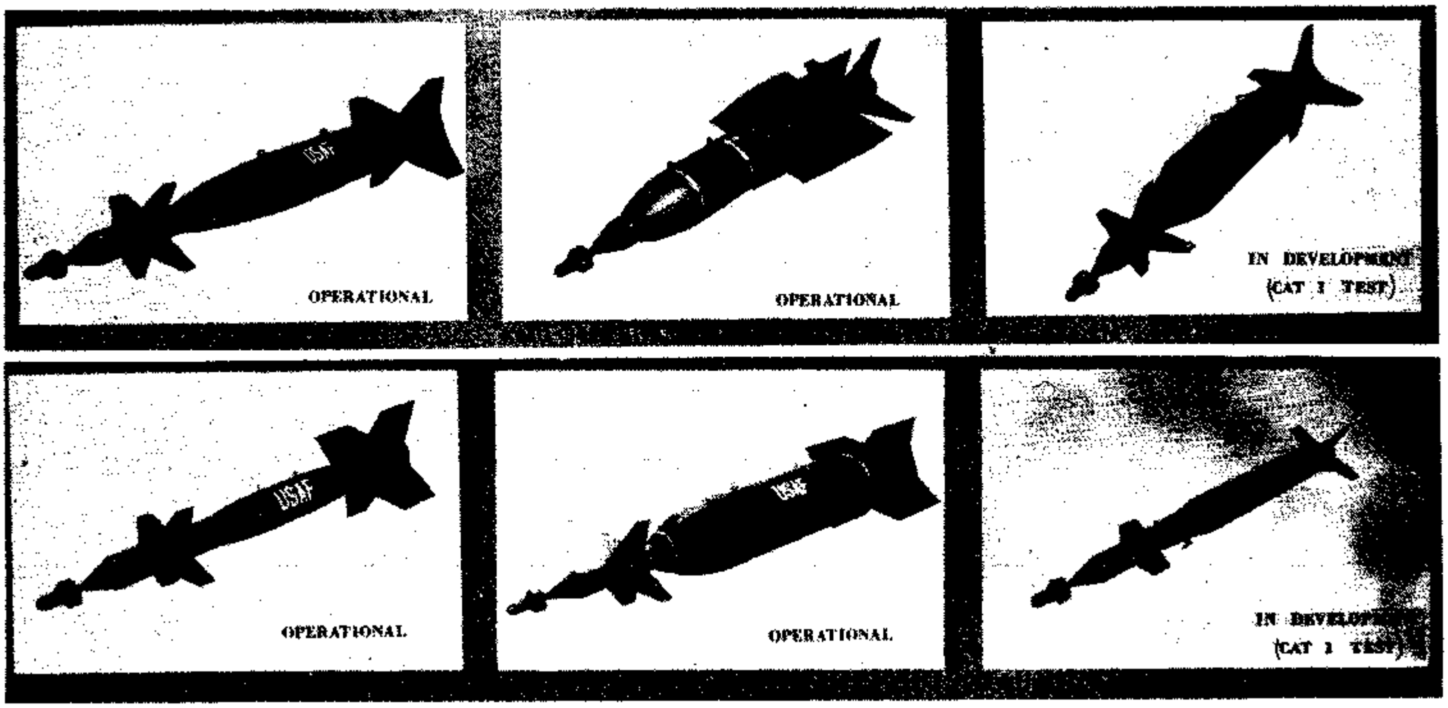
OPERATION:

The guided bomb kit directs the weapon toward a target which has been illuminated by laser energy. The desired target may be selected by the bombing aircraft, a companion aircraft, or a ground observer. The laser energy is reflected from the target and detected by the laser semi-active guidance system. The system processes the information, computes appropriate control commands, and applies these commands to movable surfaces to effect changes in trajectory, thereby guiding the weapon to the target.

The system requires no electrical connection to the unmodified delivery aircraft and is delivered in the same manner as a conventional bomb. There is no requirement for tracking or lock-on before launch, which minimizes the time required for delivery with concomitant reductions in aircraft exposure to hostile ground fire.

DEVELOPMENT:

The Armament Development and Test Centre, Eglin Air Force Base, initiated a competitive evaluation of two laser guidance concepts for standard bombs in 1965. The first laser guided bomb flight took place in April 1965. This evaluation proved the feasibility of the concept and was followed by establishment of the Paveway (Entry No.



Paveway laser guided bombs

1533.311) programme office at Wright-Patterson Air Force Base. Texas Instruments was selected to conduct engineering development to supply additional laser guidance kits for M117 GP bombs.

The remarkable accuracies realized in the feasibility demonstration, using munitions from altitudes out of range of ground fire, led to Southeast Asia evaluations with the first combat release in 1968. These accuracies also led the USAF to initiate a series of contracts to realize the benefits of the basic guidance kit with other munitions.

Since 1965, utilising the laser guidance kit developed by Texas Instruments, two additional GP bombs (MK82 and MK84) and the M118 demolition bomb have been successfully adapted to laser guidance and operationally deployed. Initial evaluations were also begun in 1970 to study application of Texas Instruments' guidance kit to the Rockeye cluster munition. Similar evaluations were initiated in 1971 for application of the kit to the Pave Storm cluster munition. During 1971 both cluster weapons were successfully tested utilising laser guidance.

STATUS:

Four configurations of laser guided bombs (the high and low speed versions of the MK82, the high speed MK84, and the M118) are now operationally deployed with the USN and the USAF. The M117 was initially deployed with the USAF, but is no longer in inventory.

In addition, the low speed version of the MK84 is now in Category II testing, and the Rockeye and Pave Storm cluster munitions are in development testing.

These eight configurations of laser guided bombs all employing the Texas Instruments guidance kit are compatable with the F-4, F-105, F-111, F-100, F-5, A-6, A-7, A-4, A-1, A-37, and B-57 aircraft.

In March 1974 it was reported that Iran had made arrangements with America for the supply of laser-guided bombs and a number (six) of airborne laser target designators. This will make Iran the first nation other than South Vietnam to be supplied with such weapons.

MANUFACTURER:

Texas Instruments Incorporated, 13500 North Central Expressway, PO Box 6015, Dallas, Texas 75222, USA.

1772.311

AMERICAN AIR-TO-SURFACE IMPROVEMENT PROGRAMME

DESCRIPTION:

Continued improvements in ground defence capabilities, as demonstrated in the 1973 Middle East conflict, have led the American DoD to embark on a number of programmes and projects to improve the capability to attack surface targets. Fundamental problems such as the extension of technology of precision guidance and stand-off range to provide a large number of aircraft to achieve "one-shot kills" without penetrating a heavily defended terminal area are receiving concentrated study.

Developments to TV-guided glide bombs to give them longer ranges are in progress, and as part of the USAF programme to emphasise conventional attack capability, **Pave Strike** (see **1533.311**, which follows), a sum of $9.4 million was allocated in the FY 1975 Budget for continued development of the Modular Guided Glide Bomb (**MGGB II**). Modifications to be demonstrated in this development will provide stand-off capability and integrate both television and DME guidance. The latter guidance technique is for use with the Airborne Locator and Strike System (**ALSS**), and the Precision Emitter Location and Strike System (**PELSS**), described later. The MGGB II will be compatible with use by USN carrier-based aircraft. A data link which will be appropriate to use in three weapons, Condor, Walleye II ER, and MGGB II is in development. Other forms of guidance are being explored and there are funding allocations for both USAF and USN requirements. Two types of imaging infrared guidance system are to be flight tested. Other captive flight tests will include radiometric correlation guidance which can be used in adverse weather conditions.

Improved kill mechanisms are another priority development area and work is continuing on the perfection of the air-delivered, anti-armour mine **GATOR**, which is for use by all US Forces.

The Modular Weapons concept has the objective of reducing the overlapping proliferation of individual weapons which tends to result from unco-ordinated exploitation of the numerous combinations of guidance, warhead and other aspects of missile technology. An advanced development programme has been set up to test the feasibility of interchangeability through hardware tests of a limited number of existing components in a combination of three warheads and three seekers, giving nine optimised weapon possibilities.

In line with US plans for application to future weapons, flight tests are to be carried out of a low-volume ramjet (**LVRJ**) engine. A power unit of the kind envisaged has the potential of producing missile speeds of Mach 3 to 4 and of operating altitudes up to 100,000 ft (30,480 m), in both air-to-air and air-to-ground roles.

In conjunction with the planned weapon improvements, there are schemes to upgrade existing aircraft with high resolution sensors to improve their weapon delivery capability. The first of these to enter service will be the **Pave Spike** (see **1533.311**) due to become operational this year. It is smaller, lighter and less costly than the similar first generation **Pave Knife** pods which were used with success in SE Asia by both the USAF and USN.

Development is continuing of Forward Locking Infra-red (**FLIR**) sensors for the USN's A-6E and A-7E aircraft, this being linked with the **TRAM** (Target Recognition and Attack Multisensor) project. The A-6E system consists of both TRAM and a laser target designator, while the A-7E TRAM is pod-mounted and contains a FLIR only. Yet another pod configuration containing a FLIR and laser designator is under development for the F-4 and possibly F-111 under the designation **Pave Tack**, as part of **Pave Strike**.

Remotely Piloted Vehicles (**RPVs**) are being closely studied as alternatives to manned aircraft for missions in high threat areas, and the USAF is engaged on a multi-mission RPV development to produce a prototype based on the existing AQM-34 type drone with an interchangeable configuration to suit it for camera or side-looking radar reconnaissance; electronic warfare jamming and seeding decoys; and dropping bombs or launching missiles such as Maverick to strike selected targets.

1533.311
PAVEWAY AIR-TO-GROUND WEAPON DELIVERY SYSTEMS

DESCRIPTION:

The USAF Paveway programme is a very large series of projects undertaken with the main objective of obtaining significantly improved accuracy in the delivery of air munitions, other than guided missiles, against ground targets in Southeast Asia. The weapons concerned are mostly bombs (with or without added homing and guidance systems) and aircraft guns. Of the many techniques tested and adopted, most were based on the use of lasers or other electro-optical devices. Appreciable improvements in accuracy have been achieved by virtue of better target marking from the use of laser designators or other devices, and a reduction of the weapon CEP (Circular Error Probability) area, reportedly to be 90-120 metres diameter. The latter is achieved by the ability of weapons such as Hobo 'smart' bombs (see Entry No. **1097.311**) to compensate, after release, for many of the factors which adversely affect CEP accuracy, such as slight delays in release, inaccurate altitude and air data values, ballistic variations etc.

Numerous separate projects were initiated within the scope of the overall Paveway programme, these are described in the following paragraphs. Many of these techniques were evolved specifically for the Vietnam War, in which the USA is now no longer involved, and some of the Pave programme listed below must be regarded as lapsed. Others will have been superseded, but where status information has been obtained, this is included in the text.

Pave Arrow:

This is a pod-housed system devised to provide pilots with facilities for acquiring laser-marked targets and directing either conventional or laser-guided bombs (see Entry No. **1534.311**) against the targets. The pod contains a laser seeker to which the aircraft gun sight is slaved. The seekers were developed and supplied by Martin-Orlando, and Korad lasers were incorporated in stabilised target designators produced by North American Rockwell for installation in Forward Air Control (FAC) aircraft. Aircraft fitted with the Pave Arrow pod included the F-100.

Pave Gat:

This designation was given to a project in which a Martin B-57 aircraft was equipped with a special Emerson Electric belly turret armed with a 20 mm gun. Gunfire was directed by means of a low-light television camera and monitor, with ranging by laser. The system was delivered to the USAF for flight trials in early 1970.

Pave Hawk:

Little is known of this system which was designed to provide night target marking from a drone. This was a Ryan vehicle and Kollsman also participated.

Pave Knife:

This is a pod-mounted system developed by Philco-Ford under a $3.6 m USAF contract for fitting to F-4D aircraft. The initial award called for six units, and the system bears the official designation AVQ-10. Shared wide-angle optics serve a Westinghouse laser target illuminator and a Dalmo-Victor low-light television camera. Stabilisation is provided. The system provides for night target acquisition and laser designation for attack by Paveway bombs. The USAF carried out tests of methods of slaving the AVQ-10 to the aircraft attack radar. Ranges of up to 12-15 km have been reported.

In November 1972 it was announced that a number of USN A-6A attack aircraft were to be fitted with AVQ-10 pods. The Navy version used a Hughes neodymium laser and a Ball Brothers Research Corporation TV camera, both mounted on a common stabilised platform. The A-6A multimode display in the cockpit was modified by Norden to enable it to accept TV video. This system produced good results in the hands of both the USAF and USN in Vietnam.

Pave Lance:

Pave Lance is a successor to Pave Knife and is similar in concept but with greater night and all-weather capability, and intended for F-111 use as well as the F-4D. A series of five study contracts was awarded by the USAF to Bell Aerosystems, Martin-Orlando, North American Rockwell, Texas Instruments and Westinghouse. Probably no longer active.

Pave Light:

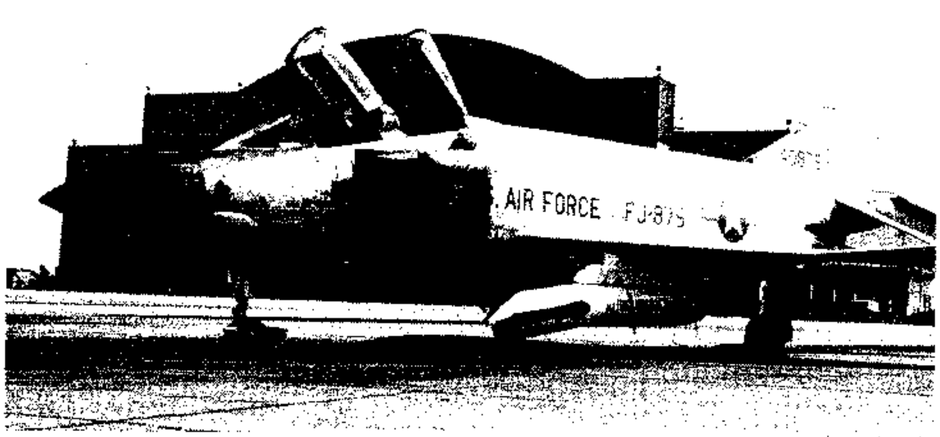
This designation was given to a stabilised laser illuminator with direct viewing arrangements for the F-4 developed by Dynasciences. The project was completed by early 1970.

Pave Mack:

This project has the objective of hitting trucks and ground transport from the air. Target illumination and designation from a FAC aircraft is by equipment similar to that employed in Pave Spot (qv), and weapons considered include Zuni rockets fitted with laser seeking heads. Martin-Orlando received a contract in December 1969 and modified a number of 2.75 in FFAR (Fin Folding Aerial Rockets) to produce what became known as LARS, Laser Aided Rocket System.

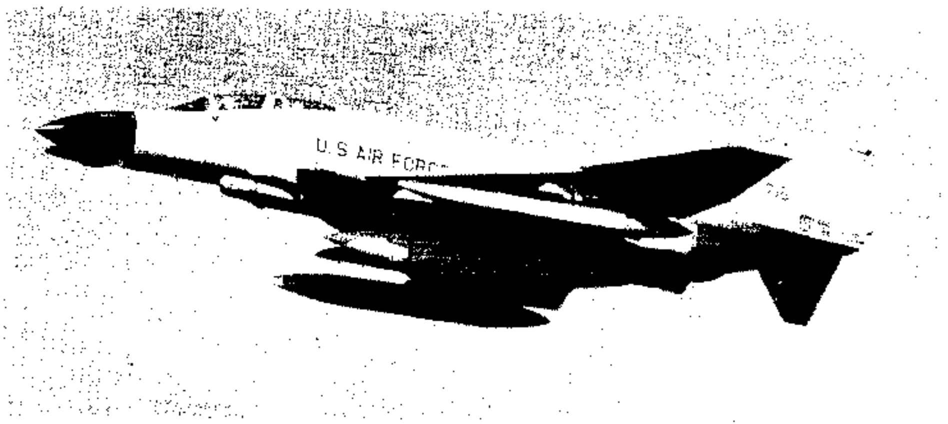
Pave Nail:

Under this programme four OV-10 observation aircraft were modified by LTV Electrosystems for use as night FAC aircraft. The contract awarded in late 1970 provided for options on a further 14 aircraft to be modified. The aircraft were fitted with the Varo, Inc stabilised periscopic night sight developed originally for the Cessna O-2A, and a combined laser range finder and target illuminator. The laser was supplied by Martin Orlando. A Loran navigation receiver and co-ordinate converter were also installed. In operation, the observer uses the sight to detect ground targets.



AVQ-10 Pave Knife low light TV and laser pod for F-4D by Philco-Ford

Pave Knife pod on F-4 aircraft


USAF Phantom carrying Pave Knife pod in the front left Sparrow missile well

using the laser to obtain range data. This is used with the Loran position of the OV-10 aircraft to derive a vector for an accompanying strike aircraft to engage the target. The laser could also be used to illuminate the target for a laser seeking bomb or other weapon.

Pave Nickel:

This is a USAF programme for the use of RB-57 aircraft, and later drones, to locate simultaneously up to 200 radiating sites along the East European boundary of the Warsaw Pact countries. Time of Arrival techniques will be used.

Pave Penny:

This is a laser bombing system for the F-4 to enable it to engage laser-marked ground targets with Paveway bombs. The laser beam can be modulated in coded fashion to offset enemy attempts at light jamming. Night vision facilities are provided in the aircraft installation. Prototype equipment produced by Martin-Orlando began flight test in late 1972.

Pave Phantom:

Phantom F-4D aircraft co-operating with Pave Nail OV-10 FAC aircraft are equipped with a Lear Siegler ARN-92 Loran navigation and computer set. This enables up to eight designated target positions to be inserted into this system in advance of the beginning of the attack. The targets can be engaged without the F-4D crew seeing them.

Pave Pronto:

A system developed for AC-130 Gunships, and employing a Korad laser. Aircraft modification is by LTV Electrosystems.

Pave Spectre:

Another AC-130 Gunship system incorporating low-light television, lasers, and IBM weapon delivery computers.

Pave Spike:

The AN/ASQ-153 Pave Spike pod is a day tracking/laser target designating system that provides F-4D and F-4E aircraft with a self-contained laser guided bomb delivery capability. Pave Spike is being built by Westinghouse under a USAF contract. It has the capability of acquiring, tracking and designating tactical targets from a manoeuvring F-4 at stand-off ranges commensurate with laser guided ordnance. The Pave Spike pod contains an optical subsystem, stabilisation and beam-pointing subsystem, TV tracking sensor, laser designator/ranger, environmental control and associated electronics. The forward nose section of the pod rotates about the roll axis to provide a search capability and the stabilised optics are housed in this section. The complete pod fits into the left front Sparrow missile well of the F-4D/E fuselage. Aircraft mounted elements of the system include a line-of-sight indicator, control panel, range indicator, modified radar control handle and weapons release computer. The AN/ASQ-153 designation denotes Pave Spike configured for the F-4D/E aircraft; the

Tropic Moon III B-57G, converted by Westinghouse for night interdiction

AN/AVQ-23 designation is that of the pod adapted for other types of aircraft.

In mid-1971 Westinghouse was awarded a $5 million contract for 50 sets and the planned USAF total requirement has been reported as more than 120. Prototype flight testing began in September 1972.

Pave Spot:

This system was originally developed by Varo, Inc for USAF Cessna O-2A observation/FAC aircraft. The sensor is a stabilised periscopic night vision sight which is lowered through the fuselage undersurface. In addition to the sighting optics, the rotating turret also contains a Korad laser illuminator.

Pave Storm:

This designation has been assigned to LTV Electrosystems studies of a laser missile-homing weapon, based on the KMU-420 fragmentation bomb. Pave Storm is somewhat heavier and has a Texas Instruments laser-seeking homing head.

Pave Strike:

This designation identifies a group of USAF programmes which, though varied individually, have the common objective of upgrading the capability for conducting precision air-to-ground strikes. The Fiscal Year 1965 Budget allocation for the various projects and developments falling within Pave Strike amounts to about $40 million in all. The principal items covered by this are:

- Modular Guided Glide Bomb II
- EO Glide Bomb (EOGB II), involving modifications to HOBO kit.
- DME Guided SUU-54 Dispenser
- Precision Emitter Location and Strike System (PELSS)
- Deployable Data Base (facilities for putting DME co-ordinates on photographs)
- Airborne Locator and Strike System (ALSS)
- EF-111A (Manned Support Jammer Aircraft)
- Advanced Development of Imaging IR guidance
  - Laser Maverick
  - Pave Tack Pod
  - Multi-Mission RPV.

Further details of some of these weapons and systems will be found in this section and also those dealing with Drones and RPVs, and Reconnaissance Systems

Pave Sword:

This project combines the basic equipment used in Pave Arrow with the laser seeker element slaved to the F-4D attack radar so that the aircraft can be directed at a laser-marked ground target.

Pave Tack:

Pave Tack is the name of a development programme forming part of the USAF Pave Strike programme, and concerned with the development of a FLIR and laser target designator pod for F-4 and F-111 type aircraft.

There are two other Paveway projects on which little information has been obtained:

Pave Eagle II:

All that is known is that the system incorporates a data link and a special purpose drone (QU-22B).

Pave Fire:

This is described as used on specially equipped F-4D aircraft

Although not bearing Paveway designations, there are a number of other programmes having similar objectives. These are briefly described in the following paragraphs.

Blind Bat:

This system is carried by some AC-130 Gunships. The equipment is similar to that used in Pave Nail and Pave Spot FAC aircraft, and the operational method also is similar, Loran target co-ordinates being transmitted to accompanying Pave Phantom strike aircraft.

Long Knife:

This is a new system due for flight testing this year in a USAF F-4D. Housed in the same pod as Pave Knife, it is to have increased accuracy and improved stabilisation. Sensors will be a Bali Brothers Research Corporation low-light level TV camera and an International Laser Systems laser designator.

Tropic Moon 3:

This programme involved equipping 12 Martin B-57G aircraft for night interdiction operations by Westinghouse for the USAF. Special equipment included the AXQ-5 television weapon delivery system, electro-optical target identification and tracking, and other sensors.

1301.321
HARPOON (AGM-84A) AIR-TO-SURFACE ANTI SHIPPING MISSILE

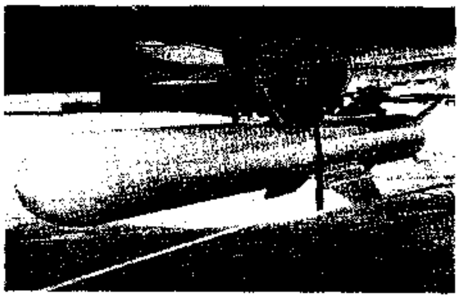
DESCRIPTION:

Harpoon, originally designated as ALSAM (Air Launched Ship Attack Missile), is an all-weather anti-ship missile for use against surfaced submarines, patrol craft, destroyers and larger vessels, merchant ships and trawlers.

The missile will be capable of being air-launched or, with the addition of a rocket booster, ship-launched. This latter version will supplement existing shipboard missile systems and will become operational on those ships which do not currently have a missile capability. McDonnell Douglas and the US Navy are adapting Harpoon for launch from submerged submarines also. Further details of Harpoon in these versions will be found in Entries Nos. **2641.221** and **2797.421**.

Approximate dimensions are length 800 cm, body diameter 30 cm, span 100 cm, and the

Air launch version of Harpoon beneath USN P-3 Orion aircraft



Harpoon in air-launch configuration

weight 900 kg. Ship launched versions will have an additional motor, with four fins, attached to the rear of the missile. Mid-course guidance will be performed by a system being jointly developed by IBM and Lear Siegler: the former providing the digital processor, and the latter the strap-down sensor/guidance sub-system. This technique uses computer techniques to process the data from non-gimballed gyros to sense missile velocity in three axes and derive control signals from this information. It is anticipated that this will be comparable to the inertial guidance technique but simpler and less costly.

The missile will employ an active radar terminal guidance seeker.

The programme is currently in advanced development. McDonnell Douglas received a $60 million contract in June 1971 and the first two test models were delivered in March 1972, one to the US Navy Naval Missile Centre at Point Mugu, California, and the other to the NASA Lewis Research Centre, Cleveland, Ohio. At Point Mugu, the first model was used for aerodynamic tests of the missile carried by a P-3 aircraft, and at the Lewis Research Centre sustainer engines developed by Garrett A Research and Teledyne CAE Division underwent wind tunnel tests installed in the second Harpoon test vehicle. Six more test models were delivered for separation tests and shipboard handling studies. For Fiscal Year 1974 the US Navy sought $19 million for procurement, plus $66.6 million for continued research, engineering and development. The Harpoon system is planned to enter operational service in 1975. The Fiscal Year 1975 Budget called for $78.2 million for the procurement of an initial production of 150 Harpoons.

Harpoon immediately after air launch from P-3

1123.311
STANDARD ARM (AGM-78B) ANTI-RADIATION MISSILE

DESCRIPTION

Air-to-ground passive radar homing missile for the destruction of surface-to-air missile battery radars. The system consists of a modified Standard (RIM-66A) medium-range missile for delivery by current high-performance aircraft equipped for the detection, identification and acquisition of the radar target. Each aircraft can carry up to four missiles.

More recently, this weapon has been adapted to two further roles – to provide Standard-equipped ships, and those previously without a missile capability, with a surface-to-surface weapon system. These programmes are described in Entries Nos. **2808.221** and **2669.221**.

The AGM-78B is propelled by a dual-thrust solid-propellant rocket motor and a conventional high-explosive warhead is carried. Speed is in excess of Mach 2, and range is estimated at over 25 km. Principal characteristics are: length 457 cm, diameter 30.5 cm, and weight 816 kg.

OPERATION:

System operation is initiated by reception of hostile radar transmission by the aircraft. The received signal is processed to extract target location, identification, and threat data. A missile is then launched and homes on to the source of radar transmission. The dual-thrust motor of the missile enables it to follow a variety of pursuit courses to the target. Missile warhead detonation, in addition to destroying the target, activates a visual marker to denote the impact area for follow-up strikes.

The Target Identification and Acquisition System (TIAS) installed in the aircraft will incorporate quite sophisticated techniques to counter the various methods adopted by the opposing force to confuse passive radar homing missiles by regular or irregular switching off of the ground radar etc. TIAS is the responsibility of IBM and the system incorporates an IBM 4-pi digital computer. Among the functions of this unit will be the computation of a trajectory for the AGM-78B on the basis of all past received data in the event of the target radar being turned off. It has been reported that TIAS will only be installed in US A-6A aircraft because of weight limitations in other types deploying the Standard ARM (F-105 and F-4). It has also been stated that a smaller, lighter version of TIAS is under development.

USAF aircraft are reported to be using an advanced version of the Wild Weasel radar warning and homing system for target identification and acquisition purposes. The processor to be used with the ECM system for Standard ARM operation has yet to be selected.

DEVELOPMENT:

Design studies for the Standard ARM, and the first development contracts, were initiated in 1966. Flight tests took place in 1967 and were completed in the following year. Full production began in 1968. Contracts awarded to the main contractor, General Dynamics, total over $100-million.

STATUS:

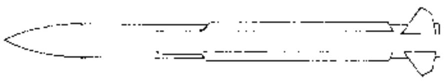
The AGM-78B Standard ARM entered operation services in 1968 with F-105F and A-6A aircraft, but deployment with F-4 aircraft appears to be lagging, and is presumably dependent upon the completion of development of a suitable TIAS for this type.

Production began in Fiscal Year 1970 on the AGM-78C version, and development is continuing on the AGM-78D model. The US Navy currently plans arming the EA-6B and E-2C electronic aircraft with this missile.

The US Navy is also developing the missile for adaptation as a surface-to-surface weapon for ship-borne applications. By mid-1971 several test firings from patrol gunboats had been made.

The Standard ARM (AGM-78) has been used as the basis of a new weapon system XAGM-97A, Seekbat, intended for air-to-air use to counter the Soviet MiG-25 Foxbat interceptor.

Standard ARM carried by A-6 aircraft



Standard ARM (AGM-78)

MANUFACTURERS

General Dynamics Corporation, Pomona Division, 1675 West Mission Boulevard, Pomona, California 91766, USA.

Maxson Electronics Corporation, Sunrise Highway, Great River, Long Island, New York 11739, USA.

1769.311
HARM – HIGH-SPEED ANTI RADIATION MISSILE

DESCRIPTION:

The HARM programme has as its objective the development of a new anti-radiation missile for use in defence suppression and similar operations, and which offers performance improvements over the existing Shrike (**1102.311**) and Standard ARM (**1123.311**). Higher speed, faster reaction, and a more destructive warhead are the likely priority improvement areas. Other desired characteristics which have been specified are: relatively low cost, integrated avionics and Electronic Warfare systems, integrated circuit construction, latest ECCM, weight of about (300 kg), an improved propulsion system, an improved frequency coverage.

DEVELOPMENT:

First contracts in support of HARM research and development were awarded during 1972. Among them were the following: Texas Instruments, guidance and avionics; Hughes Aircraft, systems analysis and guidance support; Itek, AN/ALR-45 radar warning receiver modifications; Lockheed, system studies; Dalmo-Victor, modification of DSA-20N signal analyser; Stanford Research Institute, analysis. The Fiscal Year 1975 Budget called for a F.Y. 1974 Supplemental funding of $4.0 million to accelerate HARM development and another $18 million for continued development as part of the 1975 Budget's defence suppression effort.

2831.311
TOW AIR-TO-SURFACE APPLICATION

DESCRIPTION:

As noted in the main description of the TOW anti-tank weapon system (**2830.111**), this weapon, like several other anti-tank weapons, can be used as armament for fighting helicopters.

Both the gunner's sight and the optical sensor are mounted on a specially developed gyrostabilised platform, which gives the tracking and control system a constant reference surface. The sight is pointed at the target by means of a joy-stick.

The anti-armour version of the Bell Huey Cobra is equipped with the XM-26 airborne TOW system, and up to four 2-round modular TOW launch pods can be carried, while still leaving the inboard pylons free for rocket or 20 mm minigun pods. The XM-28 turret with a 7.62 mm minigun and 40 mm grenade launcher is retained. In addition to stabilised optics and a missile tracker, the modified XM-26 sight has provisions for a laser range finder. Helmet sights allow the crew to control the turret directly or provide target acquisition for the stabilised optics.

STATUS

In 1972 the concept of TOW-armed helicopters being employed specifically as an anti-tank force for defence against armour attacks was tested under real conditions in SE Asia and in simulation exercises in Europe. In both cases very promising results were reported.

In Vietnam, TOW-Cobra helicopters were used against abandoned tanks and moving vehicles with the principal objectives of obtaining data on practical operating aspects and weapon performance under combat conditions.

The trials held in West Germany were simulations, were far more elaborate and were run to build up statistical information relating to various tactical situations as applied to both the attacking (armour) side and the defending force (TOW-Cobras and spotter/director helicopters).

Units of the West German, Canadian and American forces took part, the Bundeswehr providing the attacking formations of Leopard tanks. All participating vehicles and aircraft were equipped with Solartron Simfire laser fire simulation systems linked to comprehensive recording and scoring systems. The exercises consisted of ten trials each of delay, defence and break-through situations in which two TOW-Cobras were matched against a platoon of Leopards reinforced with a US Army Vulcan air defence unit. These 20 trials were repeated using two OH-58 scout helipters and one TOW-Cobra. The latter combination of helicopters proved most successful. The statistical outcome of the exercises was a total of 14 helicopters (10 TOW-Cobras and 4 Scouts) lost against 167 tanks and 29 Vulcan units disabled.

MANUFACTURERS.

Hughes Aircraft Company, Culver City, California, USA.

TOW missile launch from US Army helicopter during test firings at Redstone Arsenal, Atlanta, USA (Army News Features Photograph)

The gyro-stabilised sight developed by Hughes for the Huey Cobra TOW-equipped helicopter

1391.311
HELLFIRE TACTICAL AIR-TO-SURFACE MISSILE

DESCRIPTION:

HELLFIRE is an acronym (Heliborne, Laser, Fire and Forget) used to describe a new laser-guided missile under development by the US Army. The missile is said to be smaller than TOW, but with a much greater range. It is being developed for the Army's Cheyenne attack helicopter but could also be mounted aboard armoured personnel carriers for use with ground combat units as an indirect fire weapon. The missile's terminal guidance system will permit a "launch and leave" capability enabling launching aircraft to reduce significantly their exposure to the target.

In late 1971, General Dynamics unveiled its proposed system to meet the Hellfire requirement, under the designation MRAM – Multi-mission Redeye Air-launched Missile. This system uses a modified version of the Redeye heat-seeking missile, two of which would be carried in each of two re-usable launch pods attached to the helicopter.

A similar proposal for a version of the Shillelagh anti-tank missile has been made by Philco-Ford, and North American Rockwell has suggested a development of the Hornet (Entry No. **1097.311**) which was originally intended for anti-tank operations before it became a test-bed vehicle for new guidance systems. In January 1972 the US Army Missile Command invited industry proposals for a ground laser target designator for use with Hellfire, and requests for an airborne version were issued soon after. Although initial effort was directed towards the use of laser guidance, the programme has since become increasingly concerned with the development of a modular weapon capable of using a variety of guidance techniques. The Fiscal Year 1975 Budget sought $6.3 million for the development of a dual RF/IR Seeker, and another $9.0 million for further development and test work on the missile.

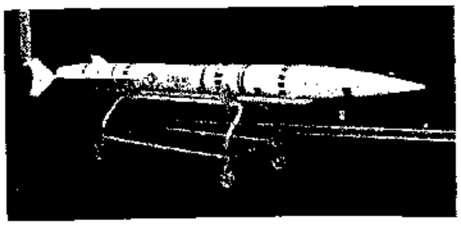
1773.311
SAGMI (SURFACE ATTACK GUIDED MISSILE)

DESCRIPTION:

One of several classified defense-suppression concepts sponsored concurrently by the USAF, the SAGMI (Surface Attack Guided Missile) was developed and demonstrated successfully by Beech Aircraft Corporation during 1971-1972, under the direction of the Air Force Armament Laboratory at the USAF Armament Development and Test Center, Eglin Air Force Base, Florida. Derived from the Beech AQM-37A missile target, SAGMI was funded under total expenditures of only $2.3 million to cover system definition, construction and flight demonstrations. Its configuration is shown in the accompanying illustration.

The programme objective was a long-range supersonic defense-suppression weapon with "fire-and-forget" capability, which could be used in conjunction with conventional munitions.

Power plant of SAGMI is a single American Machine and Foundry LR64 (modified) liquid-



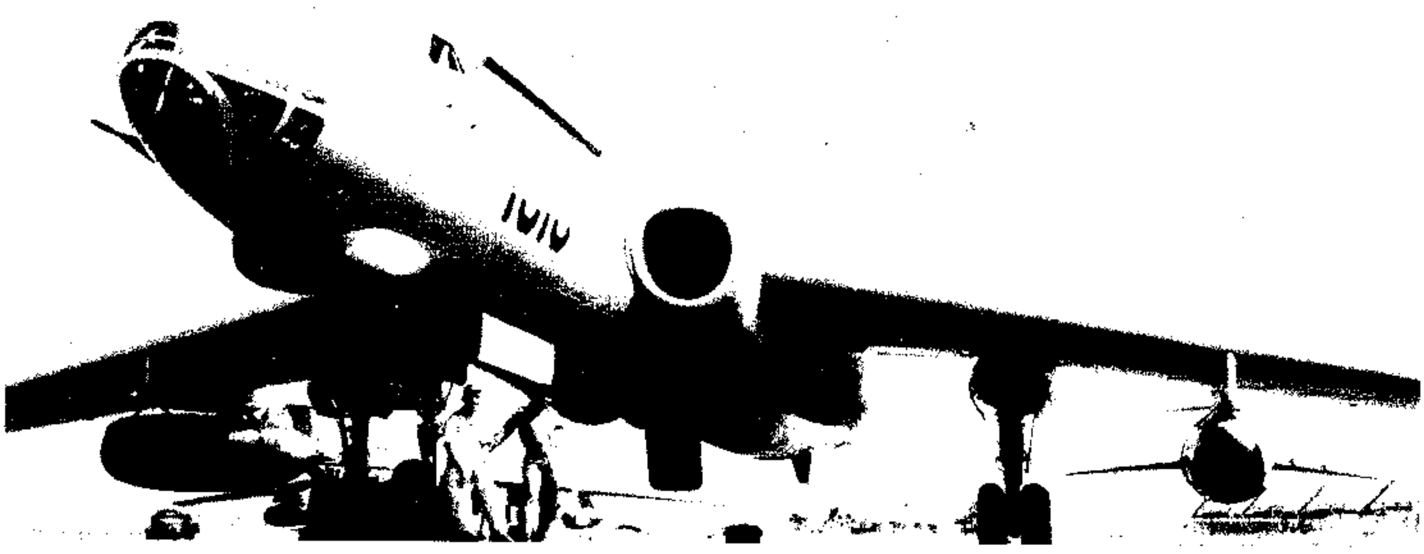
SAGMI (Surface Attack Guided Missile) developed by Beech Aircraft Corporation propellant rocket engine. The guidance technique was developed as part of a separate concurrent project and remains classified. According to reports, it enabled SAGMI to achieve outstanding terminal accuracy.

Dimensions of SAGMI are: length 5.23 m, diameter 33 cm, and wing span 1.02 m.

MANUFACTURER:

Beech Aircraft Corporation, Wichita, Kansas 67201, USA.

THE UNION OF SOVIET SOCIALIST REPUBLICS



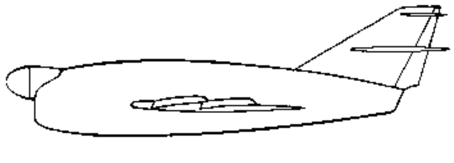
Tu 16 Badger loaded with two Kennel air-to-surface missiles

1148.311
KENNEL (AS-1) AIR-TO-SURFACE MISSILE

DESCRIPTION:

Kennel is the NATO code-name assigned to a Soviet stand-off air-to-surface weapon carried by Tu-16 (Badger) aircraft, one beneath each wing. Estimated dimensions are: length 8.5 m, wing span 4.9 m. It is powered by turbojet motor, and its general appearance is rather similar to that of the Ryan Firebee drone. Externally, Kennel is almost identical with the Samlet coastal defence missile, and the two weapons may in fact be versions of the same missile. Estimated range is up to 50 nautical miles (90 km).

A probable operational role is anti-shipping strike missions, and external evidence of electronic equipment carried by Kennel missiles suggests that either beam-riding radar or radio command link guidance is used for the major portion of the trajectory, with either passive or active radar homing for the terminal phase. The parent Badger aircraft are provided with at least two radars on the underside of the fuselage which could serve such a mode of operation.



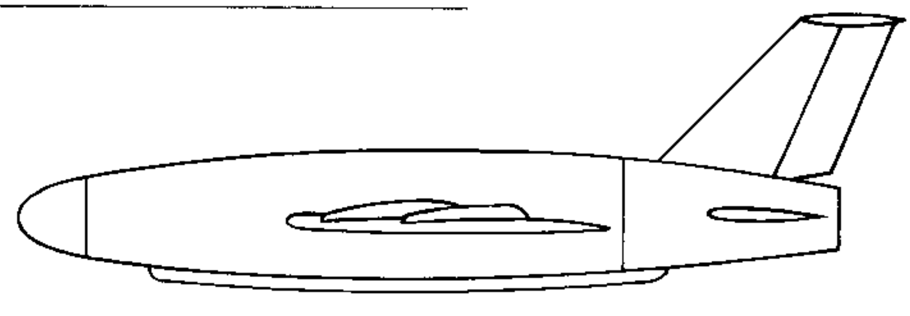
Kennel (AS-1)

In addition to the Soviet forces, the Badger/Kennel combination has been supplied to the Indonesian and Egyptian Air Forces.

1149.311
KELT (AS-5) AIR-TO-SURFACE MISSILE

DESCRIPTION:

Kelt is the NATO code-name of a Soviet air-to-surface weapon, first seen by a Tu-16 Badger bomber aircraft. It has superficial but pronounced similarities with the Kennel (Entry No. **1148.311**) which also is used with the Badger, and with the Styx shipborne surface-to-surface missile (Entry No. **1155.221**). Estimated dimensions of Kelt are length 9.4 metres and wing span about 4.6 metres. The fuselage centre-body and wings of Kelt appear to be the same or very similar to those of Kennel, while the nose section (and presumably the guidance system it carries) of Styx is employed. A rocket propulsion motor is used and the tail control surface arrangements of Kelt differ from both those of both Styx and Kennel. Western estimates of range vary between 160 km and more than 320 km, but a figure of about 180 km seems most likely.



Kelt (AS-5)

AIR-TO-AIR-MISSILES

FRANCE

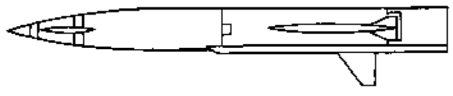
1178.331
R.511 AIR-TO-AIR MISSILE

DESCRIPTION:

Air interception missile using semi-active radar homing guidance. Principal characteristics are: length 309 cm, diameter 26 cm, weight 184 kg, wing span 1 m. Propulsion is by two-stage solid-fuel motor and range is about 8-10 km. The radar homing head is produced by Thomson-CSF.

OPERATION:

The fire control radar of the launch aircraft is used as a target illuminator radar for the missile homing head which derives guidance signals for the missile autopilot from reflected radar energy received from the target.



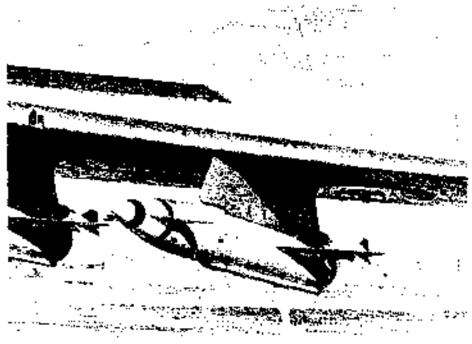
R.511

STATUS:

The R.511 is still operational with the French Air Force and must now be considered obsolescent.

MANUFACTURER:

Engins Matra, 49 rue de Lisbonne, Paris 8, France.



R.511 air-to-air missile

1176.331
R.530 AIR-TO-AIR MISSILE

DESCRIPTION:

All-weather all-aspect air-to-air missile system produced with alternative semi-active radar homing or infra-red guidance heads. Principal characteristics are: length 328 cm, diameter 26 cm, wing span 110 cm, weight 195 kg. Maximum speed is Mach 3.0 and range is 18 km. Apart from the homing heads the two versions of the R.530 are identical. Propulsion is by a two-stage solid-propellant Hotchkiss-Brandt motor of 8,500 kg static thrust. Either of two types of high explosive warhead produced by the same concern, and weighing 27 kg, can be fitted.

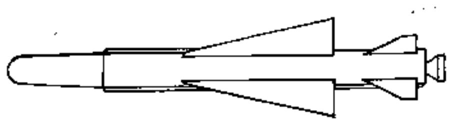
OPERATION:

The infra-red homing version is stated to be capable of successful interceptions from any aspect, relying upon heat from either the jet engine and its exhaust from the rear quarters and local airframe hot-spots by aerodynamic heating when attacking from the front. This mode of operation is intended mainly for high altitude interception in clear air or at low level beneath cloud.

The semi-active radar homing head is produced by Electronique Marcel Dassault under the designation AD26 and this is for use with an X-band target illuminating radar (normally the launch aircraft's fire control radar installation). Use of the proportional navigation method of guidance in the AD26 head permits a wide missile firing range and good hit probability against manoeuvring targets. Anti-jamming devices of an unspecified nature are incorporated which are claimed to make it almost immune from current ECM techniques and those foreseen for the near future.

The radar homing head is able to lock on data stored during the passage of the altitude echo through the target 'window'. For maximum simplicity and economy, the circuitry used to harmonise the AD26 with the fire control radar is grouped in a harmonisation pack which is installed in the parent aircraft. Pre-launch operations are performed automatically and consist of: (1) harmonisation of the AD26 head with the radar, (2) prepositioning of the aerial in the target direction, (3) pre-setting of homing head circuits to match the characteristics of the returned echo signals, (4) computation of fire control parameters for a collision course.

During the homing period, the AD26 generates the flight control signals for the stabilisation and guidance of the missile to the target. Weight of the AD26 head is 18 kg (including skin and radome) and its range is in excess of 10 km. Construction consists of two main modules. The foremost consists of gyro-aerial RF head and part circuitry, and the rear portion is a structure of three light alloy compartments containing the power supplies and other circuits.



R.530

Matra R.530 as carried on French Navy Crusader

Matra R.530 on Mirage

DEVELOPMENT:

Design and development work on the R.530 started in 1958 with Engins Matra acting as main contractor to the French Air Ministry. Entry into service was in 1963.

STATUS:

The R.530 is in full production and used with the Mirage IIIC, Mirage IIC and Crusader F-8E of the French Naval air arm. In addition to the French Forces, other users include the Australian, South African and Brazilian Air Forces. The manufacturers state that twelve nations have been supplied with this weapon. Production of the R.530 is expected to cease in 1976.

MANUFACTURERS:

Matra, 2 rue Louis Breguet, 78-Velizy -Villacoublay, France.

AD26 Homing head – Electronique Marcel Dassault, 55 Quai Carnot, 92-Saint Cloud, France.

Infra-red homing head – Société Anonyme de Télécommunications, 41 rue Cantagrel, Paris 13, France.

1349.331
SUPER 530 AIR-TO-AIR MISSILE

DESCRIPTION:

This is a developed version of the Matra R.530 weapon, intended to meet the higher speed and altitude performance requirements of the next-generation of interceptor aircraft.

The Super 530 is a high performance interception missile which succeeds the 530, with twice the possibilities in range and acquisition distance.

With a design concept for reaching targets flying at very high altitude and at high mach numbers, it comprises: a "long-wing" of low width, which gives it exceptional aerodynamic qualities, in particular in the area of load factors at altitudes greater than 70,000 feet; a motor with a very high acceleration rate, which allows the interceptor aircraft to fire with vertical separations of more than 10,000 feet.

The Super 530 is equipped with an electromagnetic homing head developed by Electronique Marcel Dassault.

This all-weather operational missile is under development for the French Air Force. Series production is planned to begin from 1977 onwards.

DEVELOPMENT:

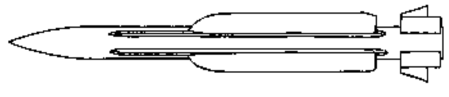
The first test firing (controlled but unguided) of the Super 530 was made after satisfactory ramp testing of a mock-up.

STATUS:

Existence of the Super 530 development programme was first publicly revealed at the Paris Air Show in May 1971. It was then stated that this missile will arm French Mirage F1 and other interceptors.

MANUFACTURER:

Engins Matra, Avenue Louis-Breguet, 78-Velizy-Villacoublay France.



Super R.530

1348.331
R550 MAGIC AIR-TO-AIR MISSILE

DESCRIPTION:

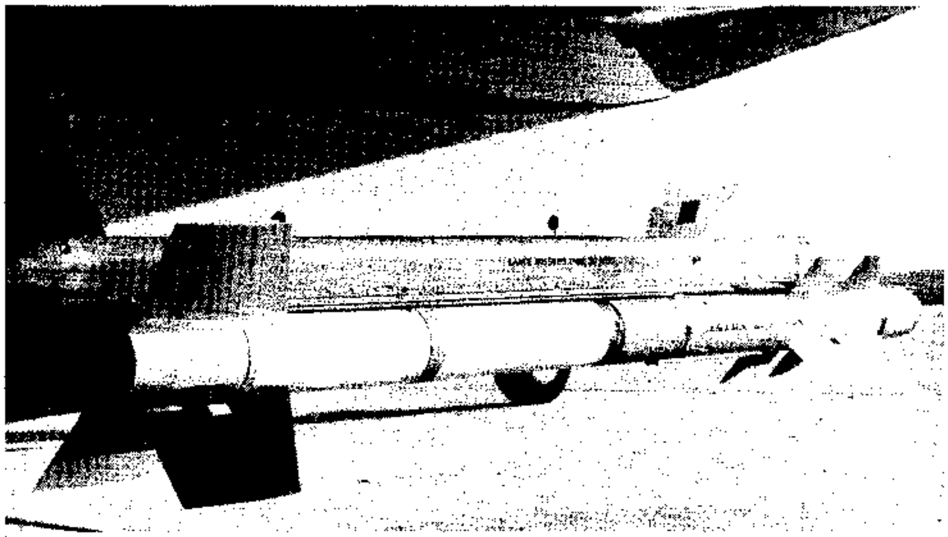
The Matra R550 Magic is a new air-to-air missile designed for 'close-combat' operations (from less than 500 m to more than 6 km), with consequent emphasis upon the ability to withstand high load factors imposed by the severe manoeuvre demands required. The general configuration of the weapon is shown in the accompanying photograph, and the estimated weight is approximately 80 kg. Length is 250 cm, body diameter 26 cm, and maximum span 65 cm. Propulsion is by a solid rocket motor, and operational range is reported to cover from 200 m, or less, to as much as 10 km. Twist and steer control of the missile is effected by the canard arrangement of fins at the forward end of the weapon. An SAT infra-red homing head provides guidance, and the special launch mount houses a liquid nitrogen container to provide cooling for the IR sensor.

DEVELOPMENT:

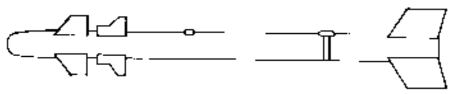
Development was initiated in 1968 and the first firing took place on January 11, 1972 when a CT-20 target drone making a tight turn was successfully engaged by an R.550 Magic launched from a Gloster Meteor test aircraft. A total of about 30 launches are envisaged in the course of development. Ten successive firings were made at the end of April, giving highly satisfactory results.

STATUS:

The R550 was first revealed at the 1971 Paris Air Show and was at the early development stage at that time. It is planned to replace Sidewinders with this missile on French Air Force and Navy interceptors. Although not intended for delivery before 1975, negotiations are taking place and MATRA has recorded three large orders from unspecified foreign air forces. The first aircraft launch under representative conditions was made in late 1973 from a Mirage III against a specially modified C20 target drone. Operational evaluation is being carried out by the French Air Force during 1974.



Matra R.550 Magic close combat missile



R.550 Magic

MANUFACTURER:

Engins Matra, Avenue Louis-Breguet, 78 Velizy-Villacoublay, France.

GERMANY (FEDERAL REPUBLIC)

1738.331
VIPER AIR-TO-AIR MISSILE

DESCRIPTION:

The Viper air-to-air missile has been developed to meet the requirements of the West German Bundeswehr and is intended as a Sidewinder replacement. Although the Viper is clearly based on the Sidewinder, in comparison with that missile a number of technological improvements have been embodied to provide a broader operating spectrum, particularly in respect of target acquisition and range, manoeuvring performance, launch conditions, and hit probability. Besides the enhanced capabilities for target acquisition, Viper also offers extended mission range, especially in low-level and dog-fight' engagements. It can be employed from large off-the-tail angles and from short ranges, restricted only by the necessary safety margin.

The improved mission capabilities are essentially obtained by the following measures:

New infra-red seeker with increased sensitivity, enlarged look angle, and increased tracking rate.

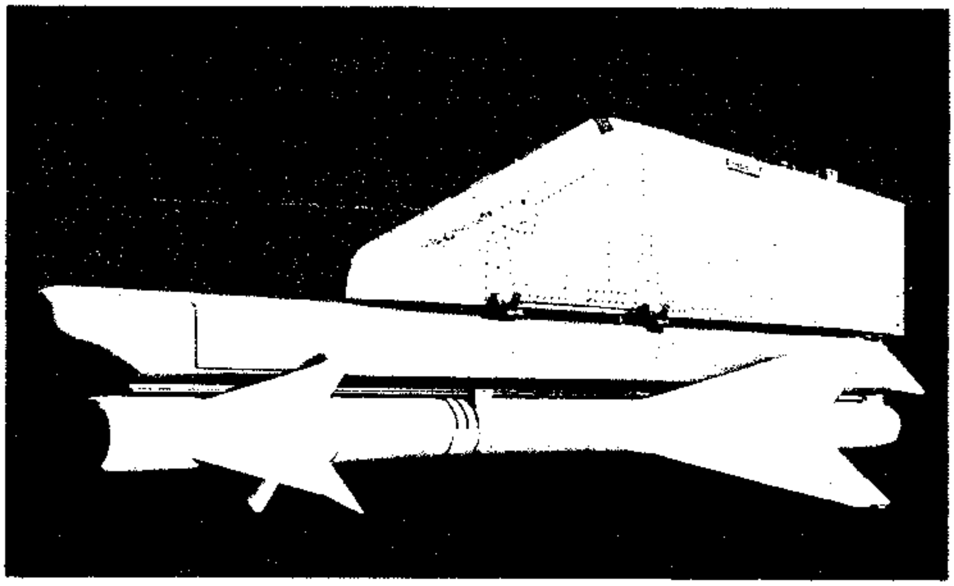
Strengthened fin actuator and improved control surface design.

Improved technology rocket motor.

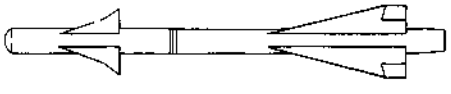
Improved aerodynamic design.

Extended target acquisition capabilities by means of acquisition unit in launcher.

The launcher attachment combines the functions of a housing for missile pre-launch equipment and as the support and release mechanism for the weapon. Equipment contained within the unit includes a cooler for the missile homing sensor, power supply, and certain guidance circuitry. For some combat conditions, the launcher is equipped with its own infra-red detector and search unit to provide target acquisition facilities for the missile homing head. This autonomous mode of operation could serve as either a standby mode or as a means of multi-target engagement if used in conjunction with other missiles using radar homing.



Viper air-to-air missile with launcher attachment containing separate IR target acquisition system and cooling pack



Viper

As can be seen from the accompanying illustration, Viper bears a close resemblance to Sidewinder in external appearance. It is made up of five main components: target seeking guidance head, warhead, proximity sensor, rocket motor, and cruciform tail fins with in-built rollerons at the tips.

DEVELOPMENT:

Development of Viper is being undertaken by Dornier as general manager of the programme, in co-operation with Bodenseewerk, with an integrated project management team.

STATUS

The prototype missile should be ready for flight test at the beginning of 1975. Entry into service is scheduled for 1977, and the F-4F and MRCA are among the aircraft types to carry this weapon.

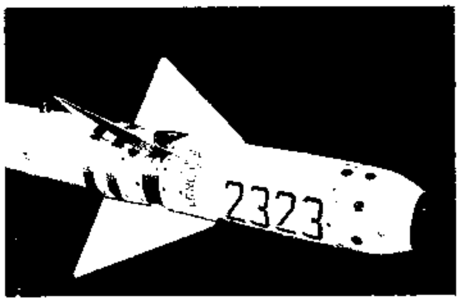
MANUFACTURERS:

Dornier GmbH, Friedrichshafen, Bodensee, West Germany.

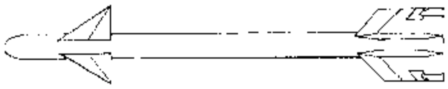
Bodenseewerk Gerätetechnik GmbH, Überlingen/Bodensee, West Germany

ISRAEL

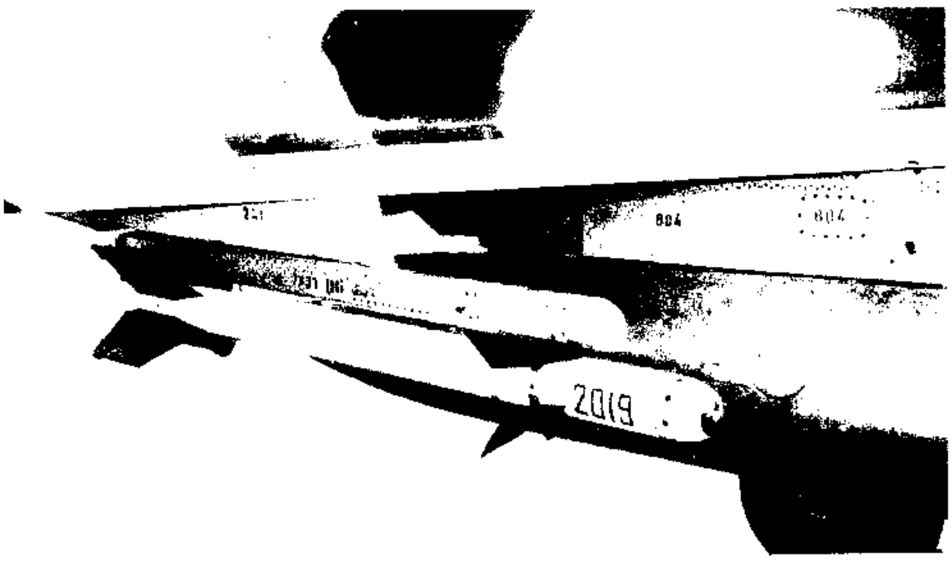
Shafrir infra-red homing air-to-air missile



Close-up of fore-end of Shafrir, showing control surfaces, fuses, and homing head



Shafrir



Shafrir missile on aircraft, showing adaptor mount

1659.331
SHAFRIR AIR-TO-AIR MISSILE

DESCRIPTION

Shafrir is an air-to-air, infra-red homing missile for use against high performance aircraft at heights up to 18,000 m (60,000 ft). It is a relatively small missile, 16 cm diameter and 260 cm long, with pneumatically-operated control fins at the fore-end and stabilising surfaces at the rear. The latter are fitted with the gyroscopically-actuated tabs found on the Sidewinder and Soviet Atoll missiles, for roll stabilisation. Approximate launch weight is 93 kg, of which the warhead accounts for 11 kg. Contact and proximity firing of the warhead are provided.

Simplicity was a major design objective, and both missile and aircraft-fitted elements of the Shafrir weapon system have been kept to the minimum. Electronics are solid state. Apart from the firing circuit, no aircraft-installed equipment is needed.

The missile and its launcher are mounted under the wing of the aircraft and attached to a specially-designed adapter.

OPERATION:

Firing of Shafrir is on a "see-and-shoot" basis. When a target is detected within the firing range, an audio signal is heard and an indicator light in the cockpit is automatically operated. This indicates that the missile launch button can be used. From this point, the guidance system is completely independent of the launching aircraft.

DEVELOPMENT:

Development was started in the mid-1960s by Rafael, the Israeli Armament Development Authority on behalf of the Israel Defence Forces. The development programme was concluded by the end of the 1960s, and production was commenced.

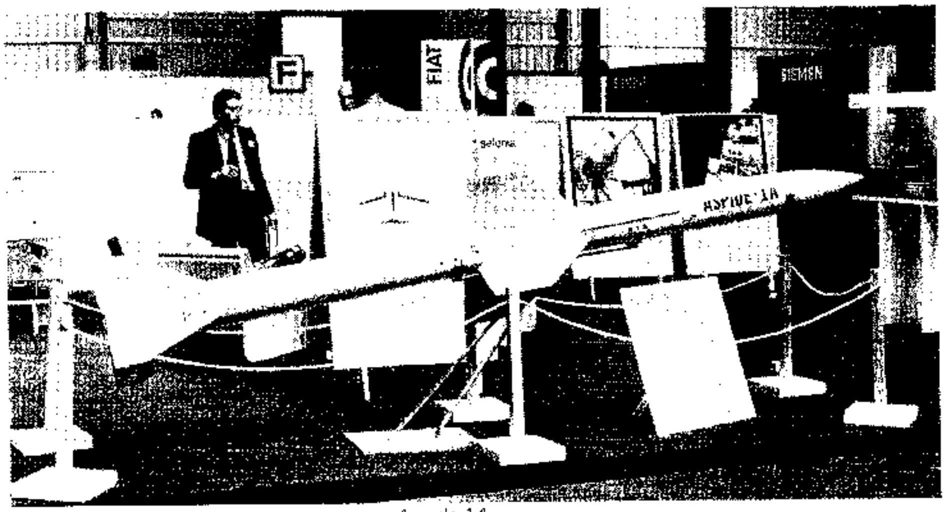
STATUS:

Shafrir has been launched in air combat with a high kill ratio on numerous occasions, according to official Israeli sources.

MANUFACTURER:

Rafael Armament Development Authority, Ministry of Defence, PO Box 2082, Haifa, Israel

ITALY



Aspide 1A

1656.331
ASPIDE MULTIROLE MISSILE

DESCRIPTION:

Aspide is a high performance multirole missile being developed for operation at all altitudes against a wide number of target types, and the Aspide-1A is optimised for air-to-air and surface-to-air missions. It is based on the use of a semi-active radar guidance system which will ensure all-weather and all-aspect operation.

The Aspide-1A was first shown in public at the 1974 Hanover Air Show when it was seen to have a configuration closely resembling the Sparrow missile it is to replace. Principal characteristics are length 3.7 m, body diameter 20.3 cm, wing span 100 cm (air-to-air) or 80 cm (surface-to-air), fin span 80 cm (a/a) or 64 cm (s/a), launch weight 220 kg, burn-out weight 163 kg. Propulsion is by means of a single-stage solid-propellant motor which will give speeds of more than Mach 2.5 in the surface-to-air role.

Present plans are to employ the Aspide-1A with the F-104/S interceptor and its successors (Entry No. **8052.302**); in the Albatros naval point defence weapon system (Entry No. **1551.281**); and in the Spada ground-based low altitude air defence system (Entry No. **2250.131**). In the first two systems, Aspide-1A will replace the Sparrow III (AIM 7E) missile currently employed.

Technical areas in which major development effort has been placed are seeker range, sub-clutter visibility, the fusing system, multiple target effectiveness, ECCM capabilities, functional modularity of construction, reliability and ease of maintenance. Thin-film microwave circuitry developed by Selenia is incorporated in the design.

DEVELOPMENT

Development was started in late 1969 and the contracting agency is the Italian Air Force.

STATUS

Manufacture of the first batch of prototypes was well advanced by early 1974, with flight tests programmed from June 1974. The R and D and evaluation programmes, including surface-to-air and air-to-air flight tests, will be completed by 1975 and production deliveries are scheduled to start during 1977.

MANUFACTURERS:

Prime Contractor – Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina Km. 12.400 Rome, Italy.

Sub-Contractors – SNIA – VICOSA SpA, Rome; Microtecnica SpA, Torino; E. SAG SpA, Genova; Nuova SACA SpA, Brindisi; Aster SpA, Milano.

JAPAN

1187.331
MITSUBISHI AAM-1 AIR-TO-AIR MISSILE
DESCRIPTION:
Few details have been disclosed of the air-to-air missile which is replacing the Sidewinder on F-86F and F-104J interceptors of the Japanese Air Self Defence Force. Guidance is understood to be by infra-red homing
STATUS:
It has been reported that the AAM-1 had already entered operational services by 1969, and a total planned production of 330 units had been delivered by late 1971.
MANUFACTURER:
Mitsubishi Heavy Industries Ltd, 5-1, Marunouchi 2-chome, Chiyoda-ku, Tokyo 100, Japan.

1188.331
MITSUBISHI AAM-2 AIR-TO-AIR MISSILE
DESCRIPTION:
The AAM-2 is under development as a successor to the AAM-1 air-to-air interception missile. The newer weapon is reported to have collision course interception capability, where the AAM-1 was limited to pursuit course attack. No other details are available.
MANUFACTURER:
Mitsubishi Heavy Industries Ltd. 5-1 Marunouchi 2-chome, Chiyoda-Ku, Tokyo 100, Japan.

SOUTH AFRICA

1535.331
SOUTH AFRICAN AIR-TO-AIR MISSILE
DESCRIPTION:
Very few details of this weapon have emerged since the announcement in 1969 by the South African Minister of Defence, Mr P. W. Botha, that an air-to-air projectile had been developed as a purely South African venture. Development had been in progress since 1966, and at the time of the Minister's statement it had recently been successfully tested at the Republic s St Lucia missile range and was nearing production status. In September 1971 the South African Air Force announced the successful engagement of a Mach 2 target with a missile launched from a Mirage III aircraft. The target was said to have been hit three seconds after launch. An announcement was made in late 1972 that initial production of this weapon had started.

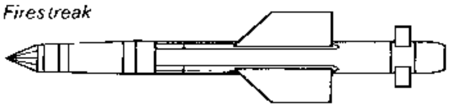
THE UNITED KINGDOM

1079.331
FIRESTREAK AIR-TO-AIR MISSILE
DESCRIPTION:
Infra-red homing, air-to-air weapon for use against high speed aircraft. All-altitude operation is possible against manoeuvring targets. Rear hemisphere engagement zone.

The missile has a cylindrical metal body carrying cruciform wings, behind each of which is a small control surface near the tail. Dimensions are: length 3.19 m, diameter 22.2 cm, wing span 75 cm. Launching weight is 136 kg and operating range is 1.2-8 km. Speed, over Mach 2. Unofficial weight for the warhead is 22.7 kg. The infra-red target tracker sensor is housed in the nose of the missile and protected by an 8-sided pyramidal nose-cone of flat glass plates.

In addition to Firestreak installations engineered to a specific aircraft type, it is available with an aircraft pack containing associated control systems, electronics and supplies, suitable for use with a wide range of aircraft types.

Firestreak



STATUS:
Firestreak has been used to equip RN Sea Vixens, and RAF Javelin and Lightning aircraft. It remains in service with the last of these types. Production ceased in 1969 and there is a phased replacement of Firestreak by Redtop.
MANUFACTURERS:
Hawker Siddeley Dynamics Ltd, Manor Road, Herts AL10 9LL, England.

Firestreak air-to-air missile carried by Lightning Interceptor

1080.331
RED TOP AIR-TO-AIR MISSILE
DESCRIPTION:
Infra-red homing air-to-air weapon for use against sub- and super-sonic aircraft. All-altitude operation is possible against manoeuvring targets, and all-aspect attack capability is provided by the Red Top homing and guidance system.

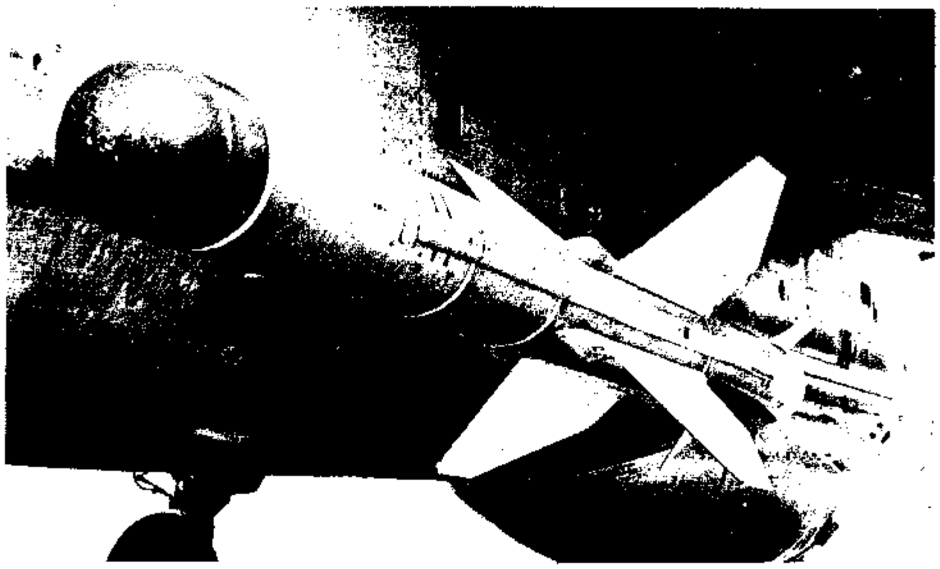
At one time referred to as Firestreak Mk IV, Red Top has a similar configuration and dimensions of the same order, but performance is considerably higher as a result of the application of advances in technology made since the start of Firestreak production.

Red Top retains the configuration of four fixed wings and four moving rear control surfaces, the design being further optimised to give operation over a very wide altitude and speed range. Wing and control surface planforms and sections differ from those of Firestreak, and match the unofficially quoted speed of Mach 3. The infra-red guidance system has been further developed to allow target interception from virtually any direction, and a hemispherical nose houses the I/R sensor.

Internally, the warhead (31 kg) has been moved forward, next to the fusing system and the control actuators have been located nearer to the surfaces they operate.

The power of the internal solid propellant booster rocket motor is also reported to be substantially greater than that of Firestreak, giving a range of at least 12 km

Missile dimensions are: length 3 27 m, diameter 22.2 cm, wing span 90.8 cm. Up to four missiles can be carried without significant detriment to aircraft performance.

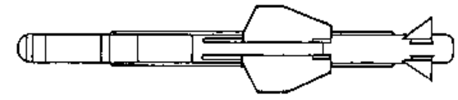


Red Top air-to-air missile on RAF Lightning interceptor

OPERATION:
Both complex and simple fire control systems can be employed for the operation of Red Top.

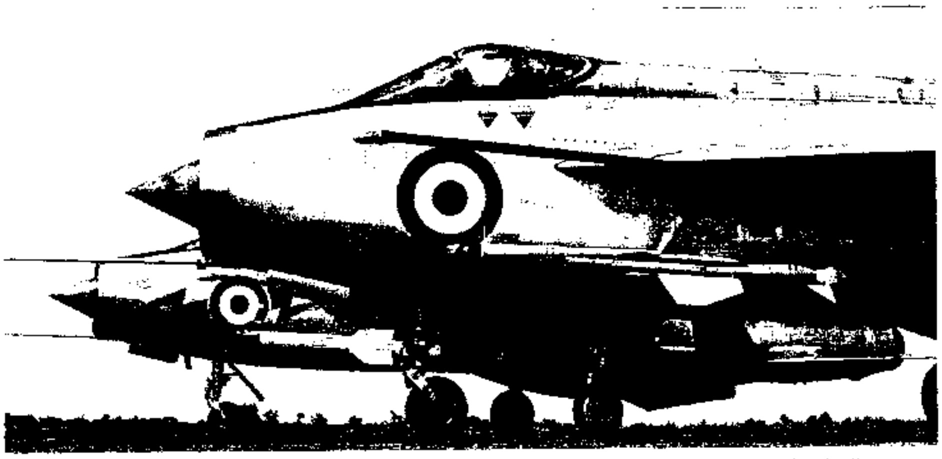
In simplified systems, the target may be acquired visually by the pilot and firing action taken upon receipt of a signal from the missile. By this method, the effectiveness of Red Top is maintained within a very compact weapon installation

The Red Top weapon system has been designed primarily as an integral part of the sophisticated United Kingdom defence system. However, the operational flexibility given by its all round attack capability allows easy adaptation to suit the requirements of any defence environment.
STATUS:
Red Top is in service with RAF Lightnings.
DEVELOPMENT:
Design studies were initiated in 1957 by



Red Top

Hawker Siddeley Dynamics in response to a UK Government requirement. Collaborating agencies included the Royal Aircraft Establishment, Royal Radar Establishment, and Royal Armament Research and Development Establishment.
MANUFACTURERS:
Hawker Siddeley Dynamics Ltd, Manor Road, Hatfield, Herts AL10 9LL, England

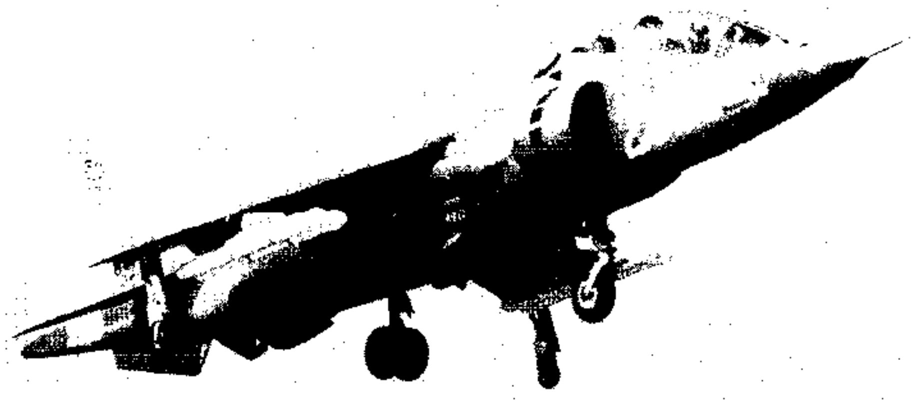


Lightning fighter aircraft carrying Red Top (nearest to camera) and Firestreak air-to-air missiles

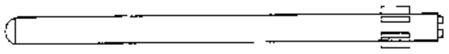
1344.331
SRAAM SHORT RANGE AIR-TO-AIR MISSILE
DESCRIPTION:
SRAAM is a new type of close-combat air-to-air missile, designed to cope with the high accelerations encountered in dog-fight conditions. Its design is such that it can operate down to a very short minimum range, even with the target manoeuvring to its design limits. At the same time, the maximum range is comparable to that of existing air-to-air weapons.

Visually aimed, and guided by a passive infra-red homing system, its thrust vector control will enable it to out-manoeuvre all types of aircraft, including crossing targets at very short range. It has a wide aiming tolerance and its high explosive warhead will be detonated by proximity or contact fuses.

The simplicity of the fire control system enables the missile to be fitted to almost any aircraft. Two weapons in their tubes are mounted on a single launch beam which contains all the fire control system. On firing, the missile container tube nose cap opens and the missile leaves the launchers, the missile fins erecting automatically as it does so. The high manoeuvre capability of SRAAM is achieved by the use of a solid fuel propulsion system employing thrust vector control. Four spoiler tabs which can be moved in or out of the jet efflux are used to effect this control. Powered by a solid-propellant motor, SRAAM is 2.73 metres long and 0.168 metres in diameter.
STATUS:
A technology development programme, which includes air firings, is in progress to prove the SRAAM concept.
MANUFACTURER:
Hawker Siddeley Dynamics Ltd, Manor Road, Hatfield, Herts AL10 9LL, England



Harrier fitted with two twin tube SRAAM launchers



SRAAM

Test firing of SRAAM

1774.331
UK SPARROW AIR-TO-AIR MISSILE
DESCRIPTION:
The UK Sparrow is a new medium-range all-weather air-to-air missile for the Royal Air Force. It is based on the Raytheon Sparrow missile and has the same general configuration and dimensions. It is a semi-active radar guided missile capable of attacking both sub-sonic and supersonic targets from very low to high altitudes and has an all-round attack capability. It employs a new advanced guidance system developed by Marconi Space and Defence Systems at Stanmore, Middlesex and a new advanced fuse system developed by EMI Electronics Ltd, at Hayes, Middlesex. The auto-pilot and power systems are being updated by Hawker Siddeley Dynamics Ltd, to include solid-state electronics and thermal batteries in place of the existing electronics and power systems to improve reliability. The missile structure will be built by Hawker Siddeley Dynamics who will also carry out assembly and test.
STATUS:
Project definition was completed in 1973 with the development programme following immediately. The development and initial production programme has been agreed with the Ministry of Defence and full development is proceeding.
MANUFACTURERS:
Hawker Siddeley Dynamics Ltd – Prime contractor
Marconi Space and Defence Systems Ltd – Homing head
EMI Electronics Ltd – Fuse
Raytheon Company – Main sub contractor

RAF Phantoms carrying Sparrow air-to-air missiles

Marconi semi-active radar homing head for Hawker-Siddeley improved Sparrow programme

THE UNITED STATES OF AMERICA

1302.331
AGILE (AIM-95) AIR-TO-AIR MISSILE

DESCRIPTION

Agile (AIM-95) is being developed by the US Navy as a thrust-vector controlled missile featuring better manoeuvrability and shorter minimum range than Sidewinder, which because of its configuration has inherent limitations in both of these aspects. Originally linked with the F-14 and F-15 aircraft programme, Agile is now seen as a weapon suitable for deployment on most fighter and strike aircraft, the former for close-in engagements and as a self defence weapon for aircraft of the latter category.

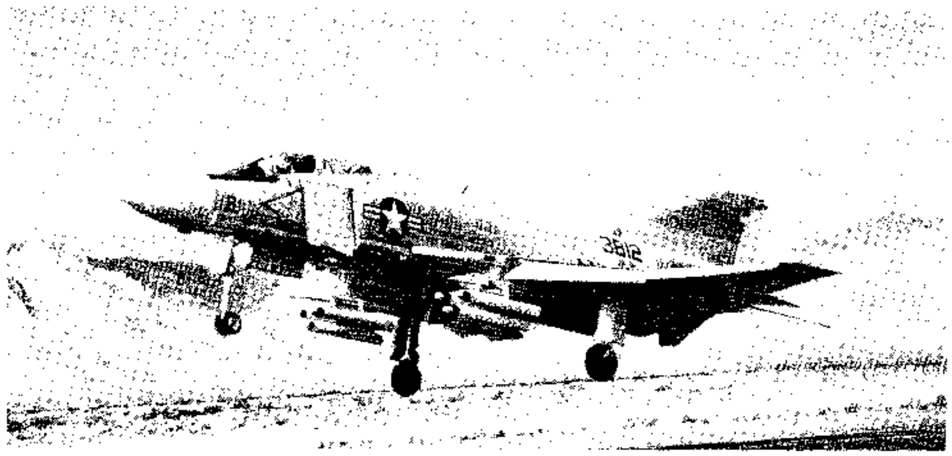
Hughes Aircraft is engaged on the development of the guidance system and the propulsion system is the responsibility of the Thiokol Corporation. The US Navy requirement calls for a missile capable of sharp, high-g turns and with a greater seeker tracking angle than current weapons, with the objective of giving USN aircraft a first-shot capability in combat. The main line of development has been based on the use of an infra-red homing head, but tests have been made of an electro-optical head and there are plans for an RF anti-radiation homing system so that Agile could be used in a defence suppression role. A new warhead which uses annular blast fragmentation is under development by the Navy.

The configuration of Agile is shown in the accompanying illustrations. The rotating assembly of eight folding fins at the rear are for stabilisation only, missile steering being effected by an hydraulically actuated gimballed nozzle for the Thiokol solid propellant motor which is housed forward in the missile body.

Cannister/launchers will be used, and either single or multiple attachments are under study as shown in the photographs. In addition to the thrust-vector controlled version of Agile, the USN has also developed a winged version which is regarded as a back-up to the main line of development and as an extra technology study facility.

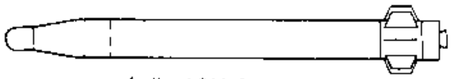
DEVELOPMENT

Development of Agile began in 1968 under the management of the US Naval Weapons Centre, China Lake. Hughes Aircraft was selected to develop the guidance element in 1973, with Thiokol as the propulsion contractor. By early 1974 the USN was engaged in extensive analysis of data derived from a number of ground firings of Agile and from simulator tests in the course of which more than 1.5 million simulated firings of Agile under combat conditions were made and recorded. This activity has been complemented by a number of airborne flight trials of Agile models and seekers. A programme review by the DoD in the summer of 1974 was arranged to determine the direction of subsequent development and procurement plans.



Agile missile mockups on Phantom aircraft for aerodynamic tests

Single Agile launchers on A-7 aircraft



Agile (AGM-95)

STATUS

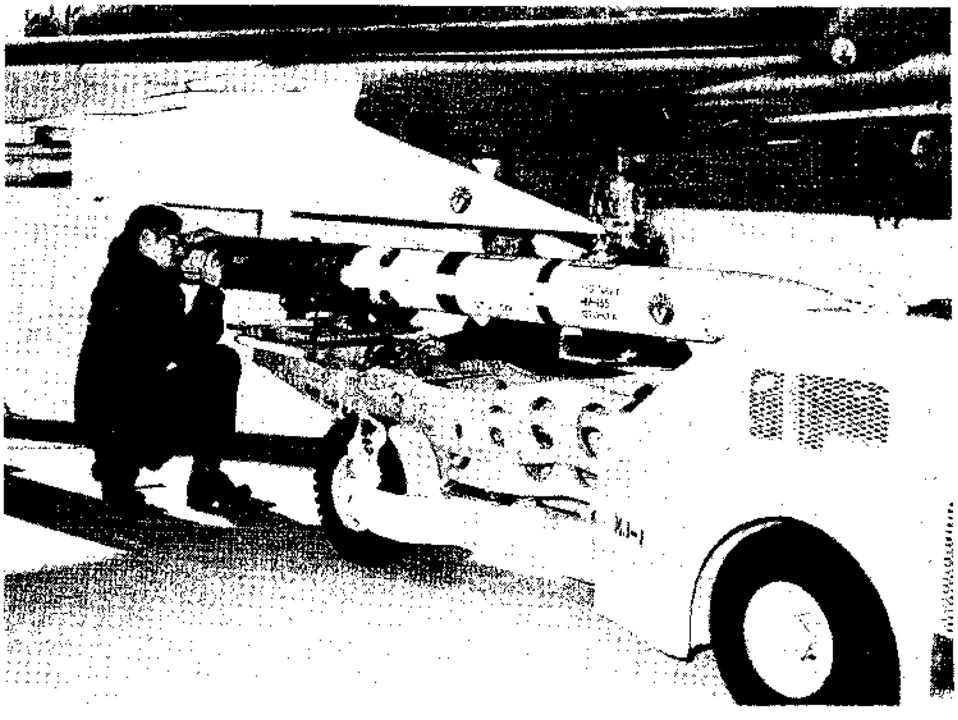
Although Agile hardware prototypes had been virtually completed by May 1974, the decision to enter engineering development was delayed until feasibility models can be flight tested and the requirement better defined. Agile RDT&E funding allocation in Fiscal Years 1973 and 1974 was $16.5-million and $18.0-million, respectively, and $20.0-million was sought for FY 1975.

1657.331
BRAZO AIR-TO-AIR ANTI-RADIATION MISSILE

DESCRIPTION:

The designation Brazo (Spanish for 'arm') has been given to a US Navy project for the development of an air-to-air defence missile that will home on to the radars of attacking aircraft such as the Soviet Foxbat high-speed, high-altitude fighter. Since the programme was made public in mid-1972, the USAF has joined in and will be responsible for test and evaluation.

The US Naval Electronics Centre is designing a passive broad-band anti-radiation homing head for the missile which is expected to be based on the Sparrow. Hughes Aircraft has been made responsible for the integration of the new heads with a quantity of Sparrow missiles which will be used for test and demonstration flights during 1973 and 1974. A BQM-34 drone was intercepted in the first air launch from an F-4D in April 1974. The USAF has given its part in the project the name of Pave Arm. The first free flight of an unarmed Brazo test vehicle was made from an F-4 fighter aircraft on April 16, 1974 at Holloman AFB. The target was a BQM-34 drone.



A test Brazo missile being checked out before the first air firing from an F-4D at Holloman Air Force New Mexico

1083.331

FALCON (AIM-4A) AIR-TO-AIR MISSILE

DESCRIPTION:

Lightweight air-to-air missile equipped with a semi-active radar homing head operating in conjunction with a target illuminating radar carried by the launching aircraft. Powered by solid fuel rocket motor. High explosive warhead. Principal characteristics are: length 198 cm, diameter 16.25 cm, wing span 50.8 cm, weight about 54.4 kg.

DEVELOPMENT:

Falcon was developed jointly by Hughes and the USAF, work starting on the project in 1947. An experimental model was produced two years later. First production models appeared in 1954. The Falcon was introduced as the GAR-1 and about 4,000 were built before an improved version appeared as the GAR-1D (now AIM-4A). Over 12,000 of this model were produced.

STATUS:

Numerous early USAF interceptor aircraft were armed with AIM-4A Falcons, and among later types of aircraft was the F-102A.

MANUFACTURER:

Hughes Aircraft Company, Culver City, California 90230, USA.

AIM-4A (formerly GAP-1D) air-to-air Falcon Missile. Semi-active radar homing is used in this version (USAF Official Photograph)

1084.331

FALCON (AIM-4C) AIR-TO-AIR MISSILE

DESCRIPTION:

Lightweight air-to-air missile, similar to the AIM-4A Falcon but equipped with infra-red guidance system instead of semi-active radar homing. Powered by solid fuel rocket motor. High explosive warhead. Principal characteristics are: length 198 cm, diameter 16.25 cm, wing span 50.8 cm, weight about 54.4 kg.

DEVELOPMENT:

The AIM-4C was developed by Hughes as a successor to the GAR-1 and GAR-1D (AIM-4A). Designation at the time of development was GAR-2. This version of Falcon was introduced in 1956, and after some 16,000 units had been produced an improved model, GAR-2A, was produced. This featured improved I/R equipment to give a wider operational environment. Over 10,000 examples of this model were built.

STATUS:

Aircraft that have been equipped with AIM-4C Falcons include the F-101B, F-102A.

MANUFACTURER:

Hughes Aircraft Company, Culver City, California 90230, USA

AIM-4C (formerly GAR-2A) air-to-air Falcon missile. Infra-red homing system is used in this version (USAF Official photograph)

1085.331

FALCON (AIM-4D) AIR-TO-AIR MISSILE

DESCRIPTION:

Lightweight air-to-air missile similar in size and configuration to the AIM-4C but equipped with the improved infra-red homing head of the larger AIM-4G Super Falcon. This gives better performance against high-speed manoeuvring targets and confers all-aspect attack capability. Principal characteristics are: length 198 cm, diameter 16.25 cm, wing span 50.8 cm, weight about 60 kg. Solid fuel motor. High explosive warhead. Speed Mach 4.

DEVELOPMENT:

Chronologically, development of the AIM-4D took place after that of other members of the Falcon series, such as AIM-4E, F, and G (which see) and its former designation was GAR-2B. As air defence missiles, earlier Falcon versions were designed for the interception of bomber aircraft. AIM-4D development was undertaken to improve performance sufficiently for the engagement of enemy fighter aircraft. This was undertaken under a joint USAF/Hughes programme.

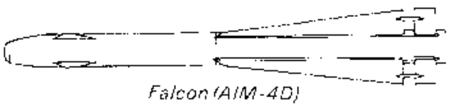
STATUS:

AIM-4D has been ordered by USAF Tactical Air Command, and aircraft to be fitted include the F-4. Thousands of AIM-4A and C Falcons have been converted to AIM-4D standard.

MANUFACTURER:

Hughes Aircraft Company, Culver City, California 90230, USA.

AIM-4D Falcon air-to-air missile being loaded onto wing pylon of an F-4 Phantom. This version of the Falcon incorporates the main body structure of the AIM-4A & C versions with the later infra-red homing system of the AIM-4G



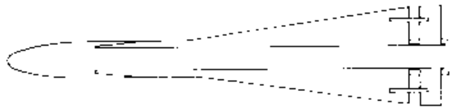
Falcon (AIM-4D)

1086.331

SUPER FALCON (AIM-4E & AIM-4F) AIR TO-AIR MISSILE

DESCRIPTION:

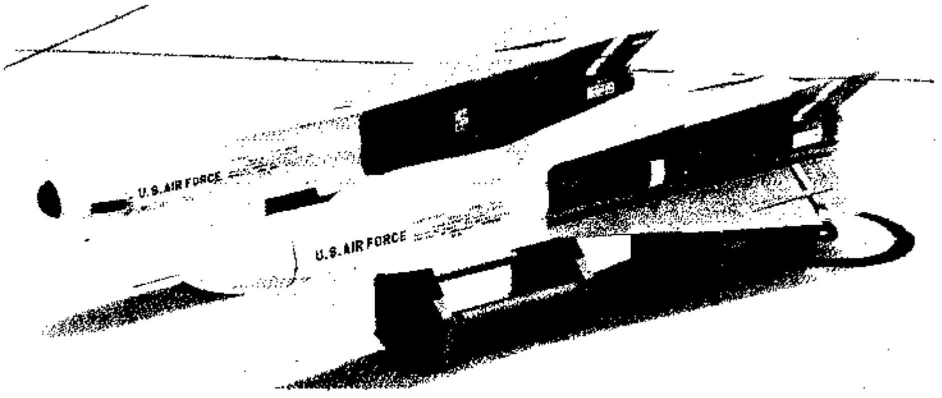
These two missiles represent an interim stage in the development of the Falcon series, coming between the AIM 4A and C and the AIM-26 models. In general configuration the AIM-4E more closely resembles the AIM-4F. This was equipped with an improved radar guidance system providing increased accuracy and greater resistance to ECM. A new solid fuel, two-level thrust rocket motor was installed to provide a high launching thrust followed by a lower level thrust to sustain missile velocity. An external feature is a 10 cm metal probe attached to the nose cone to improve missile aerodynamics.



Falcon (AIM-4E)

Guidance is by semi-active radar homing as in the AIM-4A. The AIM-4E was powered by a longer burning solid fuel rocket motor to provide longer range, a higher launching speed, and a higher combat ceiling than earlier models. A more powerful high explosive warhead was also fitted. Only about 300 models of this version were produced before being succeeded by the later variants, the AIM-4F and AIM-4G. The wings are extended forward by fillets, and weight and dimensions are slightly increased to: length 218.4 cm, diameter 16.5 cm, wing span 60.9 cm, weight about 63.5 kg, in the case of the AIM-4E, and – length 218.4 cm, diameter 16.7 cm, wing span 60.9 cm, weight 68 kg, for the AIM-4F. Speed of the AIM-4F is Mach 3.

DEVELOPMENT:
The AIM-4E was originally developed as the GAR-3 and was introduced in 1958. It was succeeded two years later, after 300 units had been produced, by the AIM-4F (formerly GAR-3A).

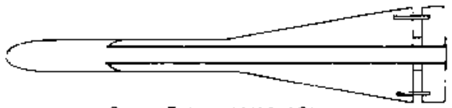


Hughes Super Falcon air-to-air missiles. The semi-active radar guided AIM-4F version is seen front, with the infra-red homing AIM-4G version behind it

STATUS:
Aircraft equipped include the F-106 Delta Dart interceptor.

MANUFACTURER:
Hughes Aircraft Company, Culver City, California 90230, USA.

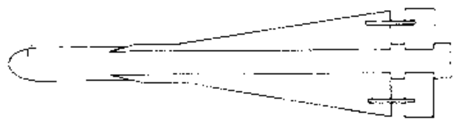
1087.331
SUPER FALCON (AIM-4G) AIR-TO-AIR MISSILE
DESCRIPTION:
The AIM-4G Super Falcon is the infra-red seeking counterpart of the AIM-4F missile. It is equipped with an I/R detector system which enables it to lock-on to smaller targets at greater ranges than earlier Hughes infra-red missiles. The same seeker is used in the AIM-4D Falcon. Compared with the AIM-4F Super Falcon, the AIM-4G is shorter (105.7 cm) and weighs slightly less (65.7 kg). A high-explosive warhead is fitted. Unofficial weight is 18 kg, and speed Mach 3.
DEVELOPMENT:
The AIM-4G was developed under the original designation GAR-4A, in parallel with the GAR-3A (AIM-4F). It was introduced in 1959/60.



Super Falcon (AIM-4G)

MANUFACTURER:
Hughes Aircraft Company, Culver City, California 90230, USA.

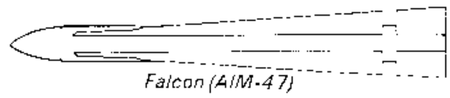
1089.331
FALCON (XAIM-26A & AIM-26B) AIR-TO-AIR MISSILE
DESCRIPTION:
The AIM-26 versions of Falcon were the result of a major programme to improve the capability of this successful series of missiles. An important consideration was the desire to achieve reliable head-on attack capability and guidance; for this reason radar homing guidance was chosen instead of infra-red; advantages of radar in this context being all-weather capability and longer acquisition range. The far higher closing speed assists in such types of engagement. There is also a possibility of the missile homing onto a forward looking radar in the target aircraft if such an equipment is fitted, and provided the operating frequencies and bandwidths of target and missile radar units are compatible.
To offset the rather lower accuracy of radar guidance compared with I/R, a much heavier warhead was called for to increase range of lethality due to blast.
An experimental series of missiles XAIM-26A (formerly XGAR-11) was introduced in the Spring of 1960. These models, while bearing a family resemblance to earlier Falcons, presented a very much bulkier appearance and were in fact much heavier – about 90 kg. Length was 213.4 cm and maximum diameter 27.9 cm. Wing span remained about 60 cm.
Extra weight was accounted for by a larger motor and heavier warhead, the former probably being required more for increased range rather than speed. An active proximity fuse, suitable for 'near-miss' kill capability, was also fitted and this



Falcon (AIM-26A)

is believed to have been based on radar. Four fuse aerials are located almost flush with the missile body, ahead of the wings. The warhead was essentially the same as that of the nuclear Genie missile (which see).
The XAIM-26A was followed by the AIM-26B (formerly GAR-11A), a conventional explosive warhead version of the AIM-26A.
MANUFACTURER:
Hughes Aircraft Company, Culver City, California 90230, USA.

1090.331
FALCON (AIM-47A) AIR-TO-AIR MISSILE
DESCRIPTION:
This is the largest of the Falcon series of air-to-air missiles and is about twice the size and weight of the AIM-4 series of weapons. Estimated dimensions are: length 320 cm, diameter 33.5 cm, wing span 83.8 cm, weight 363 kg. A solid-propellant motor is used and the AIM-47A has been credited with a range of 100 nautical miles and a speed of Mach 6.
Guidance is semi-active radar homing with the Hughes AN/ASG-18 fire control system radar acting as target illuminator. It is reported that either nuclear or conventional payloads can be carried.
DEVELOPMENT:
AIM-47A was originally developed under the



Falcon (AIM-47)

designation GAR-9 for the USAF as part of the YF-12A Mach 3 defence interceptor programme.
MANUFACTURER:
Hughes Aircraft Company, Culver City, California 90230, USA.

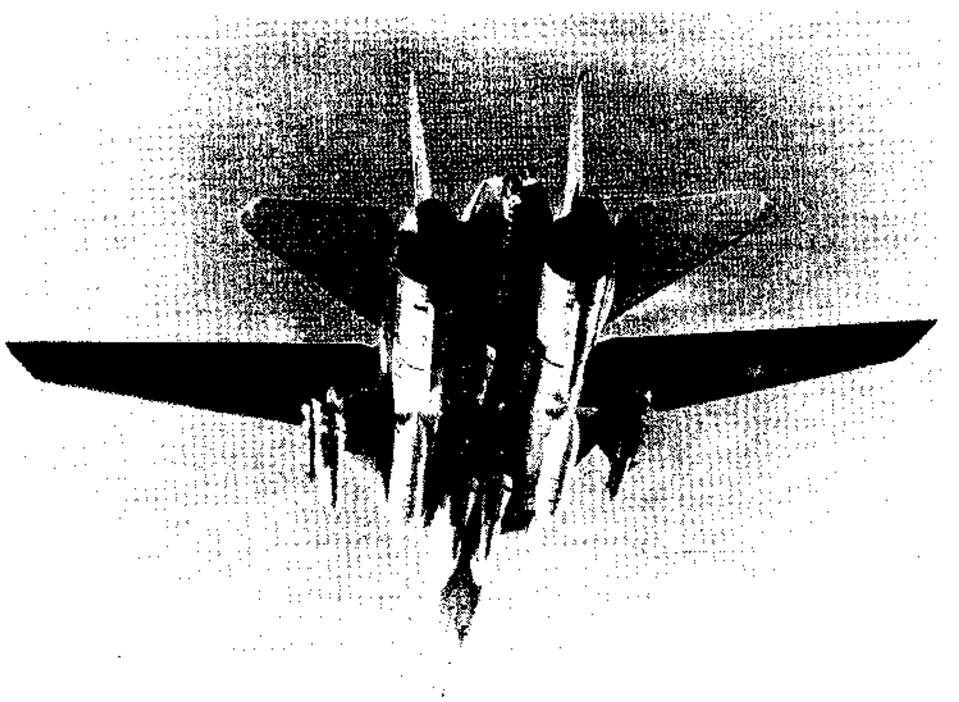
1091.331
GENIE (AIR-2A) AIR-TO-AIR MISSILE
DESCRIPTION
Air-to-air unguided missile carrying a nuclear warhead. A Thiokol solid-propellant rocket motor is used to give the Genie a range of 6 miles (9.6 km) and a speed of Mach 3. Operating ceiling is over 15,0.. m. Principal dimensions are: length 274 cm, diameter 43 cm, weight about 370 kg.
OPERATION:
Launching of the Genie is normally automatic under the control of a Hughes fire control system (probably the MG-10) which is reported to be responsible also for detonation of the warhead when the launch aircraft is at a safe distance. Arming of the nuclear warhead has to be carried out by pilot action prior to launch.
Genie is used with existing air defence systems as follows:
Radar detection of an approaching unidentified aircraft is relayed to the Air Defence Direction Centre. The ADDC plots the potential target and alerts the appropriate Air Defence Command base. An interceptor, armed with Genie rockets, is despatched and guided toward the incoming aircraft or group of aircraft.
Upon reaching the target's area, the aircraft's fire control system locks on the target. If the target is identified as hostile, the Genie is automatically launched by the fire control system, and the aircraft swings away from the area. Approaching at supersonic speed toward the enemy craft, the missile detonates with a lethal blast.
DEVELOPMENT:
Development began in 1954 and was carried out under the former designation MB-1. The first successful tests were carried out from F-89D aircraft in 1956, and later the same year from YF-

Genie (AIR-2A)

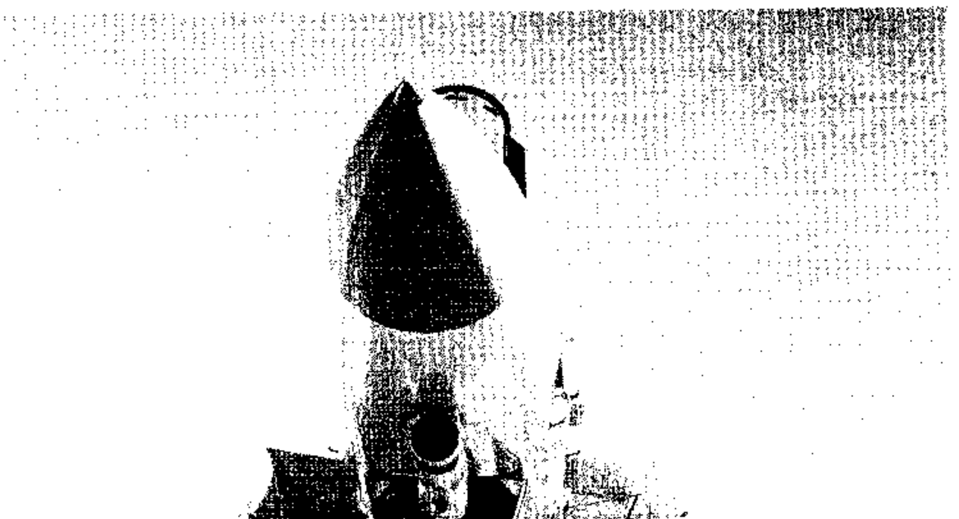
102 aircraft. A further version of Genie, AIR-2B was under development as the Super Genie, which according to unconfirmed reports would incorporate a guidance capability. This work is now suspended. The Genie development programme, prior to introduction of the missile into service, was also known as Ding Dong and High Card.
STATUS:
Genie became operational in January 1957 with USAF Air Defence Command and is operational with F-101 and F-106 aircraft. Production ceased in 1962 but is stated to extend into

thousands
MANUFACTURERS:
McDonnell-Douglas Astronautics Company, Huntington Beach, California 92647, USA.
ADDITIONAL EQUIPMENT
A practice round, for training purposes and without nuclear payload, is in service under the designation ATR-2A.

1099.331
PHOENIX (AIM-54A) AIR-TO-AIR MISSILE
DESCRIPTION:
Long-range, high performance air-to-air weapon, originally developed for deployment with US Navy F111B aircraft for fleet area defence purposes, but now in use with USN F-14 Tomcat interceptor aircraft. Officially issued characteristics include: length 396 cm, diameter 38 cm, wing span 91.4 cm, weight 380 kg. Radar homing. Mk 47 Mod 0 solid-propellant rocket motor by North American Rockwell Rocketdyne Division. Estimated range is between 60 and 90 nautical miles (110-165 km).
The complete Phoenix weapon system as developed for the F-111B (since cancelled) comprised the Hughes AWG-9 fire control and armament system – also referred to as AMCS (Airborne Missile Control System) – and interface sub-systems to tie in Phoenix-carrying aircraft with other fleet units. Digital computers are incorporated in both of the aircraft-fitted elements of the Phoenix system.
OPERATION:
During the cruise phase of missile flight, Phoenix guidance is by semi-active radar homing, the AWG-9 serving as target illuminator. Terminal guidance, reportedly within 16 km of the target, is by active radar.
The Phoenix missile incorporates a small doppler radar transmitter which is switched on to provide target illumination during the terminal guidance phase.
The complementary I/R target tracker can be used for the direction of missiles at shorter ranges, the cruise phase of flight being unguided until the active radar homer takes over for the terminal phase. In this mode the AWG-9 radar need not be used.
The ability of the AWG-9 to launch up to six missiles simultaneously against six separate targets implies that there must be a system of coding the illuminating radar transmissions during the cruise phase of missile flight to ensure that each missile pursues its designated target.
Proximity and I/R fusing methods are understood to be employed for the detonation of Phoenix missiles.
DEVELOPMENT:
The Phoenix concept was initiated in 1960 and Hughes was selected as prime contractor by the US Navy in 1962. Flight testing began in 1965, and the first successful intercept was in September 1966. The simultaneous attack capability was demonstrated in March 1969 when two drones were successfully engaged from an F-111B aircraft.
Phoenix procurement was initiated during Fiscal Year 1971. In December 1970 the Hughes Aircraft Corporation was awarded a $29,851,689 contract modification for pre-production testing and incremental funding for the AWG-9 AMCS. The US Navy requested a total of $108.8 million for Fiscal Year 1973, $98.4 for procurement, $5.3 for spares, and $5.1 for development. F-14 flight trials started in April 1972, and in December of that year four jet drone targets were successfully engaged by four Phoenix missiles launched and directed by the AWG-9 system of an F-14 Tomcat.
STATUS
The first Phoenix units were operational by Spring 1974, and procurement for Fiscal Years 1973/4/5 amounts to 180, 240, and 340, respectively. The corresponding funding for these was $89.3m, $92.5m and $94.7m.



F-14 Tomcat armed with six AIM-54 Phoenix air-to-air missiles



USN Tomcat carries four Phoenix missiles under fuselage and two on wing mounts

MANUFACTURERS:

Hughes Aircraft Company, Culver City, California 90230, USA – Prime contractor, missile, AN/AWG-9, and MAU-48 launcher.

North American Rockwell – motor.

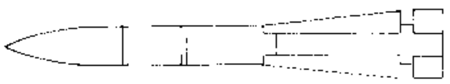
Aerojet General Corporation – motor, second source.

Downey plant – Mk.334 Proximity fuse.

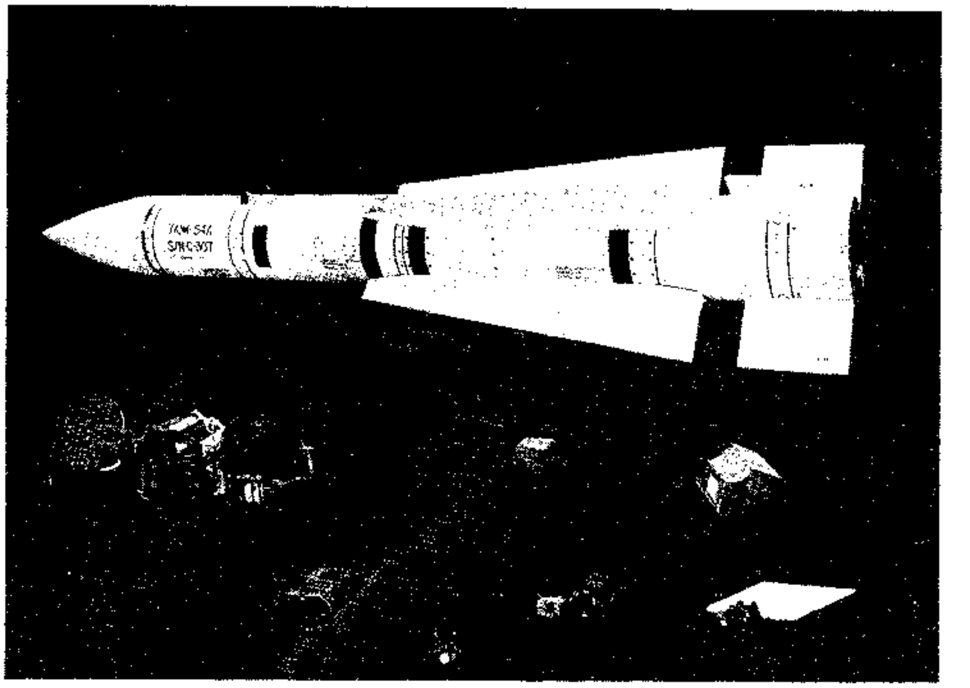
Bendix – I/R fuse.

Control Data Corporation – AWG-9 computer.

Univac – computer.



Phoenix (AIM-54A)



Arrangement of Phoenix components

1658.331

SEEK BAT (XAIM-97A) AIR-TO-AIR MISSILE

DESCRIPTION:

Seek Bat is the result of a joint USAF/General Dynamics programme to evolve a high-altitude, long-range air-to-air missile to counter the MiG-25 Foxbat interceptor aircraft, and based on the existing AGM-78 Standard ARM missile airframe. A larger propulsion unit is employed and the missile guidance system is stated to acquire and lock-on to the target before release from the launch aircraft. Infra-red homing is used to direct the Seek Bat on a pursuit course by tracking the Foxbat's exhaust trail. Interceptions at heights up to 80,000 ft (24,300 m) are intended.

STATUS:

The XAIM-97A is in development, and tests against drones started in late 1972/early 1973.

1103.331

SIDEWINDER 1A (AIM-9B) AIR-TO-AIR MISSILE

DESCRIPTION:

Short/medium-range air-to-air infra-red homing missile, for pursuit engagements. Principal characteristics are length 284 cm, diameter 12.7 cm, fin span 60.9 cm, weight 75 kg, speed Mach 2, ceiling over 15,000 m, sea-level range 1,100 m. A Rocketdyne solid-propellant motor is used and a high explosive warhead is fitted. Other features are simple design and low cost.

The AIM-9B version is in the inventory of numerous air forces and a European consortium headed by Bodenseewerk Gerätetechnik GmbH undertook licence manufacture of Sidewinders for NATO countries.

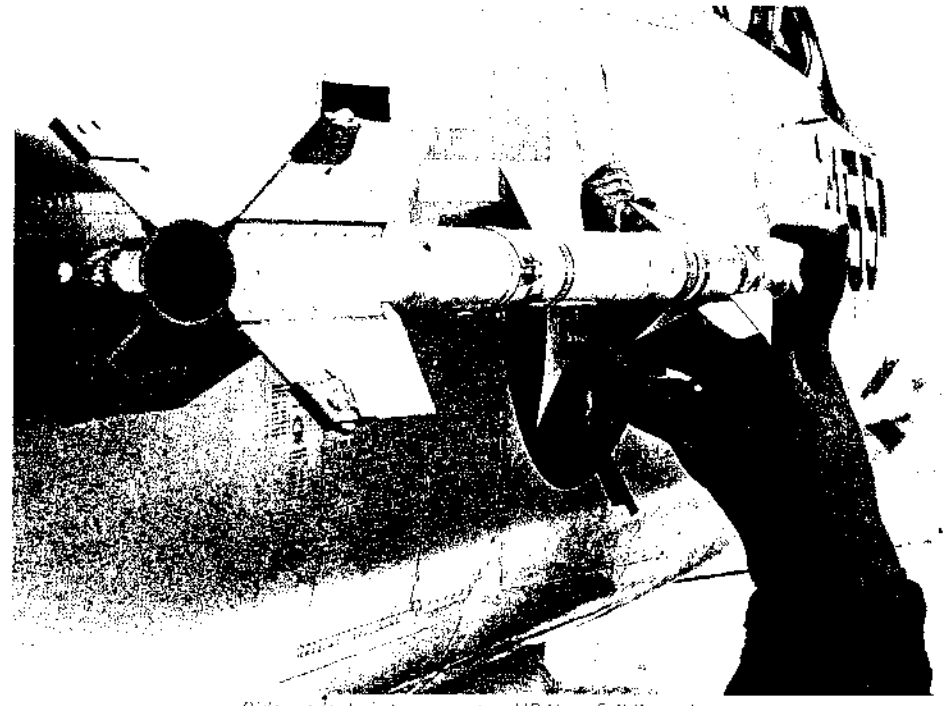
Bodenseewerk Gerätetechnik (formerly Fluggerätewerk Bodensee GmbH) was prime contractor for European production under licence of the American Sidewinder 1A (AIM-9B) air-to-air missile.

Bodenseewerk Gerätetechnik has developed an improved guidance and control unit for the Sidewinder missile, known by the designation FGW Mod 2. This is intended to increase the effectiveness of the missile against manoeuvring targets, against targets moving in front of sunlit backgrounds and in bad weather conditions.

The improvement to the infra-red system is achieved by using cooled detectors to increase sensitivity and reduce the effects of background clutter. The tracking rate against manoeuvring targets is increased by using more modern electronic components.

The German Air Force and operators in various other NATO countries modified their stocks of Sidewinder guidance and control units to the FWG Mod 2 standard. Bodenseewerk was also awarded a follow-on contract for the supply of complete Sidewinder missiles equipped with FWG Mod 2 guidance and control units. This work has been completed.

AIM-9B entered operational service in July 1956 and when US production ended in 1962, over 60,000 missiles had been procured for use by US and Allied services. At least 9,000 have been produced by the Bodenseewerk group. Most American AIM-9Bs have been the subject of a programme of conversion to AIM-9E standard.



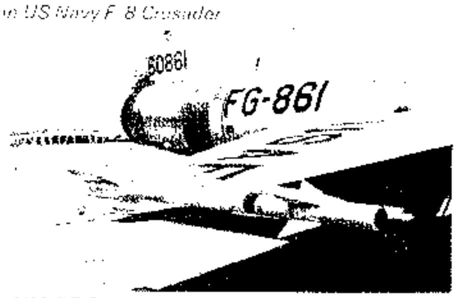
Sidewinder being prepared on US Navy F-8 Crusader

Sidewinder 1A (AIM-9B)

MANUFACTURERS:

Philco-Ford Corporation, Communications and Electronics Division, Willow Grove, Philadelphia, USA.

Bodenseewerk Gerätetechnik GmbH, 7770 Ueberlingen/Bodensee, W. Germany.

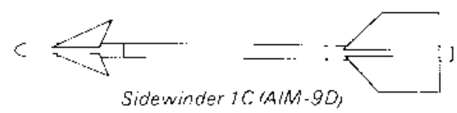


AIM-9B Sidewinder air-to-air missile mounted on wing of F-104A Starfighter

1104.331
SIDEWINDER 1C (AIM-9C and AIM-9D) AIR-TO-AIR MISSILE

DESCRIPTION:
Short/medium range air-to-air missile. The AIM-9C uses semi-active radar homing by Motorola, and the AIM-9D version employs infra-red guidance produced by Raytheon and Philco-Ford. In general appearance these models of Sidewinder are very similar to the earlier AIM-9B but a higher thrust motor is used which increases range to 18 km. Weight is 84 kg.

The radar homing head used in the AIM-9C can be used either in conjunction with the target illu-



Sidewinder 1C (AIM-9D)

minating radar of the launch aircraft or it can home on to radiation from ECM signals transmitted from the target aircraft. Designation of this guidance system is the Mk 12 Mod 3 guidance and control group. The infra-red system used in the AIM-9D is designated Mk 18 Mod 1.

STATUS:
The two Sidewinder 1C versions (AIM-9C and D) entered service in 1965, and it is understood that the bulk of production has been against US Navy requirements. The AIM-9D is reported to be in the UK inventory, and all future US Navy procurement is likely to be for this version of Sidewinder.

MANUFACTURERS
Raytheon Company, Missile Systems Division, Bedford, Massachusetts 01730, USA.
Philco-Ford Corporation, Communications and Electronics Division, Willow Grove, Philadelphia USA.
Motorola Inc. Government Electronics Division, 8201 East McDowell Rd, Scottsdale, Arizona 85252, USA.

1105.331
SIDEWINDER (AIM-9E) AIR-TO-AIR MISSILE

DESCRIPTION:
This is a modified version of the AIM-9B missile and incorporates an improved infra-red homing head and other modifications to increase low altitude performance. The AIM-9E is also known by the designation of Sidewinder LAP as a result of this characteristic. The modification programme was initiated by the USAF and it is understood that all AIM-9E missiles are the result of a major programme to update stored AIM-9B models. Production of AIM-9Es ceased in 1969, but Philco-Ford was awarded a $29.8 million USAF contract in September 1970 for a technical improvement programme to bring AIM-9B Sidewinders up to AIM-9J standard.

MANUFACTURER:
Aeronutronic Division, Philco-Ford Corporation, Ford Road, Newport Beach, California 92663, USA.

1308.331
SIDEWINDER (AIM-9G/H/J) AIR-TO-AIR MISSILE

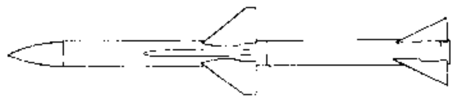
DESCRIPTION:
The AIM-9G Sidewinder is similar to earlier versions except for the addition of a vacuum tube and the Sidewinder Expanded Acquisition Mode (SEAM) system, which is said to have provided increased lead acquisition capability. The AIM-9H version incorporates SEAM plus solid-state electronics. It became operational with the US Navy in August 1970. In January 1972 Philco-Ford was awarded a $4.3 million USN contract for the production of improved AIM-9H guidance and control systems.

The AIM-9J is another improved version of the AIM-9B, and for which Philco-Ford is responsible. This version uses the same seeker as the AIM-9E but has canards of modified design and a high-performance servo system. In March 1972 it was revealed that a number of Sidewinders had been modified for an air-to-ground role, using a laser-seeker guidance system. Such missiles have been given the designation Focus (AGM-87A). No details of production contracts have been announced and the weapon is believed to be under test by the US Navy. AIM-9G procurement funding requested for 1974 was $16.8 million for the USAF and USN. Another improved version, sometimes called Super Sidewinder and designated AIM-9L, is in development for dog-fight missions and as a possible alternative for Agile (Entry No. **1302.331**).

1106.331
SPARROW III (AIM-7E/F) AIR-TO-AIR MISSILE

DESCRIPTION:
The Sparrow missile is one of the most widely-used and successful US weapons and it is currently being put to numerous applications in addition to its original role of air-to-air combat. The present production version is the AIM-7E which is 3.65 metres long, 20 cm in diameter, with a wingspan of 1.0 metre and tail fins of 82 cm span. Weight is 200 kg and a 30 kg high-explosive warhead is carried. Semi-active CW radar guidance is employed, with proximity or contact fusing of the charge. Range is about 25 km. An AIM-7E-2 version is reported to be capable of greater manoeuvrability to suit it for close-in dog-fight engagements, which also differs from the AIM-7E in having plug-in fins that do not require tools for insertion or removal.

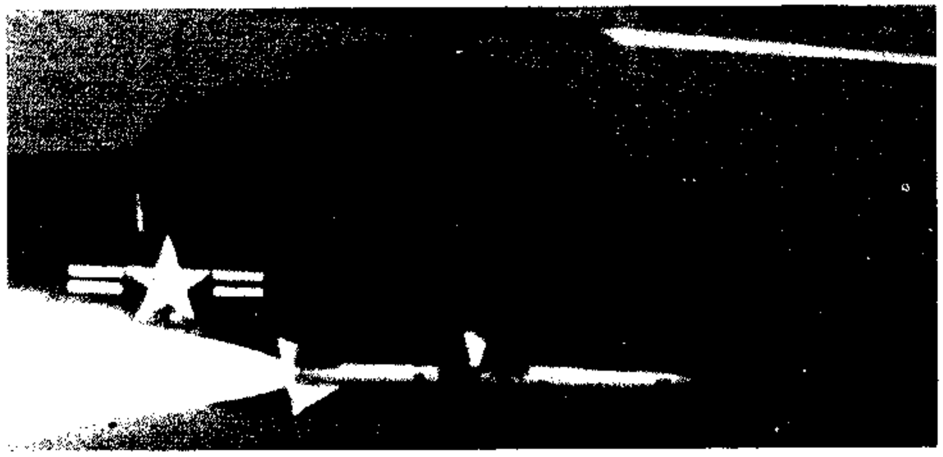
A version of the AIM-7E Sparrow as used in the NATO Seasparrow surface-to-air system bears the designation RIM-7H and differs in having folding fins to reduce the size and weight of the deck launcher/containers. The US Navy Basic Point Defence Missile System uses a version based on the AIM-7D Sparrow.



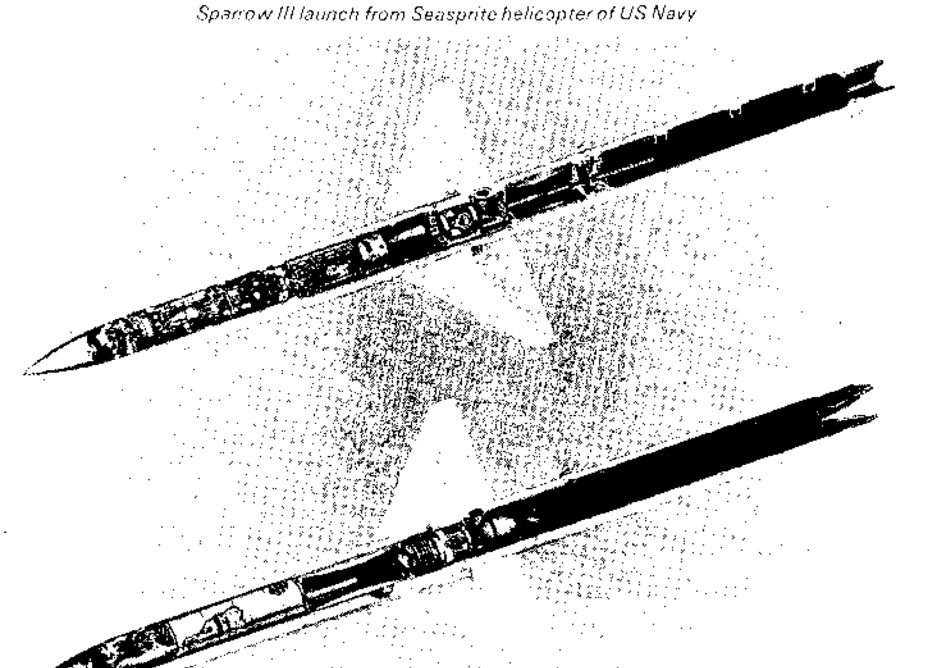
Sparrow (AIM-7)

The latest air-to-air version is the AIM-7F. This has all solid-state electronics for its improved semi-active radar guidance system and a larger solid-propellant rocket motor providing increased range. The weight is somewhat greater than that of the AIM-7E. The Sparrow missile is also forming the basic vehicle for the USN/USAF Brazo/Pave Arm weapon programme (Entry No. **1657.331**) in which application a laser-seeking homing head will be fitted.

In mid-1972 the British Government announced a programme under which EMI would develop a new fuse and Marconi Space and Defence Systems a new homing head suitable for fitting to Sparrow III missiles, and Hawker Siddeley Dyna-



Sparrow III launch from Seasprite helicopter of US Navy



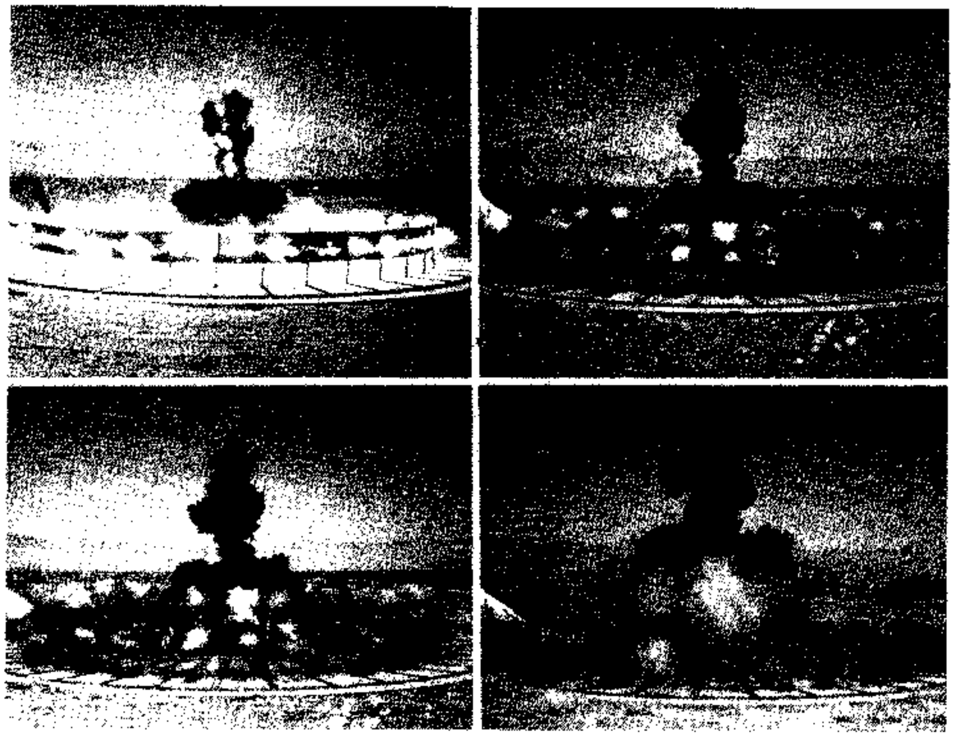
Cutaway drawings of AIM-7E and AIM-7F versions of Sparrow, showing improved electronics and larger motor mics was entrusted with integration. This led to a programme to develop a UK version of Sparrow (1774.331), and Hawker Siddeley was given access to Raytheon engineering information and the US company was granted licence rights for the Marconi head.

STATUS:

Sparrow III is in widespread use by American air forces and those of other NATO nations. Procurement in Fiscal Years 1973/4/5 was for 150, 175, and 600 missiles, respectively, for both USAF and USN requirements.

MANUFACTURER:

Raytheon Company, Missile Systems Division, Bedford, Mass 01730, USA.



Sequence of Sparrow warhead ground test

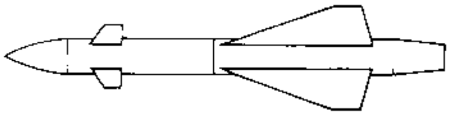
THE UNION OF SOVIET SOCIALIST REPUBLICS

1143.331
ALKALI AIR-TO-AIR MISSILE

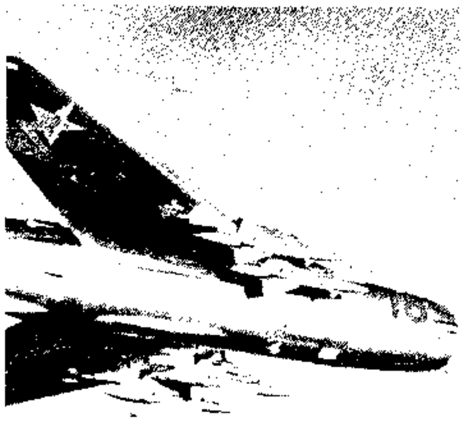
DESCRIPTION:

Alkali is the NATO code-name assigned to the Soviet air-to-air missile normally deployed on the MiG-19 interceptor, and also reported as having been carried by the MiG-17, and the Su-9. Estimated length is 188 cm, diameter 18 cm. Span of the rear fins about 58 cm, and of the forward set 32 cm. Use of a solid-fuel motor is assumed. Range is probably not more than 6-8 km, and speed between Mach 1 and 2.

Alkali guidance is generally believed to be radar based in view of the deployment of this missile on 'all-weather' interceptors, in which case it is probably of the passive homing type, with the launch aircraft fire control radar providing target illumination.



Alkali

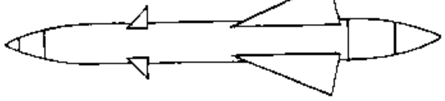


Alkali air-to-air missile

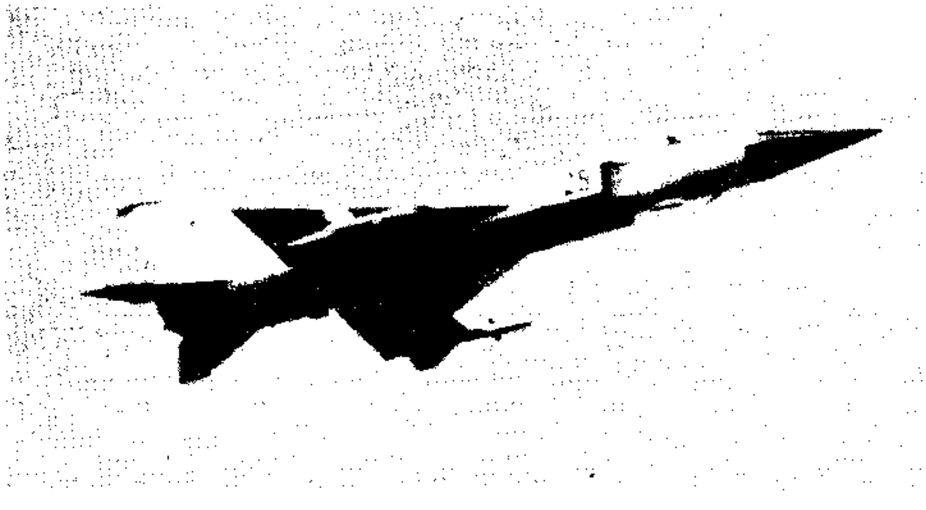
1144.331
ANAB AIR-TO-AIR MISSILE

DESCRIPTION:

Anab is the NATO code-name assigned to the Soviet air-to-air missile first seen carried by the Yak-28 (Firebar) in 1961. It has subsequently been seen on the Su-9 (Fishpot) interceptor, and is known to have been adopted as a standard weapon by the Soviet forces.



Anab



SU-11 aircraft with Anab missiles

The existence of both radar and infra-red homing versions have been reported. Length of both versions is estimated at approximately 360 cm, diameter 28 cm, wing span 130 cm. Anab has a cylindrical body with a large cruciform wing assembly at the rear of the missile, and a set of four in-line fins ahead of the wings, and about one-quarter of the missile length from the nose end.

Solid fuel propulsion is assumed, and probable range is 8-10 km.

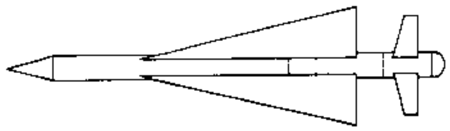
1145.331
ASH (AA-5) AIR-TO-AIR MISSILE

DESCRIPTION:

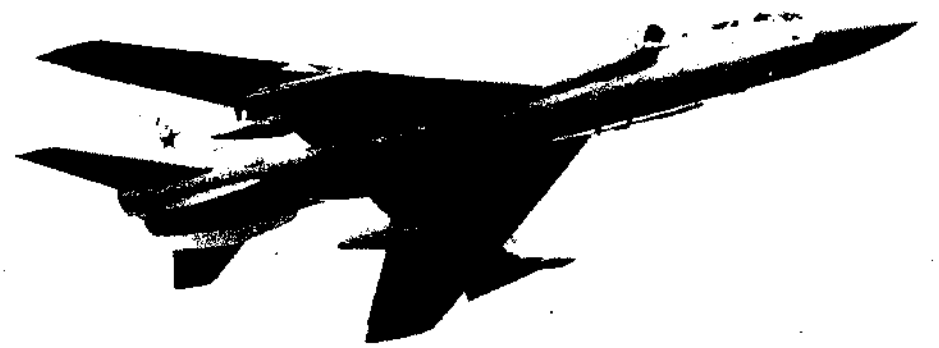
Ash is the NATO code name assigned to large missiles carried beneath the wings of Soviet Tupolev "Fiddler" long-range interceptor aircraft. Four such missiles, which are assumed by western observers to be air to air weapons, can be carried by each aircraft. Both radar guided and infra-red homing versions are in use, two radar homing missiles generally being carried on the wing outer pylons and two infra-red homing missiles on the inner pylons of the Fidd.er interceptor.

Estimated dimensions are: length 330 cm, wing span 130 cm, diameter 30 cm. Cruciform wing and tail surfaces, in-line, are fitted, the former having a sharply swept delta planform. The tail fins have little sweep on either leading or trailing edges and are mounted close behind the wing trailing edges.

The size of the missiles, parent aircraft, and the large nose radome of the latter, suggests that they are intended for long-range interception.



Ash (radar version)



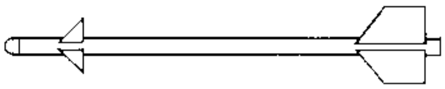
Ash air-to-air missile carried by Fiddler long range intercepter

Radar and infra-red guided Ash air-to-air missiles on Soviet Fiddler aircraft (Novosti Photograph)

1146.331
ATOLL AIR-TO-AIR MISSILE
DESCRIPTION:

Atoll is the NATO code-name assigned to a Soviet air-to-air missile, believed to bear the USSR designation SB06.

This missile closely resembles the American AIM-9B, infra-homing Sidewinder and is of similar dimensions and (estimated) weight. Atoll dimensions are: length 280 cm, diameter 12 cm, forward control surfaces span 45 cm, tail plane



Atoll

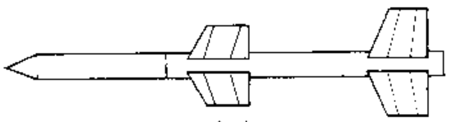
span 53 cm. Solid-propellant and conventional high explosive warhead are assumed.

Diametrically opposed pairs of the forward control surfaces are linked and work in unison for missile steering. The rear surfaces incorporate small tabs in which are inserted gyroscopic wheels driven by the airstream. It has been deduced that these are locked until after missile launch, and that their subsequent purpose is to provide additional stabilisation and/or a measure of control augmentation for missile steering.

Atoll is widely deployed with MiG-21 (Fishbed) interceptors of the Soviet home forces and on export versions of this aircraft. Known foreign users include Egypt and India. The latter country, which has over 50 MiG-21s, is setting up facilities for Atoll production under licence.

1246.331
AWL AIR-TO-AIR MISSILE
DESCRIPTION:

Very little is known of the airborne missile to which the NATO code-name AWL has been assigned. To date it has only been associated with the MiG-23 (Flipper) interceptor by Western observers, and its precise function is so far largely



Awl

a matter of conjecture. General configuration is rather similar to that of the American Sparrow IIIB, but it is estimated to be of greater weight and size with a probable length of about 5 metres.

In the absence of firm data, the method of guidance cannot be determined, but it is reasonable to assume that the Soviet authorities have examined both radar and infra-red forms. Alternative versions of Awl, equipped with either type of guidance may exist.

SUB SURFACE-TO-SURFACE WEAPON SYSTEMS

2221.411
INTRODUCTION

So far as is known, all the current weapon systems that come within the definition of this sub-section are carried by manned submarines. It is possible to envisage other arrangements; but international agreement has somewhat reduced (although by no means extinguished) enthusiasm for the development of unattended missile systems for deployment on the sea bed. The unmanned pre-programmed missile-launching submarine, however, remains a possibility: but so far as is known it is no more than this.

In terms of deployed strategic weapons the USA was until recently clearly in the lead, outnumbering the USSR by something like four to one. USSR deployment has recently been catching up rapidly, however, and in fact the terms of the interim agreement on offensive weapons, made at the same time as the Nixon-Brezhnev treaty in May, 1972, permit a greater deployment by the USSR than by the USA. In part this larger deployment is assumed to be offset by the more advanced MIRV techniques incorporated in the American missiles but it now seems virtually certain that the Russians will extinguish that lead before long.

Strategic Cruise Missiles

As noted in entry **1759.411** below, the United States authorities have initiated a development project for submarine-launched cruise missiles one outcome of which should be a strategic weapon.

The purpose of arming the US submarine fleet with such missiles is to introduce a new threat against which their potential enemies would have to take steps to protect themselves: such a project also has the advantage of lying outside the scope of the SALT agreements.

The USSR, of course, has extensive experience in the development and deployment of cruise missiles. Those that are currently known are generally regarded as tactical rather than strategic missiles although some may carry nuclear warheads. There can be little doubt, however, that if there is not already a submarine-launched strategic cruise missile available to the Soviet Navy there very soon will be.

CHINA (PEOPLE'S REPUBLIC)

2051.411
CHINESE SUBMARINE-LAUNCHED BALLISTIC MISSILES

No definite information is available on Chinese SLBM developments. The Chinese Navy has one ballistic missile submarine of the Soviet G class, built at Dairen in 1964. This has three vertical ballistic missile tubes in the enlarged conning tower. At present the armament of this submarine is believed by some to be short-range ballistic missiles with a range capability of perhaps 600 km – probably Serb missiles (**1153.411** below). Opinions on the subject differ, however, and there are those (including senior US officials) who believe that this submarine is unarmed.

Whether the Chinese authorities will seek to enlarge the capability of their naval forces in the SLBM direction or not is presumably a matter of priority. From what has so far been done in the fields of nuclear weapons and rocketry it seems likely that they have the required technological capacity; what has to be decided is how the total available missile development and manufacturing resources are to be allocated to ICBM, SLBM, IRBM, anti-aircraft and battlefield missile projects.

Official US opinion, as presented by Admiral Thomas H. Moorer in March 1974, is that the People's Republic is believed to be determined to develop both a submarine-launched ballistic missile and a modern ballistic missile submarine to go with it. It is now thought unlikely, however, that such a system could become operational before 1977. Whether or not the existing Chinese nuclear submarine is armed it is to be expected that it will be used for trials of a new missile. No other Chinese ballistic missile submarines are known but the possibility that one or more are under construction cannot be ruled out.

FRANCE

1134.411
MSBS SUBMARINE LAUNCHED BALLISTIC MISSILE

DESCRIPTION:

MSBS (Mer-Sol Balistique Stratégique) is a medium-range, two-stage submarine-launched weapon forming a vital part of the French nuclear deterrent force. In general concept it is similar to the American Polaris missile family. Size and weight are somewhat greater, however, and with the present version at least, range and the explosive power of the nuclear warhead are somewhat smaller.

The present (M-1) version of the missile is currently operational and is deployed in submarines of the SNLE (Sous-marines Nucléaire Lanceur d'Engins balistiques) class each of which is capable of accommodating 16 missiles in two rows of 8 launch tubes aft of the 'sail'. Of these submarines, *Le Redoutable* has been in service since 1971 and *Le Terrible* since early 1973. These are the first two of an initial series of SNLE, and *Le Foudroyant*, *L'Indomptable* and *Le Tonnant* will be in service before the end of 1978. Each submarine can launch all 16 missiles in 15 minutes. *Le Redoutable* and *Le Terrible* have both test-fired M-1 missiles under operational conditions. No details of these vessels' fire control and navigation systems have been released, but the latter must be assumed to be inertial, and the general mode of operation very similar to that employed by American and British submarines of this type.

Logistical support for the MSBS system is provided by the Ile Longue Naval Base in Brest Bay where there are the assembly and storage facilities necessary to keep the missiles in operational readiness.

Live testing of these missiles began in 1966 in the Sahara Centre near Hammaguir. The first underwater launches took place from a caisson at the Centre d'Essais de la Méditerranée, and then from the experimental, conventionally powered submarine, *Gymnote*. Final testing was handled by the Centre d'Essais des Landes offering a longer range with a target zone in the Azores.

CHARACTERISTICS – M-1 MISSILE.

Height: 10.4 metres
Diameter: 1.5 metres
Weight: 18 metric tons (approx.)
Guidance: Inertia with EMD Sagittaire digital computer
Propulsion:

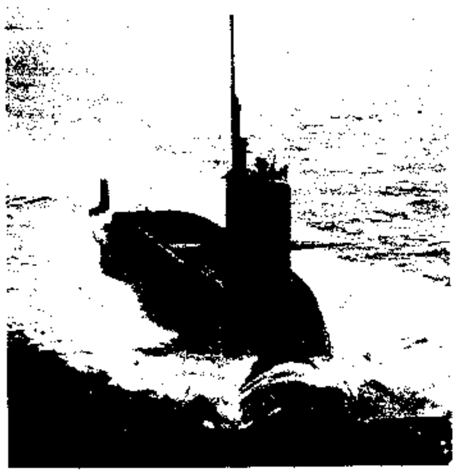
First-Stage: Type "904" motor in flow-turned vascojet 1000 casing containing 10 metric tons of solid propellant. Four gimballed nozzles for control.

Second Stage: "Rita" I motor in wound fibreglass casing containing four metric tons of solid propellant. An internal thrust vector system consisting of four freon jets spaced at 90 degrees round the single fixed nozzle is used for control.

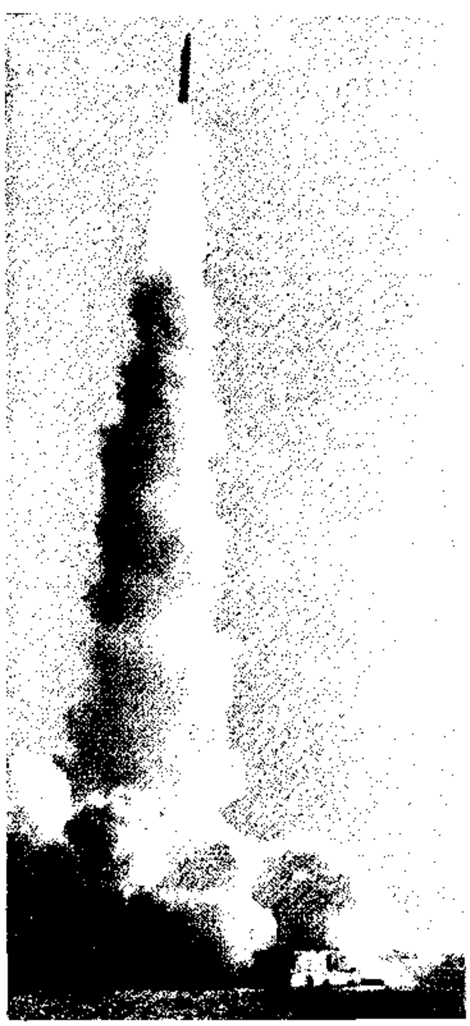
Warhead: Nuclear – reported to be 500 KT.

Range: 1,350 nm (approx) (2,500 km)

An improved version of the MSBS is now under development. Known as the M-2, its principal difference will be that of increased range. A new,

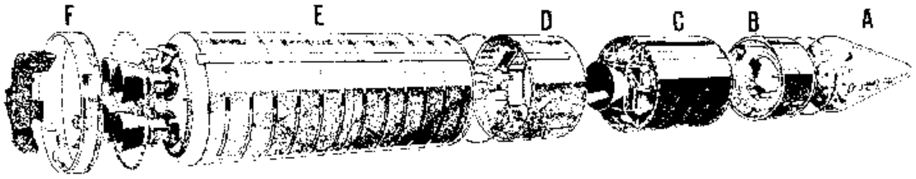


Le Redoutable



M.011 MSBS missile launch

higher performance, second stage – the Rita II – similar in principle but powered by 6 metric tons of solid propellant instead of 4, will replace the Rita I stage. The new missile will equip the third SNLE (*Le Foudroyant*) and the first two submarines will be modified to accept the new missiles during their normal refitting periods. The M 2 will have the same nuclear warhead as the M-1: from 1976 onwards, however, a new re-entry vehicle will be used. This will have a megaton-range thermonuclear warhead and penetration aids which will further increase the operational performance of the MSBS. This new configuration is called the M20.



The MSBS missile. A. Warhead. B. Control and guidance package. C. Second-stage motor D. Interstage fairing. E. First-stage motor. F. Skirt

MANUFACTURERS:

As in the case of the SSBS, the governmental agency in control is the Direction Technique des Engins and the industrial prime contractor is the Division des Systèmes Balistiques et Spatiaux of Aérospatiale, (SNIAS) whose responsibilities, in addition to the missile itself, include the on-shore assembly and check-out operations at the naval base, as well as the command and control launch procedures aboard the submarines.

Structures – Aérospatiale, SNECMA
Cases – Aérospatiale
Motors – SEP
Propellants – SNPE
Equipment – SAGEM, EMD, Matra, Souriau, LCT, Air-Equipement, Aérospatiale
Re-entry body – Aérospatiale
Nuclear charge – Commissariat à l'Energie Atomique
Integration – Aérospatiale
Environment – Electronic (Command & Control) – CII, SINTRA, SILAT

FRANCE / INTERNATIONAL

2219.421
SUBMARINE-LAUNCHED EXOCET

This is a proposal for an advanced version of the French Exocet missile (**1156.221**) that can be launched from a submerged submarine. Although no details have been published, it is assumed that the general characteristics of the missile will be not very different from those of Exocet – a range of some 40 km, for example, and a payload of some 700 kg.

Development of the new missile system was to be carried out in accordance with an Anglo-French agreement negotiated in mid-1969. The main contracting companies were the Missile Division of SNIAS for France and the British Aircraft Corporation for the UK. It is understood that the project has now been turned down, so far as the British authorities are concerned, in favour of the USGW (**2441.421**); but it is still possible that it will continue as a French project with or without collaboration by other countries.

STATUS:

No definite information

MANUFACTURERS:

Aérospatiale, rue Béranger, Chatillon-sous-Bagneux, France.

THE UNITED KINGDOM

2390.411
UK POLARIS MISSILES

DESCRIPTION:

Although the United Kingdom stopped developing strategic ballistic missiles when the Blue Streak project was cancelled, the country has retained many of the facilities that it was using for such development work; and the engineering teams have continued to work in many related fields. Although the Polaris missiles which equip the UK nuclear-powered ballistic missile submarines are largely of US manufacture, the contribution made by British industry is sufficient to justify giving the UK a separate listing in this sub-section.

The Royal Navy's ballistic missile submarines are equipped with the A-3 Polaris missile. These missiles, however, are supplied to the UK without warheads, and nuclear warheads of UK design and manufacture are fitted, together with re-entry bodies, fusing and arming devices, all developed and manufactured in the UK.

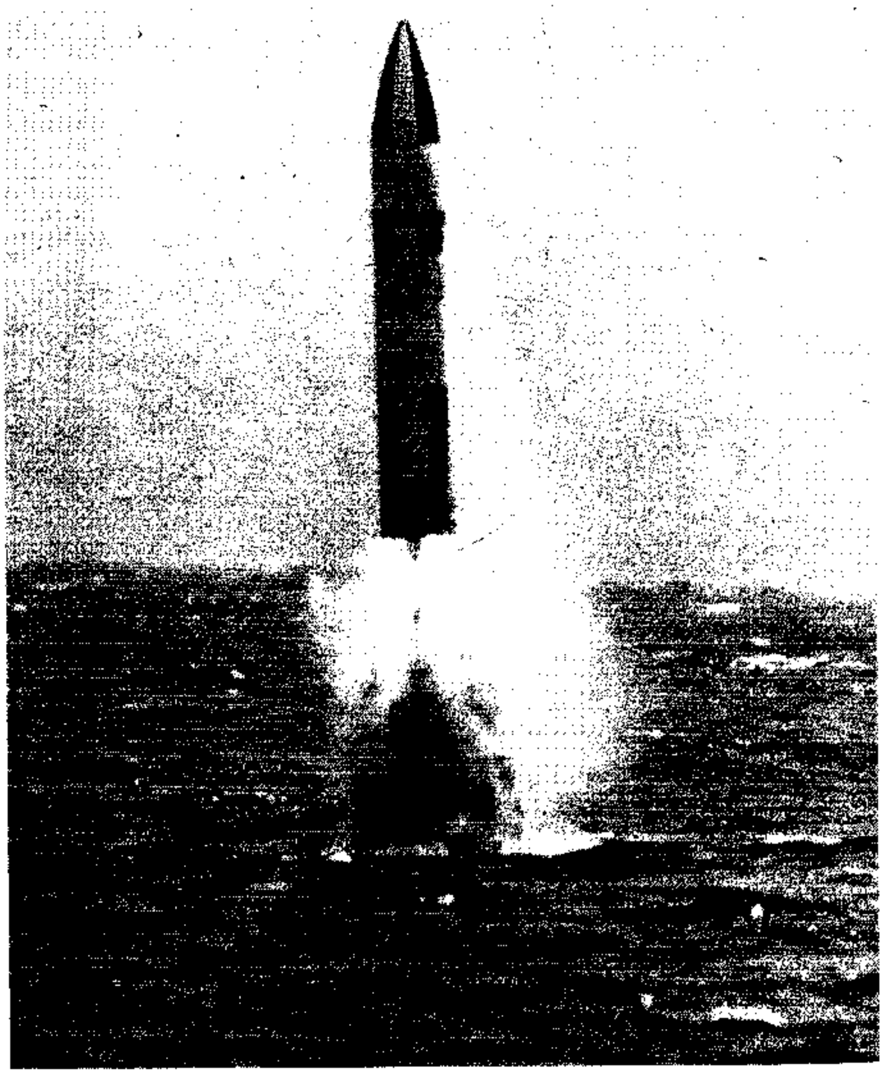
STATUS

It is widely agreed that something needs to be done to modernise the British force, but no information is available on the option that are being considered. An underground test explosion carried out in connection with the British programme in 1974, however, suggests that some agreed programme is being implemented.

MANUFACTURERS:

About 800 British firms are or were associated with the UK Polaris programme. Some of the major contractors are listed below.

Submarines:
Vickers
Cammel Laird
Nuclear Reactors:
Rolls Royce
Royal Navy Polaris School:
George Wimpey & Co.
Vickers
GEC-Marconi
British Aircraft Corporation
Sperry
EMI
Crew Training Simulator:
GEC Marconi



Royal Navy Polaris missile (MoD Royal Navy Photograph)

2441.421
UNDERWATER TO SURFACE GUIDED WEAPON (USGW)

DESCRIPTION:

Little information has so far been released concerning this project. In broad outline, however, the proposal is for an air-flight missile which can be launched from a submerged submarine, rise to the surface and thence travel as a conventional air-flight missile towards a surface target.

Clearly the project has quite a lot in common with the submarine-launched Harpoon project (**2797.411**) and possibly with the proposed submarine-launched Exocet (**2219.421**) which it has superseded as a British project. It should be stressed, however, that it is essentially a tactical weapon that is being proposed. the fact of launching through the submarine's torpedo tubes in any case limits the range of design opportunities; but although it is believed that a substantial range is among the desiderata it is also believed that any kind of strategic nuclear capability is not.

It is understood that the missile to be used is a derivative of the HSD/Matra Martel (**1022.311**) and that it will be enclosed in a capsule made of four detachable sections and of a size that is compatible with a 21-inch torpedo tube. This capsule, on launching, will be boosted from the torpedo tube by a rocket motor having sufficient energy to propel the missile clear of the water. When this happens the capsule and boost motor will be discarded, the missile's control surfaces will be deployed and it will fly under power from its main motor, following what is now becoming a conventional climb, dive and skim path towards its target.

STATUS:

The UK Ministry of Defence has placed contracts with British industry for the design of the USGW which is intended to replace the torpedo as the main armament of the nuclear-powered hunter-killer submarines in the Royal Navy.

Prime contractors for the missile are Hawker Siddeley Dynamics Ltd. supported by Marconi Space and Defence Systems Ltd for the guidance system and IMI Ltd for the propulsion system.

THE UNITED STATES OF AMERICA

1130.411
POLARIS A-2 (UGM-27B) FLEET BALLISTIC MISSILE

DESCRIPTION:

Polaris is a two stage ballistic missile powered by solid-fuel rocket motors and guided by a self-contained inertial guidance system independent of external commands or control. There are currently two generations of Polaris, A-2 and A-3. Polaris A-1 was officially retired from active duty when the USS Abraham Lincoln (SSBN 602), the last of the first five SSBNs to carry it, returned to the United States on 14 October 1965, for her initial overhaul and refit to A-3. By the time these words appear in print, the A-2 missile, too, should have been phased out of fleet service.

The 1,200 nautical mile (2,220 km) range Polaris A-1 was 8.53 m long, 137 cm in diameter, and weighed about 13,600 kg. Each of its motors exerted thrust through four nozzles in the motor base. Thrust vector (direction) control was exercised by devices called jetavators. Both first and second stage motor cases were made of steel.

The 1,500 nautical mile (2,780 km) range operational Polaris A-2 missile is similar to the A-1 in general appearance and diameter. However A-2 is 76 cm longer and uses a more powerful solid-propellant than A-1. New features include a second stage rocket motor case made of wound fibreglass instead of steel, and rotating nozzles instead of jetavators.

A thermo-nuclear payload is carried, the yield of which is reported to be about 800 kilotons.

Polaris missiles are deployed in vessels of the US Navy nuclear submarine fleet, each ship carrying a total of 16. More details of the Polaris fleet appear later.

OPERATION:

Missile guidance: The inertial guidance system used in Polaris was a refinement of earlier inertial systems and was the most compact of any US ballistic missile. The missile's guidance package consists of an inertial platform and a digital computer. The inertial platform is a gyro-stabilized set of three accelerometers. Once launch has occurred, the computer is in full control of the missile.

In-flight missile accelerations are measured by the inertial platform and integrated into velocities. These velocities are fed continuously to the computer. The computer constantly compares this attained velocity information with the required velocity received from the ship's fire control system prior to launch and stored within the computer memory.

When the missile has acquired that velocity which will permit the payload to continue on to the target on a ballistic trajectory, the computer issues a signal which commands separation from the second stage motor, and the payload continues on a ballistic trajectory to the target.

Navigation: Two positions must be known for missile launching: target and launcher. In the Polaris system this puts great importance on navigation since the position of the launcher is the position of the ship and is continuously changing. Several methods complement each other in the FBM submarine to provide a high order of accuracy in determining ship's position. Heart of the system is the Ship's Inertial Navigation System (SINS), a complex system of gyroscopes, accelerometers and computers, which relate movement and speed of the ship in all directions to true north to give a continuous ship position information.

The SINS installation differs between the various classes of US nuclear submarines. The 508 class of vessel is fitted with three Mk 2 SINS; the 608 class has two Mk 2 SINS; and 12 of the 616 class have two Mk 2 SINS. The first 19 vessels of the 616 class were fitted with three SINS of the same type. All of these inertial systems are produced by the Autonetics division of North American Rockwell as the N7 Mark 2 SINS guidance system.

Numerous equipments are included in the submarine navigation system to provide an all weather capability of verifying the accuracy of SINS. These include both optical and electronic devices.

In addition to astro-navigation the US Navy Transit navigation satellite, Loran and other position-fixing data sources are used for periodic updating of SINS.

Fire Control: The fire control system is a large digital geoballistic computer which processes coordinated data such as ship's location, local vertical true north target location and other data, and determines from these the proper trajectory for each of the 16 missiles at any given moment. Because many of these data change in value as the ship moves, the fire control computers can recompute all 16 trajectories every few seconds for transfer to the missile guidance computer memory store.

The fire control mechanism can prepare missiles for launch at the rate of about one per minute.

Two Polaris fire control systems have been produced by the General Electric Company for the FBM vessels. The first, the Mk 80, was originally installed in vessels of the SSB(N) 598 and SSB(N) 608 classes, but the five submarines of the former now have the Mk 84, following their conversion from A-1 to A-3 Polaris missiles. The Mk 80 fire control systems which were produced in Mod 0, 1, 2 and 3 versions, on these ships were probably converted to the Mk 84 at the same time as the missile conversion.

The Mk 84 fire control system is fitted in the 31 submarines of the SSB(N) 616 class.

Missile launching: Polaris missiles are launched from the submarine by an air ejection or a gas/steam generator system. On the latter a small fixed rocket is ignited and its exhaust directed through cooling water into the base of the launch tube. The missile is propelled from the tube, through the water and to the surface. At that point the missile's first stage rocket motor ignites and sends the missile on its way. Each launch tube has its own launching system independent of the other tubes. Vital parts of each missile are accessible for inspection and maintenance when loaded in the launching tubes and while the submarine is underway at sea.

Communications: VLF (Very Low Frequency) radio is the principal means of communication with submerged vessels of the USN FBM force, reception at these frequencies being possible to well below periscope depth. The Omega navigation system also operates in this part of the radio spectrum and could presumably be used as a further source of navigational data for up-dating SINS without any need for surfacing, although suggestions that the Omega system is indeed so used have been rejected by an official spokesman.

DEVELOPMENT:

Flight testing of Polaris began on 24 September, 1958, with the first launching of what was known as the AX series of test vehicles. After 17 AX flight tests, the pre-prototype tactical version, AIX, began flight tests on September 21, 1959, and during the next ten months, 30 AIX models were flown at the Atlantic Missile Range.

The 31st A-1 marked the first firing of a Polaris from a submerged submarine. On July 20, 1960, the lead Fleet Ballistic Missile submarine, USS George Washington, conducted a completely successful firing while submerged off Cape Canaveral. Less than three hours later, she launched a second successful A-1.

Development flight testing of the second generation Polaris A-2 began in November 1960 and continued in parallel with submarine firings of the Polaris A-1. Originally conceived as basically an A-1 with a 76 cm longer first stage, the A-2 developed into a missile with many advances over the A-1. Beginning late in 1961 a series of A2X missiles were modified to flight test certain subsystems and equipment designed for later use in the A-3. The first successful submerged launch of an A-2 came from the USS Ethan Allen on October 23, 1961, while cruising submerged off Cape Canaveral.

The first and to date only full systems launch of a US strategic missile occurred on May 6, 1962, when the USS Ethan Allen, cruising in the Pacific with Joint Task Force 8, successfully launched a Polaris A-1 with nuclear warhead. The nuclear detonation was successful.

1131.411
POLARIS A-3 (UGM-27C) FLEET BALLISTIC MISSILE

DESCRIPTION.

The A-3 version of Polaris represents a major re-engineering of the basic missile to achieve a 60 per cent increase in range for approximately the same weight and dimensions as the A-2 model.

Range of the Polaris A-3 is 2,500 nautical miles (4,630 km), much of this increase over the 1,500 nm (2,780 km) of the A-2 being attributable to reduced structure and component weight and the use of a new solid-propellant for the two-stage motor. Both stages of the A-3 motor are of glass fibre construction. The inertial navigation system of the A-3 missile is about 60 per cent smaller than that of the A-2.

There is also a difference in the external appearance, the later A-3 weapon having a constant circular cross-section along its length and a blunt rounded nose cone instead of the large and small diameter cross-sections which are a feature of the A-2. Overall length is increased by 15 cm to 9.55 m, but diameter and approximate weight remain the same at 137 cm and 13,600 kg, respectively.

In many ways the most significant difference between the two missiles is in the warhead. Initially, the A-3 missile was fitted with a single warhead of about 1 MT – not greatly different from that of the A-2. Subsequently, however an MRV warhead was developed for the missile; and most of those now in service have been fitted with a 3 × 200 KT MRV warhead.

OPERATION:

Targeting data for a variety of operational contingencies is carried aboard each submarine on patrol in the form of prepared magnetic tapes. This information is fed into the fire control system, together with continuous navigational data from SINS and sea state information from the ULCER system. The latter enables compensation to be made for currents which could affect the missile after it is ejected from the launcher tube.

DEVELOPMENT:

A series of A-2 experimentally modified Polaris missile launchings began in the latter part of 1961 to test freshly designed sub-systems and equipment for the A-3 version. The first successful launch of the new version was achieved at the seventh attempt, extensive static and ground testing being carried out between shots to isolate and cure specific problems. The first tube-launching at sea occurred on October 26, 1963. Entry into operational service with the US Navy was in September 1964.

It has been stated by the US Navy that each submarine on station in the Atlantic and Mediterranean has all 16 missiles ready to fire 96% of the time, 15 ready 99.9% of the time and 14 ready always.

STATUS:

Of the 41 fleet ballistic missile submarines of the US Navy, the five *George Washington* class were originally fitted with the Polaris A-1 missile, the five *Ethan Allen* class and eight of the *Lafayette* class with the A-2 missile and the remaining 23 *Lafayette* class submarines with the A-3 missile.

Subsequently the *George Washington* class have been converted to the A-3 missile; and the *Ethan Allen* class should have been similarly converted by the time these words appear in print. The 31 *Lafayette* class submarines will have their A-2 or A-3 missiles replaced by Poseidon (**1133.411**).

According to the latest available US official statements, all Poseidon conversions will be complete by mid-1977 – giving a total strength of 31 Poseidon submarines (496 launchers) and 10 A-3 submarines (160 launchers).

MANUFACTURERS:

More than 20,000 contractors and government agencies have been engaged in work on the American FBM system. Some major contractors and government agencies are listed below. Production of Polaris A-2 was completed in June 1964 and the A-3 production was complete in June 1968.

FBM Submarines:

Electric Boat Division, General Dynamics Corp. Groton, Connecticut

Newport News Shipbldg. and Drydock Co., Newport News, Virginia

Mare Island Naval Shipyard, Vallejo, California

Portsmouth Naval Shipyard, Portsmouth, New Hampshire

Submarine Propulsion:

Westinghouse Electric Corp., Pittsburgh, Pennsylvania

General Electric Corp., Lynn, Massachusetts

Navigation:

Autonetics Division, North American Rockwell, Anaheim, California

Sperry Gyroscope Co., Division of Sperry Rand, Inc., Great Neck, Long Island, New York

Communications:

Sylvania Electric Products Co., Buffalo, New York

Princeton Labs, RCA, Princeton, New Jersey

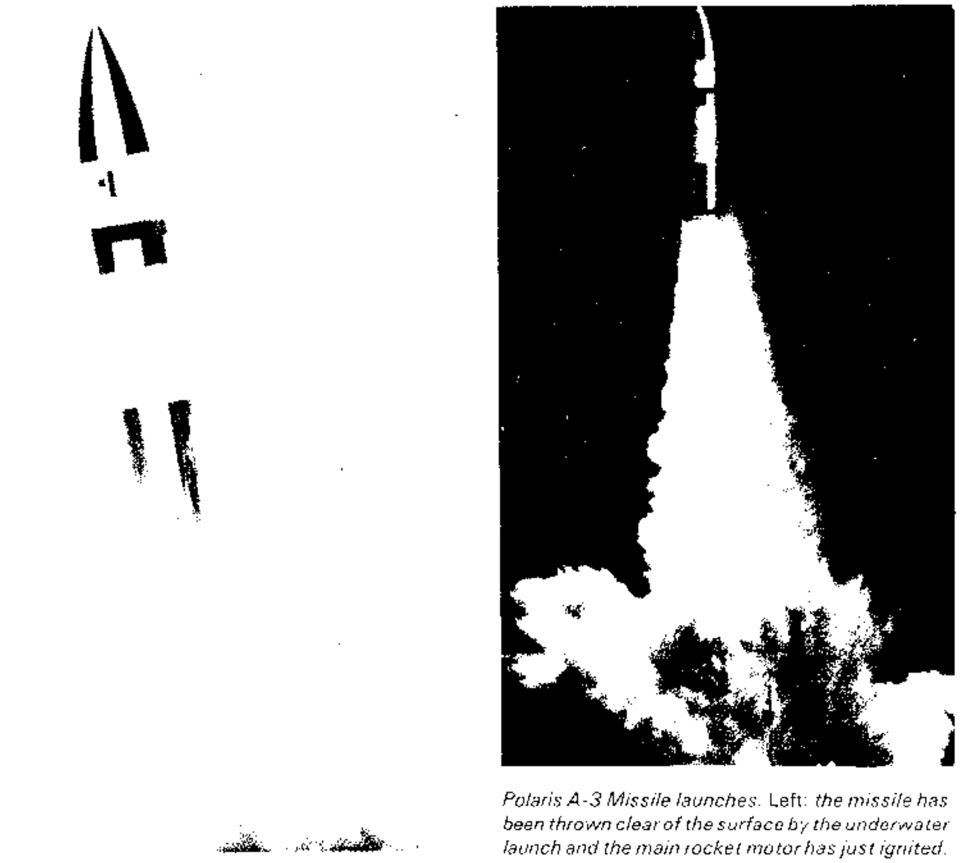
Bell Telephone Labs, Whippany, New Jersey

International Telephone and Telegraph Labs, Nutley, New Jersey

Fire Control:

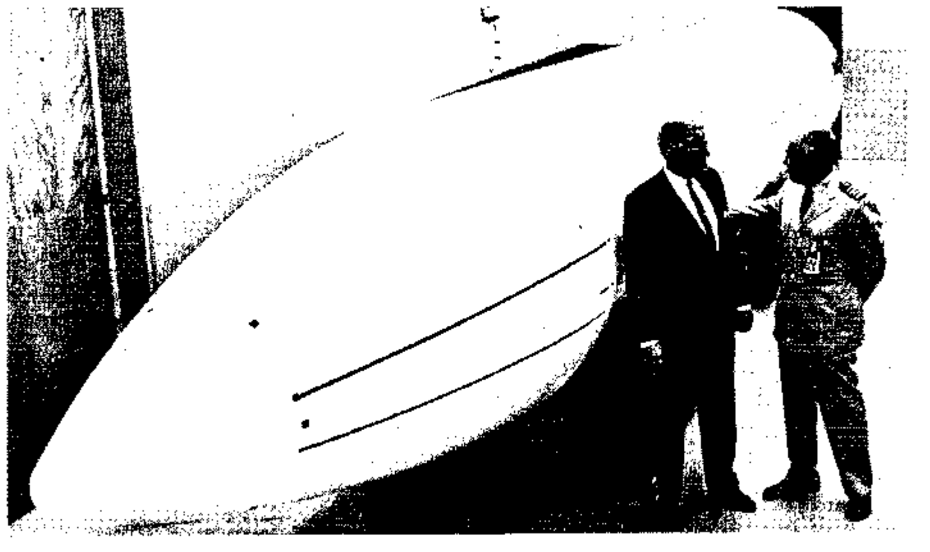
General Electric Co., Ordnance Dept., Pittsfield, Massachusetts

Hughes Aircraft Co., Culver City, California



Polaris A-3 Missile launches. Left: the missile has been thrown clear of the surface by the underwater launch and the main rocket motor has just ignited. Right: the motor is developing full power. (US Navy Official)

Equipment check-out in progress at the centre missile level station on the USS George Washington. *Missile tubes are to the right of the picture* (US Navy photograph)



Last production Polaris A-3 missile at the Lockheed Missiles and Space Company factory

"SACE" Shorebased Automatic Checkout Equipment:
Lockheed Missiles & Space Co., Sunnyvale, California
Lockheed Electronics Co., Plainfield, New Jersey
Lockheed Aircraft Service Co., Ontario, California
Missile Checkout:
Northrop Corp., Nortronics Division, Anaheim, California
Launching:
Westinghouse Electric Corp., Sunnyvale, California
Hughes Aircraft Corp., Culver City, California
Minneapolis-Honeywell Regulator Co., Minneapolis, Minnesota
Raytheon Co., Lexington, Massachusetts
Warhead:
Lawrence Radiation Lab, Atomic Energy Commission, Livermore, California
Instrumentation:
Interstate Electronics Corp., Anaheim, California

Weapon System Coordination:
Vitro Corp. of America, Silver Spring, Maryland

Missile System Manager:
Lockheed Missiles and Space Co., Sunnyvale, California
Missile Propulsion:
Aerojet-General Corp., Sacramento, California
Hercules Incorporated, Wilmington, Delaware

Missile Guidance:
Massachusetts Institute of Technology, Cambridge, Massachusetts
General Electric Co., Ordnance Dept., Pittsfield, Massachusetts

1133.411
POSEIDON C-3 (UGM-73A) FLEET BALLISTIC MISSILE

DESCRIPTION:

Two-stage, solid-propellant strategic missile designed for launching from submerged submarines of the US Navy. Successor to the Polaris A-2 and A-3 weapons currently deployed. Range of Poseidon is the same as for the Polaris A-3, 2,500 nautical miles (4,630 km), but weight is more than doubled at 29,480 kg. Dimensions are correspondingly greater at length 10.36 m, diameter 188 cm, but the new missiles are capable of deployment in the launch tubes of existing Polaris submarines without major modifications to the ship.

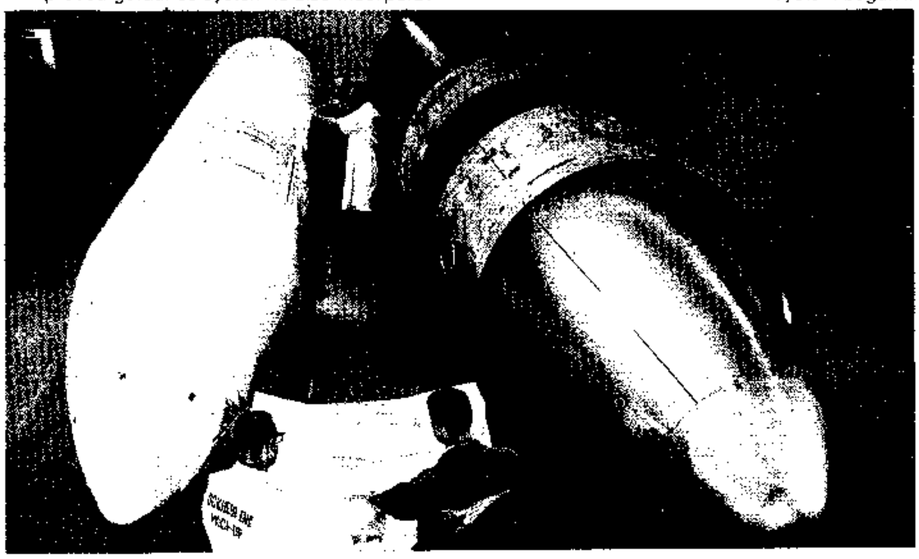
A considerably increased nuclear payload consists of an MIRV warhead which enables a single Poseidon to be used against a number of targets. An improved guidance system is also incorporated which provides double the accuracy, it is claimed, of the earlier weapons.

A new fire control system, Mk 88, is being produced for the Poseidon system by the General Electric Company. This interfaces with a new version of the Autonetics SINS (Ships Inertial Navigation System), the missile and the launcher. Mk 88 performs target calculations, insertion of data into the guidance system, test and checkout launch order, and sequence control.

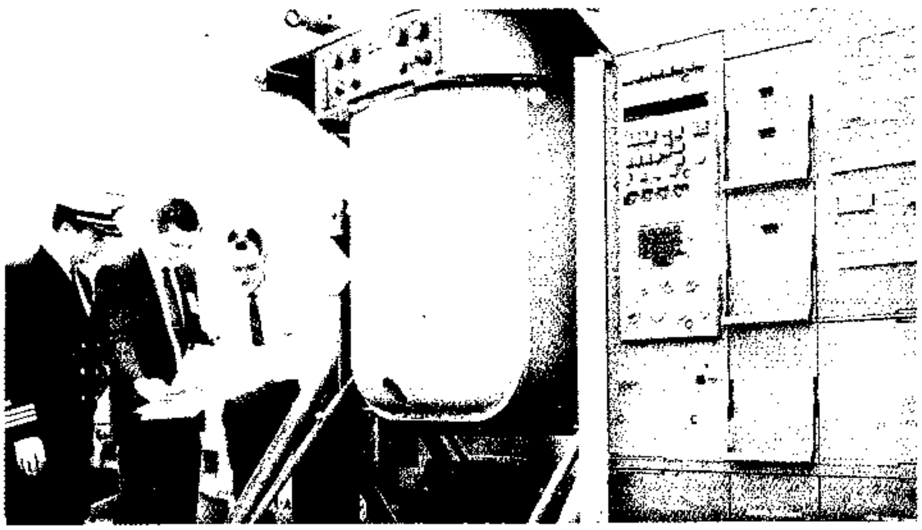
DEVELOPMENT:

The first flight model of Poseidon was launched on August 16, 1968, from Cape Kennedy, Florida. The fourteenth launch, in December 1969, was the first complete test of the weapons system, including the launcher, control and missile subsystems. Development flight testing was completed in June 1970 with 14 of 20 launches described as successful by the Navy.

Work on the Mk 88 fire control system began in



Comparison of Polaris A-3 (left) *with Poseidon C-3 Fleet Ballistic Missile*



New version of Autonetics N7 SINS (Ship's Inertial Navigation System) for Poseidon carrying submarines

First operational launch of a Poseidon missile from the SSB(N) James Madison *on the 3rd August, 1970* (US Air Force photograph)

1965 and the first prototype was delivered by GE in 1968.

STATUS:

After a delay of three months caused by production line problems, Poseidon became operational on March 31, 1971, when the USS *James Madison* deployed on patrol from Charleston, South Carolina.

Prior to initial deployment there had been nine Poseidon firings from FBM submarines, the first having been launched from the USS *James Madison* on August 3, 1970.

Thirty-one vessels of the Navy's FBM force are being fitted with the C-3 Poseidon. The conversion programme began in February 1969, and is scheduled for completion in mid 1977. Only submarines of the 'Lafayette' class are being converted. By the beginning of March, 1974, 20 conversions had been completed and deployed, two were at the pre-deployment stage, six were undergoing conversion and three had not been started. The Poseidon test programme ran into difficulties in 1973 when several failures occurred as the results of a variety of component malfunctions. A retrofit modification programme has since been devised and is expected to restore the SLBM force to its specified standards of reliability and accuracy.

MANUFACTURERS:

Lockheed Missiles & Space Company, PO Box 504, Sunnyvale, California 94088, USA – prime contractor.

General Electric Company, Ordnance Systems, Electronic Systems Division, 100 Plastics Avenue, Pittsfield, Massachusetts 01201, USA – Mk 88 fire control system.

Autonetics Division, North American Rockwell Corporation, 3370 Miraloma Avenue, Anaheim, California 92803, USA – SINS.

2797.421
SUBMARINE-LAUNCHED HARPOON MISSILE

DESCRIPTION:

The basic Harpoon ship-to-ship operational concept (see **2641.221**) has been extended to a submerged launch by placing the missile in a capsule for the through-water part of the launch trajectory. This capsule has been designed to be compatible with standard submarine torpedo tubes and torpedo loading and handling equipment.

The capsule, with its booster motor, is accelerated from the torpedo tube by pneumatic or hydraulic force and rises to the surface because of its buoyancy. The path to the surface taken by the capsule is controlled by aft fins mounted on the capsule. A broach sensor is fitted to the capsule and signals when the surface is reached, initiating a sequence of events which separates the fore and aft ends of the capsule and ignites the booster. The missile then flies out of the capsule and follows a standard ship-launched missile flight plan to the target.

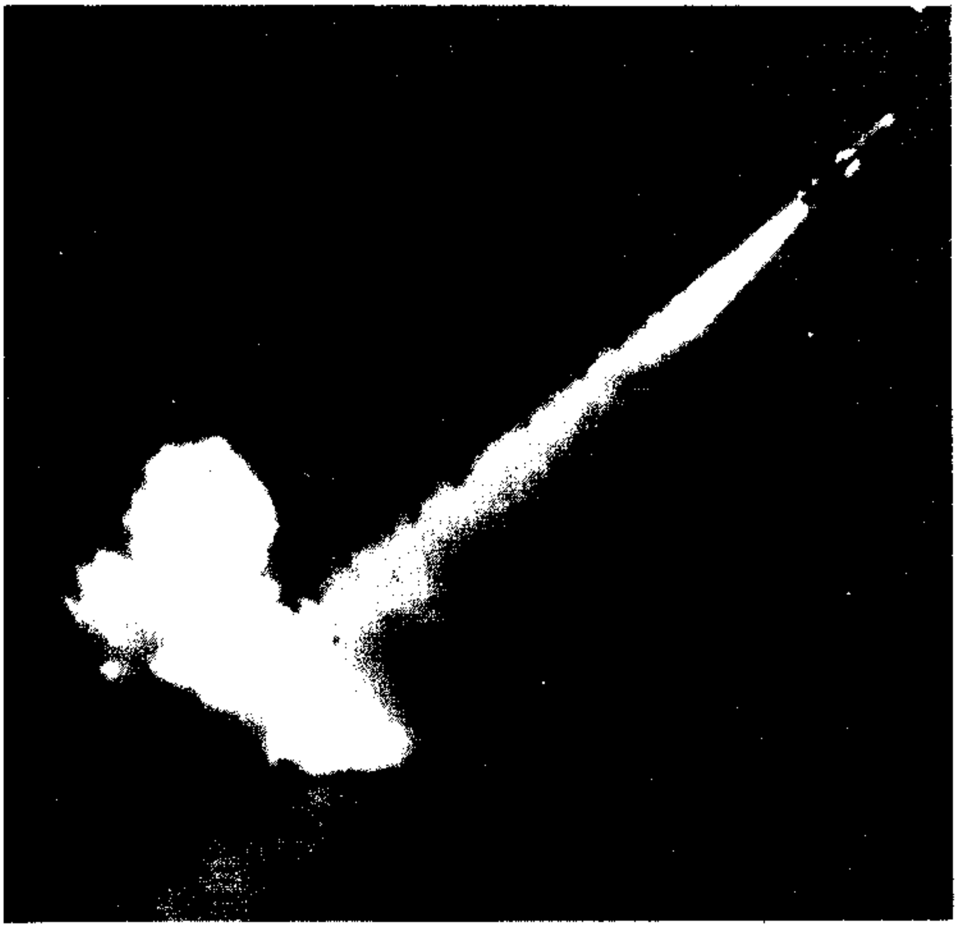
Targeting is accomplished by inserting into the computer range and bearing data obtained from ship's sources or third party observers on the surface or airborne.

STATUS

The encapsulated version of Harpoon is in full development and scheduled for deployment on US Navy attack submarines in the mid 1970s.

MANUFACTURER:

McDonnell Douglas Astronautics Company, PO Box 516, St. Louis, Missouri.



Submarine-launched version of Harpoon in flight

1759.411
SUBMARINE-LAUNCHED CRUISE MISSILE (SLCM)

DESCRIPTION:

This programme, also known as the US Navy Cruise Missile because of the intention of providing for surface-ship launching and possibly air launching, is a development project to provide US submarines with an underwater-launched cruise missile for both strategic and tactical purposes. The programme is paralleled by the ALCM (Air-Launched Cruise Missile) project of the USAF and both services have been instructed to ensure that there is maximum commonality between the two weapons. Each service has been given prime responsibility for one broad aspect of the SLCM/ALCM system: the turbofan cruise motor is a USAF responsibility, and the USN will take the lead in guidance system development.

Both tactical and strategic versions of SLCM are to be suitable for launching from standard size torpedo tubes. The tactical model will have a range of 300 nautical miles (555 km) or more and is likely to be armed with a conventional warhead for anti-ship, and possibly shore bombardment, missions. The strategic version's maximum range is to be about 1,500 nautical miles (2,780 km) and a nuclear warhead will be available. In both instances cruising speed will be subsonic, in the interests of range, and at low level for optimum

This artist's impression attempts to show all phases of a submarine launched cruise missile launch from submarine to cruise, but is best regarded as indicative of the general configuration of the missile penetration capability.

The guidance system for the cruise phase is expected to be a development of the TERCOM (Terrain Comparison) technique upon which the USN has been working for some years (see also entry **2719.111**). Equipment which has been used in this project includes a Honeywell APN-194 radar altimeter, Texas Instruments 2520-2 digital computer, and a Singer-Kearfott ASN-90 inertial navigator. The last of these items is essential to provide navigational data during over-water legs of the cruise flight path and during breaks in the data on terrain contour-matching which is the basis of the TERCOM technique. The combination of TERCOM and inertial navigation is called TAINS – Tercom-Aided Inertial Navigation System. Terminal guidance is likely to be by active radar homing. From what is known of these navigation techniques, it appears that TERCOM has no application over flight paths that do not pass over land. This suggests that there may eventually be three guidance package options for various SLCM applications: TAINS for the strategic version used to attack heavily defended land targets; straight inertial for tactical SLCMs intended solely for anti-ship operations; and TAINS for tactical SLCMs intended for shore bombardment.

STATUS:

The US Fiscal Year 1975 budget allocated $45 million for a competitive flight demonstration programme to provide information upon which to base a decision to develop either or both variants of SLCM.

2840.411
TRIDENT (C-4) UNDERSEA LONG-RANGE MISSILE SYSTEM (FORMERLY ULMS)

DESCRIPTION:

What was formerly called ULMS (Undersea Long-range Missile System) and has now been given the name Trident is a seabased intercontinental ballistic missile now being developed as a successor to the US Navy's Polaris/Poseidon programme. Development of the system was somewhat delayed as a result of the debate over whether the United States should continue to improve existing land-based strategic systems (i.e. Minuteman) or move its nuclear deterrent force to sea. However, ULMS development was strongly endorsed by the Secretary of Defence in early 1970 as an effort to counter recent technological developments and the decision by the USSR to undertake a worldwide anti-submarine effort. In March 1971 the Secretary of Defence reiterated his support for ULMS, terming it a major factor in future strategic force planning and in 1972 he announced that the programme would be accelerated so that the first Trident submarine could be operational by 1978 – two to three years ahead of the original plan.

Subsequently, however, the shape of the programme was changed – largely as a result of the absorption into it of what was previously a separate proposal for extending the range of the Poseidon missile – and now involves the development of two new missiles and a new submarine. The first missile – variously known as Expo (for extended-range Poseidon), ULMS-1, Trident 1 and now C-4 – will essentially be an extended-range Poseidon (7,000 km capability) and it will be retrofitted to the existing Poseidon submarines; it will also, pending the availability of the second missile, be used as initial equipment for the new Trident submarine. It will carry the Mk 500 re-entry vehicle (see **2708.111**) and will be powered by first, second and third-stage motors all specially developed jointly by Thiokol and Hercules Inc.

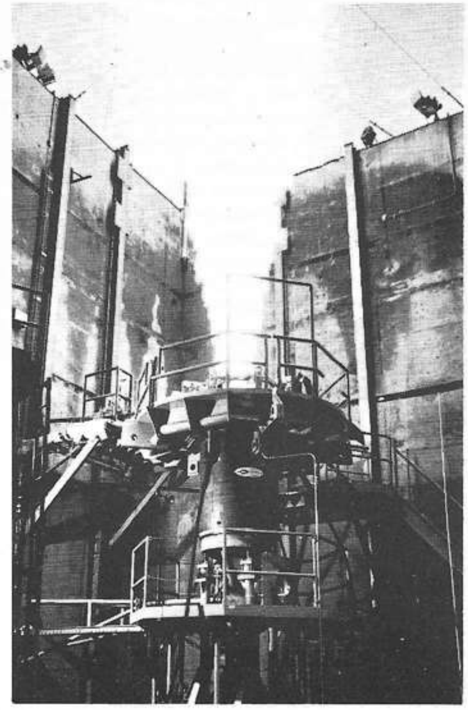
The second missile is expected to have a range of nearly 10,000 km and will be able to be launched only from the new submarine. This submarine is expected to be roughly twice the size of a 'Lafayette' class submarine and it will carry about 24 Trident missiles.

The Trident submarine is expected to be quieter than the existing vessels and be capable of reaching greater depths. Modular construction techniques will be used to reduce maintenance costs and in-port time and it is said that it will have an increased alert rate whereby a smaller force can maintain a given number of launchers on alert. The submarine will also carry an improved sonar unit and an advanced defensive weapons system.

The extended range of the Trident missile will permit the Trident fleet to operate from some 60 million square miles of ocean rather than the 3.5 million square mile range of the Poseidon fleet. The submarines could also be based exclusively in continental US bases, eliminating the dependence upon foreign ports.

STATUS:

Development work has started on the first Trident submarine, of which ten are to be built – the remaining nine being started at a rate of two per year beginning in FY 1975. The programme for the C-4 missile has been put back from its original operational date of 1977-78 to late 1978. The initial operational date for the Trident submarine is also in FY 1979. First fittings of the C-4 missile may therefore be in the Trident submarine instead of in the 'Lafayette' class as originally intended; nevertheless it is still planned to retrofit C-4 missiles in place of Poseidon in ten submarines – but not starting until early 1979. The new Trident missile will not be operational until the early 1980s.



Test firing of third-stage motor for the C-4 missile. This was the first test in which the United Technology Centre's "Techroll" fluid bearing was used in the steering device

MANUFACTURER:

Prime contractor: Lockheed Missiles & Space Company.

THE UNION OF SOVIET SOCIALIST REPUBLICS

2946.411
RUSSIAN SUBMARINE-LAUNCHED BALLISTIC MISSILES

As with so many other classes of Russian weapons there is little unanimity among Western observers regarding the nature, nomenclature, performance and deployment of the submarine-launched ballistic missiles of the Soviet Navy. The confusion is not reduced by the use, by the US authorities, of a single alphanumeric code series to cover both ship- or submarine-launched cruise missiles and SLBMs.

What does appear to be reasonably generally agreed is that the Y-class nuclear submarines are equipped with the Sawfly (**1154.411**) missile and that these submarines carry 16 of these missiles. From more than one source comes the suggestion that this is the missile that is known by the US alphanumeric code as SSN-6.

From various sources come identification of the SSN-4 with Sark (**1152.411**) and the SSN-5 with Serb (**1153.411**) – the latter being somewhat better favoured as a suggestion than the former. Another usually well-informed source, however, denies both identifications; moreover, Admiral Moorer, at that time Chairman of the US Joint Chiefs of Staff, making his FY 1975 Military

Z-V class Russian submarine – an early missile carrier

Posture statement in February 1974, illustrated it with some silhouettes of Russian SLBMs which appear to identify the SSN-5 with Sark, SSN-6 with Serb and SSN-8 with Sawfly. Although the Admiral's sources of information must be among the best available, we have seen mistakes in diagrams of this kind on previous occasions and choose not to accept these identifications at present.

The accompanying table gives what is believed to be a reasonable indication of current missile deployment. To minimise confusion the missiles are described only by their NATO code-names.

Scud-A missiles, referred to below, were probably used for early experiments and are no longer in naval service (see **2969.111** for details). For Sawfly (ER) see under Sawfly (**1154.411**).

Soviet Missile-equipped Submarines

Class	Propulsion	Missile	Number of Launchers
C	Nuclear	Shaddock-type	8
D	Nuclear	Sawfly (ER)	12
E1	Nuclear	Shaddock-type	6
E2	Nuclear	Shaddock-type	8
G1	Conventional	Sark (formerly Scud-A)	3
G2	Conventional	Serb	2
G3	Conventional	Serb	3
H1	Nuclear	Sark	3
H2	Nuclear	Serb	3
J	Conventional	Shaddock-type	4
W	Conventional	Shaddock-type	2-4
Y	Nuclear	Sawfly	16
Z-V	Conventional	Sark (formerly Scud-A)	2

1152.411
SSN-4 (SARK) SUBMARINE-LAUNCHED BALLISTIC MISSILE

DESCRIPTION:

Sark is the NATO code-name assigned to what has come to be regarded as the prototype Soviet submarine-launched strategic missile.

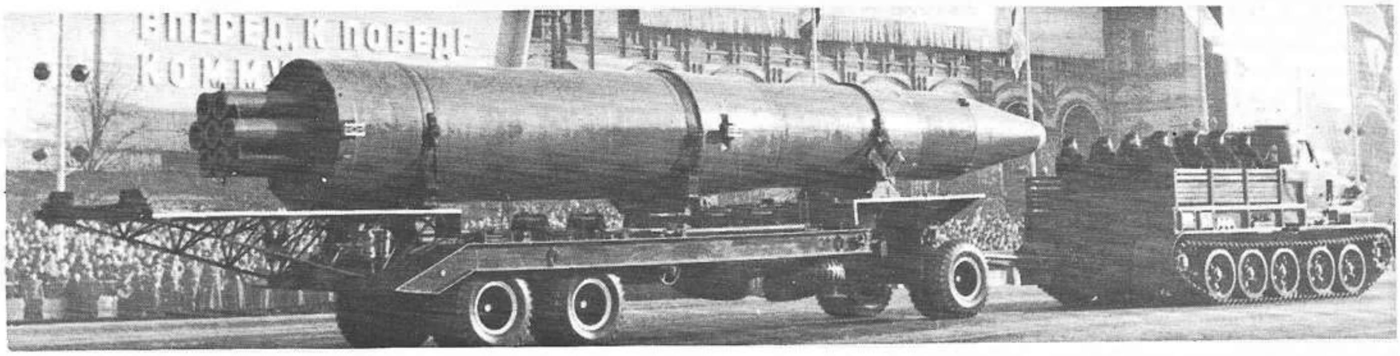
In general appearance it is similar to the American Polaris A-2 weapon of the same type, however it is estimated to be considerably larger with a length of 15 m and a diameter of 180 cm. Launch weight has been estimated at between 18 and 20 tons. Sark is believed to be a two-stage solid-propellant powered vehicle with a probable range of about 650 km. It should be noted, however, that at least one well-known observer of the Soviet naval scene has recently published figures that are all substantially smaller than the above – notably the range which is given as some 600 km. All seem to agree, however, that the missile is inertially guided.

STATUS:

Sark was first fitted in modified Z-class (Z-V) submarines following earlier installation of a missile similar (and probably identical) to Scud-A (**2969.111**). A test firing is believed to have taken place in 1955. Few if any of these submarines remain in service in this form.

Subsequent Sark fittings were in the early G-class (G-1) submarines (again preceded by Scud-A). One of these submarines is in the fleet of the People's Republic of China (**2051.411**). The early H-class nuclear submarines (H-1) were also fitted. Z-V submarines carried two missile launch tubes, G-1 and H-1 submarines three each.

In all these fittings Sark was installed for surface launching; and the sole justification for including it in this section is its connection with later SLBMs which could be launched from submerged submarines. Some observers claim that it has never in fact been an operational weapon – but the point is of little relevance because it is almost certainly not operational now.



Sark SLBM

1153.411
SSN-5 (SERB) SUBMARINE LAUNCHED BALLISTIC MISSILE

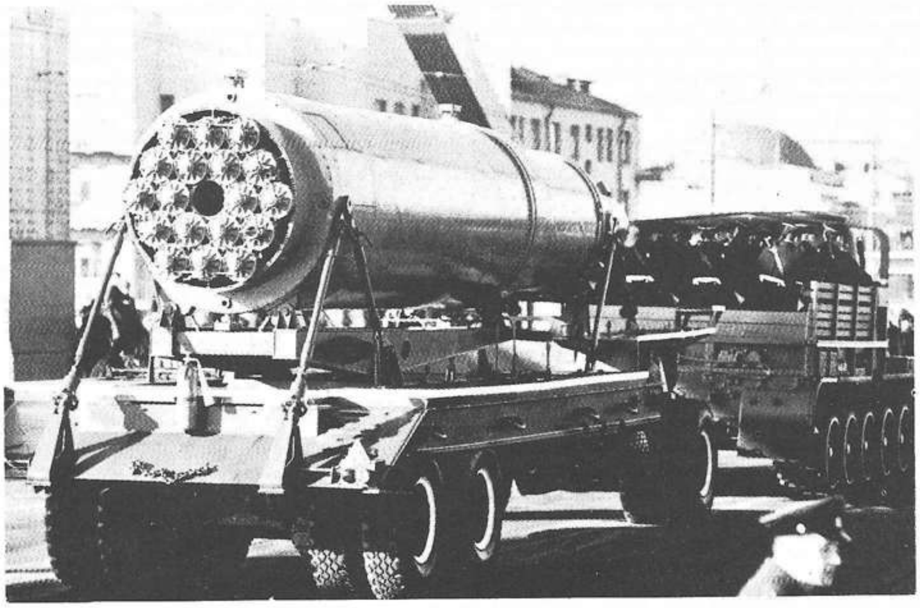
DESCRIPTION:

Serb is the code-name assigned by NATO to the successor to the Sark (**1152.411**) Soviet submarine-launched ballistic missile. Serb has been described as representing the second generation in this class of missiles in the USSR.

Like its forerunner, Serb is similar in appearance to the Polaris A-2 missile in service with the US Navy, and it is understood to be a two-stage solid fuel vehicle with inertial guidance. In size it conforms more closely with the dimensions of Polaris than does Sark, which is appreciably larger. Estimated Serb dimensions are: length 10 m, maximum diameter 1.5 m. Launch weight has been estimated at around 18 tons. While there is fairly close agreement, among the various authorities on these dimensions, there is far from being agreement on the missile's range capability. Estimates vary from about 1,200 km to about 2,400 km. A single re-entry vehicle with a warhead in the megaton range is carried.

When the Serb missile was displayed in the November 1967 parade, what is apparently a different ejection system to that employed in American submarine launcher tubes was revealed. At the base of the missile there is a cluster of 18 small, electrically fired cold-gas nozzles which are assumed to be used to eject the missile from the sealed launcher tube. On passing clear of the submarine, the section carrying these gas motors is probably jettisoned from the main missile body by means of explosive bolts fired when the first stage ignites.

It is probable that Serb was originally intended for installation in E-class nuclear submarines, but these were switched to a cruise missile role by a 1957-58 decision, and the missile when completed was retrofitted to G-class and H-class submarines in place of Sark. First submarine launch is believed to have been in March 1962.



Rear end of the Serb submarine-launched ballistic missile showing gas jets for ejection from launch tube

STATUS:

Operational in the later G-class (conventional) and the later H-class (nuclear) submarines on scales of two or three launchers per submarine.

1154.411
SSN-6/8 (SAWFLY) SUBMARINE LAUNCHED BALLISTIC MISSILE

DESCRIPTION:

It is probable that two missiles, known to the US authorities (or so it seems) as SSN 6 and SSN-8, are at present covered by the single NATO designation Sawfly. Up to the time of going to press, at least, there has been no news of a new name for the later of these two missiles.

It is generally agreed that the missile is some 15 m long and 1.8 m in diameter, that it has a launch weight of around 20 tons, that it is powered by a two-stage solid-propellant motor and is inertially guided. Range is variously estimated between 2,700 km and 3,500 km.

Until recently the missile was believed always to be equipped with a single re-entry vehicle with a warhead in the megaton range. Since our last edition went to press, however, it has been reported that the SSN 6 has been fired with a warhead of the MRV (but not MIRV) type.

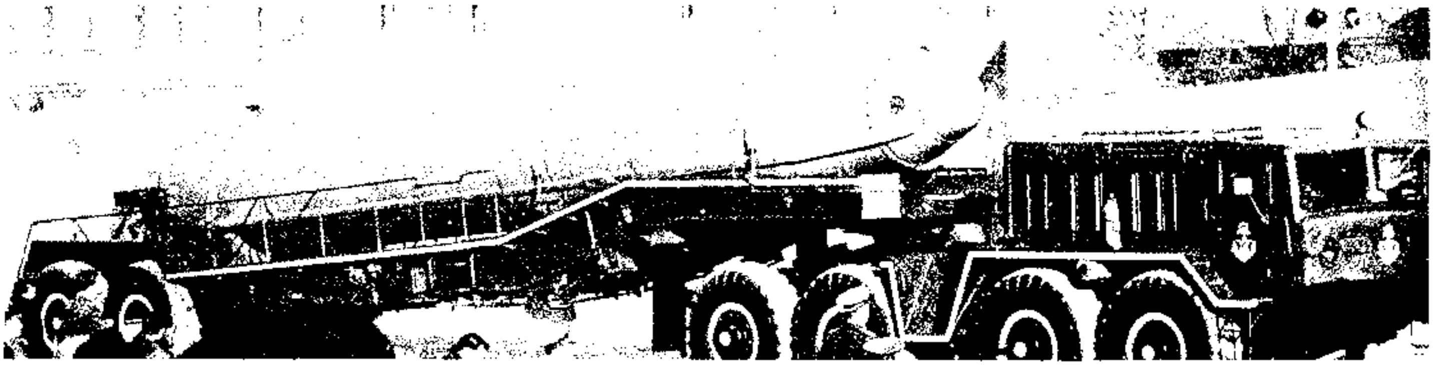
STATUS:

So far as is known, Sawfly is being installed only in the Soviet Y-class nuclear submarines. Each submarine is equipped with 16 launch tubes.

Sawfly (ER)

What is, according to some observers, a new missile or, according to others, an improved version of the Sawfly missile just described is known by the US alphanumeric designation SSN-8.

No identified photographs of the missile have yet been seen but information from official US sources suggests that the new missile is indeed a – probably larger – version of Sawfly. The name Sawfly (ER) has no official standing and is intended simply to indicate the most important characteristic of the new missile – that it has a range of some 7,500 km which is greater than any operational US SLBM. Sawfly (ER) is now operational in D-class submarines. It is also reported that the missile has been tested with a warhead of the MIRV type; and although this is not yet an operational warhead it seems likely that it will be operational before the American C-4 MIRV missile (**2840.411**) enters service. The latter, of course, is likely to have a much more sophisticated warhead than that which the Russians are likely to be able to deploy in the time available.



Sawfly submarine-launched ballistic missile

2987.411
SSN-7 SUBMARINE LAUNCHED CRUISE MISSILE

DESCRIPTION:

Little is known about this weapon other than that it is one of the family of cruise missiles developed in recent years in the Soviet Union, that it is carried by C-class Soviet nuclear submarines, on a scale of eight launchers per submarine, and that it can be launched while the submarine is submerged.

The missile is said to have autopilot control and presumably also has some form of homing system. Range has been variously reported between about 45 and 55 km; and it has been suggested that over a large part of its flight path it operates as a surface skimmer.

The submarine launch capability of this missile is undoubtedly one of the causes of the recent flurry of interest in submarine-launched tactical missiles among NATO countries. Most proposals currently under consideration in these countries however, contemplate the use of standard torpedo tubes as launchers – presumably because of the difficulty of retrofitting anything larger without denying the submarine the option of firing conventional torpedoes. The C-class submarine however, was designed from the outset to carry both missiles and torpedoes and was thus not so restricted in its choice of missile design as are the NATO designs.

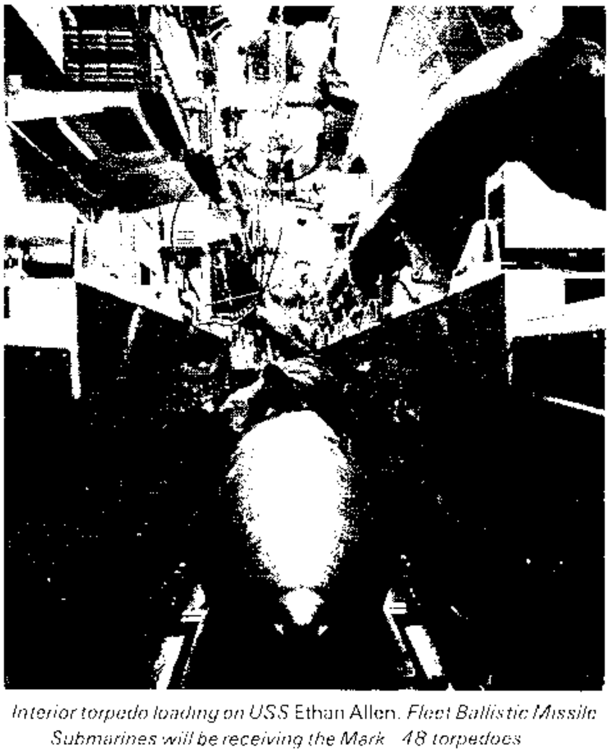
TORPEDOES

2295.441
INTRODUCTION – TORPEDOES

Torpedo development has long been one of the more neglected areas of weapon system activity; and although advances in relevant technologies have been reflected in a number of new designs in the past thirty years or so, a surprisingly large number of torpedoes whose designs date back forty years or more are still in service.

Since the emergence of the nuclear powered ballistic-missile submarine (SSBN) as a major strategic weapon, however, fresh impetus has been given to the development of the anti-submarine torpedo as one of the few types of weapon that offered an opportunity of countering the SSBN threat. Some of the development programmes concerned with this problem are now coming to fruition but others are just starting.

As explained in the introductory note on surface-to subsurface weapons (**2293.141**) the fact that some torpedoes can be used in two or more different roles makes it more sensible to group all torpedoes together rather than separate them by function. The entries set out below, however, are known not to be exhaustive – as the brevity of some descriptions indicates, information on some torpedoes is not easily come by; and the reader is also invited to consult the tabulation in Section 4 (**2296.444**) which – while still not exhaustive – contains some sketchy data on a few torpedoes that are not listed below in addition to tabulated data on those that are.



Interior torpedo loading on USS Ethan Allen. *Fleet Ballistic Missile Submarines will be receiving the Mark 48 torpedoes*

FRANCE

7501.441
ACOUSTIC TORPEDOES L3, E14 & E15

DESCRIPTION:

These torpedoes, which are further described individually in the entries that follow, have been designed with as many common parts as possible.

The weapons systems use part of the equipment pertaining to the submarine weapons of frigates and submarines. The sonar equipment detects, identifies and gives the position, route and speed of the target and, depending on the type of sonar, the depth of submergence. From this data, the directional launching system determines the straight path leading the torpedo near the target and conveys the relevant information to the torpedo tube stations and to the torpedoes. The torpedo follows this route until its homing equipment picks up the target. This then guides the torpedo either to impact or sufficiently close to the target to cause the proximity firing mechanism to operate.

Speed and range performances are selected to match the ranges of the sonar equipment carried by current French vessels.

The effective area of the explosive charge is consistent with the accuracy of self-guidance and with the operating requirements of the proximity fuse.

Propulsion is provided by a high-speed electric motor in series which drives, via a differential inverter-reducer, two contra-rotating propellers. The motor is rated from 40 kW (L3 and E14) to 50 kW (E15). Energy is provided by a storage battery comprising 76 (L3 and E14) or 120 (E15) Cd-Ni cells A/hr. The propulsion motor, operating as a rotary converter, powers the acoustic self-guidance system, and supplies the magnetic firing system and its ancillaries (50 V, 400 Hz, single-phase).

An automatic pilot guides the torpedo during the approach phase: it consists of an electric gyroscope which is started by air pressure within 0.4 second, and operates in conjunction with a depth regulator that controls the rudders via two pneumatic servo-motors. A 250-barye air tank starts the gyroscope briskly and supplies the servo-motors and the operating gear that sequences the various components.

OPERATION:

The L3 torpedo which is a strictly anti-submarine weapon incorporates the AS-3 active acoustic self-guidance system. Ultrasonic pulses are transmitted from and received by a bank of magnetostrictive transducers pendulated in the torpedo nose, the arrangement being such as to enable range bearing and elevation to be measured.

Location in azimuth and elevation is used to guide the torpedo according to a pursuit curve: the self-guidance system sends to the servo-motors, via electric valves that bypass the automatic pilot, the commands providing diving, rising and lateral control. These commands are applied for about the duration of the interval between successive pulses and cease as soon as the self-guidance system no longer confirms them.

A pendular system restricts the angle of trim of the torpedo from +10 deg. to −40 deg.

As the torpedo nears the target, the pulsed rate increases so as to improve the accuracy of pursuit and of the acoustic exploder mechanism.

On reception of a first distance echo less than 20 metres away, the exploder mechanism is triggered, bringing about explosion of the charge 3.5 seconds later. (If used for range practice, an adjuster stops the torpedo when 150 metres from the target.) If the torpedo overshoots the target beyond its assumed position, it proceeds with a specific search run.

If after a computed time the torpedo has not detected the target at the previous position it starts a circular search (if in shallow waters) or a helicoidal search (if in deep water).

The E14 and E15 torpedoes can be used only against surface ships or against noisy submarines when close to the surface.

The E14 torpedo has the same geometry and mechanical features as the L3 but the self-guidance system is passive. A bank of four transducers, in conjunction with a phase detector detects the target-radiated noise within a one-kHz bandwidth. This unit supplies two voltages whose difference enables it to locate the target in azimuth. After amplification and when these voltages have reached a given value, the self-guidance system sends lateral control commands by means of electric valves whereby the servo-motors abut against a limit switch (on/off control).

On nearing the target, the self-guidance system initiates the counter-command. The torpedo rotates in the same direction until it receives the counter-command. This avoids "break-off" of the torpedo when nearing the bows of the target, or permits resumption of an attack that aborted owing to the proximity fuse.

The magnetic proximity fuse system (M-7) is passive. Two probes detect the space variation of the magnetic field. When the torpedo passes under the target a signal of significant form develops which triggers the exploder mechanism of the charge. The range is about four metres under the hull of a frigate.

The protective system is designed so that arming of the exploder system and the authorisation to transmit the self-guidance system commands cannot take place until a 350-metre run from emergence from the torpedo tube has been accomplished.

The E15 torpedo has the same self-guidance system as the E14 but the geometry, range and explosive charge are different.

MANUFACTURERS:

Programme Direction – DTCN, 2 rue Royale, 75-Paris 8e.

Manufacturer – CIT-ALCATEL, Division Marine, 33 rue Emeriau, 75725-Paris CEDEX 15, France.

1163.441
E14 ACOUSTIC TORPEDO

DESCRIPTION:

Conventionally-shaped, submarine-launched, anti-ship (or anti-submarine in certain circumstances) torpedo with strong body in light alloy and laminated nose cone, with the following five compartments:

(1) acoustic passive self-guidance and electro-magnetic firing;
(2) the explosive charge and the inertial firing system;
(3) accumulators;
(4) air tank and automatic pilot;
(5) electric motor for propulsion.

CHARACTERISTICS:

Length: 168" (4,291 mm)
Diameter: 21" (533.4 mm)
Weight: 900 kg
Speed: 25 knots
Range: 5,500 metres
Explosive Charge: 200 kg
Submersion: Can be set within the range 6 to 18 metres (continuously variable)
Guidance: Acoustic, passive, average range 500 metres
Firing: Contact (inertial) and influence (magnetic)
Target: Surface vessel from 0 to 20 knots and submarine at shallow depth

STATUS:

Quantity production. The equipment is in service with the French Forces.

MANUFACTURERS:

CIT-ALCATEL, Division Marine, 33 rue Emeriau, 75725-Paris CEDEX 15, France.

Programme Direction – DTCN, 2 rue Royale 75 – Paris 8e.

1164.441
E15 ACOUSTIC TORPEDO

DESCRIPTION:

Conventionally-shaped, submarine-launched, anti-ship (or anti-submarine in certain circumstances), torpedo with strong body in light alloy and laminated nose cone, is a lengthened version of the E14 model 1 torpedo. It has the following five compartments:

(1) acoustic passive self-guidance and electro-magnetic firing;
(2) the explosive charge and inertial firing;
(3) accumulators;
(4) air tank and automatic pilot;
(5) electric motor for propulsion.

CHARACTERISTICS:

Length: 6,000 mm
Diameter: 550 mm
Weight: 1,350 kg
Speed: 25 knots
Range: 12,000 metres
Submersion: Can be set within the range 6 to 18 metres (continuously variable)
Guidance: Acoustic, passive, medium range
Explosive Charge: 300 kg
Firing: Contact (inertial) and influence (magnetic)
Target: Surface vessel from 0 to 20 knots and submarine at shallow depth

STATUS:

Quantity production. The equipment is in service with the French Forces.

MANUFACTURERS:

CIT-ALCATEL, Division Marine, 33 rue Emeriau, 75725-Paris CEDEX 15, France.

Programme Direction – DTCN, 2 rue Royale, 75-Paris 8e.

1165.441
L3 ACOUSTIC TORPEDO

DESCRIPTION:

Conventionally-shaped, ship-launched or submarine-launched, anti-submarine (to 300 m) torpedo with strong body in light alloy and laminated nose cone, with the following five compartments:

(1) acoustic active self-guidance and electro-magnetic firing;
(2) the explosive charge inertial contact firing system;
(3) accumulators;
(4) air tank and automatic pilot;
(5) electric motor for propulsion.

CHARACTERISTICS:

	21" version	550 version mod. 1
Length:	170" (4,318 mm)	4,300 mm
Diameter:	21" (533.4 mm)	550 mm
Weight:	900 kg	910 kg
Speed:	25 knots	25 knots
Range:	5,500 metres	5,500 metres
Max. submersion:	300 metres	300 metres
Explosive charge:	200 kg	200 kg

Guidance: Acoustic, active, range approx 600 metres with favourable inclination of the target submarine. Type AS3T

Firing: Contact (inertial) and proximity (acoustic)

Target: Submarine from 0 to 20 knots and up to 300 metres depth

STATUS:
Quantity production. The equipment is in service with the French Forces.
MANUFACTURERS:
CIT-ALCATEL, Division Marine, 33 rue Emeriau, 75725-Paris CEDEX 15, France.
Programme Direction – DTCN, 2 rue Royale, 75-Paris 8e.

2096.441
L4 AIRBORNE ACOUSTIC TORPEDO

This torpedo is designed to be launched from aircraft or from the ASW missile Malafon (**1179.241**). It is suitable for attacking submarines navigating under water at speeds below 20 knots.

DESCRIPTION:
Conventionally-shaped torpedo having a body made of removable sections of moulded magnesium alloy and comprising the following main compartments:

(1) head section containing the guidance system, the acoustic firing circuits and the warhead (which is contained in a removable canister) with its inertial percussive firing mechanism;
(2) centre section containing the battery and priming elements;
(3) tail section containing the air reservoir, the propulsion unit (electric motor driving two contra-rotating propellers through a reduction gear) and the steering mechanisms.

In addition there are the launching devices designed to insert the torpedo smoothly into the water. These comprise a parachute and release mechanism aft and an ejection cap forward.

OPERATION:
Once in the water the torpedo describes a circular path until its detection mechanisms locate the target; after which it changes course and homes on the target. On reaching its target the warhead is detonated either by the acoustic proximity mechanism or on impact.

CHARACTERISTICS:
Length: 3.13 m including parachute
Diameter: 533 mm
Weight: 540 kg
Speed: 30 knots
Guidance: Active acoustic homing
Target: Submerged submarine at up to 20 knots

STATUS:
In service with the French Navy.
SOURCE:
Direction Technique des Constructions Navales, 2 rue Royale, Paris-8e.

2128.441
L5 MULTI-PURPOSE TORPEDO

DESCRIPTION:
Most recent of the 'L' series of torpedoes the L5 is now operational in the French Navy.

There are two models of the torpedo, the lighter L5 Mod 1 (1,000 kg) being intended for use by surface vessels and the heavier L5 Mod 3 (1,300 kg) being for submarine launch. Both models are of 533 mm calibre and have a speed of 35 knots.

Both models are fitted with a Thomson-CSF active/passive homing head. This has four operating models – direct attack or programmed search with either of the two homing techniques.

MANUFACTURER:
Programme Direction – DTCN, 2 rue Royale, 75-Paris 8e.

2146.441
Z16 SUBMARINE-LAUNCHED TORPEDO

DESCRIPTION:
This is a large submarine-launched anti-ship torpedo. Its main operational features are a programmed sinuous course and remote depth control. The sinuous track makes it difficult for the target to take evasive action even if the torpedo approach is detected.

CHARACTERISTICS:
Length: 7.2 m
Diameter: 550 mm
Explosive charge: 300 kg
Firing: Magnetic proximity or contact

GERMANY (FEDERAL REPUBLIC)

2000.441
SST4 WIRE-GUIDED TORPEDO

DESCRIPTION:
This torpedo is believed to be known also as the Seal and is a 21-inch anti-shipping weapon developed in Germany during the 1960s to replace the older, unguided 21-inch torpedoes then in use.

First fitted (retrospectively) on the *Zobel*-class fast patrol boats (after trials on the earlier *Seeschwalbe*) and subsequently specified also for the Type 143 guided-missile gunboats, the SST-4 mountings are in each case a pair of launch tubes which fire their weapons nose-first over the stern.

Primarily designed to engage surface vessels, the torpedo can also be used against submarines close to the surface but has no deep-dive capability. Torpedo fire control on the type 143 gunboat is by the AGIS (Automatisierte Gefechts und Informations-system Schnellboote) tactical data system in conjunction with the HSA M27 system track-while-scan radar (see **1259.281** and **1590.253**). An important feature of this system when used in conjunction with the SST-4 torpedo is the use of the wire link between the torpedo and the launch vessel to relay data from the torpedo's sonar back to the tactical data system.

STATUS:
Operational in at least the West German navy.
MANUFACTURERS:
Believed to be the AEG Shipbuilding Division in Wedel and Krupp Atlas Elektronik GmbH in Bremen, West Germany.

2178.441
SEESCHLANGE (SEA SERPENT) TORPEDO

DESCRIPTION:
It is understood that two wire-guided torpedoes have been developed in recent years under the direction of the Bundesant für Wehrtechnik und Beschaffung. The two torpedoes were known as the Seal and the Sea Serpent, the former being for use against surface ships and the latter being a deep-diving weapon for use against submarines.

No details of performance are available; but both torpedoes are believed to have been of 21-inch (533 mm) calibre and it is believed that the "Seal" version is the torpedo also known as the SST-4 (**2000.441**).

STATUS:
The SST-4 is certainly operational and it is assumed, but not definitely known, that the Sea Serpent is also.
MANUFACTURERS:
It is understood that the development emerged from a co-operative programme between the AEG Shipbuilding Division in Wedel and Krupp Atlas Elektronik GmbH in Bremen, West Germany.

ITALY

2001.441
SUBMARINE-LAUNCHED TORPEDO TYPE G6e

DESCRIPTION:
This submarine-launched 21-inch (533 mm) torpedo is designed for use against surface vessels or snorkeling submarines.

Main features are acoustic homing and depth preset by NATO 'A' cable. Length is 6 metres.

STATUS:
Operational.
MANUFACTURER:
Whitehead – Moto Fides SpA, Via S. Orlando 10, 57100 Livorno.

2002.441
SUBMARINE-LAUNCHED TORPEDO TYPE G62ef ('Kangaroo')

DESCRIPTION:
This system comprises an unarmed 21-inch (533 mm) wire-guided transport torpedo containing a Mk 44 lightweight 12¾-inch (324 mm) torpedo. Its purpose is to enable the small torpedo to be launched from one submarine to attack another submarine.

The Mk 44 torpedo is built by Whitehead-Moto Fides in Italy under licence from the US Navy. It is believed to be identical in design to the American original (**2820.441**) and is an acoustic homing weapon which is normally launched from surface vessels or from the air.

The G62ef torpedo is 6.2 metres long and carries its 2.573 metre-long burden in what would otherwise be the warhead compartment. Depth is preset by NATO 'A' cable.

STATUS:
Operational.
MANUFACTURER:
Whitehead – Moto Fides SpA, Via S. Orlando 10, 57100 Livorno.

2003.441
SUBMARINE- OR SURFACE-LAUNCHED TORPEDO TYPE A.184

DESCRIPTION:
This new torpedo is currently in development and is presumably intended to replace the G6e weapon (**2001.441**). Wire-guided, it is a 21-inch (533 mm) weapon which can be launched from either submarine or surface vessels against either kind of vessel. It is equipped with an automatic acoustic homing system. Length is 6 metres – the same as the G6e.
STATUS:
Development.
MANUFACTURER:
Whitehead – Moto Fides SpA, Via S. Orlando 10, 57100 Livorno.

2004.441
SURFACE- OR AIR-LAUNCHED LIGHT-WEIGHT TORPEDO TYPE A.244
DESCRIPTION:
This is a small torpedo of the same diameter as, and only slightly longer than the American Mk 44 (**2820.441**) and it appears that it is intended to replace the Mk 44 (currently built in Italy under licence) in Italian service at least.
Not much information on its characteristics is available; but it is clearly a sophisticated anti-submarine weapon, incorporating acoustic homing and having shallow water capabilities, anti-reverberation and CCM characteristics. It is intended to be launched by surface vessels, helicopters, ASROC and aircraft – and presumably also by the G62ef torpedo or a successor (see **2002.441**). Length is 2.7 metres and diameter 12¾ inches (324 mm).
STATUS:
Development.
MANUFACTURER:
Whitehead – Moto Fides SpA, Via S. Orlando 10, 57100 Livorno.

SWEDEN

2323.441
TORPEDO TYPE 41

DESCRIPTION:
Torpedo Type 41 is a small active homing weapon designed to operate in shallow water or under other acoustically difficult conditions. Its homing sonar operates to give both azimuth and depth guidance and the torpedo can be used against both surface targets and submarines. Propulsion is electrical.
The torpedo is 2.5 metres long, has a diameter of 400 mm and weighs 250 kg. It can be launched from surface vessels or submarines.
Both impact and proximity fuses are fitted.
The torpedo is easily maintained and can be used in conjunction with simple fire control equipment. It is therefore suitable as armament for almost any kind of vessel – even fishing boats.
STATUS:
Type 41 was extensively tested before adoption by the Royal Swedish Navy with which it has been in service for several years. A further development programme is in hand: this is aimed at producing a torpedo with the same external dimensions but suitable for launching from helicopters as well as from surface vessels and submarines.
MANUFACTURER:
Förenade Fabriksverken, S-631 87 Eskilstuna 1, Sweden.

2367.441
TORPEDO TP 61

DESCRIPTION:
Torpedo Type 61 is a 21-inch (533 mm) wire-guided weapon carrying a 250 kg explosive charge. Designed for use against surface targets, it can be launched from either surface vessels or submarines and can readily be adapted to fit a variety of launch tubes.
Hydrogen peroxide is used as an oxidiser, and it is said that this gives a run about three times as long as that of a conventional torpedo travelling at the same speed.
Maintenance requirements are low: storage time without overhaul is 10 years with only routine checks each year, and the torpedo will remain operational in its tube for up to 4 months without overhaul.
STATUS:
The torpedo has been produced in large numbers for the Royal Swedish Navy and has been supplied to some NATO countries, including, it is believed, Denmark and Norway. Extensive firing trials have established its reliability in a variety of conditions.
MANUFACTURER:
Förenade Fabriksverken, S-631 87 Eskilstuna 1, Sweden.

THE UNITED KINGDOM

2552.441
TORPEDO MARK 8

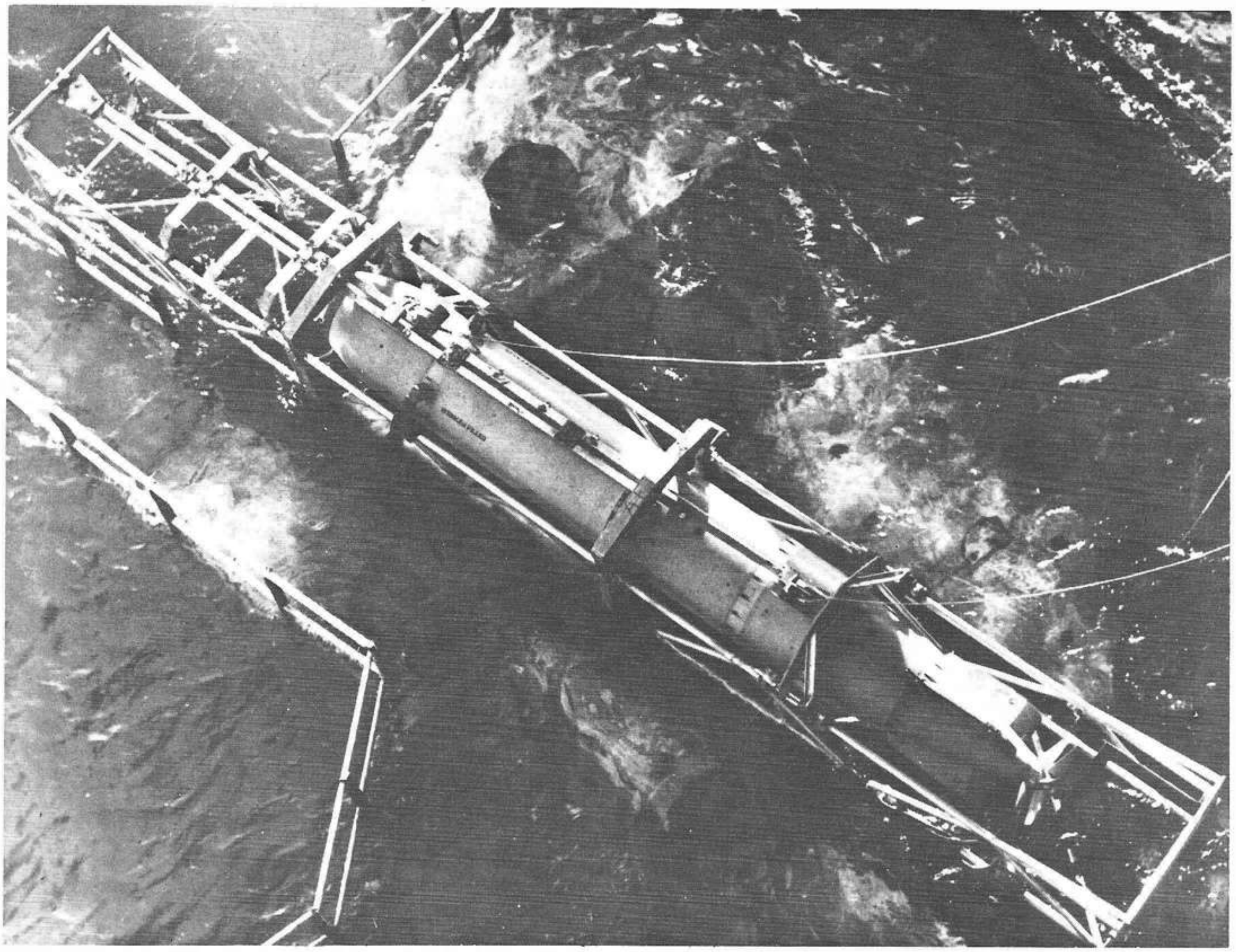
DESCRIPTION:
Quite possibly the longest-lived of all torpedo designs and certainly a remarkable survival in an otherwise reasonably sophisticated navy, the Mark 8 torpedo, which was designed in the early to mid-1930s, was certainly in service in the Royal Navy – including nuclear-powered submarines – until 1973, may possibly still be in service with some minor vessels and is almost certain to be found in some other navies.
Like the American Mark 14 (**2813.441**) the Mark 8 is a 21-inch (533 mm), compressed-air-driven, free-running weapon. Although it can scarcely be regarded as reasonable that so unsophisticated a device should continue to be the primary armament of the principal attack submarines of the Royal Navy; it should perhaps in justice be said that, within its limitations, it has performed well and given service which is honourable as well as long.
STATUS:
Obsolescent. Being replaced in RN service by the Tigerfish torpedo (**2440.441**).

2448.441
TORPEDO PROJECT 7511
DESCRIPTION:
This project covers the development of a new lightweight torpedo for use on surface ships or by helicopters or other aircraft.
The project is on the one hand a replacement for the Mark 31 project (**2473.441** 1971-72), which has been cancelled, and on the other hand aimed at providing a torpedo which the Royal Navy can use in place of the American Mark 46 (**2822.441**). The Mark 31 project, which was cancelled after about five years, was aimed at providing a replacement for the American Mark 44 (**2820.441**) which was the forerunner of the Mark 46.
STATUS:
Believed to be in study phase.
MANUFACTURER:
Marconi Space and Defence Systems Ltd, Marconi House, Chelmsford, Essex, England.

2471.441
TORPEDO MARK 20 (IMPROVED)
DESCRIPTION:
To meet the need for an inexpensive torpedo compatible with modern control systems Vickers has updated the Mk 20 torpedo.
The Mk 20 is a silent running, electrically-driven anti-submarine sonar homing torpedo of proven reliability. The improved version aims at providing a cost-effective alternative to existing torpedoes and in addition, when used in conjunction with the Oberon-class submarines, extends the submarine's attack capability, since fire control parameters can be updated to the moment of firing, even from the submarine's counter-measure tubes.
To bring the Mk 20 torpedo into line with modern submarine weapon control systems, light-weight synchro-mechanisms have been fitted which enable the depth and course angles to be set using a standard NATO 'A' link (umbilical cable).
Careful consideration was given throughout the modification to ensure that the total weight of the weapon and its dynamic characteristics remained unchanged: and calculations and tests have shown that the hydrodynamic and operational performances remain identical to those of the Admiralty standard torpedo.
CHARACTERISTICS:
Length: 4.11 m
Diameter: 21 in (533 mm)
Weight: Practice – approx 746 kg. Warshot – approx 821 kg
Buoyancy: Practice – approx 18 kg positive. Warshot – approx 61 kg negative
Range: Warshot – 11,000 m at 20 kt
Battery: Practice – Lead-acid. Warshot – Perchloric acid
Homing: Passive sonar (depth and azimuth)
Warhead: 91 kg. Torpex contact pistol
Function: Anti-submarine with limited anti-ship capability
Running Depth: 3-64 m
Max Homing Depth: 244 m
Turning Circle: 64 m diameter
STATUS:
In December 1970, successful trials were carried out on the improved torpedoes and final discharge trials from a submarine at sea were concluded during 1971.
Torpedoes are held in unmodified form by the

UK Ministry of Defence and are available only on a government-to-government basis.

MANUFACTURER:
Vickers Ltd, Barrow Shipbuilding Works, Barrow-in-Furness, England.



Improved Mark 20 torpedo loaded in launching cradle for test firing

2440.441
TORPEDO "TIGERFISH"

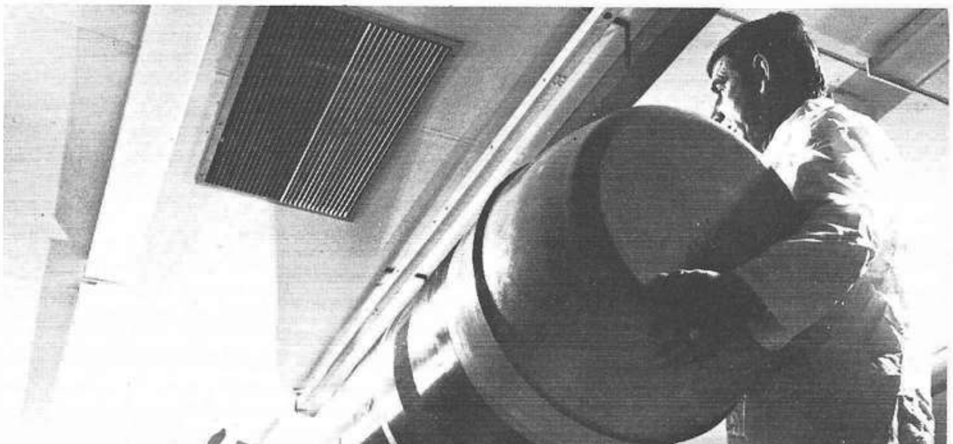
DESCRIPTION:

Tigerfish is the name given to the production weapon derived from a redevelopment of the Mk 24 torpedo (**2472.441** 1972-73). The weapon is a 21-inch wire-guided/acoustic homing torpedo fitted with impact and proximity fuses and is designed for submarine launch.

Wire guidance is used in the initial stages of an engagement up to the point where the torpedo's active/passive acoustic homing system can control the run in to the target. Wire is dispensed from both torpedo and submarine so as to avoid any wire stress due to their relative motion. The torpedo is roll-stabilised by controlling ailerons on retractable mid-body stub wings and is steered by hydraulically powered cruciform control surfaces mounted at the tail.

The torpedo carries its own computer which is connected through the guidance wires to the computer of the submarine's torpedo fire control system. During the wire guidance phase the on-board computer responds to the demands of the submarine computer; and on the homing run it interprets the data from the homing system sensors and calculates and commands the appropriate course, subject to a priority overriding steer-off azimuth control from the submarine.

During a homing run using the torpedo's active sonar the interrogation rate is progressively increased, as the torpedo nears the target, so as to improve system accuracy. The interrogation rate is controlled by the on-board computer – which is thus performing several functions during this phase: interrogation control, sonar data computation, torpedo steering control and data transmis-



Tigerfish torpedo

sion to the submarine to update its own computer memory.

CHARACTERISTICS:
Length: 6.464 m
Diameter: 21 inches (533 mm)
Weight: 1,550 kg (in air)
Speed: Dual high / low selectable at all times
Fuse: Impact and proximity
Propulsion: Electrically driven contra-rotating propellers

STATUS:
In production for the Royal Navy. Data given above relate to the warshot torpedo: there are also exercise and dummy (handling) versions. The exercise version is similar to the warshot but has rechargeable batteries, becomes buoyant at the end of the run and has an instrumentation pack for data analysis in place of the warhead.

Possibilities of system improvement are being studied.

MANUFACTURERS:
Marconi Space and Defence Systems Ltd, Marconi House, Chelmsford, Essex – main contractor.
Major sub-contractor – The Plessey Company Ltd, Ilford, Essex.

2491.441
DRILL & PRACTICE TORPEDO MW 30 (MARK 44)

DESCRIPTION:
The Anti-submarine Drill and Practice Torpedo MW 30 is designed to provide practice in the handling, loading, arming and release of Mark 44 torpedoes (**2820.441**).

The drill round has the same dimensions and centre of gravity as the warshot weapon and is fitted with the same external attachments and controls – such as the arming pin and seawater scoop and the umbilical socket – as the Mark 44. It will withstand an external pressure of 6.8 atmospheres and will withstand shock accelerations (with a maximum duration of 8 milliseconds) of 40 g aft 120 g forward and 50 g laterally; so that it can be used for practice launches from a variety of launchers. Shortly after entering the water it floats on the surface. For airborne launches there is provision for the recording of airborne presetter settings.

Operational life is designed to be a minimum of 150 launchings and the operational temperature range is −18° to +70°C. Storage temperature limits are −45° and +70°C and the round has a storage life of 15 months between inspections.

STATUS:
In service.

MANUFACTURER:
Plessey Marine, Uppark Drive, Ilford, Essex, England.

Plessey MW 30 drill and practice torpedo

THE UNITED STATES OF AMERICA

2813.441
TORPEDO MARK 14

DESCRIPTION:
Torpedo Mark 14 is a 21-inch (533 mm), submarine-launched, compressed-air-driven weapon which first went into service in the US Navy in 1935. It is 5.25 metres long and weighs 1,780 kg.

Some serious problems were encountered when the torpedo came to be used in earnest during the Second World War. The torpedo has both influence and contact fuses; and it was found that the former was so liable to premature detonation that it had to be disconnected before launch while the contact fuse was liable to failure. The depth-control gear was also unreliable and frequently caused the torpedo to run too deep.

An urgent programme corrected these faults, however, and the torpedo continues in service to this day with the US Navy and elsewhere.

STATUS:
Operational.

2814.441
TORPEDO MARK 16

DESCRIPTION:
Torpedo Mark 16 is a 21-inch (533 mm) torpedo designed as a successor to the Mark 14 but which in the event has been used in parallel with it throughout its period of service in the US Navy. It is 6.25 metres long, weighs 2,180 kg and carries a 400 kg explosive charge. Propulsion is by a fuel / hydrogen peroxide thermal engine.

STATUS:
The Mark 16 torpedo was withdrawn from US Navy service in 1973 but may still be in use elsewhere.

2815.441
TORPEDO MARK 18

DESCRIPTION:
Developed during the Second World War, the Mark 18 weapon was designed by Westinghouse using a captured German torpedo as a starting point. Propulsion was electric.

More than 8,500 of these torpedoes were built for use in the Second World War and the Korean conflict. The weapon is no longer in production but some survivors may still exist.

2831.441
TORPEDO MARK 27

DESCRIPTION:
Torpedo Mark 27 was an electrically-propelled, free-running weapon with passive sonar homing. Designed as a dual-purpose weapon it was used by the US Navy as a means of obtaining tactical experience in training exercises prior to the introduction of the Mark 37 Mod 0 torpedo (**2817.441**). Available data on Mk 27 relates to Mod 4.

Like its Mk 37 successor, the Mk 27 had a diameter of 19 inches (482.6 mm); its length was 3.23 metres. Although it was primarily used as a training device by the US Navy some production torpedoes were fitted with warheads and sold overseas.

STATUS:
No longer in US Navy service. Possibly still in service elsewhere.

2816.441
TORPEDO MARK 28

DESCRIPTION:
This weapon was developed by Westinghouse during the Second World War and more than 2,000 were produced. It is no longer in production.

Successor to a number of weapons of which only development quantities were built (notably the Marks 19, 21, 22 and 26) the Mark 28 was an all-electric 533 mm-calibre weapon, 6.25 metres long. It used passive acoustics and pattern running for terminal homing.

STATUS:
Not definitely known, but believed to be no longer in USN service.

2817.441
TORPEDO MARK 37 MODS 0 AND 3

DESCRIPTION:

Designed primarily as a submarine-launched anti-submarine torpedo, but suitable for deck launching by the Mark 23 and Mark 25 torpedo launchers, the Mark 37 torpedo is a 19-inch (482.6 mm) weapon that has been described as the first successful high-performance anti-submarine torpedo. The 19-inch diameter of all versions of this torpedo was chosen to enable the torpedo to swim out from a standard 21-inch launch tube – an arrangement with obvious operational advantages.

Of the four reported versions of this torpedo Mods 0 and 3 feature active and passive terminal homing. The weapon is an all-electric dual-speed device 3.52 metres long and weighing 648 kg (warshot) or 540 kg (practice).

Mod 3 is an updated version of Mod 0, the updating consisting of the incorporation of a large number of minor modifications.

DEVELOPMENT:

Developed by Westinghouse the Mark 37 Mod 0 torpedo first went into service in 1957. Mark 37 torpedoes have been produced in large quantities by the Naval Ordnance Plant, Forest Park, Illinois, and are still in widespread use in the US Fleet.

STATUS:

Operational, but replacement by the Mark 48 torpedo (**2823.441**) has now begun.

2818.441
TORPEDO MARK 37 MODS 1 AND 2

DESCRIPTION:

These versions of the Mark 37 torpedo differ from Mods 0 and 3 (**2817.441**) in their size and method of guidance; in other respects they are substantially similar.

Both versions are wire guided, whereas the Mark 37 Mods 0 and 3 are free-running torpedoes. Both are 4.09 metres long and weigh 766 kg (warshot) or 657 kg (practice).

Just as Mod 3 is an updated version of Mod 0 so is Mod 2 a version of Mod 1 updated by the incorporation of a number of minor modifications.

STATUS:

Operational.

2830.441
TORPEDO MARK 37 CONVERSION (TORPEDO 37C)

DESCRIPTION:

Torpedo 37C is available in two types which are conversions of the wire-guided Torpedo Mk 37 Mod 2 (**2818.441**) and the non-wire-guided Mk 37 Mod 3 (**2817.441**). In each case the modification is carried out using a conversion kit developed by Northrop Corporation to improve the speed, range and acoustic capability of the torpedo.

The conversion kit is designed for user installation and incorporates an Otto fuel engine which replaces the electric motor and batteries. This replacement propulsion system increases the torpedo's maximum speed by more than 40% and nearly doubles its range. These improvements, together with a substantial increase in acoustic capability bring the torpedo into line with weapons of more recent design at moderate cost.

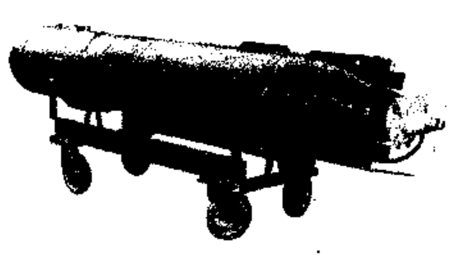
Whereas the Mark 37 torpedo was designed as an anti-submarine weapon, the 37C can be used also against surface vessels. The modification kit thus considerably extends the usefulness of the weapon; and it includes such operational improvements as re-attack logic, shallow water capability and the ability to attack slow or stationary targets.

STATUS:

In production and entering service in the Canadian Armed Forces and the Royal Netherlands Navy.

MANUFACTURER:

Northrop Corporation.



Northrop Torpedo 37c

2819.441
TORPEDO MARK 43

DESCRIPTION:

Two models of this torpedo have been produced, one (Mod 1) for launching from either fixed-wing aircraft or helicopters, the other (Mod 2) for launching from helicopters only. The latter is now regarded as obsolete.

Torpedo Mark 43 is a 10-inch (254 mm) weapon 2.35 metres long and weighing 120 kg. It is electrically propelled.

2820.441
TORPEDO MARK 44

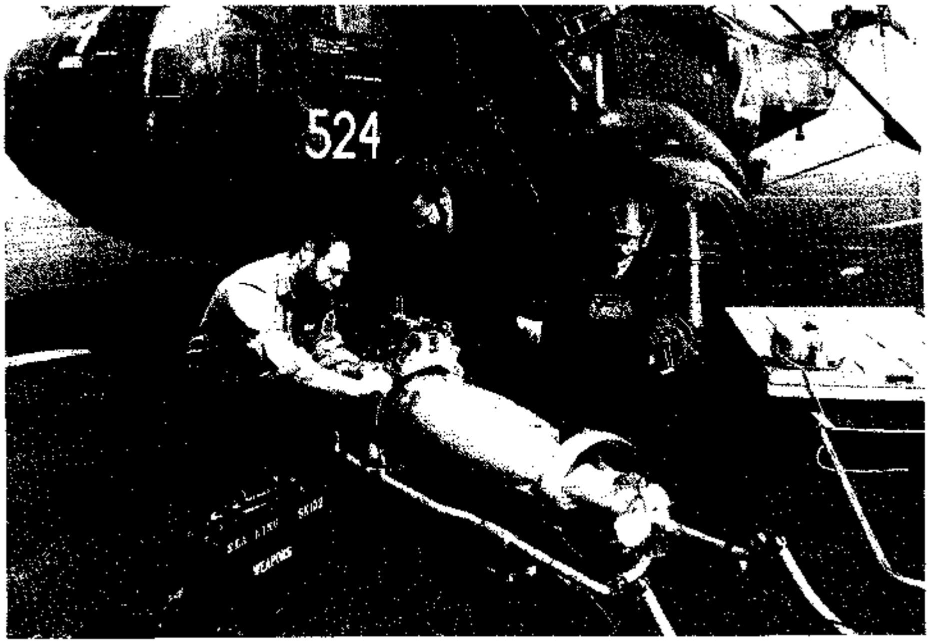
DESCRIPTION:

This is a lightweight torpedo designed for launching from aircraft or helicopters, from surface vessels (using Mk 32 tubes) or by the ASROC rocket system (**6001.241**).

Two models have so far been produced but the differences in dimensions are trivial. Both torpedoes are electrically propelled and their calibre is 12.75-inch (324 mm). Approximate length is 2.56 metres and the torpedoes weigh about 233 kg. Active acoustic homing is used. Depth and course settings are entered by umbilical cable. Arming is by seawater scoop.

STATUS:

Mark 46 (**2822.441**) is the replacement for the Mark 44 in USN service but the Mark 44 continues in service in other countries – notably the UK.



Mark 44 torpedo being prepared for loading on a Sea King helicopter

2821.441
TORPEDO MARK 45 (ASTOR)

DESCRIPTION:

This 19-inch (483 mm) anti-submarine torpedo (ASTOR stands for Anti-Submarine Torpedo Ordnance Rocket) is a high-speed long-range weapon and it is capable of carrying a nuclear warhead. It first went into service around 1960.

Intended for use by nuclear-powered or modernised diesel-electric submarines the Mark 45 torpedo is approximately 5.76 metres long and weighs about 1,310 kg. It has a high maximum speed and can submerge deeply without damage. Although designed primarily for use as a wire-guided ASW weapon it can also be used against surface targets. Maximum range is in excess of 16 km.

MANUFACTURER:

Westinghouse Systems and Technology Divisions, Baltimore, Maryland, USA.

2822.441
TORPEDO MARK 46

DESCRIPTION:

Torpedo Mark 46 is a lightweight, 324 mm calibre weapon designed, as a successor to the Mark 44 (**2820.441**), for use with several ASW systems. It can be launched from surface vessels, fixed-wing aircraft or helicopters and can be carried by the ASROC rocket (**6001.241**). Mk 32 tubes are used for surface launching.

The torpedo was the first of the weapons which emerged from the RETORC (Research Torpedo Configuration) programmes – specifically the RETORC I programme carried out by the US Naval Undersea Centre (NUC) Pasadena Laboratory with industrial assistance. USN handling of the transition from this research programme to industrial development has been criticised on the grounds that the transfer took place a year too soon – so that concept formulation and contact definition phases were skimped – and that an arbitrary reduction of a year in the planned industrial development programme was imposed on the contractor. The problems resulting from these actions were satisfactorily resolved in the end, however, and the Mk 46 torpedo is a current operational weapon in US Navy service.

The Mk 46 is a deep-diving, high-speed torpedo fitted with an active/passive acoustic homing system and intended for use against submarines. After water entry it searches for, acquires and attacks its target: if it misses the target it is capable of multiple re-attacks.

Two models of the Mk 46 have been produced. Mod 0 was the first US torpedo to be powered by a solid-fuel motor: it is 2.67 metres long and weighs about 258 kg. Mod 1 is slightly lighter and is powered by a liquid mono-propellant (Otto) motor.

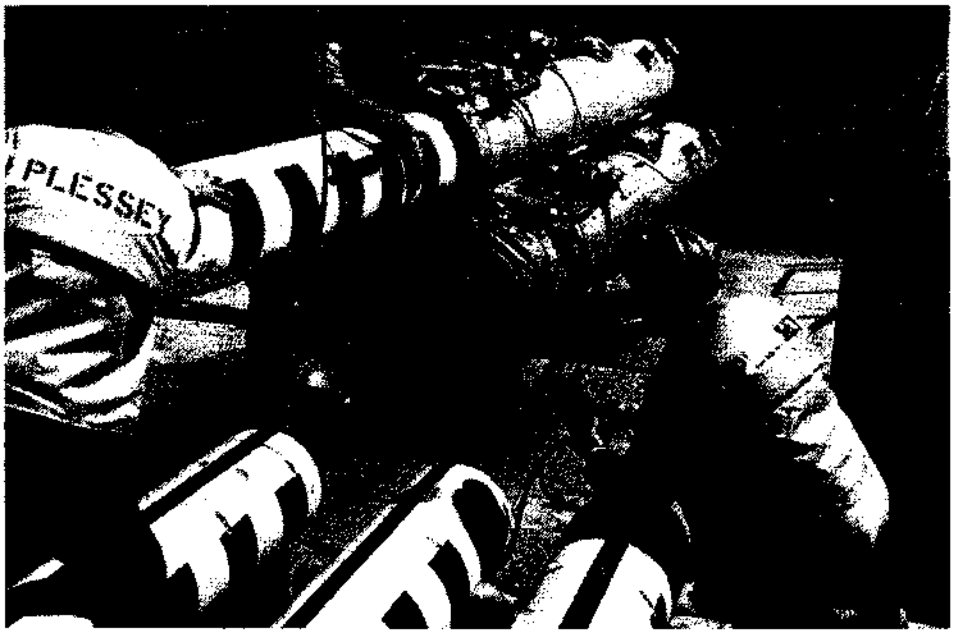
STATUS:

Operational. The first delivery to the US Navy was made on 28th October, 1965. Following the cancellation of the Mk 31 torpedo a quantity of Mk 46 torpedoes was purchased as an interim measure by the UK Ministry of Defence for Royal Navy use.

MANUFACTURERS:

Aerojet-General Corporation, Azusa, California, USA were responsible for the development and early production of both Mod 0 and Mod 1.

Honeywell Inc and Clevite Corporation have also been involved in manufacture.



Triple trainable Mk 32 torpedo launcher being loaded with Plessey MW 30 drill torpedoes

2541.441
CAPTOR – ENCAPSULATED TORPEDO

DESCRIPTION:

Captor – a contraction of "encapsulated torpedo" is the name given to an anti-submarine system comprising a Mark 46 torpedo (**2822.441**) inserted into a mine casing.

The mine/torpedo system can be laid in deep water and is suitable for air-dropping from, for example, B-52 bombers. It is understood that the operational plan involves sowing the mines in narrow seas – e.g. those between Greenland, Iceland and Great Britain – to attack and destroy enemy submarines as they attempt to pass through on their way to or from their operational stations. If desired, the torpedo could be fitted with a nuclear warhead.

It is understood that the system is equipped with means of discriminating between submarines and surface vessels: it may be surmised also that there is some technique whereby a friendly submarine (or other vessel) can inhibit the torpedo release mechanism.

STATUS:

Following an eight-year development programme costing some $100 million, Captor is now scheduled to enter service in mid-1975.

MANUFACTURER:

Goodyear Aerospace Corporation, 1210 Massillon Road, Akron, Ohio 44315, USA.

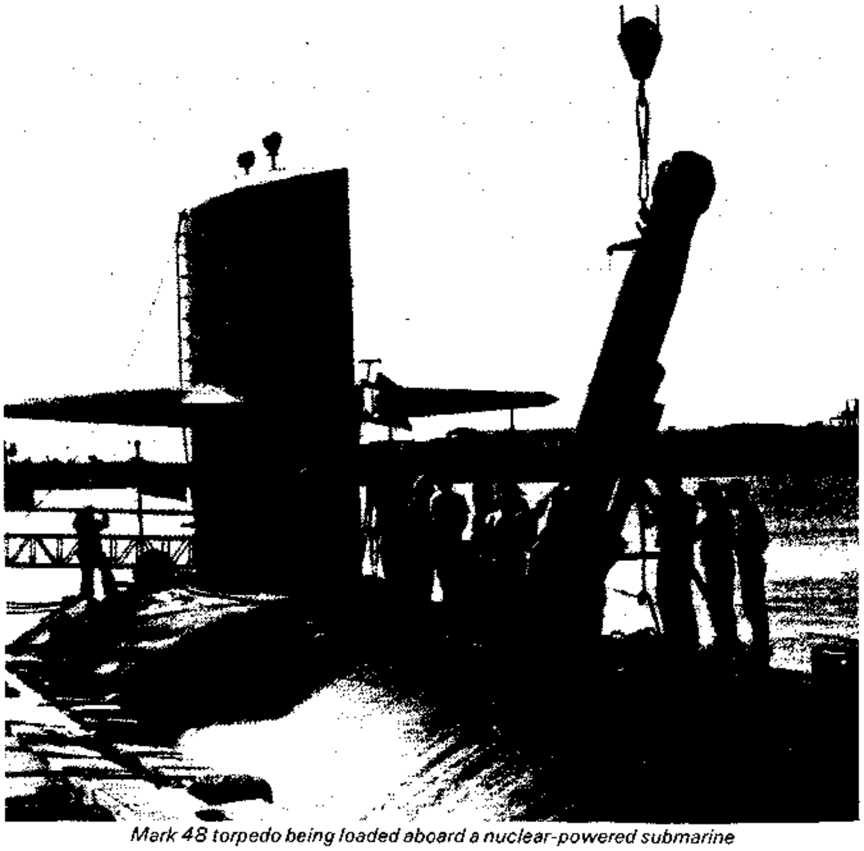
2823.441
TORPEDO MARK 48

DESCRIPTION:

Torpedo Mk 48 is a highly-sophisticated 21-inch (533 mm) submarine-launched anti-submarine and anti-ship weapon which has been described – possibly correctly – as the most complex torpedo ever designed.

Like the Mk 46 torpedo (**2822.441**) the Mk 48 is a result of the RETORC (Research Torpedo Configuration) programmes. RETORC II, the programme which resulted in the Mk 48, was carried out by the Applied Research Laboratory (formerly the Ordnance Research Laboratory), by Pennsylvania State University and by the Naval Underwater Systems Centre at Newport, R.I. This programme was initiated in November 1956; development characteristics were established by December 1960; and by May 1962 the development was put out to tender, the torpedo then being described as the EX-10. As a result of this competition it was decided to proceed with two significantly different competing designs, and contract definition contracts were awarded to Westinghouse Electric Corporation and Clevite Corporation (now Ocean Systems Division, Gould Inc). On the results of these contracts Westinghouse was awarded a contract to develop and produce prototypes of Mk 48 Mod 0 and a back-up programme for a different acoustic system was covered by a contract awarded to Clevite in 1964.

Mod 0 was an ASW-only system; but in 1967-68 it was decided that an anti-surface ship capability was needed as well. Contracts were accordingly awarded to Westinghouse for the



Mark 48 torpedo being loaded aboard a nuclear-powered submarine development of a Mod 2 version and to Clevite for the development of the Mk 48 Mod 1. Both developments were taken to the pilot production stage – pilot production being authorised in 1970 – and it was not until 1971 that a decision was taken to adopt the Mod 1 for service use. A production contract was awarded to Gould (ex-Clevite) on 2nd July, 1971.

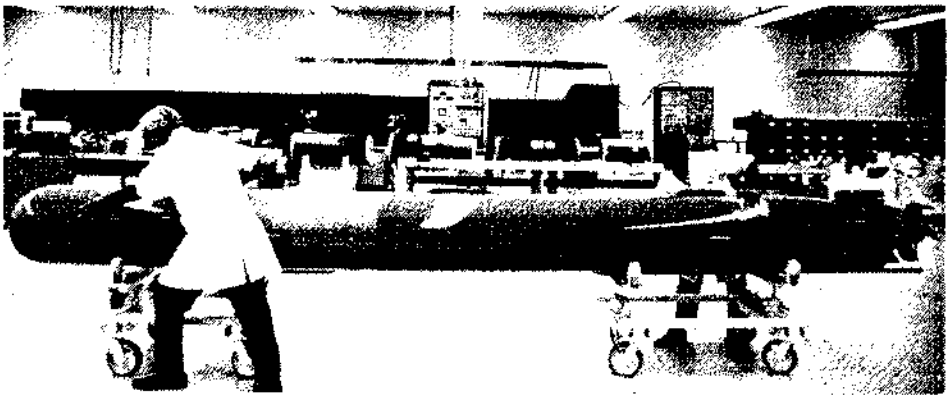
The chosen Mod 1 torpedo is a high-speed, long-range, deep-diving weapon which can be operated with or without wire command guidance and can use active and/or passive acoustic homing. Like the Mk 46 torpedo, after entering the water it executes a target search, acquisition and attack procedure and is capable of multiple re-attacks if it misses the target, but has the added facility of wire guidance if required. Propulsion is by means of a piston-type swash-plate engine powered by hot gas and driving a pump jet propulsor.

CHARACTERISTICS:
Length: 5.8 m
Diameter: 21 in (533 mm)
Weight: about 1,600 kg
Max speed: 93 km/h
Max range: 46 km
Max depth: 500 fathoms (914 m)
STATUS:
Operational in US Navy since early 1972. Will be primary armament on the new SSN-688 nuclear-powered hunter-killer submarines. Approximately 500 Mod 1 torpedoes were produced in FY 1974 and a similar quantity is planned for 1975. This is expected to satisfy the urgent needs of the USN. An attempt by the British Government to purchase a quantity of Mk 48 torpedoes in 1971/72, to tide the Royal Navy over the gap caused by the delay in the Mk 24 programme, was unsuccessful as all available torpedoes were required by the USN.
MANUFACTURER:
Gould Inc. Ocean Systems Division, Cleveland, Ohio, USA.

2618.441
FREEDOM TORPEDO
DESCRIPTION:
Developed by Westinghouse as a private venture, but with the benefit of their long experience in designing torpedoes for the US Navy and incorporating many components that are common to Navy torpedoes, the Freedom Torpedo is a full-size weapon with a large warhead which is intended for use against surface shipping.

Basically a 19-inch (483 mm) weapon it is used with 21-inch (533 mm) tubes, and it is suitable for either deck-launching or submarine launching. It is compatible with a wide range of fire control systems and can be launched from fast torpedo boats or destroyers. A contact detonator is used and arming is dependent on distance travelled; there is also an anti-circular run protection device. The torpedo is powered by a seawater battery.

Two models are available. Mod 0 is wire-guided with programmed terminal patterns. Mod 1 is wire-guided and fitted with a long-range homing system.


Freedom Torpedo

CHARACTERISTICS:
Length: 572 cm
Diameter: 48.3 cm. With runners for 21-inch tubes
Weight: Warshot, 1,237 kg. Exercise 950 kg
Speed (electric propulsion): 40 knots
Range: 10,900 m
Battery (seawater): 9-minute life
Launch:
Surface: Deck or rack
Submarine: Tube
Launch Modes: Impulse or swim out
Depth at Impact: Can be set between 2 and 15 metres
Explosive Charge: 295 kg minimum
Buoyancy: Warshot, Negative; Exercise, Positive
MANUFACTURER:
Westinghouse Defence and Electronic Systems Centre, Balitmore, Maryland, USA.

2793.441
NEW TORPEDO PROJECTS

DESCRIPTION:
According to American press reports the US Navy is in process of developing a new deep-diving torpedo known as DEXTOR – acronym for Deep Experimental Torpedo – and intended ultimately for use against deep submerging nuclear-powered submarines.

Another report states that a new lightweight torpedo is to be developed for introduction into US Navy service in the 1980s.

No details of either project have been received but the report concerning DEXTOR has stated that Honeywell will be the principal contractor for the programme.
STATUS:
Project.
MANUFACTURER
Believed to be Honeywell Inc.

THE UNION OF SOVIET SOCIALIST REPUBLICS

2995.441
533 mm TORPEDO
DESCRIPTION:
Certainly until recently, and possibly on a continuing basis, the standard calibre of torpedo in service in the Russian Navy has been 533 mm weapons. A torpedo of smaller calibre was in use on torpedo boats and escort vessels before the Second World War, but this is now to be found only on P-4-class patrol boats.

It may confidently be assumed that torpedo development in the USSR has generally proceeded along lines similar to those of developments in Britain, France and the USA and has probably taken the form of development from wartime German pattern-running and homing torpedoes.

It is, however, worth noting that somewhere around the late 1950s a version of this torpedo with a nuclear warhead was deployed in some submarines – probably the F and N classes. Although the nuclear torpedo is almost certainly a very much less significant weapon in Russian eyes now than it was then, there are probably several still in service.

Two distinct stages have been distinguished in the development of surface vessel launchers for torpedoes of this calibre; and the fact that the launchers are of slightly different lengths at these two stages may indicate that the corresponding torpedoes are also different – but it does not necessarily do so.

The dates of introduction of these two launcher groups appear to have been about 1948/49 and 1957/58. Apart from the difference in length just mentioned the principal change appears to be from manual local training to remote power training. 1-, 3- and 5-tube launchers are found in the earlier series; 2-, 3-, 4- and 5-tube launchers in the later.
STATUS:
All the above types of launcher seem still to be in service, as also, presumably are the torpedoes. 533 mm torpedoes are also a standard weapon on Russian submarines; but the use of 406 mm weapons (**2997.441**) has also been reported.

2996.441
AIRBORNE TORPEDO
A torpedo smaller than the standard 533 mm weapon is used by the Russian Naval Air Forces. It is thought possible that this is a development of the pre-war 18-inch calibre weapon, but no details are known.

2997.441
LIGHT TORPEDO
Of comparatively recent development a 406 mm torpedo is now in service with some submarine chasers and light destroyers of the Russian Navy. This is launched from trainable tubes that are only about 5 metres long, so the torpedo must be quite a small one. No other details are available but it should be noted that the use of this calibre of torpedo on submarines has also been reported

UNDERWATER WEAPONS

THE UNITED STATES OF AMERICA

1128.441
SUBROC (UUM-44A) ANTI SUBMARINE MISSILE

DESCRIPTION:

Submarine launched missile which follows a short underwater path before transferring to an air trajectory for the major portion of its journey to the target area. When this is reached, a nuclear depth bomb is separated from the remainder of the missile and then follows a ballistic trajectory to the point where it re-enters the water. The nuclear charge then sinks to a predetermined depth before detonation.

Principal characteristics of Subroc are:- length 625 cm, diameter 53.3 cm, weight 1,853 kg (approx), range 56 km (approx). Speed 'supersonic'. Solid-fuel motor.

OPERATION:

The UUM-44A missile forms part of an advanced anti-submarine system designed for deployment in nuclear-powered attack submarines operating against submerged vessels armed with strategic missiles. This system includes the AN/BQQ-2 Raytheon integrated sonar system and the Mk 113 Subroc fire control system produced by the Librascope division of Singer-General Precision Inc.

After detection and location of a target submarine, co-ordinate data is fed into the attack submarine weapon system which programs an optimum mission profile for the Subroc missile. It is assumed that this can be accomplished in virtually 'real-time'.

The Subroc missile is launched horizontally from a standard 21-inch (53.3 cm) torpedo tube, by conventional means. At a safe distance from the launch vessel (which need not be directed toward the target area for firing) the solid-fuel missile motor is ignited and the missile follows a short level path before being directed upward and clear of the water. Missile stability and steering is effected by four jet deflectors, which function in both the water- and air-borne sectors of the trajectory. Guidance is by means of an inertial system (SD-510) produced by Kearfott.

When free of the water, Subroc is accelerated to a supersonic speed and guided toward the target area. At a predetermined point separation of the nuclear depth bomb is initiated by explosive bolts and a thrust-reversal deceleration system which enables the warhead to continue to the re-entry point on a ballistic trajectory controlled by vanes on the depth bomb. The remainder of the missile falls free behind the bomb.

Impact with the water is cushioned to protect the arming and detonation devices. A pre-set depth sensor detonates the nuclear charge when the bomb is in the vicinity of the target.

Subroc missiles can be carried in torpedo tubes without attention for long periods, and launched with minimal preparation time.

DEVELOPMENT:

Development of the UUM-44 began in June 1958 at the US Naval Ordnance Laboratory, White Oak, Maryland, under the management direction of the Bureau of Naval Weapons, with Goodyear Aerospace Corporation as the prime contractor. Technical evaluation was completed in 1964, and production and operational deployment began in 1965.

STATUS:

Subroc is now operational on nuclear-powered attack submarines. Each ship carries four to six Subroc missiles. Production is expected to continue at least until 1978.

MANUFACTURERS:

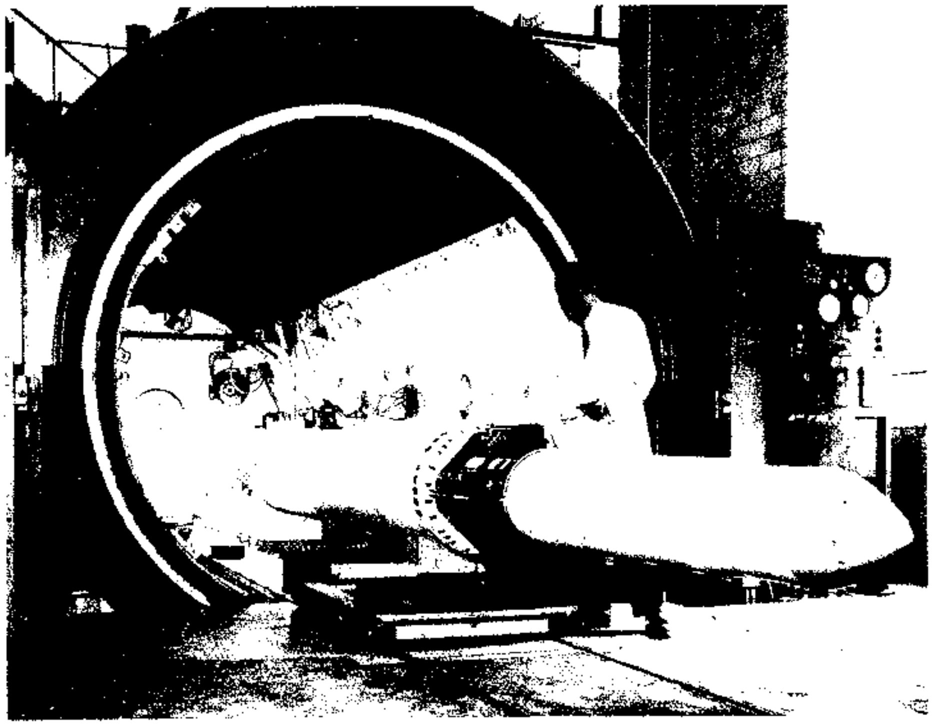
Goodyear Aerospace Corporation, 1210, Massillon Road, Akron, Ohio 44315, USA Prime contractor.

Singer-General Precision, Inc., Librascope Division, 808 Western Avenue, Glendale, California 91210, USA – Mk 113 fire control system.

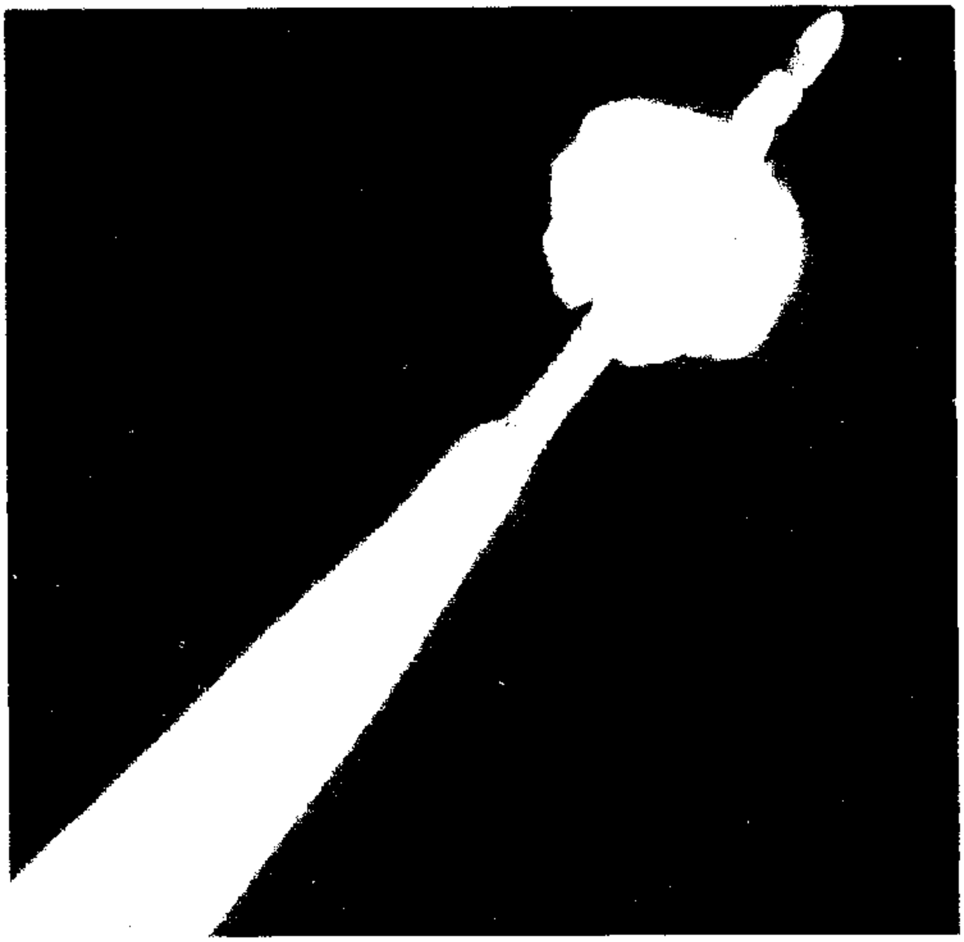
Singer-General Precision, Inc., Kearfott Division, 1150 McBride Avenue, Little Falls, New Jersey 07424, USA SD 510 inertial guidance system

Sandia Corporation, Livermore Radiation Labs, Livermore, California, USA – nuclear warhead.

Thiokol Chemical Corporation, Elkton Division, Elkton, Maryland, USA – solid-fuel motor.



Subroc missile at the US Naval Ordnance Laboratory at White Oak, Maryland. Missiles are given an underwater pressure test in this pressure chamber (Official US Navy photograph)



SUBROC launch sequence. Launched horizontally from a submarine's torpedo tube (1) the rocket travels a safe distance from the ship before the rocket motor ignites and thrusts the missile out of the water; (2) the weapon builds up to supersonic speed; (3) the rocket motor separates from the nuclear depth bomb; (4 and 5) as the guidance system takes over; (6) to direct the missile to its target

DRONES AND RPVs

AUSTRALIA

2017.391
JINDIVIK

The Jindivik continues to be a standard weapons target in Australia and the United Kingdom. Total value of orders, including associated equipment exceeds $47 million. Total value of export orders exceeds $25 million.

Optional equipment includes:

(1) An airbrake fitted under the rear fuselage, which may be used as a dive brake to reduce descent time from high altitude. Power to activate the airbrake is supplied from the aircraft pneumatic supply. The airbrake may be used to control speed when two Jindiviks are flown in close formation. For this purpose a separate pneumatic supply is provided.
(2) An in flight variable fin tab.
(3) Bolt-on extension wings: 40 inch (103 cm), or 80 inch (206 cm) for extra high altitude.
(4) Wing tip pods: Mk 8 for fuel and optical mis-distance measuring equipment and Mk 5 for MDI equipment only. These pods may be used in conjunction with the extension wings.
(5) Recoverable towed targets employing infra-red or active radar augmentation.

LEADING PARTICULARS:

Power plant: One Bristol Siddeley Viper Mk 201 turbojet engine
Systems: Non-regenerative pneumatic system using air stored in accumulator. Engine driven alternator, 9KVA, 208V, 3-phase 300-550 Hz. 24 VDC battery
Remote control: Aircraft controlled from ground or airborne station
Take-off: Aircraft mounted on trolley from which it lifts off, 305 metre run
Landing: On retractable skid. 457 metre run
Max Payload: 108 kg
Max Diving Speed: 630 kmh standard. 1,040 or 445 kmh for short or extended span
Max Cruising Speed: 910 kmh
Economic Cruising Speed: 250 kmh
Rate of Climb: 4,570 metres/min at S/L
Service ceiling: 18,900 metres standard. 16,760 or 20,100 metres for short or extended span
Range with allowances: 820 km standard. 1,320 km with Mk 7 pods

TONIC TOWED TARGET SYSTEMS:

Tonic is the official name given by the Department of Supply Weapons Research Establishment, to a high speed towed target system designed primarily for use in conjunction with the Jindivik Mk 3 drone, but may be used with other drone aircraft.

The operational capabilities of the system are based upon the philosophy of short tug/tow separations. This enables the tug aircraft to employ cine cameras to record miss-distance information whilst the displacement of the tug from the target is such as to keep it clear of the weapon's anticipated lethal area. The targets are carried on underwing pylons and supported by conventional bomb release units. The winch unit which controls the streaming and recovery of the

Jindivik target drone

target/s is normally mounted in the tug aircraft's fuselage. One or two targets may be streamed to pre-set tug-target separation distances and when commanded by the radio link recovered by the tug.

In the locked-out state the target/s may be towed at speeds up to 450 knots I.A.S. The target/s can be streamed or recovered in straight flight at speeds up to 250 knots I.A.S. The recovery sequence may also be carried out with the tug aircraft descending at a rate not exceeding 4,000 feet per minute. "Stream Port" or "Stream Starboard" radio command signals energise the appropriate release unit and the target separates from the tug aircraft in a nose down attitude, thus adding to its weight a negative lift to assist in pulling wire off the drum. This is opposed by a magnetic brake which increases its torque load as the target approaches its programmed separation distance where it is "locked out" by a plate clutch. On the command "Recover" both the plate clutch and the magnetic brake are de-energised. Simultaneously the winch motor is energised, and the towing wire is wound back on to the drum. In the event of a weapon strike or malfunction, an explosive wire cutter, sited near the winch unit, permits jettison of the towed target/s.

TONIC TARGETS:

The target is a centre of gravity tow and is available in two forms: infra-red augmented (six pyrotechnic flares); or active micro-wave augmentated. Both versions are of the same dimensions and aerodynamic configuration being cylindrical metal bodies of 16 cm diameter with a main plane of 51 cm span and cruciform tails. The overall body length is 122 cm.

Two WRETAR cameras are fitted to the tug aircraft wing pods. They operate together, controlled by the radio link from the ground.

For a tow wire length of 300 feet, the cameras are fitted with lenses of 1-inch focal length. The cameras are accurately aligned to each other and prisms mounted externally on the camera lenses direct the fields of view to contain the target. The field covers a circle of approximately 300-feet diameter at this distance. Timing signals are sent from the ground by radio for time correlation of the two cameras. With the above arrangement, all missiles intercepting the target will appear on at

Tonic Mk 5 radar augmented tow with early type nose-cone. The rotatable latch for offset towing can be seen on top of the body

least three cine frames from each camera. Three is a convenient number for computing the miss-distance, using a modified triangulation method of solution. The cameras can be stopped and restarted so as to record up to three interceptions in one sortie.

STATUS:

Jindivik orders received as at 31 December 1973 stand at 466. The number of Jindiviks delivered to that date number 423, details of orders/deliveries are as follows:

	Ordered	Delivered
United Kingdom	226	194
Joint UK/Australia Weapons Projects	163	163
United States Navy	42	42
Royal Swedish Air Force	10	10
Royal Australian Navy	25	15

Up to 1 January 1974, Jindiviks had flown 2,832 sorties at the RAE, Llanbedr, North Wales and one particular Mk 3A drone had flown 270 sorties at Woomera.

MANUFACTURER:

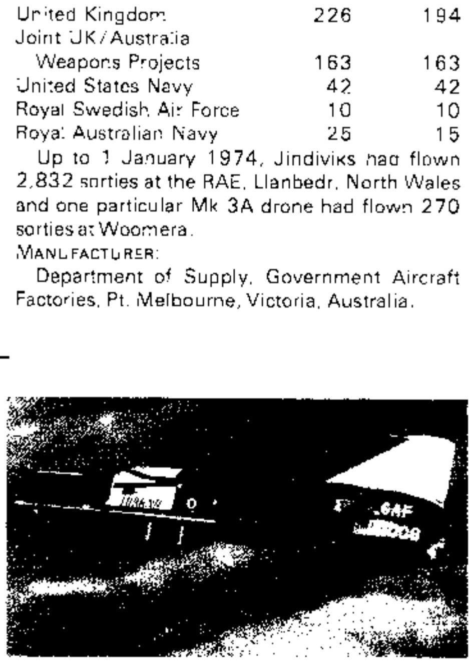
Department of Supply, Government Aircraft Factories, Pt. Melbourne, Victoria, Australia.

1523.391
TURANA

DESCRIPTION:

The Turana target drone system was conceived and is designed as an adaption of the Ikara anti-submarine weapon system (**6002.241**) used by the Royal Australian Navy and Royal Navy. Turana is designed for parachute recovery and all elements of equipment are suitable for at least 20 complete missions, including sea water immersion followed by simple refurbishing procedures.

The drone fuselage is a composite metal/glass-fibre structure containing a Microturbo Cougar - 022 engine, fuel tank, control system, power supply, and recovery system. The nose section can be ejected on command by means of a pyrotechnic charge, and it contains a 19 cm diameter Luneberg lens for forward looking passive radar augmentation, and a recovery parachute. A re-



Turana target drone in flight

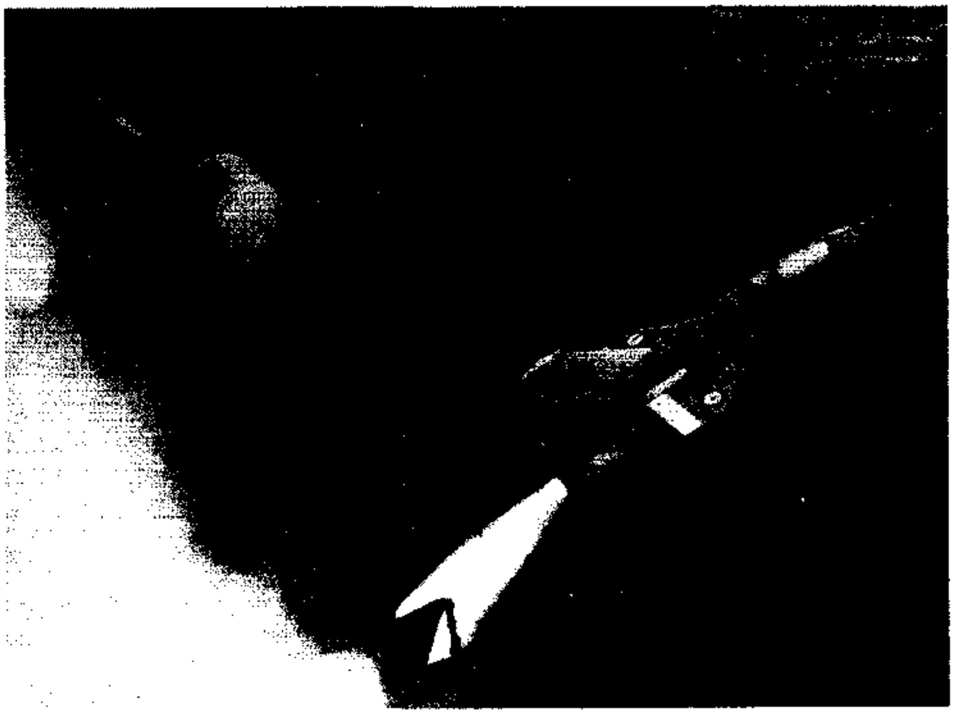
movable bottom fairing, between the nose and the air intake, provides access to a compartment for telemetry or special equipment. The telemetry unit is an Australian developed equipment providing up to 48 channels and operating at 465 MHz. Smoke emission on command is provided for visual augmentation of the target. Flotation is provided by a combination of sealed equipment compartments and integral light foam sections:

Principal dimensions are:

Length	3.37 m
Height	1.01 m
Height (with booster)	1.19 m
Wing span	1.53 m
Weight (less booster)	214.3 kg
Speed at end of boost	177 m/sec
Payload (level flight)	45.5 kg
Operating speeds	150 to 400 knots
Altitudes	15 to 9,144 m

OPERATION:

Turana may be launched from an Ikara ship launcher or from a simple portable unit on board ship or on land. In the former case, the missile handling equipment is used for the insertion of the drone into the launcher. The drone is controlled in flight by means of the target control unit which is connected to either the ship's Ikara Guidance System, or in the case of non-Ikara based operations, directly to a command transmitter. Return data facilities are available, though not essential. If used, flight information is presented to the operator on the target control unit. Navigation is presented by the controller using a plot or a PPI display which is driven by either the Ikara tracking system or any suitable radar. After recovery the target is washed down and given a short engine run. A replacement parachute pack and boost motor are fitted and after checkout the Turana is ready for immediate re-use.



Turana target drone being launched at sea from Ikara ASW missile launcher

DEVELOPMENT:

An Australian Government sponsored programme aimed at meeting a RAN target requirement was approved in mid-1969. Design was undertaken at the Government Aircraft Factories, Melbourne, with assistance from the Weapons Research Establishment, S.A., the Aeronautical Research Laboratories and the Defence Standards Laboratories in Victoria. First flight tests were held at Woomera in March 1971 and were followed by further flights at both Woomera and the RAN Jervis Bay Missile Range (JBMR).

STATUS:

Turana is entering RAN service in 1974 and deliveries against an RAN order have commenced.

MANUFACTURER:

Department of Supply, Government Aircraft Factories, Pt. Melbourne, Victoria, Australia.

BELGIUM

2020.351
EPERVIER

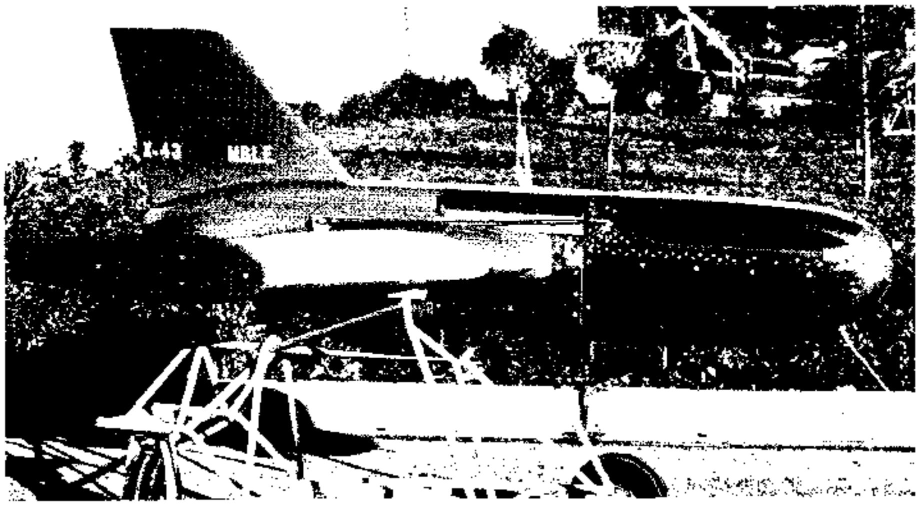
The Epervier is a battlefield surveillance system using a ramp launched remotely-controlled drone.

During a development programme extending over some five years several versions of the system have been created. The latest, the X-5, has a turbojet engine to power the drone, take-off being rocket-assisted, and this gives it a cruising speed which is adequate to satisfy the military requirement.

In designing the system to meet the evident need for positional accuracy in battlefield surveillance, while at the same time keeping its vulnerability to ECM within reasonable limits, the manufacturers have selected a compromise between direct radio control and pre-programmed flight. During the major portion of its airborne mission the drone is controlled either by its autopilot or by an airborne flight programmer; but flight orders or orders to start programmes, start or stop surveillance processes, stop engine and so forth can be given over a command radio link which also interrogates the drone to determine its position.

SPECIFICATION:

Type: Battlefield Surveillance Drone system
Cruising Speed: 500 kmh
Cruising Altitude: 2-3,000 m
Launch Weight: 139 kg
Launch Method: By mobile ramp
Payload: 20 kg
Powerplant: Turbojet, rocket assisted
Length: 2.15 m
Span: 1.70 m
Guidance: Airborne programmer plus digital command link and secondary radar position-finding
Accuracy: Maximum linear error 150 m at 50 km
Recovery: By parachute within radius of 150 m



The X-4 Epervier at Salto di Quirra

The digital command link comprises a ground-based controller and command transmitter and an airborne command receiver and decoder. During flight in a straight line the interval between commands may be very long; the drone meanwhile maintaining its heading and altitude by autopilot control.

The tracking system comprises an airborne transmitter, which responds to interrogations from the command transmitter when instructed to do so by the airborne decoder. The computer transforms the co-ordinates derived from the command/tracking system – which effectively operates as a secondary surveillance radar – into map co-ordinates and operates the pen recorder to plot the drone position. From then until the next interrogation and response it uses the knowledge of the drone's commanded heading, altitude and speed to predict its position, updating that prediction with each successive interrogation.

During programmed flight the drone can execute up to ten orders – such as turns, changes in altitude or starting and stopping cameras – during a flight of up to 80 km. While under programmed control the drone will respond to any order over the command link other than a position interrogation.

These arrangements give the Epervier a good deal of protection against ECM and its small size and relatively high cruising speed makes it a difficult target for anti-aircraft weapons.

STATUS:

The award of a contract for full production of the X-5, as the Belgian Army version will be known, by the Belgian Government was announced in June 1971.

MANUFACTURERS:

MBLE (Manufacture Belge de Lampes et de Matériel Electronique), 80 Rue des Deux-Gares, Brussels 7.

CANADA

2034.351
CANADAIR AN/USD-501 RECONNAISSANCE DRONE

DESCRIPTION:

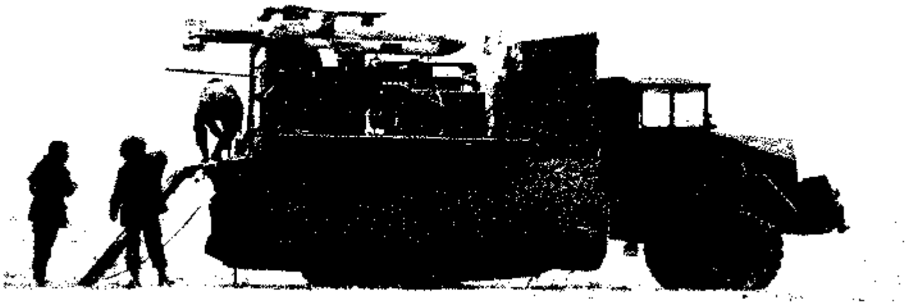
Short-range battlefield reconnaissance drone for day and night surveillance and artillery target acquisition purposes. Configuration of the vehicle is apparent from the illustration and its dimensions are, length 260 cm (plus 113 cm launch booster), diameter 33 cm and wing-span 94 cm. Straight and level speed is 400 knots (740 kph) and range is up to 120 km.

The reconnaissance sensor equipment is carried in a sensor pack located midway between the wings and the forward control fins. The sensor pack is capable of rapid removal and replacement and four versions are available – three photographic and one infra-red linescan. Camera options are KRb 8/24 Carl Zeiss camera, an Itek Corporation twin camera pack, and a Hycon panoramic camera. The IR Linescan is the Hawker Siddeley Dynamics Type 201, which see. The sensors currently in use are the KRb 8/24 and IR linescan.

The AN/USD-501 is powered by a Williams WR2-6 single-stage turbojet which also drives an alternator giving electrical power during flight. Launching from a vehicle-mounted ramp is assisted by a Bristol Aerojet Wagtail booster.

OPERATION:

After launch, the drone's subsequent flight path is pre-programmed and is maintained by DR navigation, aided by a propeller driven air-distance measuring unit, a directional gyro and a vertical gyro. Height is thought to be controlled by reference to a barometric sensor. Operation of the reconnaissance sensor equipment is also pre-programmed, the results are recorded on film for rapid processing after the return of the drone. To the rear of the sensor pack, and on the upper side of the fuselage is a flare pack containing 12 flares which are discharged under the control of a stepper switch. Normal operating height of the AN/USD-501 is between 300 and 1,200 metres.



Preparation for launch of AN-USD-501 drone

Recovery is assisted by an X-band homing receiver working in conjunction with a beacon located at the recovery site. The drone is also equipped with an X-band transponder and this is probably provided to assist radar tracking, both over the target area and during recovery. Shutdown of the motor initiates parachute deployment and the drone is inverted to come to rest on a pair of air-inflated landing bags carried in containers in the upper part of the fuselage.

DEVELOPMENT:

Development was initiated in 1959 by Canadair under the designation CL-89. In 1963 development contracts were awarded by Canada and the UK and the official designation of AN/USD-501 was allocated. In 1965 West Germany joined the programme, costs being shared equally between the three partners. Cost of development reported as £15 million.

An extended fuselage version with the Canadair designation CL-289 has been considered by the West German and other authorities. This would offer increased range/payload advantages.

Future developments which have been considered include a solid-state flight programmer with increased capacity; a real-time data link; alternative sensor system; simulated anti-ship cruise missile systems; and automation of mission planning and programming, and maintenance.

STATUS:

Production was started in 1967 and over 110 test flights were made in the course of evaluation trials. 90 of these took place at Yuma Proving Grounds, in Arizona, a US Army facility, and a further 20 flights were carried out by a three-nation proving team at Camp Shilo, Manitoba. These are reported to have been extremely successful. A total of nearly 300 drones had been ordered at June 1970 at a cost of approximately £28 million. Additional quantities have since been ordered by Britain and Germany, bringing total production to early 1973 to more than 400. Deliveries have been made to the armies of all three participating countries and in June 1971 it was evaluated by the Italian Ministry of Defence, and a production agreement was concluded between Canadair and Meteor SpA. The system is in service with the armies of Britain and Germany.

MANUFACTURER:

Canadair Ltd, Cartierville Airport, Montreal, Canada.

FRANCE

2123.351
NORD 510 FLYING PLATFORM

DESCRIPTION:

The Nord 510 Flying Platform has been designed by their Shrouded Propeller Vehicle Department as the modern all-weather counterpart of a captive observation balloon. It is the vehicle part of Project Orphée (Observation Radar Par Hélicoptère) which is described as having a potential surveillance range of several dozens of kilometres.

The captive platform can rise to a height of 300 metres above the lorry which carries it and the control gear. It is powered by a Turbomeca Astazou II turboprop engine driving a horizontal, shrouded four-blade propeller of diameter 1.8 metres. This produces an excess of lift over platform weight of some 500 kg but this is reduced by the cable weight.

STATUS:

At the 1974 Hanover Air Show the Dornier company revealed the information that a French Orphée radar was being considered as a payload option for the Kiebitz tethered reconnaissance platform (Entry **2183.351**), which suggests that SNIAS and the German concern may now have combined their respective efforts in this area into a single project.

MANUFACTURER:

Société Nationale Industrialle Aérospatiale, Division Engins Tactiques, 2 rue Béranger, 92320-Chatillon, France.

2127.351
NORD R 20

DESCRIPTION:

R 20 is a battlefield reconnaissance drone developed from the Nord-Aviation CT 20 target drone. Like the CT 20 it is ramp-launched with the aid of two solid-propellant booster rockets, after which it is powered by a Marboré II turbojet.

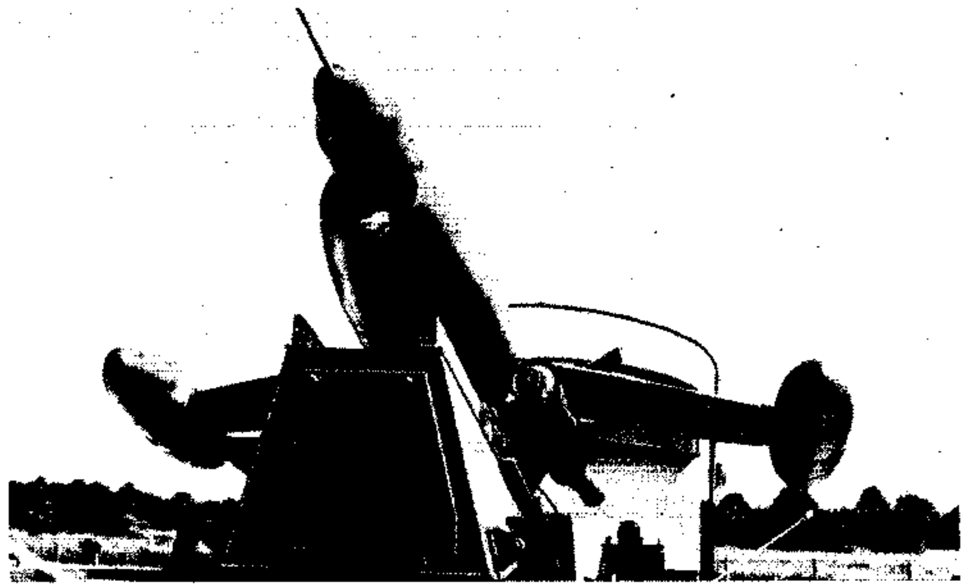
Standard NATO cameras and other surveillance equipment are carried by the drone, which can photograph more than 200 square kilometres of territory in a single sortie. Radio-controlled when near the launch vehicle, the drone is autopilot guided over the major part of its flight; and an over-target accuracy of 300 metres at 100 km range is claimed. An electronic programme is carried and this enables the R 20 to follow a reasonably complicated flight plan.

Operating speed is Mach 0.65 and operating radius at low altitude is 160 km.

In 1974 it was revealed that an improved version, designated R 21, was under study.

MANUFACTURER:

Société Nationale Industrielle Aérospatiale, Division Engins Tactiques, 2 rue Béranger, 92320-Chatillon, France.



R20 battlefield reconnaissance drone

2125.391
AEROSPATIALE CT 20

DESCRIPTION:

The CT 20 is a turbojet-powered radio-controlled target of medium performance, which can also be used as a tug for a towed target. It is standard equipment for training military units in the use of air-to-air and surface-to-air missiles – notably the Hawk; and over 1,200 have been sold to French, Italian, Swedish and other armed forces.

LEADING PARTICULARS:

Power Plant: One Turbomeca Marboré II, IV or VI turbojet engine

Remote Control: From ground or airborne station. Automatic descent in case of radio control failure

Take-off: From launching carriage powered by powder rockets on 10 metre ramp. 7.5 g acceleration

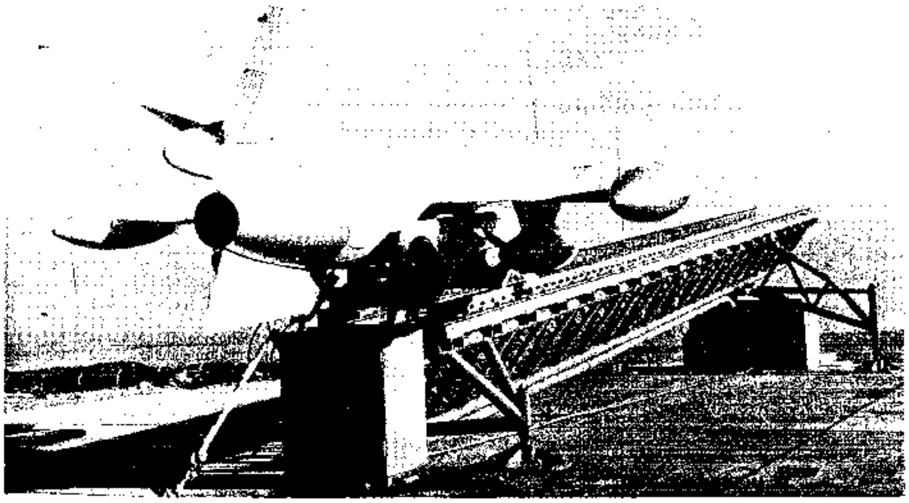
Max Speed: at 10,000 m 900 kmh with Marboré II or 950 kmh with Marboré VI

Rate of climb: Time to 10,000 metres, 6 min

Service Ceiling: 12,000 m or 15,000 m with Marboré II or VI

Endurance: Mean 60 min

Special Features: Low altitude flight can be programmed down to about 100 metres. A very low altitude version, the CT-20/TBA has been developed with height control by a TRT AVH-6 radio altimeter. This permits operating heights down to 30 m. This model also incorporates different control and telemetry sub-systems.



Nord CT20 drone on launcher. A Dornier System SK3L towed target is carried under the starboard wing

Drone can be used to tow an SK3L Dornier target with no more than 15% loss of performance.

The last-mentioned feature is important because of the difficulty of using piloted aircraft to tow targets for some modern weapons. It is the result of a joint development by Nord-Aviation and Dornier System GmbH.

MANUFACTURER:

Société Nationale Industrielle Aérospatiale, Division Engins Tactiques, 2 rue Béranger, 92320-Chatillon, France.

1808.391
HALBRAN TARGET-MISSILE

DESCRIPTION:

Low cost, ballistic trajectory target-missile intended for the training of military units using either small calibre ordnance, or short range surface-to-air missiles.

The Halbran target missile is available in two versions: (I) for light gun firing, 5 km range, (II) for surface-to-air missile firing, 13 km range.

The target-missile comprises

- the propulsion system, consisting of a solid propellant rocket motor and graphite nozzle, a tail unit, smoke generators, and the igniter, fastened on a diaphragm that seals off the motor;
- the target body, consisting of a laminated plastics cylinder, non-reflective to electromagnetic waves, and a nose cone.

Simple missile assembly can be performed directly on the launch pad. Launching is achieved from a readily operated launch ramp, adjustable in elevation and azimuth angle. The rocket motor delivers a single thrust level in version I, and two thrust levels in version II. The tail unit includes off-set fins which cause spinning of the target, for stabilisation.

MAIN CHARACTERISTICS:

	HALBRAN I	HALBRAN II
Range:	5 km	13 km
Maximum altitude:	1,200 m	3,500 m
Speed:	310 m/s	370 m/s
Radar reflecting surface	1 m^2 in bands L, S, X	
Length:	2.586 m	2.994 m
Diameter:	0.227 m	
Mass:	58 kg	80 kg
Lateral deviation:	15% of the range at three standard deviations	

Optional on board equipment:

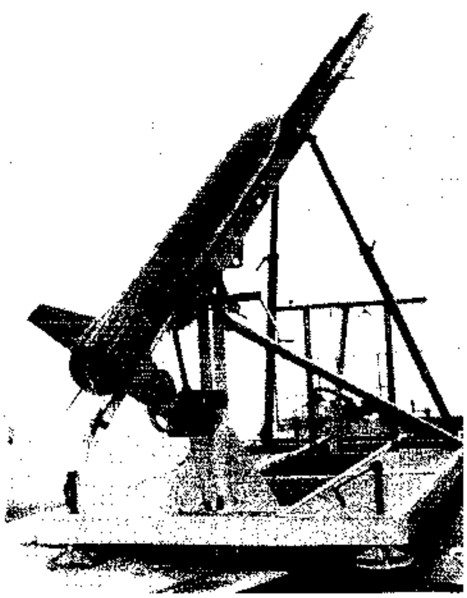
Smoke composition tracers

Radar reflectors: luneberg lens or "candle like" reflector

Acoustic scorer capable of generating a high intensity flash of light on passing of a supersonic projectile close to the target, or of being fitted with a transmitter enabling ground scoring of "direct hits".

DEVELOPMENT:

Halbran target-missile has been developed by Société Européenne de Propulsion under DRME contract (Direction des Recherches et Moyens d'Essais, Service des Equipements des Champs de Tir).



Halbran target-missile ready for launch

MANUFACTURER:

Société Européenne de Propulsion, 3 Avenue du Général de Gaulle, 92-Puteaux, France.

GERMANY (FEDERAL REPUBLIC)

2183.351
DORNIER EXPERIMENTAL KIEBITZ (PEEWIT) DO 32 K

The aircraft/helicopter division of Dornier GmbH has developed a mobile drone system, designated Do 34 Kiebitz, based on the Do 32 K experimental Kiebitz.

The experimental Kiebitz was developed, under contract from the Federal Ministry of Defence, to evaluate the feasibility of an automatically stabilised tethered rotor platform, capable of utilising sensors for reconnaissance, communications and ECM purposes at an altitude which considerably increases their effectiveness.

The rotor and transmission system, comprising a two-blade "cold jet" rotor, driven by compressed air from a KHD T 212 turbine and turbo compressor, were taken from the Do 32 single-seat helicopter, and the flight control system and the servo motors for rotor blade pitch control from the Do 32 drone helicopter. The complete system consists of a tethered rotating-wing platform (first demonstrated in flight in late 1970) and a mobile ground station such as a truck or tracked vehicle. Fuel for the turbine is fed through the tether by means of a pump installed in the ground station, making possible long periods of operation. The rotor turns at 340 rpm.

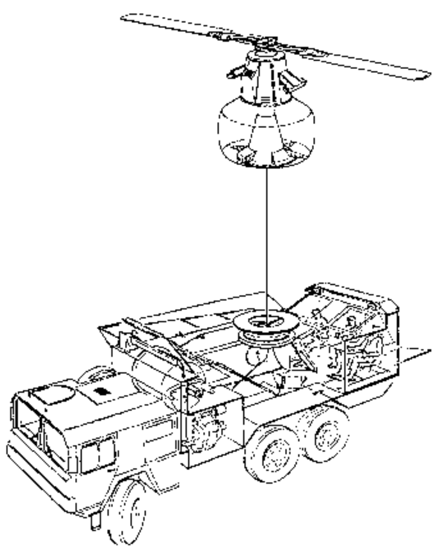
The platform contains a three-axis autostabiliser which works through the cyclic pitch control system and compressor exhaust control system. The ground vehicle serves as transporter, take off and landing ramp, and power supply station. An easy to operate winch permits the drone to be reeled in and out at a rate of 590 ft (180 m)/min. De icing and a high degree of weather resistance make operations almost independent of weather conditions.

The Kiebitz is intended for use as an emergency transmitter aerial in the long, medium and short wavebands; as a relay and directional station for TV, VHF and radio communications; for measurement of field strength for localising optimum transmitter positions, photographic survey and reconnaissance, meteorological measurements or radar reconnaissance to detect low-flying objects; and as a directional receiver. Power supply on board the vehicle is 200 W 28 V DC.

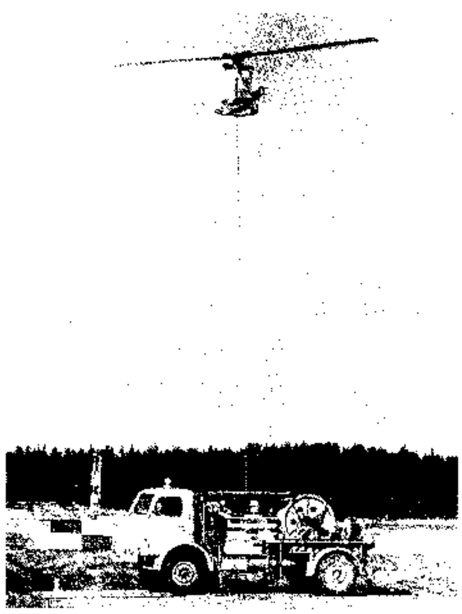
Five experimental rotating-wing vehicles were built, and these completed approximately 100 hours of successful test flying, including take offs and landings using a very short tethering cable and tethered flights to an altitude of 200 m. Following successful completion of the tests designed to perfect the flight control system, calculations were made to evaluate the detectability of the Kiebitz. In addition to measurement of the vehicle's infra-red radiation and radar profile, details were also obtained of the distances at which the rotor platform is discernible acoustically and optically. Also, so far as possible with the experimental vehicle's payload capacity, tests were performed with applications sensors. These included an RDF system, developed by Dornier, which used the Kiebitz rotor as an integral part of the D/F system by means of a blade-tip antenna; and a Grundig television camera, with oscillation-damping suspension and Dynalens lens-stabilisation, to determine the feasibility of such an installation for reconnaissance and surveillance purposes.

Dimensions, external:
Diameter of rotor: 7.50 m
Height overall: 1.60 m
Body diameter at bottom edge: 0.75 m
Weights:
Weight without tether and without payload: 200 kg
Max payload to 200 m, ISA: 50 kg
Performance:
Reel-in / Reel-out speed: 1.5 m/sec
Operational ceiling: 200 m

The experimental programme is still active, especially for payload and sensor investigations.



Arrangement of Do 34 Kiebitz



Do 32 Experimental Kiebitz

DORNIER DO 34 KIEBITZ

PLATFORM:

The rotor's twin blades are suspended on straps and driven by cold air expanded through the blade-tip nozzles. No torque which could act on the platform is produced with this drive principle.

The Kiebitz has undergone a further engine change, and air for the rotor blades is supplied by a radial compressor and an Allison 250-C20 shaft turbine. The turbine is installed on the slant, which makes for good positioning of the intake. The payload compartment is located on the underside of the airframe, this arrangement enabling sensors to be changed quickly and space for a large volume radome. A cone-shaped airframe has been selected to reduce radar reflection.

The complete system is vehicle housed, and consists of a landing platform, winch system, guidance and control post, flight vehicle and sensor, check-out system, fuel tank for 12 hours operation, and auxiliary equipment. After arrival on site, the drone can be in position at an operational height of 300 metres in eight minutes.

In the guidance and control system the determining factors here are the required wind speed of 14 m/s + 8 m/s, the available thrust reserves, and the requirements of the various sensors. These different factors led to a control system which aligns the Kitbitz according to airframe attitude and position in relation to the ground – a drift control system with the drift from the desired position being measured by an electromagnetic sensor. The flight vehicle's control and guidance system and the display and operating equipment in the ground station enable the Kiebitz to meet a wide variety of requirements as a sensor carrier.

SENSORS:

A tethered rotor platform is basically suited for the following land and sea missions:

(1) reconnaissance and surveillance
(2) electronic countermeasures
(3) fire control
(4) telecommunications and data-transmission

Within this wide spectrum of applications a number of specific sensors are under consideration and are being examined:

Battlefield Reconnaissance Radar: A bilateral agreement between Germany and France has been signed to define, integrate and test the battlefield reconnaissance system Argus (Entry **1809.351**) which consists of the Kiebitz rotor-platform and an advanced version of the LCT Orphée Radar.

Passive Electronic Warfare Equipment: Operational trials will be carried out with the Dornier experimental Kiebitz and the Decca RDL-2. The Decca RDL-2 consists of a high probability of interception display, automatic and visual pulse analysis, band and frequency measurement. Discussions are in hand with several armed services on the possible merits of this (passive) and active ECM equipment aboard the Kiebitz.

Naval Strike and Surveillance System – Sea-Kiebitz: The performance of current on board missile guidance or target detection equipment on ships is severely limited by the height of masthead aerials. The strike range of medium range missile systems is therefore limited. This can be avoided by the use of Sea-Kiebitz, a combination of the Kiebitz rotor platform and the Ferranti Sea Spray Radar (**1342.353**), as a missile guidance and surveillance aid for FPB's and ships. Experimental trials are being discussed at this time.

Low Flying Aircraft Detection Radar: Aircraft flying in the shadow of hills are detected too late by ground based low flying aircraft detection radars. The reaction time is too short to guarantee an effective defense. Due to its mission height of 300 m the Kiebitz equipped with a suitable radar extends the range considerably.

Data (Do 34):
Dimensions, external:
Diameter of rotor: 8.00 m
Height overall: 1.45 m
Body diameter of bottom edge: 1.05 m
Weights:
Weight without tether and without payload: 285 kg
Max. payload to 300 m, ISA: 140 kg
Performance:
Reel-in / Reel-out speed: 3 m/sec
Operational ceiling: 300 m

STATUS:

The definition phase was completed in October 1971 after which the design phase was commenced. Dornier has stated that a system will be available by 1975. The first flight will take place in autumn 1974.

MANUFACTURER:

Dornier GmbH, 799 Friedrichshafen, Bodensee, West Germany

1537.351
DORNIER AERODYNE E1

DESCRIPTION:

Development of the Aerodyne wingless high-speed VTOL drone was begun by Dr. A. Lippisch in the USA and is being continued by Dornier GmbH. The general appearance of the Aerodyne is shown in the accompanying photograph. The experimental Aerodyne E1, which was developed from 1968 to 1971 and successfully flight-tested in 1972, is about 18 ft 0 in (5.5 m) long and weighs approx 959 lb (435 kg). It is powered by a 370 shp MTU 6022 A3 turboshaft engine. Lift and propulsion are generated by a shrouded propeller, the slipstream from which is deflected downward by vanes for vertical take-off and landing. Control is by deflection of the turboshaft exhaust, which emerges at the end of the tailboom, and by a flap in the propeller slipstream.

Hydraulic actuators are used for the controls and are governed by the on board attitude control system. The Aerodyne is flown by a ground pilot via a radio link. It is equipped with a 58 channel telemetry system. Hovering flight tests have shown extremely smooth attitude stabilisation and very low ground-effect.

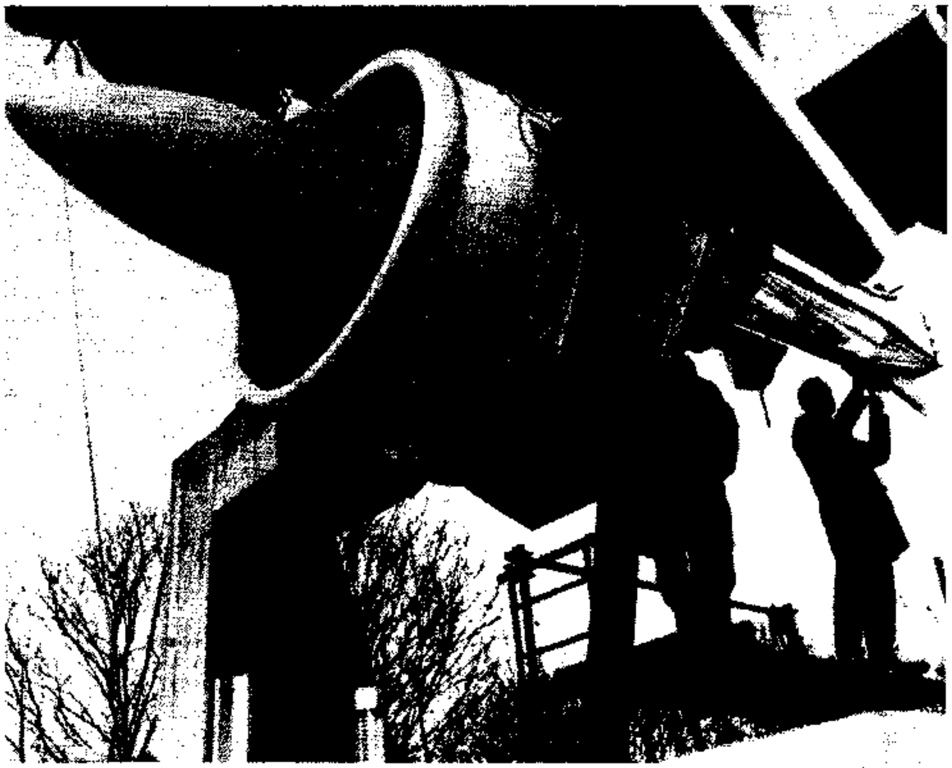
Features of the Aerodyne are simplicity, VTOL capability with low fuel consumption, high speed capability and easy handling. These features give exceptional usefulness for a broad variety of landbased and ship borne RPV-missions. Special interest exists for reconnaissance and fire control.

STATUS:

In parallel with the continuing experimental programme with the Aerodyne E1, mission analysis and parametric studies are being carried out

Dornier Aerodyne wingless high-speed VTOL drone to define operational Aerodyne versions for a variety of operational tasks. Dornier GmbH and Hawker Siddeley Dynamics have established co-operative arrangements in the field of Aerodyne systems.

MANUFACTURER:
Dornier GmbH, 799 Friedrichshafen, Bodensee, West Germany.


Dornier Aerodyne being prepared for flight test

1810.391
DORNIER AERIAL TARGET SYSTEM (DATS)

DESCRIPTION:
The Dornier aerial target system DATS can be adapted to a wide variety of aircraft and target drones. It consists of the airborne and the ground system. The airborne system incorporates an automatic tow reel with cable cutter, a launcher to carry the tow target during the towing vehicle's take off and the tow target. The tow target is a streamlined body with cruciform stabilising fins made of glass fibre reinforced plastic. For optical, radar and/or infra-red augmentation it will be equipped to meet specific requirements with twelve remote ignitable smoke cartridges, a radar reflector, and instead of the smoke cartridges, with four IR-flares. Mixed operation with six smoke cartridges and two IR-flares is also possible. Further an acoustic or electromagnetic miss distance indicator can be installed. After completion of a mission the tow target is recovered by parachute.

Using an aircraft as towing vehicle, tow reel, launcher and control sensors will be installed into a special pylon (target launch unit) which is mounted either directly to the aircraft's wing or locked to the standard armament pylon of the aircraft. The aircraft will be fitted out with two target launch units, one each under the left and right wing. Controlling of the two launch units is performed by one target control unit from the cockpit.

With a target drone as towing vehicle, the tow reel is mounted into the fuselage of the drone and the launcher under its wing. Target release is remotely controlled. The ground system incorporates a command unit for remote ignition of pyrotechnic augmentation aids in the tow target, the MDI ground station for monitoring and recording of the hit result, as well as several tests sets and tools. Two basic types of two targets equipped due to specific requirements are available: (1) the smaller DS-SK 4, mainly used with target drones, and (2) the larger DS-SK 5, used with manned aircraft. Main components of the two types are interchangeable. The ground system is for both types almost the same.


Dornier target system on T-33A aircraft

MANUFACTURER:
Dornier GmbH, 799 Friedrichshafen, Bodensee, West Germany.

INTERNATIONAL

1809.351
ARGUS SURVEILLANCE SYSTEM

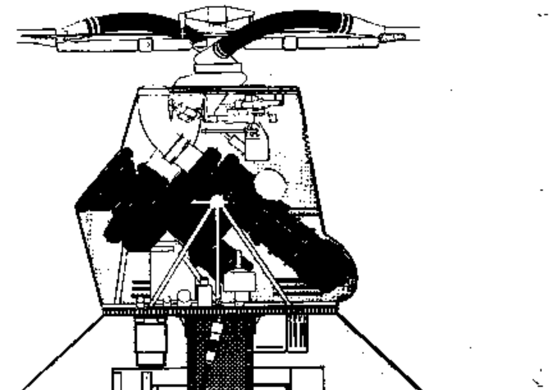
DESCRIPTION:
On March 6, 1974 the governments of the Federal Republic of Germany and the French Republic signed an agreement covering the joint production of a prototype of the Argus battlefield surveillance system. This system consists of a Kiebitz (Entry No. **2183.351**) tethered rotor platform from Dornier GmbH, of Friedrichshafen, and the Orphée radar sensor from LCT (Laboratoire Central de Télécommunications), of Vélizy-Villacoublay.

The prime contract for coordinating the integration of this system and its testing was awarded to Dornier. Cooperation between the authorities and industry is controlled by an Argus Steering Committee representing the German and French governments.

Kiebitz experimental units have so far flown more than 100 hours on 900 flights at altitudes up to 200 m. The continued development of the Kiebitz initiated by Dornier in August 1972 under a preliminary contract from the Federal Ministry of Defence forms the basis for the German share in the Argus system. The radar sensor installed on the Kiebitz rotor platform will be an advanced version of the Orphée radar developed and successfully tested by LCT in France over the past years under contract to the Délégation Ministérielle à l'Armement (Section d'Études et Fabrications des Télécommunications). A modernised version of Orphée (Observatoire Radar Porté par Hélicoptère) will be used. The original model was for installation in a Nord 510 helicopter but the project was allowed to lapse.

Apart from the tethered and remote-controlled Kiebitz rotor platform and the Orphée radar system, the complete Argus system consists of a mobile ground station and a tethering cable.

The ground station is housed in a container mounted on a 7-ton cross-country truck. The container is furnished with all the equipment required for transport purposes and for a twelve-hour operation of the system (e.g. a measuring system for exact determination of the Kiebitz position and instruments for the transmission and evaluation of the data supplied by the radar).


Argus system drone layout

If the radar sensor is raised to an altitude of at least 300 m above ground, the Argus system can be used to detect, identify and track vehicles over great distances. The Argus system thus makes a substantial contribution to surveillance of the battlefield in depth.

It is likely that the Decca Radar RDL-2 series of passive electronic warfare equipment, which was the subject of earlier collaboration between Dornier and Decca, could be one of a variety of payloads that could be lifted by Kiebitz for differing battlefield surveillance and reconnaissance roles.

MANUFACTURERS:

Dornier GmbH, Friedrichshafen, West Germany.

LCT – Laboratoire Central de Télécommunications, Velizy-Villacoublay, France.

ITALY

2236.391
METEOR DRONES

Meteor SpA has developed and produces for the Italian and foreign armed forces a range of propellor-driven and turbojet powered radio controlled drones covering a speed range between 600 km/h and Mach 2.8 at altitudes ranging from sea level to 25,000 m. The company also produces under licence the Northrop NVM-1, NVM-2, and USD-1 drones, and co-produces with Aérospatiale the CT-20 target drone, with Canadair the AN/USD-501 surveillance drone, and with Beech Aircraft Corporation, the BM-1 target missile system. The characteristics of some drones developed and produced entirely by Meteor are briefly noted below.

The Meteor P1 is a sub-sonic target drone used for training with directed anti-aircraft batteries of both medium and large calibre, and ground-to-air missiles. Speeds up to 500 kph are possible and the minimum radius of turn is 750 metres. Operating altitudes range from 500 to 9,000 m. Radar target augmentation can be provided by either passive (Luneberg lens) or active (transponder) means. MDI and flight data can be telemetered to a ground station.

The drone is powered by a 100 hp Meteor Alfa 1 four-cylinder, X-type two-stroke air cooled engine with compressor, driving a variable pitch propeller. Launching can be effected from ground or ship by means of a ramp and a re-usable Meteor 8785/LNZ solid-propellant booster providing a thrust of 2,300 kg.

Control is by radio command link, providing proportional commands in altitude and steering, and on-off commands for automatic altitude hold, wing controls, flares, automatic recovery, etc.

This version is in use by the Italian and South African Forces.

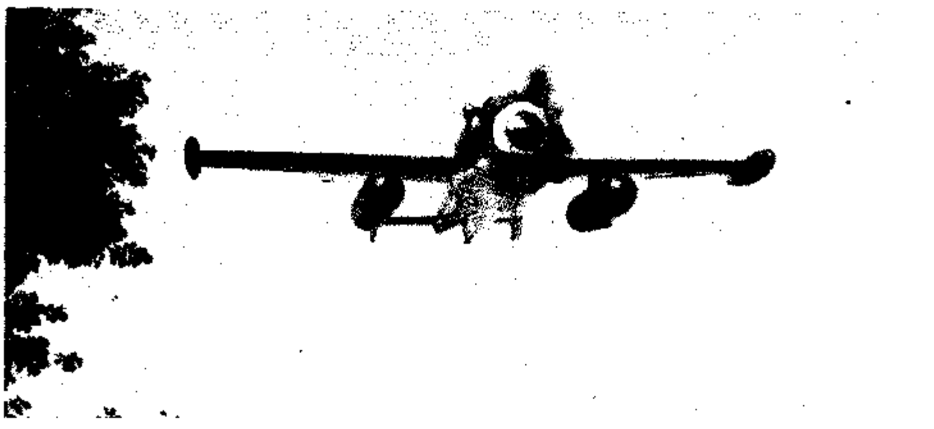
The Meteor P1/R is a reconnaissance version of the P1, with appropriate modification for this role. These include a zero-length ramp and the addition of a programmed guidance system. This system is used for part of a mission, normal radio command link being used for the despatch and recovery phases, the latter being by parachute. Tracking is by means of radar and a transponder carried by the drone.

Reconnaissance sensors include cameras and TV equipment. Sensors are carried in a pod which may be recovered separately.

The PX drone is available with either of two alternative power units, McCulloch 0.100.1 (70 hp) or 0.100.3 (90 hp). These two versions complement the Meteor P1, and having lower maximum speeds, corresponding to the lower power of their engines, and are appropriate to the use of lower performance guns and missiles than those for which the P1 was designed.

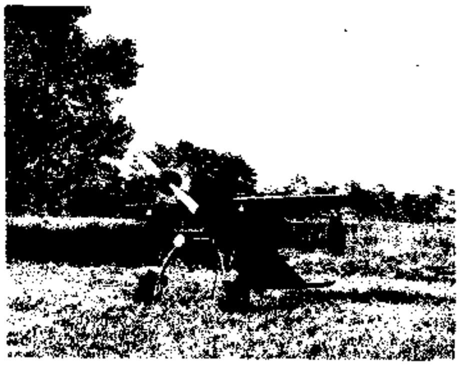
MANUFACTURER:

Meteor SpA, Costruzioni Aeronautiche ed Elettroniche, 146 Via Nomentana, 00162-Rome, Italy.



Meteor P1sR reconnaissance drone in flight

Launch of Meteor PX target at sea

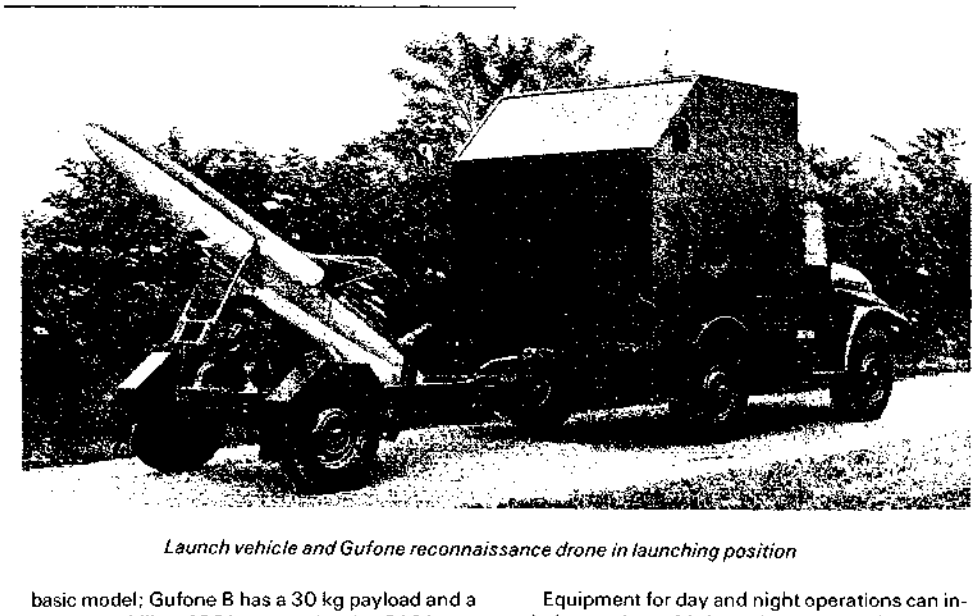


Meteor PI/R reconnaissance drone on mobile zero-length launcher

1345.391
GUFO TACTICAL RECONNAISSANCE SYSTEM

DESCRIPTION:

This system comprises the ground equipment and drones required for tactical reconnaissance by normal optical cameras or infra-red techniques over enemy territory. Based on considerable experience in drone and RPV development, Meteor has evolved the Gufo tactical reconnaissance system to meet anticipated requirements in the 1975-1985 period. The system is claimed to be particularly suitable for use in mountainous country. Payloads up to 30 kg can be carried at speeds of up to 740 km/h to target areas within a range of 200 km from the launch site. Recovery to within a radius of 100 m can be achieved. The Gufo system utilises the Gufone (Owl) drone, which is a modified Northrop Chukar (MQM-74A) target drone. Modified by Meteor to carry new guidance equipment and sensors, and equipped with inflatable bags to absorb landing shocks, the Gufone is employed in three versions. The standard Gufone has a payload capacity of 30 kg and a penetration capability of 55 km at sea level to 135 km at 10,000 m; Gufone A has double the payload capacity but otherwise is similar to the basic model; Gufone B has a 30 kg payload and a range capability of 90 km at sea level to 210 km at 10,000 m.



Launch vehicle and Gufone reconnaissance drone in launching position

Equipment for day and night operations can include a variety of infra-red sensors and cameras using 50, 70, or 75 mm film to photograph a strip of terrain more than 102 km long and, respectively, 1000 m, 2000 m, or 3000 m wide, from heights of 305 m, 610 m or 915 m.

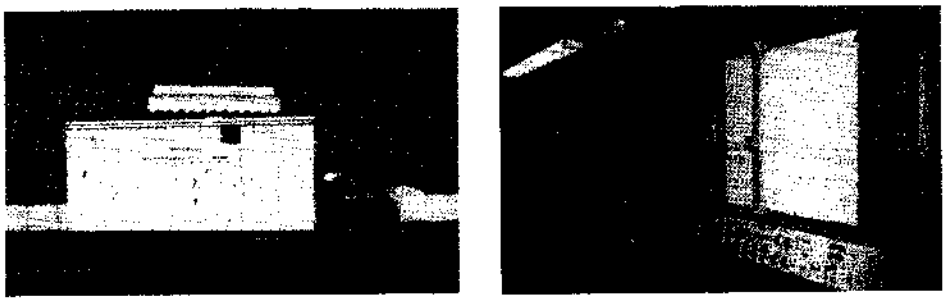
For night operations, the Gufone can carry 14 wingtip flares which are released at predetermined intervals. At take-off, the 55 kg st turbojet engine is supplemented by two Meteor 8785/CNS solid-propellant jettisonable boosters, providing a total thrust of 2,600 kg for 0.7 second.

A military unit deploying the Gufo system is comprised of four sections:

(1) Launch
(2) Guidance and Control
(3) Sensor Recovery, Interpretation and HQ
(4) Vehicle Recovery and Preparation

The launch section is equipped primarily with two launch trucks, each towing a launch trailer carrying one Gufone drone ready for flight, with each launcher supported by a Land Rover which is used to ferry empty launch trailers to the vehicle recovery and preparation area, returning with another flight-ready drone. The maximum launch rate from each launch truck is one drone per 10 minutes.

The guidance and control section is equipped with a medium-size truck on which is the Drone Control Centre. This contains a guidance station, tracking and plotting system, and computer. Since it can control only one drone at a time and the Gufone has an endurance of about one hour, the first-line equipment needed for continuous 24-hour surveillance comprises one DCC, two launch trucks, two launch trailers, and 24 drones. In addition, the sensor recovery, interpretation and HQ section normally will use a film processing and interpretation truck, one or more HQ vehicles, and if required, a 'receiver' truck for telemetered data, plus the necessary transport arrangements for sensors between recovery areas and processing vehicles.



External and internal views of Gufo system control vehicle.

DEVELOPMENT:

Design studies were commenced by Meteor SpA in 1969.

STATUS:

Flight trials have been carried out but no details of production contracts have yet been released.

MANUFACTURERS:

Meteor SpA, Via Nomentana 146, Roma, Italy.

Northrop Corporation, Ventura Division, Newbury Park, California, USA.

1884.391

CONDOR AND SUPER-CONDOR TARGET DRONES

DESCRIPTION:

The Condor and Super-Condor are inexpensive target vehicles based on the self-pressurised, prepackaged liquid propulsion rocket technique developed by SAI-Ambrosini. In this case, a two-stage rocket configuration is employed, the rocket only becoming live at launch, resulting in complete safety in transport, storage and handling. Condor is designed to have a shallow trajectory, and is able therefore to simulate the following: in the initial part of its trajectory, the aircraft pull-out after an attack; in the central part of trajectory, which is essentially level, a napalm delivery; and in the last part of flight, a rocket or cannon attack. Visibility of the rocket in the low-level simulation is good, but this is augmented by the steam trail of the sustainer. Launch is effected from a simple, light-weight ramp. Super-Condor is similar in most respects except for dimensions and higher performance, and is intended for the same type of training missions as Condor.

CHARACTERISTICS:

Body diameter: 108 mm
Overall length: 2,640 mm
Fin span: 442 mm
Take-off weight: 41 kg

	Condor I	**Condor IV**
Max range:	2,700 m	8,500 m
Max altitude:	490 m	2,200 m
Max flight time:	21.2 sec	45 sec
Average flight speed:	120m/sec	190m/sec
Take-off acceleration:	120m/sec^2	224m/sec^2

Super Condor

Body diameter: 280 mm
Overall length: 5,360 mm
Fin span: 780 mm
Take-off weight: 296 kg
Max range: 8,500 m
Max altitude: 1,800 m
Max flight time: 44 sec
Average flight speed: 186 m/sec
Take-off acceleration: 195 m/sec^2

Super-condor target rocket on launcher and ready to fire

MANUFACTURER:

Societa Aeronautica Italiana Ing. A Ambrosini & Co, Passignano sul Trasimeno, Rome, Italy.

Hunting Engineering Ltd – UK licencees.

THE UNITED KINGDOM

1660.351

SHORTS SKYSPY SURVEILLANCE DRONE

DESCRIPTION:

In concept Skyspy represents a new type of aerial vehicle designed from the outset as a drone, free from the restraints of manned flight. It derives its lift and propulsion forces by vectoring the gross thrust output of a low-pressure ducted fan, augmented by aerodynamic force components generated on the duct surfaces and intake lip. Skyspy is remotely controlled, is powered by an efficient piston engine, with a low IR signature, and has a small radar echoing area. It provides a stable platform for its airborne sensors and systems at all airspeeds from hover through to maximum speed in the conventional forward flight mode. When fitted with its payload of sensors the vehicle is intended to detect, position or track targets in real time and relay this information, using secure data links, to a ground or ship-based controller. Many other applications are envisaged for Skyspy including the capability of providing a command link for over-the-horizon weapon control systems.

Whilst being of simple, compact design the following features are inherent in Skyspy:

Stabilised aerial platform
Quiet noise levels
Very small visual silhouette
Faint radar echo
Vectored ducted-fan thrust
VTOL and hover performance
Conventional forward flight
Low susceptibility to gusts
Weak IR signature
Modular construction
Low damage risk
Transportable by land, sea or air
Low cost power unit

The vehicle consists primarily of a centrebody carrying the engine, fuel, control and stabilisation actuators, low-pressure fan, and an axi-symmetric duct connected to the centrebody by an engine mounting spider and by stators. Aerofoil surfaces for pitch, roll/yaw and rotational stabilisation and control are set across the duct exit and integrate, in part, with low aspect ratio wings located on the exterior of the duct. The centrebody comprises the major part of the vehicle weight; the duct being a simple, light but rigid structure. An equipment (payload) pod is located on the forward duct support structure and the autopilot and power supply equipment are at the rear, in the wall of the duct. The resulting vehicle is structurally and mechanically simple and relatively inexpensive.

A very wide variety of applications for Skyspy are envisaged as indicated below. The all-up weight, payload, equipment standard and ground facilities provided are directly related to the operational role requirements.

Model of Short's Skyspy ducted fan surveillance drone

Army reconnaissance
Naval over-the-horizon viewing
Weapon control and delivery
Target spotting
Coastguard surveillance
Border patrol and police duties
Fishery protection
Search and rescue operations
Forest fire spotting

Emergency relief and medical support service

Skyspy can be engineered in a variety of sizes with little extra development required, and using suitable available power plants. Typical characteristics quoted are a payload of 30 kg carried by a 1.2 metre diameter vehicle, powered by an 80 hp engine, and a mission duration of up to two hours. Studies are in progress for the use of turbine engines in Skyspy vehicles for roles which demand larger and more sophisticated payloads and improved performance.

MANUFACTURER:
Short Brothers & Harland Ltd, PO Box 241, Airport Road, Belfast BT3 9DZ, Northern Ireland.

1811.391
AEL FALCON DRONE

DESCRIPTION:

The Falcon low-cost, reusable short-range aerial reconnaissance system based on the Falcon unmanned miniature aircraft is the product of three years of continuous development based on an original idea from the Royal Military College of Science, which recognised the merit of a versatile, simple, rugged and very low-cost miniature aircraft.

Falcon forms the nucleus of a range of training and operational systems and is itself one of a series of similar aircraft, each having characteristics that match particular applications.

The Falcon reconnaissance system (FRS) uses a radio-triggered automatic 35 mm camera, which provides up to 20 high-definition photographs from altitudes up to 900 m and operating at ranges out to 3 km from the controller. Target location is achieved by photo/map comparison and Falcon can be positioned for photography at maximum range in as little as 4 minutes from the decision being taken.

At regimental level, FRS is used to check camouflage effectiveness and to reconnoitre deployment areas.

Due to Falcon's small size, high speed and inherent structural ruggedness, it is not vulnerable to small arms fire and its very low radar and infrared signatures prevent detection by more sophisticated systems.

The effectiveness of low-level air defence systems such as Rapier, Blowpipe and light anti-aircraft guns, is critically dependent on the operator's skill, both in acquiring and in tracking the target aircraft. Realistic training is essential, ideally with high-speed aircraft practising ground attack runs. Falcon approaches this ideal since it accurately simulates such aircraft in appearance and crossing rates, yet at negligible operating cost. It can be operated from within a unit's area with a mission response time of under 4 minutes, thus giving regiments their own 'air support'. Falcon is equipped with X and S band radar enhancement devices and can thus alarm related surveillance radars enabling the complete engagement sequence to be practised.

Falcon can tow a 3 m drogue target (a standard accessory) on a 150 m line for live firing practice.

The standard FRS kit allows the Falcon to be used for offensive action. Up to six 1 kg napalm or anti-personnel bomblets can be carried and can be released individually or simultaneously by radio command.

Launching and retrieval can be made as with an orthodox aircraft from flat ground, or where this is not possible, a catapult launcher and catching net are available as standard accessories. The Falcon has a measure of auto stabilisation; the required flying skills can be gained by a trainee with average aptitude in a five-day course of instruction.

CHARACTERISTICS:
Configuration: Delta
Span: 2.55 m
Length: 0.65 m
Weight: 9.1 kg
Engine: 4 bhp, 45 cc
Fuel capacity: 80 cc
Flight duration: 16 minutes
Radio guidance system: Hand-held 3 W transmitter with output fed into a quarter-wave horizontal dipole on a 3 m alloy mast of 25 mm diameter
Operating range (with optical system): 3 km
Speed: 224 km/h (120 knots)
Landing speed: 37 km/h (20 knots)
Payload: 5.4 kg
Maximum controlled altitude: 915 m at 3½ km

STATUS:
The Falcon system has been supplied to the Libyan Armed Forces.

MANUFACTURER:
Aero Electronics (AEL) Ltd, Gatwick House, Horley, Surrey, RH6 9SU, England.

1885.391
PETREL TARGET

DESCRIPTION:

The Petrel is a non-recoverable supersonic ballistic target developed from the well-known and extensively used Petrel research rocket. It is designed to simulate a missile threat and is used for defence weapon system development and evaluation, and for crew training. A variety of passive radar augmentation systems are provided, depending upon the nature of the trials being carried out. A benefit arising from the development of this target from a research rocket is that the low dispersion which was demanded of the research Petrel means that, although unguided, Petrel may be used for target applications where the permissible range areas are restricted.

CHARACTERISTICS:
Length: 3.35 m
Diameter: 19 cm
Main Motor: Lapwing
Boost Motor: 3 × Chicks
Range: Variable with launch angle – 22,500 m at 30° app
Altitude: Variable with launch angle – 1,200 m at 30° app. 160 km at 86° app
Speed: Variable with launch angle – near Mach 3 at low angles, can be reduced with drag devices
Time of flight: Approx 30 seconds at low launch angles

DEVELOPMENT:
Developed as a research rocket, but now additionally used for target applications. The Bristol Aerojet Skua research rocket also is available for use as a supersonic ballistic target.

MANUFACTURER:
Bristol Aerojet Limited, Banwell, Weston-Super-Mare, Somerset, England BS24 8PD.

THE UNITED STATES OF AMERICA

1812.391
LAST – LOW-ALTITUDE SUPERSONIC TARGET (XBQM-8)

DESCRIPTION:

LAST (Low-Altitude Supersonic Target) is a conversion of the RIM-8D and RIM-8F Talos naval missile (**1030.231**) designed to act as a low cost target to provide threat simulations against the US Army SAM-D (**2800.131**) and US Navy Aegis (**2507.231**) air defence weapon systems. Modifications to the normal Talos round include the provision of a new tracking beacon, a radar altimeter and an on-board command receiver. There is additional payload capacity for such options as miss-distance indicator equipment, cameras, chaff or flare dispensers, and ECM jammers. The basic configuration and dimensions are as for the Talos anti-aircraft missile, described in an earlier entry (**1030.231**) in this volume.

DEVELOPMENT:

Work was started on the development contract in June 1972 and the last flight test in June 1974 was scheduled to complete the development programme. Of the eight targets covered by the contract, five were flown at the White Sands Missile Range and two at the Pacific Missile Range. All major test objectives were met, including a demonstration of cruise capability at less than 250 ft (76 m) for 20 nm (37 km).

The second flight model of the Talos missile-based LAST – Low Altitude Supersonic Target – vehicle photographed during trials at the US Army White Sands Missile Range

MANUFACTURER:
The Bendix Corporation, Aerospace Systems Division, 400 South Beiger Street, Mishawaka, Indiana 46544, USA.

1101.391
QUAIL (ADM-20C) DECOY MISSILE

DESCRIPTION:

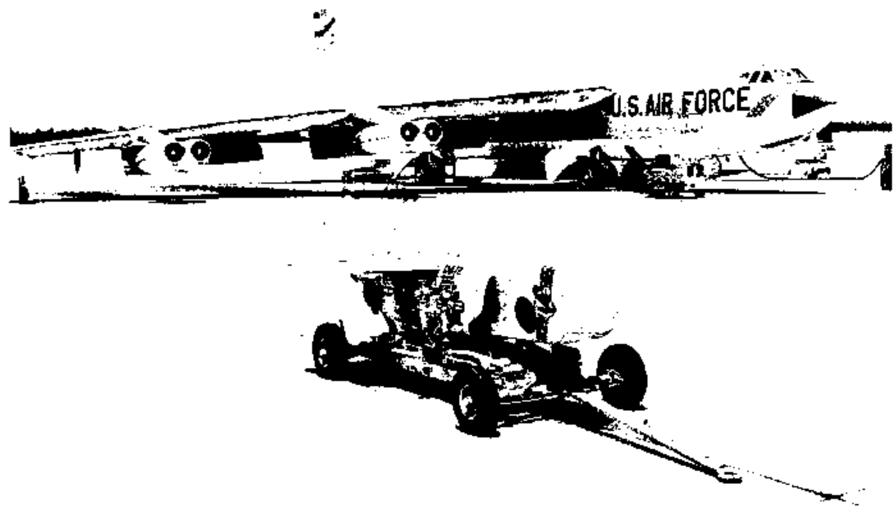
Formerly designated GAM-72, the Quail is a missile drone designed to afford USAF Strategic Air Command B-52 aircraft with defence against opposing forces by acting as a decoy. It is carried on special racks in the B-52 bomb bay, and after release it produces a radar signature similar to that of a B-52. By confusing enemy radar it assists penetration by the bombers themselves. Principal characteristics are: – length 304 cm, width (wings folded) 76 cm, height 103 cm, wing span 168 cm, weight 499 kg, speed over 960 khp, range over 400 km. It is powered by a general Electric J 85 turbojet motor, and guidance is by a gyro autopilot. The payload can include ECM equipment and a self-destruct explosive charge.

STATUS:

The ADM-2C is operational with USAF Strategic Air Command B-52 units. Production ceased in February 1961 and the last delivery was in May 1962.

MANUFACTURERS:

McDonnell Douglas Corporation, St. Louis, Missouri 63166, USA.



ADM-2C Quail decoy missile on loading trolley

1220.391
SCAD DECOY MISSILE (AGM-86A)

DESCRIPTION:

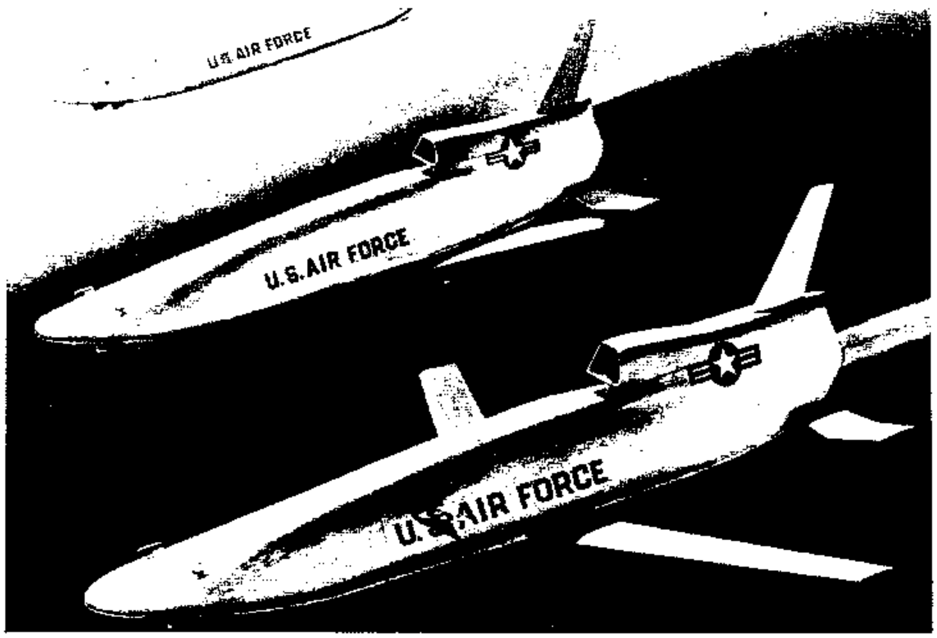
SCAD (Sub-Sonic Cruise Armed Decoy) was originated as a successor to Quail for B-52 aircraft and as a combined decoy/weapon for the B-1 strategic bomber. After several years of development, the American DoD decided in 1973 to halt further work on this project and to transfer the effort to the more recent ALCM (Air-Launched Cruise Missile) project (**1766.311**). The latter weapon is planned to have a number of common features with the US Navy's new SLCM (Submarine-Launched Cruise Missile) (**1759.411** and **1758.311**), among them being the air-breathing turbo-jet power unit. The USAF is expected to employ as much as possible of the technology developed for the SCAD programme in the ALCM.

Details of SCAD appear in the last edition of Jane's Weapon Systems.

STATUS:

SCAD advanced development was approved by the Deputy Secretary of Defense in July 1970, and in September of that year the Cornell Aeronautical Laboratory was awarded a $4.34 million contract for electronic warfare payload and credibility analysis studies.

Principal SCAD contractors named in 1972 were Boeing for the airframe, Litton for guidance and Philco-Ford for the decoy electronics. The project was cancelled by the DoD in 1973.



AGM-86A Subsonic Cruise Armed Decoy is shown with variable wing sweep and retracting canard control surfaces in this artist's impression

2521.391
BEECH CARDINAL (MQM-39A, MQM-61A)

DESCRIPTION:

The Beech Cardinal is a target drone used for ground-to-air and air-to-air missile system testing and crew training. Originally developed for the US Navy it has for several years been in use in many other countries. More than 2,000 have been built since production started in 1959.

LEADING PARTICULARS:

Power Plant: One McCulloch 125 C.V. engine driving a two blade propeller
Guidance: Radio command
Take-off: Rocket assisted by two JATO bottles for zero-length launches
Recovery: Parachute
Max level speed: 550 kmh
Service ceiling: 13,000 metres
Endurance: Over 1 hour at 7,600 metres
Special Features: Equipment can be carried to give radar returns appropriate to much larger aircraft and infra-red sources can also be carried.

Modified version can be used to tow a target. Strike panels can be fitted, with infra-red sources, to minimise damage from direct hits by homing missiles.

Smoke generators and/or navigation lights can be fitted for visual location

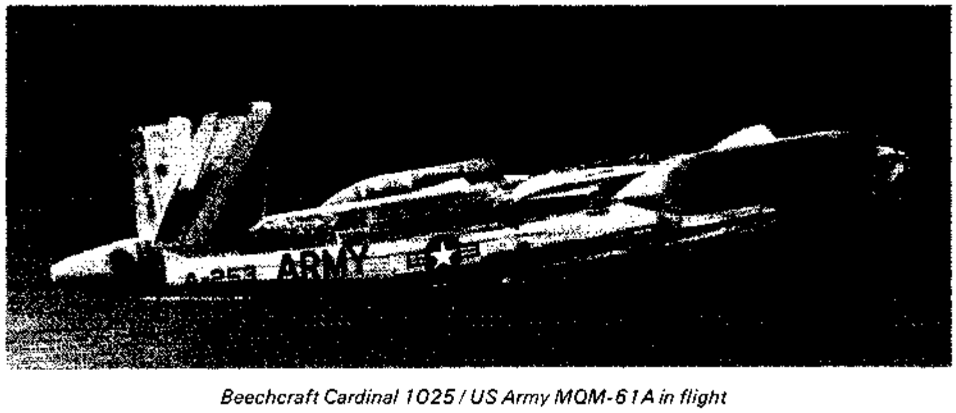
Babcock miss-distance indicator can be fitted.

STATUS:

The MQM-61A has been in use since 1958, and since then has been adopted by the US Navy and Army, and the Swiss, Spanish and German Armies. By 1974, 2,300 had been ordered and delivered.

MANUFACTURER:

Beech Aircraft Corporation, Wichita, Kansas 67201, USA.



Beechcraft Cardinal 1025 / US Army MQM-61A in flight

2522.391
BEECH MODEL 1019 (AQM-37A)

DESCRIPTION:

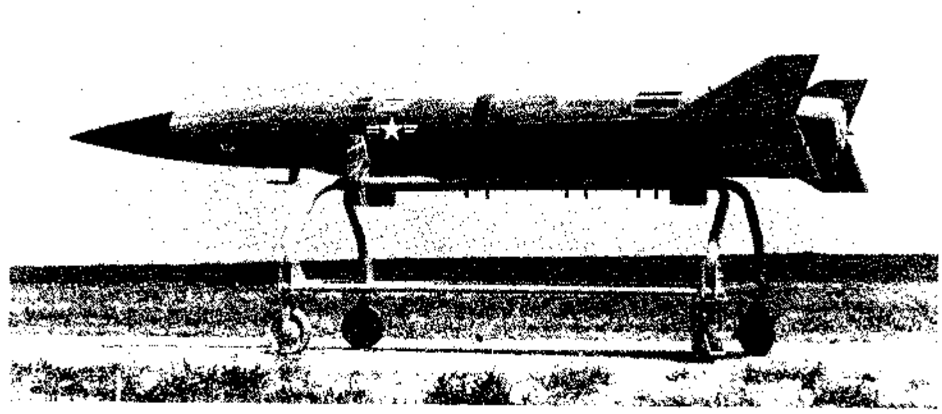
This is a non-recoverable, supersonic, air-launched missile target system designed to simulate invader aircraft and missile threats and to provide defence weapon system evaluation and crew training. The target provides both active and passive radar augmentation for radar acquisition and tracking; and a chemical flare is provided for infra-red homing. Two optical miss-distance systems are available.

LEADING PARTICULARS:

Power Plant: One Rocketdyne/AMF LR64 P-4 dual-chamber liquid-propellant rocket-engine
Guidance: Programmed
Launching: Air-launched
Recovery: Non-recoverable. Automatic destruct system operates at end of flight or in case of major failure. Command destruct standby system for added range safety
Operating speed: Mach 0.4 to Mach 3.0
Operating height: 300-24,500 metres
Endurance: 15 min
Special Features: Approx 0.04 cu m of space in nose section for optional scoring and augmentation systems. Target compatible with non-cooperative scoring systems such as the Babcock 800 B2

In addition to the AQM-37A models built for the US Services, four other variants have been announced:

MODEL 1072 (SHORT SD.2 STILETTO): Version for UK substantially re-engineered by Short Brothers & Harland to meet British requirements, including virtually complete replacement of the radio and radar systems and control system changes. Total of 55 ordered, of which the third batch, of 20 targets, were fitted by Beech with a single chamber rocket motor. The Stiletto is launched from a Canberra PR MK-3 aircraft. In a successful first test flight at Llanbedr on August 1, 1968, the drone was released at 55,000 feet (16,750 m) and flew for more than 28 nautical miles (52 km) at an average speed of Mach 1.4 before the flight was terminated by a commanded explosive destruct.


Beechcraft Model 1019 Missile Target (AQM-37A)

Principal modifications made by Shorts were the incorporation of a British EMI T44/1 telemetry system; provision of additional 15V flight break-up system (WREBUS); installation of radioactive miss-distance indicator (RAMDI), with associated radio link; introduction of Plessey IR 112A/IR 310 tele-command system with heading and turns command circuitry; modification to propulsion system to give Mach 2 performance at 60,000 feet (18,300 m); and changes in the radar augmentation system. The current Stiletto system consists of the basic target vehicle plus a number of optional mission kits which can be either installed by Shorts or delivered separately for customer installation.

MODEL 1088: Manufacturer's designation of five targets supplied to Italy. These are intended for air launch from F-104S aircraft of the Italian Air Force.

MODEL 1094: Designation of 15 targets ordered in mid-1973 by the French Air Forces. A follow-on quantity of 30 has been negotiated. Delivery of the first articles to begin in May 1974.

MODEL 1095: The UK Ministry of Defense has negotiated for the purchase of ten Model 1095 targets. This version has been modified to the specifications of the MOD and will be used for crew training exercises on the Hebrides Range.

STATUS:

The AQM-37A is in service with the USN (1962), USAF (1967), US Army (1968), UK (1966), Italian Air Force (1969), and French Air Force (1974). A successor HAST – High Altitude Supersonic Target – is under development. Flight tests of the production configuration began in late 1972. Earlier tests were carried out using a modified AQM-37A fitted with the United Technology Centre hybrid rocket which will be used in production models.

MANUFACTURER:

Beech Aircraft Corporation, Wichita 67201, Kansas.

1813.391
BEECH MODEL 1092

DESCRIPTION:

The Beechcraft Model 1092 is a pilotless, recoverable target drone designed for in-sight or out-of-sight control. Essentially, it is a jet-powered derivative of the proven Model 1025 piston-engined target vehicle (**2521.391**), and is claimed to have a cost-effectiveness better than any other system in its performance category. The configuration of the Model 1092 can be seen in the accompanying illustration.

LEADING PARTICULARS:

Power Plant: One Teledyne CAE 372-2 (J402-CA-400) turbojet engine, rated at 290 kg st. The engine can be throttled by remote command, permitting a very wide variety of mission profiles with endurances (depending upon mission speed and altitude) of up to several hours.
Launch and Recovery: Launchings utilise the zero-length procedure, with solid-propellant rocket motors providing the boost thrust. The target is recovered following completion of flight by a single-stage 14.6 m diameter parachute. The vehicle has flotation capability and may be recovered over land or water
Control and Guidance: Stabilisation and command control is by two-axis autopilot, with a Babcock digital command receiver/decoder providing the ground link
Dimensions: Wing span 3.68 m. Length overall 4.60 m. Body diameter 0.45 m
Weight: Max launching weight 454 kg
Performance: Max level speed 834 km/h. Ceiling 12,200 m

MANUFACTURER:

Beech Aircraft Corporation, Wichita, Kansas 67201, USA.

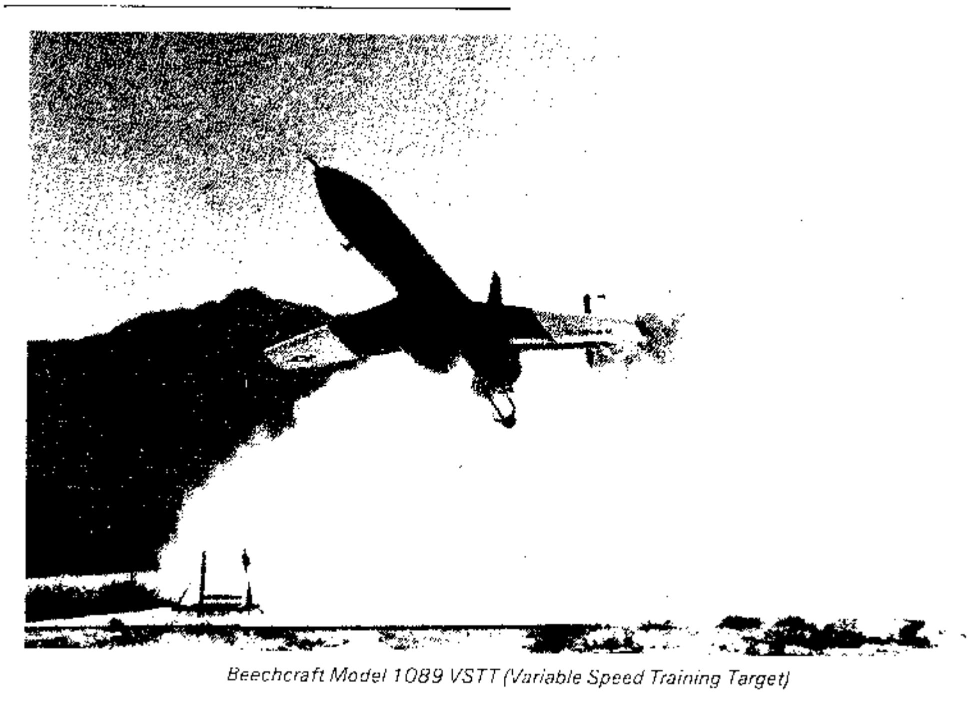
1814.391
BEECH MODEL 1089 VSTT

DESCRIPTION:

Beech Aircraft Corporation is participating in a "price and performance" competition to design and develop a new Variable Speed Training Target (VSTT) for the US Army's Missile Command. The programme consists basically of the following three phases: (1) design and manufacture of hardware; (2) contractor flight tests; and (3) Army evaluation tests. The principal function of the VSTT will be to tow a variety of targets for missile training and evaluation. Two TA-8 radar augmentation targets or two TA-8 infra-red augmentation targets can be carried on each mission and towed separately as far as 1,500 m behind the VSTT.

The VSTT will serve as an aerial target for air defence systems such as Chaparral, Redeye, Hawk and Vulcan, and is expected to become the primary subsonic missile training target for the US Army. The VSTT will be capable of operating at altitudes from 90 m to 12,200 m and at speeds of up to 500 knots (936 km/h).

As of March 1974, twenty flights in the contractor development test programme and in the US Army evaluation programme were completed. In these flights high altitude, speed, flight control


Beechcraft Model 1089 VSTT (Variable Speed Training Target)

and towing capability have been demonstrated as well as operation of the recovery system. Recoveries are being made with minimal damage to the crushable, impact absorbing nose.

The Beech VSTT, shown in the accompanying illustration, is powered by a Teledyne CAE 372-2 turbojet engine of 290 kg st and carries 64 US gallons (242 litres) of fuel. It is launched from the ground with a JATO booster and has a drogue and main parachute command recovery system.

The modular design employed throughout the system provides for ease of fabrication and for economy in operation and maintenance. One unique design feature is the flat airfoil section of the wing and tail surfaces. The fuselage is cylindrical. Low cost bonded honeycomb is used for the immovable aero surfaces while the aero control surfaces are constructed of aluminium skins and filled with poured-in-place foam. Support equipment is both minimal and lightweight providing for transportability and deployment of the system. Checkout and launch equipment is packaged in two suitcase size containers.

The guidance and control system provides for both ground control and for preprogrammed flight. The flight control operator is provided with all pertinent flight information by radio link from sensors located in the vehicle and the operator can command vehicle manoeuvres as well as recovery. In flight the guidance and control system automatically stabilises about the roll, yaw, and pitch attitudes and provides altitude and velocity hold modes.

LEADING PARTICULARS:

Guidance: Radio command

Dimensions: Wing span 3.00 m. Length 5.13 m. Height 1.47 m. Body diameter 0.38 m

Areas: Wings (total projected) 2.52 m^2. Horizontal tail surfaces 0.79 m^2. Vertical tail surfaces 0.43 m^2

Weights: Launching weight (including booster) 460 kg. Usable fuel 173 kg

Performance: Endurance: more than 3 hours

MANUFACTURER:

Beech Aircraft Corporation, Wichita, Kansas 67201, USA.

1815.391
BEECH MODEL 1070 HAST

DESCRIPTION:

Beech Aircraft is continuing a development programme for the USAF Armament Laboratory at Eglin AFB, Florida, under contracts totalling $13 million, to provide a high-performance air-launched aerial target system for use by the three Services of the US Department of Defence. The HAST (High Altitude Supersonic Target) is a continuation of the former Sandpiper project, which concluded a successful flight test programme in 1968. A hybrid propulsion system and a command manoeuvring system were demonstrated in that flight test programme. In 1971 Beech received authority to build 12 flight test units of the HAST and 13 refurbishment kits, and delivery of the former began in 1972. A recovery system development programme utilising an inert HAST vehicle has been completed. This programme has proved the recovery system with both water and aerial retrieval of the vehicle. Captive flights have been completed and powered flights are scheduled at two month intervals. The target is intended initially to be carried by F101 Voodoo, F-4 Phantom, F-14 Tomcat and F-15 Eagle aircraft.

The flight performance envelope of the HAST covers a range from Mach 1.2 at 12,200 m to Mach 4.0 at 30,500 m. The target is designed to be air-launched at speeds of Mach 0.8 to 2.5. Manoeuvres of between 5g at 10,670 m and 1.15g at 27,400 m are to be performed. The vehicle is to be capable of performing "S" and 180° turns in the horizontal plane and altitude changes in the vertical plane. Manoeuvres can be preprogrammed or can be initiated via ground command radio link. Modular payloads with a wide variety of options will be available for accurate simulation of aircraft or missile threats. Payloads will include various radar and infra-red augmentation devices as well as a flare/chaff dispenser. Vector miss-distance scoring systems will also be included.

Beechcraft Model 1070 HAST (High Altitude Supersonic Target)

The modular recovery system has been developed as an optional feature for mid-air retrieval of HAST, or for land or water recovery. Refurbishment of recovered targets will permit their re-use.

LEADING PARTICULARS:

Guidance: Pre-programmed, with ground command interface

Dimensions: Wing span 1.02 m. Length 5.08 m. Height 0.66 m. Body diameter 0.33 m

Areas: Wings (total exposed) 0.97 m^2. Foreplanes (total exposed) 0.12 m^2. Stabilisers (each) 0.31 m^2

Volume: Payload volume 0.041 m^3

Weights: Launching weight 519 kg. Propellant 297 kg. Payload 38 kg

Performance: Endurance at Mach 3 – 5 min

MANUFACTURER:

Beech Aircraft Corporation, Wichita, Kansas 67201, USA.

2615.391
FIREBEE (BQM-34A/MQM-34A)

DESCRIPTION:

One of the best-known target drones in the world, the Teledyne Ryan Firebee has a history dating back to 1951. Development of the current version began in 1958, however, and various improvements have been added since the first production model of this version flew in 1960.

Firebee is a turbojet-powered remotely controlled drone used mainly for target purposes but with the capability of being used in a reconnaissance role (see following entries). Designation of the current standard version is BQM-34A: there is also a version known as MQM-34D used by the US Army, which has a longer burning rocket booster for ground launch and extended wings which enable it to take off at a loaded weight some 450 kg greater than the maximum for the BQM-34A.

LEADING PARTICULARS:

Power Plant: 722 kg thrust Continental J69-T-29 turbojet

Guidance: Radio control. Drone carries R425/ARW-59 (USAF) or AN/DRW-29 (USN) radio control receiver and A/A37G-3 flight control system

Launch: Air launch or ground launch with JATO rocket

Recovery: Parachute system deployed by remote command or in the event of loss of power, damage or system failure

Max level speed: 1,040 kmh at 2,000 metres

Max diving speed: Mach 0.95

Max cruising speed: 1,000 kmh at 15,000 metres at 800 kg AUW

Rate of climb: 4,875 metres/min at S/L

Operating height range: 15-18,300 metres

Endurance: 75 mins at 15,000 metres

Flotation time: 1 hour with 25% fuel

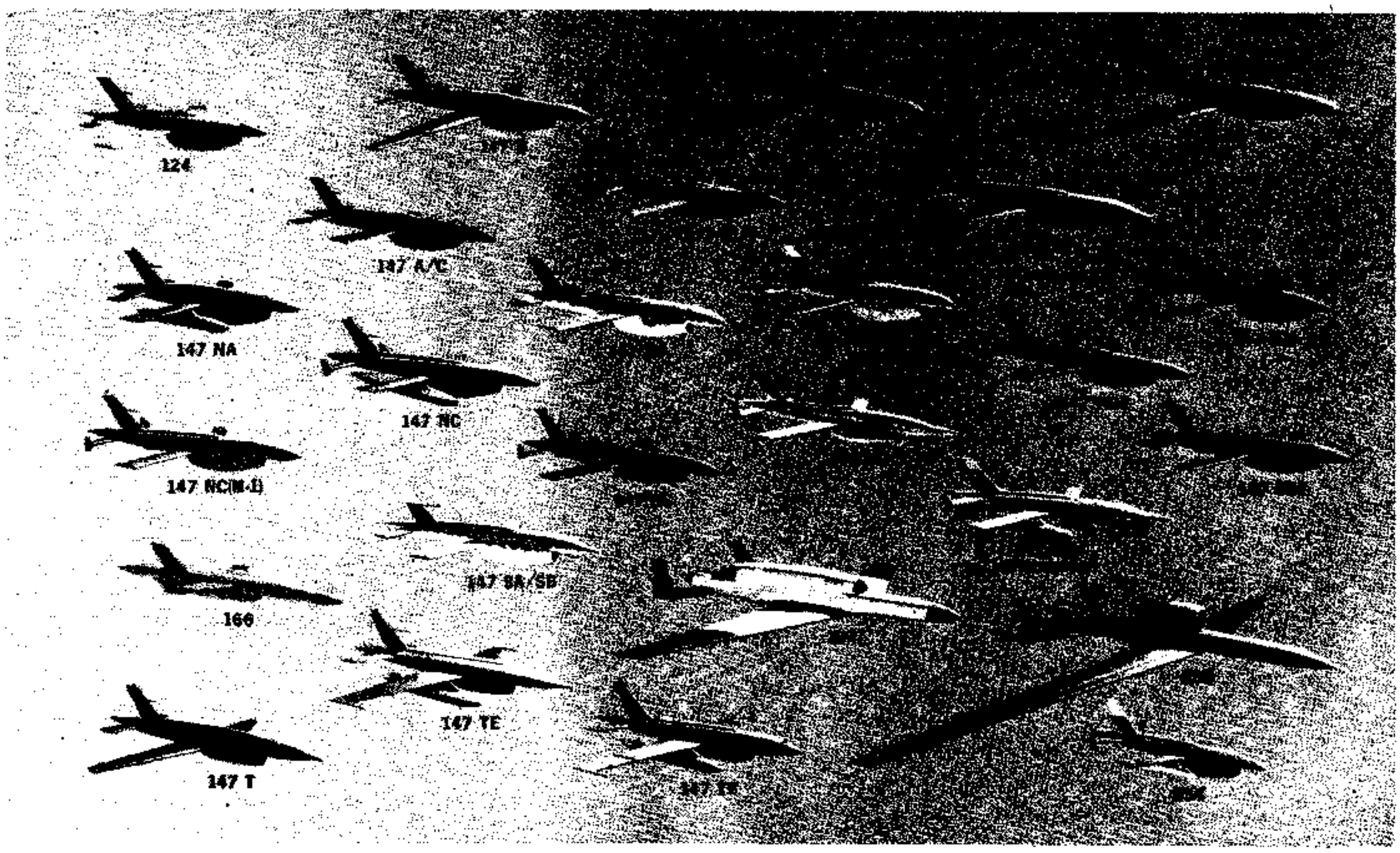
Special features: Adjustable TWT amplifiers for L, S, X and C-band radar signal enhancement. Increased manoeuvrability kit to give 5-6 g turn capability.

RALACS – Radar Altimeter Low Altitude Control System – available for precision low altitude flights at 15 metres altitude, over water or 30 metres over land

BQM-34E Firebee I (Ryan Model 124) target loaded on wing of launch aircraft

MANUFACTURER:

Teledyne Ryan Aeronautical, San Diego, California, USA.



Composite picture of Ryan drones for target, reconnaissance, electronic warfare, Elint and Sigint, and other missions. Principal characteristics of the most important models are given in the nearby table, and other details are contained in the entries for the various models that follow

Teledyne Ryan Drone Characteristics.

Service No.	Ryan No.	Length ×	Span ×	Diameter (m)	Wt (kg)
AQM-34G	147NA	7.92	4.41	0.94	1655
AQM-34H	147NC	7.92	4.41	0.94	1700
AQM-34J	147NC(M-1)	7.92	4.41	0.94	1299
AQM-34K	147SRE	8.84	4.41	0.94	1527
AQM-34L	147SC	9.14	3.96	0.94	1390
AQM-34M	147SD	9.14	4.41	0.94	1412
AQM-34M(L)	147SD	9.14	4.41	0.94	1412
AQM-34N	147H	9.14	9.75	0.94	1733
AQM-34P	147T	9.14	9.75	1.00	1720
AQM-34Q	147TE	9.14	9.75	1.00	1756
AQM-34R	147TF	9.14	9.75	1.00	1860
AQM-91A	154	10.36	14.6	0.97	2379
BGM-34A	234	7.19	4.41	0.94	1270
BGM-34B	234	7.92	4.41	0.94	1466
BQM-34A	124	6.98	3.93	0.94	1134
BQM-34E/F	166	8.62	2.77	0.60	1065
MQM-34D	124	6.98	3.93	0.94	1134
YQM-98A	235	11.4	24.75	0.82	6486

2616.391
FIREBEE II (BMQ-34E)

Description:

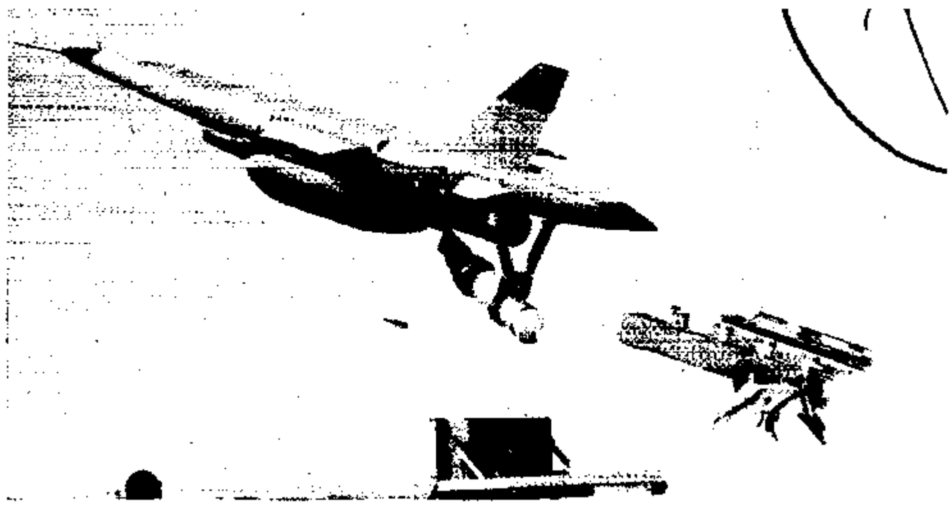
The Ryan Model 166 Firebee II is a supersonic target drone developed for the US Navy as an advanced version of the subsonic BQM-34A drone described above. The new drone is designed to provide aerial target presentations at around 15,000 metres altitude at supersonic dash speeds up to Mach 1.5 for a period of 10 minutes. With full fuel load, range time may be extended to 75 minutes. Among other improvements the new drone is designed to carry much more in the way of radar enhancement and tracking aids than its predecessor.

Leading Particulars:

Power Plant: 835 kg thrust Continental YJ69-T-6 turbojet engine

Guidance: Drone carries AN/DRW-29 radio control receiver and A/A37G-3 flight control system

Launch: Ground launch with JATO bottle



Firebee II supersonic target drone

Recovery: Similar to BQM-34A
Max Speed: Mach 1.5 at 18,000 metres
Operating height range: 15-15,250 metres
Endurance: 83 minutes total
Flotation time: 24 hours
Special equipment: AN/DLQ-1, -2 and -3 ECM equipment.
AN/USQ missile scoring system.
RALACS (see above).
X-band and C-band tracking beacons.
TWT radar augmentation for S- C- and X-band.
Solid-state radar augmentation for P-band.
Passive radar reflectors.
Dorsett TM-4-31A, telemetry system

MANUFACTURER:
Teledyne Ryan Aeronautical, San Diego, California, USA.

The British Aircraft Corporation concluded an agreement covering sales and manufacture in 1968. In 1970 BAC received a Ministry of Technology contract for a feasibility study relating to the operation of Firebee II in the Cardigan Bay missile range.

DC-130 drone launch aircraft carrying four Ryan Firebee target drones. Beneath left wing are two subsonic Firebee I (BQM-34A, Ryan Model 124), and under right wing are supersonic Firebee IIs (BQM-34E, Ryan Model 166)

1392.351
147 SERIES RECONNAISSANCE DRONES
DESCRIPTION:

The Teledyne Ryan Model 147 series of drones is an extensive one and comprises at least 21 different models which have been developed mostly in response to specific USAF reconnaissance requirements associated with American operations in S E Asia. Further details of these reconnaissance and surveillance programmes appear in the Reconnaissance Systems section of this book, which follows.

Although based on the successful Model 124 Firebee target drone airframe, and therefore bearing a close resemblance to it, the various Model 147 drones and RPVs individually differ widely in a number of characteristics and are generally both larger and heavier than the target models. The adjacent table of dimensions for the principal Model 147 versions indicates the range of these variations and the other illustrations in this section illustrate the detail differences in configuration which exist. Either one of three Teledyne Continental CAE J-69 engines is used to power Model 147 RPVs, the 1,700 lb (770 kg) st T-29, 1,920 lb (870 kg) T-41A, or 2,700 lb (910 kg) J100-CA-100.

The manufacturer's designations include suffix letters to denote the various models, and the USAF designations adopt the same procedure (but different letters); and, to the extent permitted by security considerations, the following list gives details of individual models and their operational roles.

Model 147A/C: Probably prototype low/medium level photo-reconnaissance version. Built under USAF Big Safari programme, and based on Firebee I drone.
Model 147B: Probably prototype high level photo-reconnaissance version. Larger than A/C models.
Model 147D: Probably developed low/medium level reconnaissance model
Model 147E: Probably developed high level reconnaissance version.
Model 147G/J: Two 147G drones were modified in 1972/3 for use as test vehicles in the FDL-23 project undertaken by the USAF Flight Dynamics Laboratory to study control techniques and applications of RPVs. Also known as Red Baron, this project includes an examination of the uses of RPVs in a possible air-superiority role. The modified 147Gs have the normal Lear Siegler drone autopilot but with yaw axis con-

Four versions of the Teledyne Ryan Aeronautical Model 147 drone, with DC-130A launch and control aircraft being prepared for flight

Model 147TE drone awaiting loading. The aircraft in the background, already with two more drones beneath its wings, is a specially-equipped DC-130E launch and control aircraft. Chin radome houses antenna for UPQ-3 microwave guidance and control system trol and three-axis proportional control facilities added. In the nose of the 147G is a Cohu 945 line TV camera, equipped with a 10:1 remotely operated zoom lens, the video from which is telemetered back to a remote control position on the ground. The latter is equipped with a large-screen display, which in conjunction with flight data telemetered from the RPV, enables the ground pilot to 'fly' the drone. The ground station is also equipped with tracking radar to provide accurate navigational information. The radar used is a C-band FPS-16 equipment which is also used to provide the necessary data link command facilities for piloting the 147G.

Model 147H (AQM-34N): Medium altitude reconnaissance model. Entered SAC service about 1968.

Model 147NA (AQM-34G): Low altitude version with wing pod mounting points, used for electronic warfare operations. Probable dual recce/jamming capability. Can carry ALE-2 chaff dispenser pods.

Model 147NC (AQM-34H): Low altitude version with wing pod mounting points, used for electronic warfare operations and with photo-reconnaissance capability. Initially developed for use in Vietnam as an ECM precursor vehicle in support of air strike forces under the Combat Angel programme, but not operationally deployed in the SE Asia theatre. AQM-34H drones are now operational with the USAF 11th Tactical Drone Squadron. A variety of EW pods can be carried, for both active and passive ECM missions, the Model 147NC being able to carry either two ALE-2 or ALE-38 chaff dispensers, or ALQ-71 or QRC-335 noise jammer pods. The drone is equipped with a doppler navigator system and provision for a programmed flight path.

Model 147NC(M-1) (AQM-34J): This is similar to the Model 147NC (above) but without the wing pod mounting points. It is used by the USAF 11th Tactical Drone Squadron for low altitude photo-reconnaissance and training missions.

Model 147NP: Low/medium altitude version, probably for day reconnaissance.

Model 147NQ: Similar to Model 147NP.

Model 147NRE: Low/medium altitude mode. Probably for night reconnaissance missions.

Model 147NX: Low/medium altitude model. Probably for experimental night reconnaissance role.

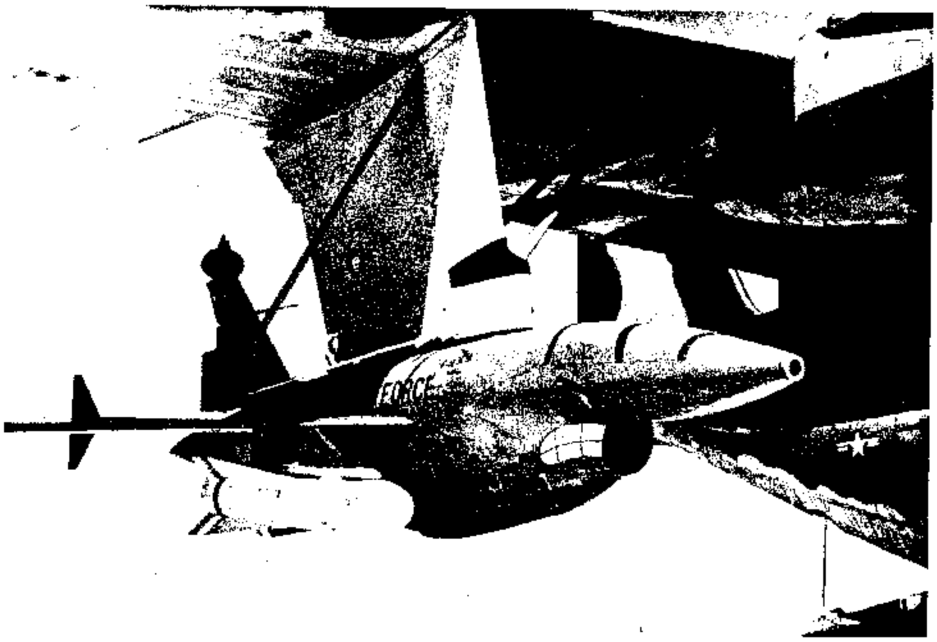
Model 147SA/SB: Day reconnaissance version for low/medium altitude operations.

Model 147SC (AQM-34L): Low level photo-reconnaissance version. Downward looking camera carried in extended nose. Equipped with doppler navigator, and provision for command guidance. Used by USAF Strategic Air Command 100th Strategic Reconnaissance Wing in Korea under Compass Bin programme. Also deployed with 11th Tactical Drone Squadron, USAF, from 1969 onward.

Model 147SD (AQM-34M): Low level reconnaissance model. Used in Compass Bin programme (above). The AQM-34M was modified by the addition of a Loran navigation system to improve track keeping and navigational accuracy, modified drones bearing the USAF designation AQM-34M(L). Teledyne Ryan also produced an Extended Range version of the Model 147SD with hard point mounts for wing tanks. It is possible that these mounts could also be used to carry either active or passive ECM pods as an alternative to extra fuel. As used in the Far East, the AQM-34M was employed also for leaflet dropping in a programme code-named Litterbug.

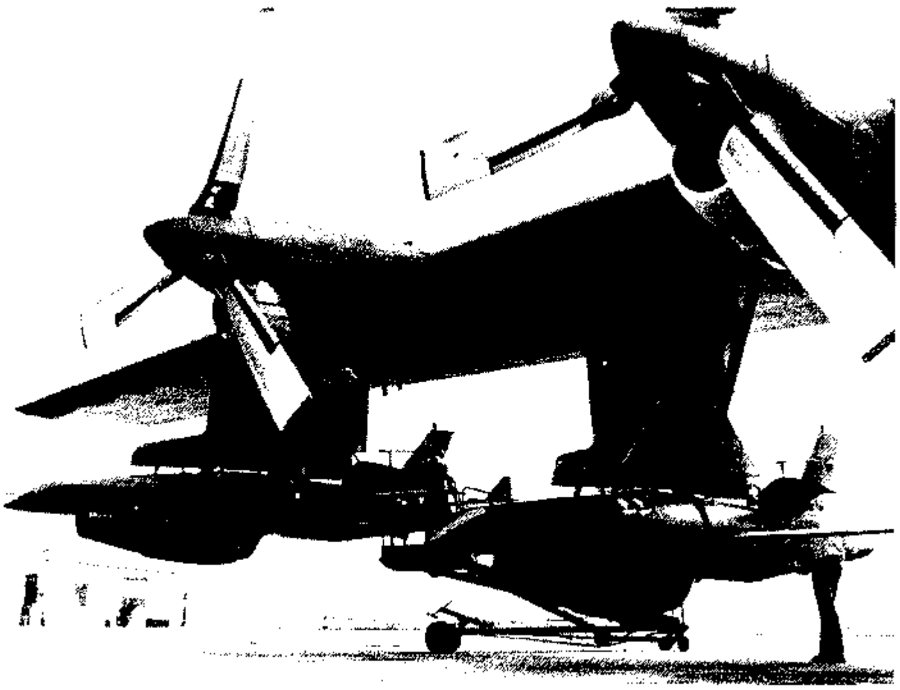
Model 147SRE (AQM-34K): Low/medium altitude night reconnaissance version. Deployed with 11th Tactical Drone Squadron, USAF.

Model 147T (AQM-34P): Medium altitude night surveillance version, probably equipped for infra-red linescan reconnaissance and Elint operations.



BGM-34A Ryan Model 234 drone armed with Maverick TV-guided missile for offensive drone operation trials

Recovery by helicopter of Model 147TF drone after a mission



Model 147 drones on DC 130A launch and recovery aircraft being prepared for flight

Model 147TE (AQM-34Q): Medium/high altitude night Sigint and Elint model, with extended range capability by means of wing tanks and with provision for command guidance and data telemetry. Used in Combat Dawn programme in Vietnam. Flight durations of 8 to 12 hours have been reported.

Model 147TF (AQM-34R): Similar to Model 147TE (above) and employed on same missions, but probably with differing payload to suit other frequency bands and types of signal gathering missions.

Update (YAQM-34U): Under this programme a number of Model 147SC low-level reconnaissance drones were equipped with improved avionics and flight control equipment to improve navigational accuracies and thereby enhance the operational performance. The programme also included adapting the Model 147SC drone to carry pods from which battlefield monitoring sensors for the Igloo White surveillance and monitoring system (**1397.151**) could be dispensed. The main navigational aid provided in the Update package is a Loran C/D equipment (which has the advantage over the doppler navigator used in some other Model 147 drones of not radiating RF energy which could reveal the drone's presence to an enemy), with the TERCOM (Terrain Comparison) system available as an alternative for areas lacking Loran coverage. The latter is based on a digital comparison of the changes in terrain height encountered as the drone over-flies the ground with a stored version of the planned flight profile. Another item of the Update package which is relevant to this as well as other aspects of operation is a Honeywell APN-194 radar altimeter. The first Update flight test was made in March 1973, about one year after commencement of the programme which was scheduled to run for about 12 months.

OPERATION:

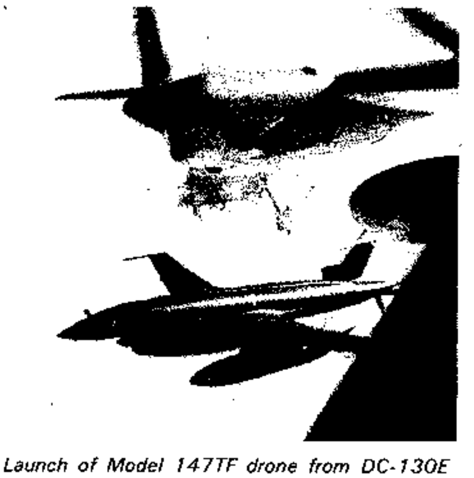
Model 147 drones have been developed for the following broad categories of operational roles:

Photographic reconnaissance.
Infra-red linescan reconnaissance.
Sigint collection.
Elint collection.
Active ECM
Passive ECM.
Sensor seeding.

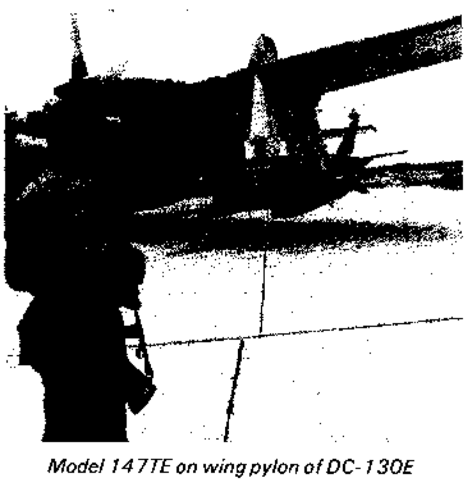
In some cases two or more of these roles may combine on a single vehicle, and the number of possible permutations is further increased by other operational variables such as low, medium or high altitude, day or night missions, long or short range, and whether data is recorded on board the drone or relayed back to an airborne or ground-based station as it is gathered. Another important option is the type of control procedure adopted, which can range from a completely self-contained and pre-programmed mission profile to the RPV technique of remotely piloting the vehicle and controlling the sensor functioning from a ground-based or airborne control station. The differing operating circumstances bring their own particular requirements for navigation and other drone sub-systems, which results in a relatively wide variation in equipment. For example, a high-level, long-range Elint drone would require a navigation and guidance system that gave relatively modest positional accuracy over a long-term, while a low-level photo-reconnaissance drone would require the best navigational accuracy obtainable to ensure that the desired targets are overflown and that data gathered can be accurately correlated. In a similar way, the nature of the operational role will have a bearing on the quality of flight stabilisation that is provided.

A typical navigation and guidance package comprises an air data computer and its related sensors, a doppler navigator, twin-gyro platform and a programmer unit. In addition, provision is made for varying degrees of manual over-ride for flight corrections or mission changes, in one instance the necessary two-way data link facilities for this are provided by means of a transponder (APQ-25 or APQ-26) on the drone working in conjunction with Univac UPQ-3 microwave guidance and control system. This provides for monitoring of on-board drone flight parameters, radar tracking of the vehicle and for command guidance facilities. As mentioned above, the Update programme is concerned with the provision of more sophisticated navigation equipment and other projects are concerned with the means of providing more elaborate and comprehensive guidance facilities, including the ability to permit multiple RPV operations.

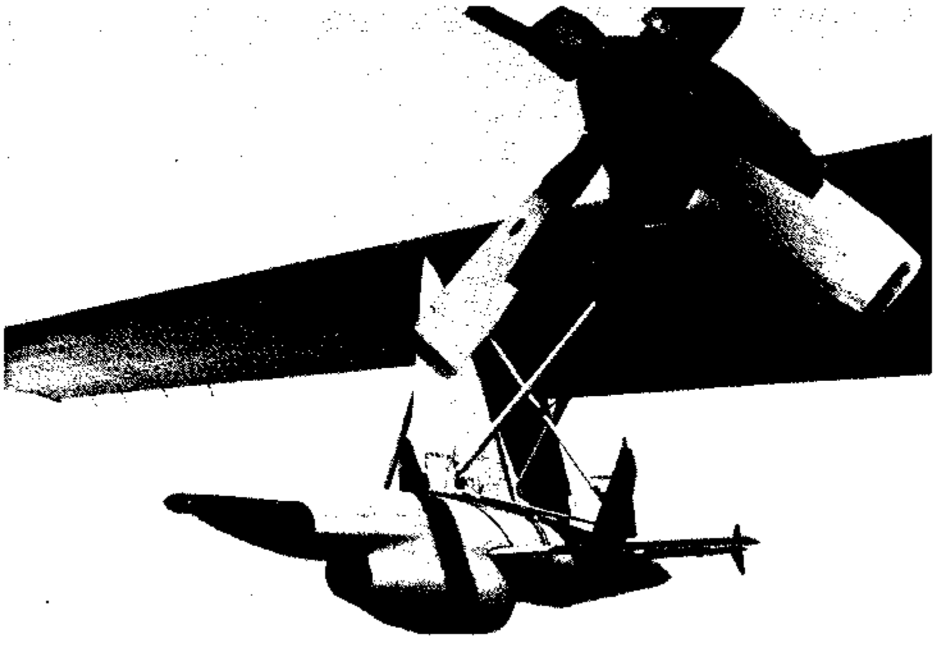
A launching from beneath the wings of specially modified DC-130 aircraft is the normal technique, these aircraft being equipped with the UPQ-3



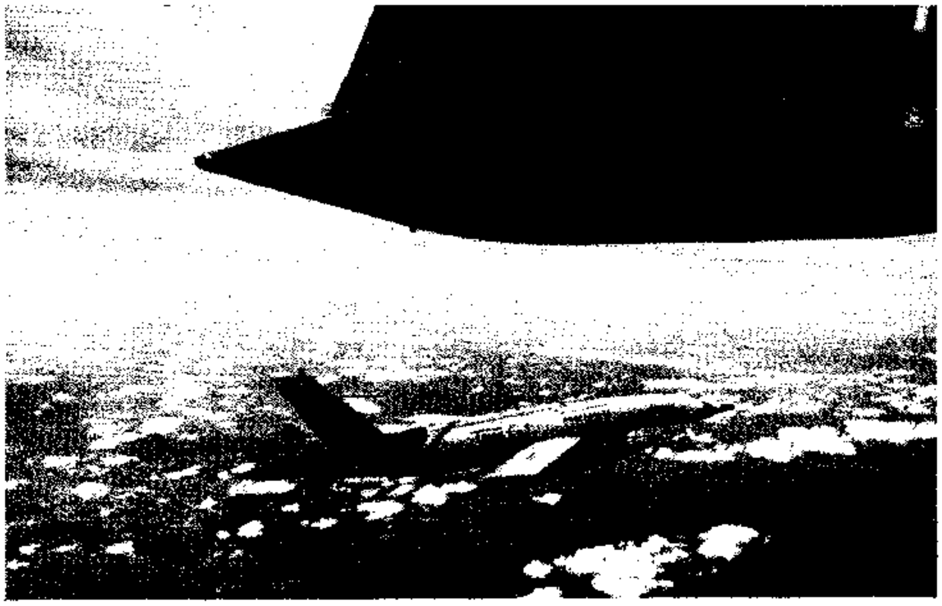
Launch of Model 147TF drone from DC-130E launch and control aircraft



Model 147TE on wing pylon of DC-130E



Another version of Model 147 drone. Note nose sensor package



Start of mission for Ryan Model 147SC drone system to permit their operation as airborne guidance and control stations. The system allows for control to be passed to a similar station on the ground, provided line-of-sight radio contact can be maintained with the drone (at the time(s) that it is necessary to either exercise control over the drone or receive data from it). A mission is generally terminated by shut-down of the drone engine, deployment of drogue and support parachutes, dumping of remaining fuel, and mid-air recovery by specially equipped CH-3 helicopter.

STATUS:

Reconnaissance drones, mostly of the Ryan Model 147 family, carried out a major part of the SE Asia photo-reconnaissance duties since their introduction in that theatre nine or ten years ago. They have also performed many other electronic intelligence missions and then undertook both active and passive ECM duties. Reconnaissance missions of less publicised nature have been carried out at various times in other parts of the world. Three USAF Commands operate the DC-130 drone launch and control aircraft: Tactical Air Command, with the 11th Drone Squadron at Davis-Monthan AFB, Arizona; Strategic Air Command, with the 100th Strategic Reconnaissance Wing operating Far East-based units; and Air Force Systems Command, 6514th Test Squadron, now based at a special facility at Hill AFB, Utah having moved from Edwards AFB in the latter part of 1973. The total number of DC-130s operated is relatively small but it is planned to increase their number by seven or eight in the course of the next two or three years. The Fiscal Year 1975 Defence Budget also envisaged the procurement of another 50 drones.

Future developments, in addition to those outlined above, include the use of high-altitude drones as relays for the data-relay function between data collecting drones and the base station, and improvements in recovery techniques. Others are related to the anticipated counter-measures which are likely to be encountered as the use of drones and RPVs increases and ensuring the necessary security of command and data links. Connected with the progression from drones towards remotely piloted vehicles are studies of the best techniques of effecting control, including the human factors problems involved.

Model 147SC reconnaissance drone on carrier DC-130 aircraft

1393.351
MODEL 154 (AQM-91A) FIREFLY RECONNAISSANCE DRONE

DESCRIPTION:

The Teledyne Ryan Model 154 Firefly drone has been designed for high altitude reconnaissance missions over hostile territory, and certain of its design features are stated to have been incorporated with the specific objective of ensuring high survival characteristics. They include shape and construction methods to achieve a low radar cross-section, and minimum infra-red emission from the J97 turbojet power unit.

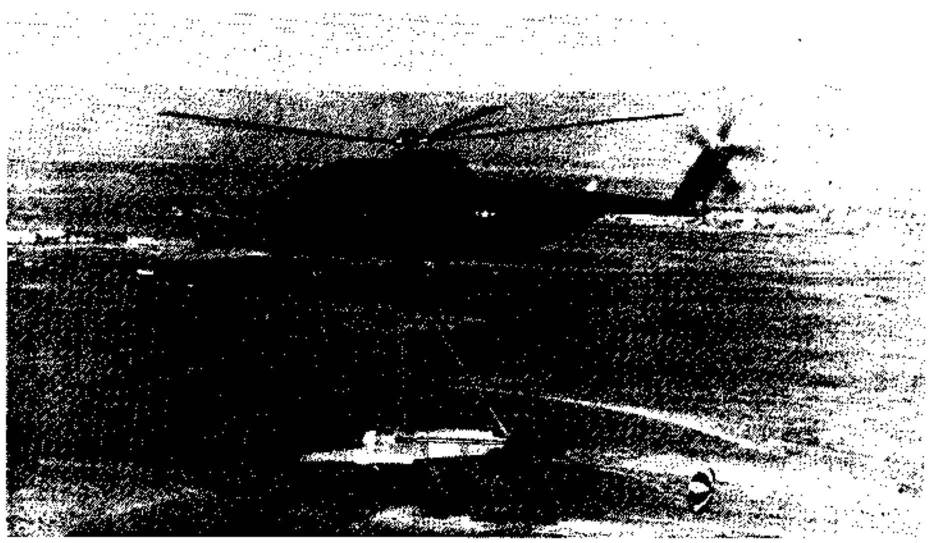
The USAF designation is AQM-91A.

A more sophisticated navigational system than that of the 147 series of drones (Entry No. **1392.351**) is believed to be fitted, and this probably includes an inertial platform, doppler navigator, and a digital computer. A transponder for use with the Univac UPQ-3 microwave command guidance system to assist recovery by parent aircraft or ground station is also fitted. Retrieval is by means of a multi-parachute system and mid-air collection.

The sensor payload includes the Itek KA-80A optical bar panoramic camera.

STATUS:

US reports claim that the 154 Firefly has, as yet, been produced in small quantities only, probably less than 50. No details of operational use have been obtained.



Teledyne Ryan Aeronautical Model 154 drone after mid-air recovery by helicopter

MANUFACTURER:

Teledyne Ryan Aeronautical, San Diego, California, USA.

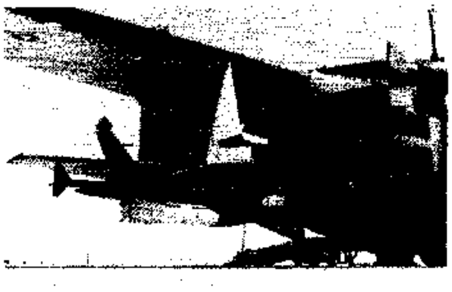
1818.311
MODEL 234 (BGM-34A/B) GROUND ATTACK DRONES

DESCRIPTION:

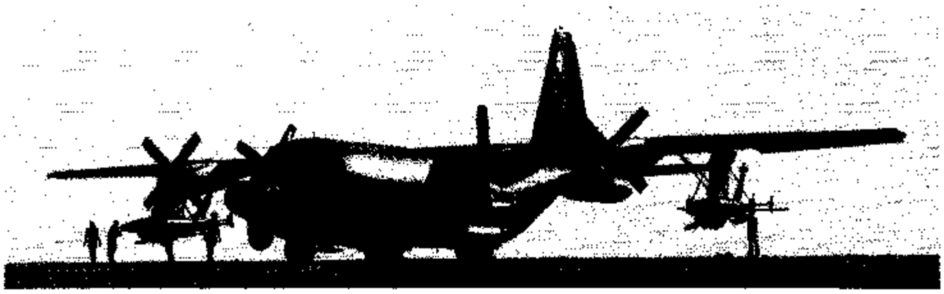
The designations BGM-34A and BGM-34B have been allocated to two more versions of the prolific Teledyne Ryan Firebee family of drones and RPVs, in this case specially adapted for the evaluation of the capability for the delivery of missiles and bombs in the ground defence suppression role. As can be seen from the table of Teledyne Ryan drones, the BGM-34B is longer and almost 200 kg heavier than the BGM-34A.

A batch of eight of the latter type were delivered to the USAF in the 1972-3 period, these being equipped with a nose-mounted TV camera, the video from which was telemetered back to the remote pilot in the DC-130 parent aircraft via the UPQ-3 microwave link which is standard for many of the Model 147 reconnaissance drones and RPVs. Maverick (**1098.311**), Shrike (**1102.311**), and HOBO electro-optically guided bombs (**1597.311**) were carried and launched in a series of tests directed at the study of RPVs for daylight defence suppression operations. In one mode of operation, the drone camera is used by the operator to locate and identify the target, whereupon this information is used to direct the camera of the Maverick's homing system onto the target for lock-on. Another technique for use against radar targets is for the radiation homing head of the Shrike to perform target identification and designation for the Maverick camera. The

BGM-34A RPV beneath wing of DC-130-E launch and control aircraft. RPV has Shrike anti-radar missile under right wing and Mk IV retarded bomb under left wing



BGM-34A RPV in USAF defence suppression evaluation trials has Maverick TV-homing missile on wing pylon



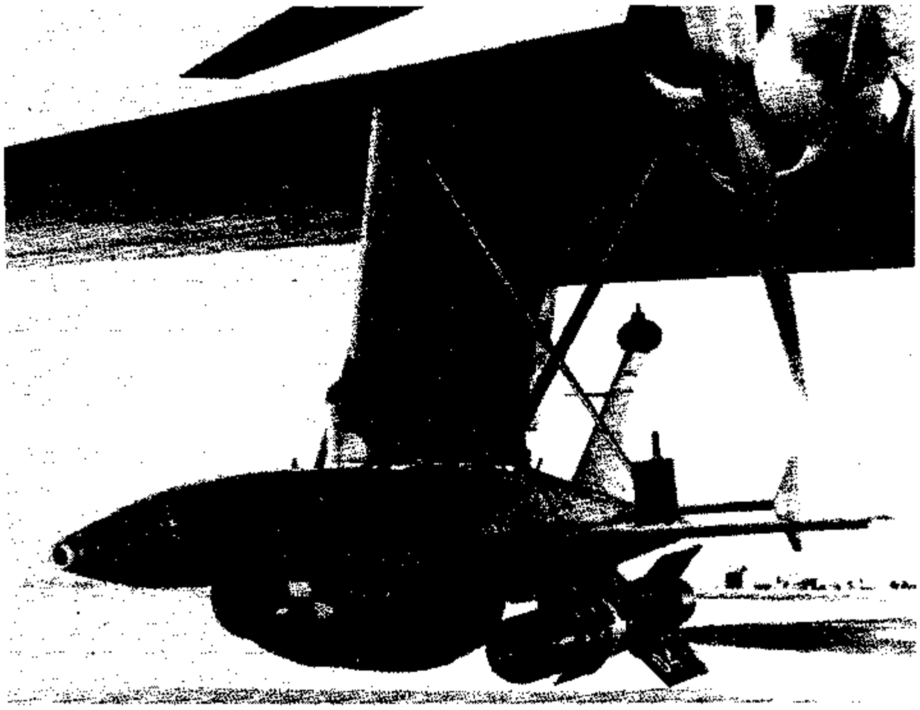
USAF DC-130E launch aircraft ready for BGM-34A test mission in defence suppression evaluation programme. RPVs have Shrike missiles and Mk IV bombs on board

Shrike could then be launched but if it failed to hit the target (through shut-down of the radar, for example), the Maverick could be launched to seek the same target by electro-optical homing.

The BGM-34B version was introduced in February 1973 and apparently exists in several versions. It is intended to extend the test and evaluation work initiated with the BGM-34A aircraft which preceded it. One important addition to the missions studied was that of night operations and laser target designation, or marking facilities. Two BGM-34Bs have been fitted with a smaller, lightened version of the Philco-Ford Pave Knife low-light level TV/laser target marker system, in this case being installed in the nose of the drone instead of the original pod housing. The laser target marker would permit the direction of laser-homing bombs carried either by the marker RPV or by stand-off aircraft or other drones. To provide the necessary additional data link capacity for multiple vehicle operation which is implicit in this concept, Sperry Univac has carried out modifications to the existing UPQ-3 link system as well as work on alternative systems, and RCA and other electronics concerns are also active in the area of multiple RPV control.

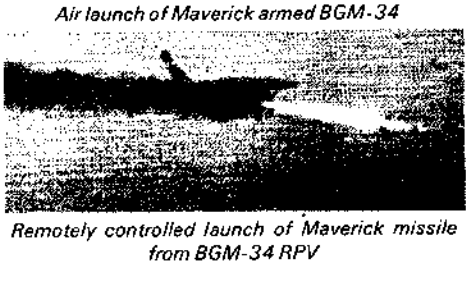
BGM-34B RPV for strike weapons delivery was rolled out by Teledyne Ryan on February 9, 1973

DC-130 RPV launch aircraft carrying BGM-34 loaded with HOBO and Mk IV bomb



BGM-34A, RPV X4 carrying HOBO electro-optically guided bomb. Note characteristic 'onion' antenna for UPQ-3 microwave link on fin of drone

Air launch of Maverick armed BGM-34



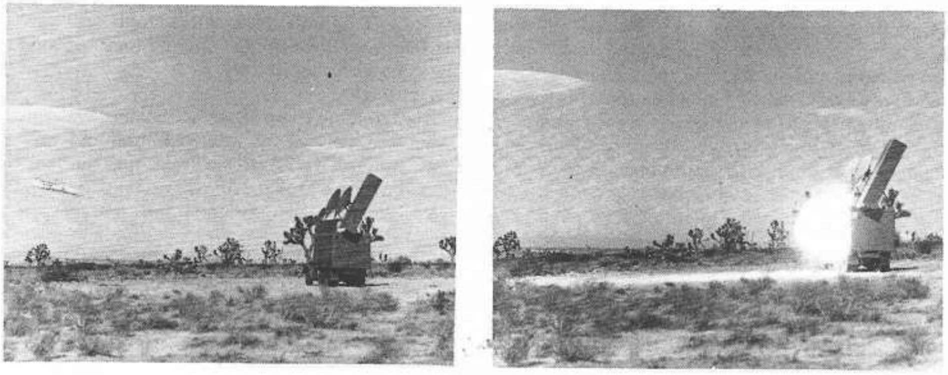
Remotely controlled launch of Maverick missile from BGM-34 RPV

Loading HOBO electro-optically guided bomb onto wing of BGM-34A RPV for tests

Other sensors and other weapons are likely to be tried in the course of the BGM-34 studies which are expected to run for a considerable period as this important development is carefully assessed in greater depth than was always possible before American disengagement from Vietnam.

MANUFACTURER:

Teledyne Ryan Aeronautical, San Diego, California 92112, USA.



Maverick missile launched from BGM-34 RPV successfully attacks mock-up of ground SAM radar van

1816.351

MODEL 235 (YQM-98A) COMPASS COPE R DRONE

DESCRIPTION:

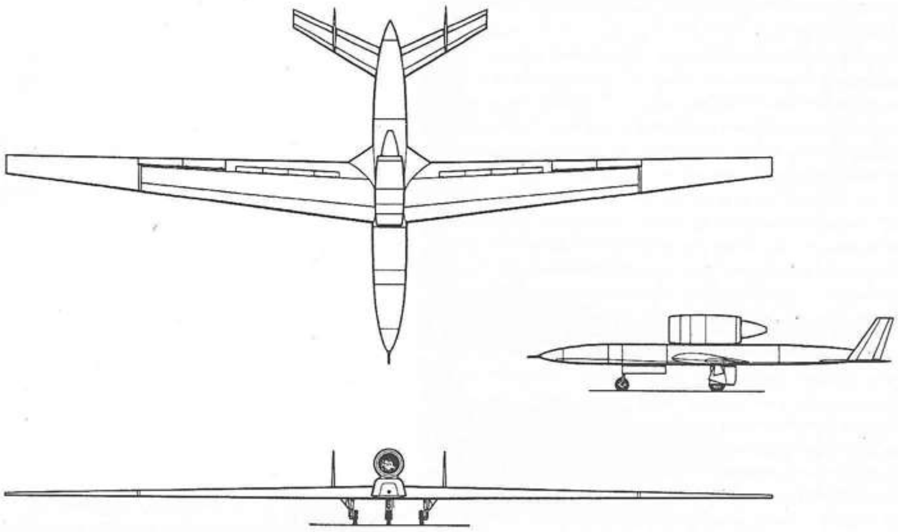
The Model 235 is the Teledyne Ryan entry in response to the USAF call for two prototypes of a new high-altitude, long endurance RPV under the Compass Cope reconnaissance programme (**1504.351**). The 'R' in the designation Compass Cope R denotes Ryan to distinguish between the competing model produced by Boeing as Compass Cope B (YQM-94A) (**1817.351**).

The configuration of the Model 235 is shown in the adjacent illustrations and the main characteristics are as follows.

LEADING PARTICULARS:

Power Plant: One Garrett AiResearch ATF-3 (XF104-GA-100) turbofan of 1833 kg st
Length: 11.4 metres
Span: 24.75 metres
Diameter: 0.82 metre
Max T/O Weight: 6,486 kg
Mission Payload: 317 kg
Cruising Speed: Subsonic

Operationally, the Compass Cope programme is intended as a follow-on and an extension of the



General arrangement drawing of Teledyne Ryan Model 235 (YQM-98A) Compass Cope R drone

One of the two YQM-98A Compass Cope R prototypes nearing completion

Over-fuselage mounting for Garrett AiResearch ATF-3 turbofan engine is seen in this view of Compass Cope R drone

Roll out ceremony for both Compass Cope R prototypes in January 1974 earlier Compass Dawn monitoring and surveillance programme carried out in SE Asia. Where the latter was principally concerned with Sigint and Comint operations, the roles envisaged for Compass Cope vehicles includes these functions and others such as battlefield reconnaissance, TOA/DME (Time-of-Arrival/Distance Measuring Equipment) missions, communications relay, ocean surveillance, atmospheric sampling, and photo-reconnaissance. Operating altitudes of up to 23,000 metres have been mentioned and mission durations of as much as 30 hours. These, and other, considerations have led to a different form of launch and recovery procedure from the normal air launch and recovery techniques employed in Model 147 operations, and it is planned to have the Compass Cope drones operate from runways like a conventional aircraft.

DEVELOPMENT:

The Teledyne Ryan Model 235 was developed under a cost-plus-fixed-fee USAF contract awarded on June 13, 1972, and in its design experience gained with the Model 154 was applied. Both the two prototypes called for under the contract were completed by December 1973 and were formally rolled out on January 4, 1974. They could have been ready to start flight tests in the following month but Congressional cuts in Compass Cope funds imposed a delay.

STATUS:

The entire Compass Cope programme is the subject of some uncertainty, partially as a result of there being no US arm able or willing to commit itself to a firm procurement requirement for the production version, but this is expected to be reflected only as variations in the pace of the project rather than outright cancellation.

MANUFACTURER:

Teledyne Ryan Aeronautical, San Diego, California 92112, USA.

1817.351

COMPASS COPE B DRONE (YQM-94-A)

DESCRIPTION:

The YQM-94A, with the competing Teledyne Ryan YQM-98A (**1816.351**), is under consideration as the high-altitude, long endurance vehicle required for the Compass Cope reconnaissance and surveillance project. To differentiate between the two models they are referred to as Compass Cope R and B, respectively to denote Ryan and Boeing, the manufacturers concerned. Similar contracts were awarded to both companies, (that to Boeing having been placed about a year before Teledyne Ryan's) and called for the production of two prototypes. The main characteristics of the Boeing YQM-94A are given below.

LEADING PARTICULARS:

Power Plant: One General Electric J97-GE-100 turbojet rated at 2,390 kg st. Other power plants have been considered
Length: 12.8 metres
Span: 24.43 metres
Max T/O Weight: 5,897 kg (approx)
Mission Payload: 317 kg
Cruising Speed: Mach 0.5 to 0.6 at 15,000 to 21,000 m

A retractable tricycle landing gear is fitted and conventional runway take-off and landing techniques will be used instead of the air launch and recovery system which is normal for most current drone operations. Details of envisaged operational roles are given in the entry for the YQM-94A (**1816.351**, above) and in that for Compass Programmes (**1504.351**) in the following section of this volume.

DEVELOPMENT:

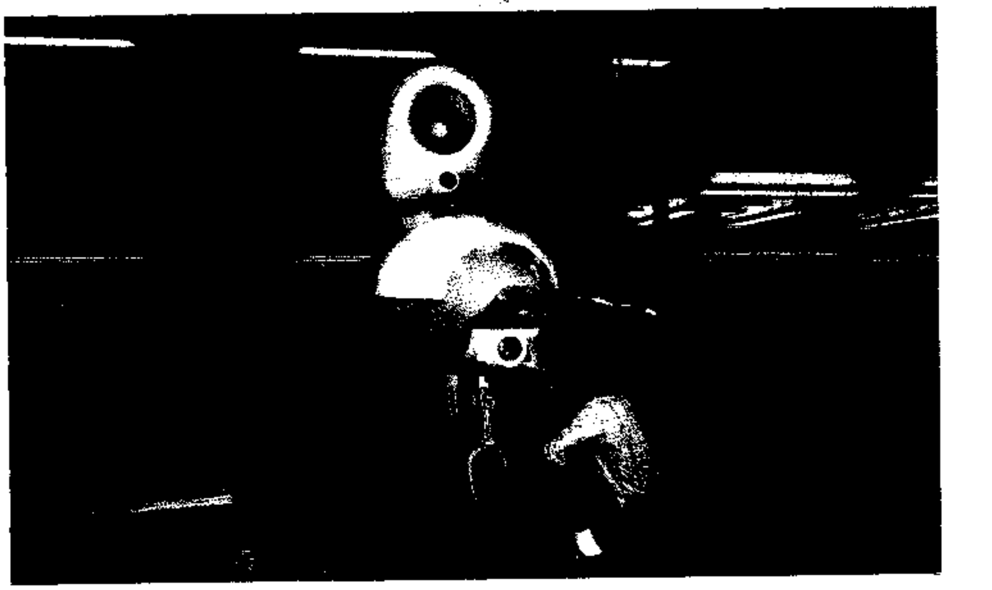
Design studies were started by Boeing in late 1970, followed by the award of a USAF prototype contract in July 1971. First of the two prototypes ordered was rolled out in late November 1972. This was delivered to the USAF in February 1973, and it was planned that flight tests should be carried out by the USAF 6510th Test Squadron at Edwards AFB, California. However a crash which occurred on August 4th destroyed the prototype YQM-94A.

STATUS:

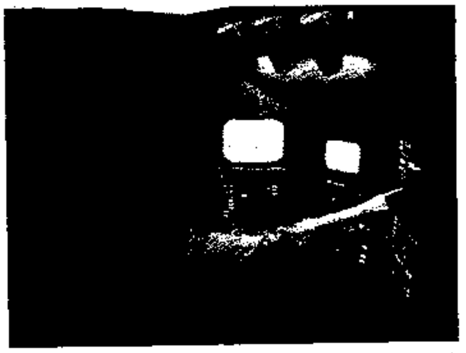
The entire Compass Cope programme is the subject of some uncertainty, partially as a result of there being no branch of the US Forces able or willing to commit itself to a firm production and procurement programme, and also due to reductions in funding. However, complete abandonment is unlikely.

MANUFACTURER:

Boeing Aerospace Company, Seattle, Washington 98124, USA.



Boeing Compass Cope B (YQM-94A) long endurance drone prototype. Note television camera housed in nose



The ground-based control station from which Compass Cope B vehicles are flown by remote control

1538.351

L450F XQM-93A RECONNAISSANCE DRONE

DESCRIPTION:

The L450F is a single-engine turboprop aircraft developed and equipped for medium altitude, long range strategic reconnaissance missions. It also may be used for certain tactical functions. The main characteristics of the aircraft are: wingspan 17.37 m, length 8.84 m, gross weight 2,086 kg, payload 320 kg, endurance 24.30 hours, cruise speed 165 km/hr.

Two L450F aircraft were funded by the USAF for flight trials and evaluation, and in April 1972 it was reported that one of them had successfully met USAF endurance and altitude requirements. The possibility that a batch of 12 L450Fs might be purchased for use by the USAF in the Compass Dwell signals intelligence gathering programme was mentioned late in 1971. In the event, neither the L450 nor the competing Martin Marietta Model 845A was put into production.

MANUFACTURER:

LTV Electrosystems, Inc., Greenville, Texas, USA.

1539.351

BEECH QU-22A/B BONANZA DRONE

DESCRIPTION:

The QU-22 is a modified version of the Beech Bonanza light aircraft, equipped for pilotless operation in a variety of battle area roles. A total of six aircraft were converted to QU-22A standard and 27 to QU-22B standard. Additional equipment includes electrical generating facilities with increased capacity to power sensor equipment, drone stabilisation and control systems, command equipment, transponders, data relay, and navigation sub-systems. The QU-22 was used in the Pave Eagle Programme (Entry No. **1533.311**) as a relay aircraft for data gathered by Igloo White (Entry No. **1397.151**) ground censors. A number of QU-22Bs were modified for use as remote controlled Forward Air Control (FAC) aircraft. After losses in SE Asia, the remaining aircraft of this type were withdrawn from service and put into storage.

2638.391

GYRODYNE QH-50D DRONE HELICOPTER

DESCRIPTION:

The QH-50D is the final production version of a series of drone helicopters that Gyrodyne produced while working on a US Navy contract, placed in 1958, for development of a specialised drone helicopter as the airline component of the DASH (Drone Anti-Submarine Helicopter) weapon system.

The QH-50D drone is powered by a Boeing T50-BO-12 shaft-turbine and is capable of carrying a weapon load of either two Mk 44 torpedoes or one Mk 46 torpedo.

Max speed: About 150 kmh

Speed for max range: About 150 kmh
Speed for max endurance: 100 kmh
Max rate of climb: 856 metres/min at S/L
Vertical rate of climb: 700 metres/min at S/L
Service ceiling: 4,875 metres
Max range, 10% fuel reserve: 227 km
Max endurance, 10% fuel reserve: 1 hr 43 min
Combat radius: 87 km

STATUS:

The QH-50D was considered for possible use in a number of Advanced Research Projects Agency programmes, including Night Gazelle, Night Panther, and Blow Low. The USAF has also investigated a number of armed roles for this platform. Evaluation trials have involved the inclusion of laser target designators, radar, and low light level TV in the payload. The DASH programme is no longer active.

MANUFACTURER:

Gyrodyne Company of America Inc., St. James, Long Island, N.Y.

2732.391
NORTHROP NV-105 CHUKAR

DESCRIPTION:

The Chukar is a lightweight target drone designed for anti-aircraft gunnery, surface-to-air missile and air-to-air missile training and weapon systems evaluation. Radio-controlled it is turbojet powered and is recoverable.

LEADING PARTICULARS:

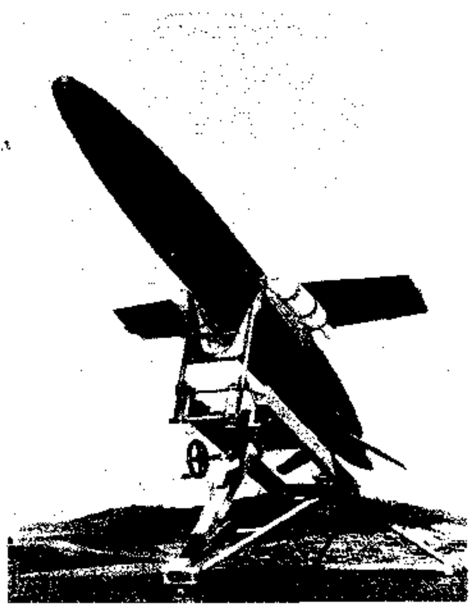
Power Plant: Williams Research Corporation WR24-6 turbojet, 2 JATO rockets for launching
Guidance: Radio control, automatic stabilisation and altitude hold
Launch: Rocket-assisted from zero-length launcher
Recovery: Parachute system operating on ground command or automatically on loss of power or system failure
Max level speed: 760 kmh at S/L; 815 kmh at 6,000 metres
Econ. cruising speed: 390 kmh at S/L
Rate of climb: 2,000 metres/min at S/L
Range: 300-450 km according to speed and height

STATUS:

The supply of a number of Chukar drones to Israel for non-target uses was reported in 1971.

MANUFACTURER:

Northrop Corporation, Ventura Division, Newbury Park, California 91320, USA.



MQM-74A Chukar gunnery target drone

1822.391
NORTHROP NV-123 VSTT (VARIABLE SPEED TRAINING TARGET)

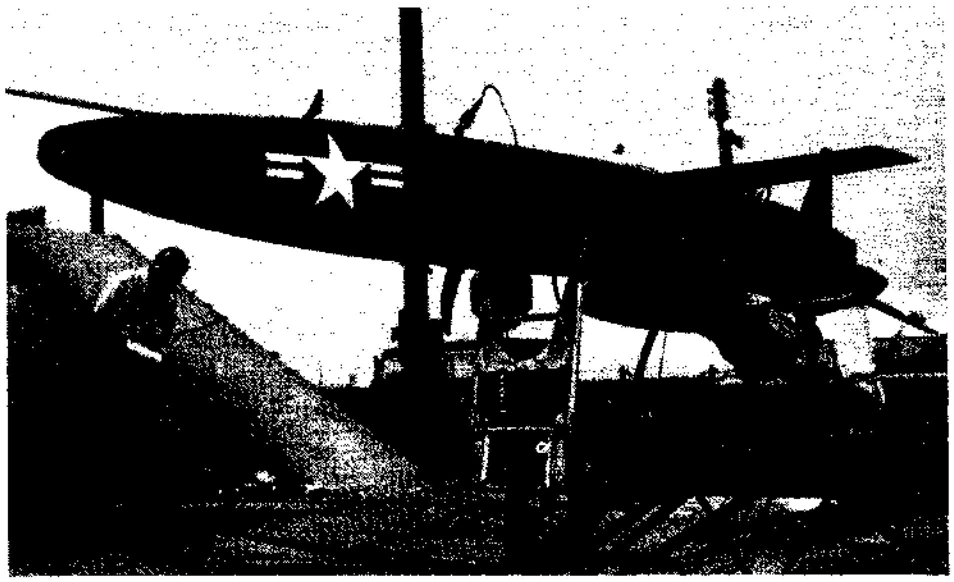
DESCRIPTION:

The NV-123 is Northrop's entry in the competition to provide the Variable Speed Training Target drone in response to the US Army requirement for training the crews of weapon systems such as Hawk, Redeye, and Chaparral in engaging high-performance air targets. The competing vehicle is one by Beech, described in Entry No. **1814.391**, which also gives more information about the operational requirement.

The Northrop NV-123 bears a close resemblance to the MQM-74C Chukar II target drone (**2732.391**).

LEADING CHARACTERISTICS:

Power Plant: Williams Research Corporation WR24-17 turbojet engine rated at 90 kg st. Single solid-propellant rocket booster motor for launch
Launch: Rocket assisted from zero-length ground launcher
Recovery: Parachute
Length: 3.8 metres
Diameter: 0.36 metres
Span: 1.7 metres
Launch Weight: 175 to 235 kg, depending on payload
Sea Level Speed: 450 to 1,050 km/h, variable
Altitude: 100 to 13,000 m
Duration: 2-3 hours



Bendix LAST (Low-Altitude Supersonic Target) prior to test launch at White Sands Missile Range

STATUS:

First flight of the NV-123 was made in early 1974 and a decision on which of the competing VSTT vehicles is to be put into production was due to be taken later in 1974 following test and evaluation flights.

MANUFACTURER:

Northrop Corporation, Ventura Division, Newbury Park, California 91320, USA.

1819.391
PQM-102 TARGET DRONE

DESCRIPTION:

In March 1974 it was announced that the USAF was about to make its first purchase of 22 F-102 Delta Dagger interceptor aircraft converted for use as unmanned target drones, in which form they bear the designation PQM-102. One of the main functions of this new class of target drone is for the testing and evaluation under realistic conditions of the latest types of air-to-air weapons and the new generation of fighter aircraft. There are already F-102s which have been withdrawn from front-line service and by 1975-6 it is planned to withdraw the remainder from USAF service; the PQM-102 inventory will be established from this source.

The USAF plans to build up a force of up to 132 of these drones at an annual rate of 22. Although classified as drones, the PQM-102 qualifies for the USAF RPV definition. A pilot sitting in a van at the end of the runway will carry out the preflight checks remotely and then 'fly' the aircraft off the ground and clear of the airfield area for handing over to the range radar mission controllers. If the drone survives the mission, the procedure will be carried out in reverse to recover the target vehicle.

DEVELOPMENT:

Sperry was awarded a $5.5-million contract in Spring 1973 for the conversion of an initial batch of six Convair F-102 aircraft for the target drone mission. Of the six, two retained the manual pilot facilities, these two models being designated QF-102; the other four were configured for full unmanned operation.

1820.351
RPAODS (REMOTELY-PILOTED AERIAL OBSERVATION/DESIGNATION SYSTEM)

DESCRIPTION:

This is a joint US Army/ARPA (Advanced Research Projects Agency) programme which has been in progress since 1972-73 with the objective of developing lightweight, low cost tactical RPV systems with day and night surveillance sensors and laser target designation capabilities. It is expected to result in vehicles that weigh in the region of 16 kg, cost less than $10,000 in quantity and have the capability of acquiring tactical information at ranges up to 80 km from their launch point.

In the interests of cost limitation the prospect of using vehicles similar to model radio-controlled aircraft is receiving a high proportion of the total effort but more exotic elaborations on this theme also are under examination. Many of the leading US defence contractors have made their own studies, proposals, and/or experimental prototypes, some of which have been the subject of US Army and USAF trials.

A new mini-RPV (miniature Remotely Piloted Vehicle) of advanced design was delivered to the US Army Electronics Command by Philco-Ford Corporation in May 1974, and is now undergoing flight tests at Fort Huachuca in Southern Arizona. These flights are being made in conjunction with tests of other RPV configurations as a preliminary step in development of the RPAODS programme.

The new Philco-Ford RPV, known as Praeire II is a glass-fibre aircraft measuring only 2.89 m in length, with a 3.66 m wing span, and weighing less than 40 kg. It is a pusher design, with the engine mounted in a streamlined pod above and behind the wing. Its payload is a unique target designation system fitted inside the fuselage nose section. The system employs a TV camera and laser for visual acquisition, tracking, identification and designation of ground targets for precision attack by laser guided projectiles and bombs.

The Praeire II is the newest in a series of mini-RPVs developed by Philco-Ford's Aeronutronic Division at Newport Beach, Calif. The original Praeire I vehicle (from the Latin, "leading soldier") was developed for the Defence Department's Advanced Research Projects Agency (ARPA) under a contract with the US Air Force Aeronautical Systems Division. Like the current Praeire II, the Praeire I system employed a stabilized sighting system with TV and laser for target designation. The Air Force, at Eglin Air Force Base, Fla., conducted a series of highly successful Praeire I RPV flight tests with actual drops of guided weapons against simulated combat targets.

Other versions of this new RPV series include night-time designation systems called "Calere I and II", employing miniaturized FLIR (Forward Looking Infra-Red) sensors in place of the daytime TV sensor.

Primary emphasis by Philco-Ford and the military in the design and development of mini-RPVs has been on extremely lightweight and low cost sensor packages and aircraft systems.

It is expected that the test and engineering phase will continue for at least another year before the stage of placing production contracts is likely to be reached. The Fiscal Year 1975 Defence Budget called for a sum of $5.5-million for continuation of the RPAODS programme.

1821.391
KAMAN RPV AND DRONE PROGRAMMES

DESCRIPTION:

The feasibility of using an unmanned, tethered, rotary-wing, aerial platform for battlefield surveillance and target acquisition will be investigated by Kaman Aerospace Corporation. A Kaman subsidiary, under a $52,000 study contract awarded in early 1974 by the Eustis Directorate, US Army Air Mobility Research and Development Laboratory, Fort Eustis, Virginia.

The study will consider various concepts providing a stable, elevated platform capable of housing sensing devices for search, detection and observation while hovering for lengthy periods at prescribed altitude.

A wide variety of rotary-wing configurations will be analyzed to determine their suitability for use as manned, tethered vehicles, together with their respective ground support requirements. From this analysis, an optimum concept will be selected for further design and study in the context of various mission requirements which may be imposed.

One concept advanced by Kaman envisions a tethered, rotary-wing drone launched and retrieved from a 2½-ton cargo truck. A command and control truck and a fuel truck are included in the system, which has mobility, flexibility and self-sufficiency.

Kaman Aerospace has been active in the design and development of tethered and free-flying, remotely piloted, rotary-wing vehicles for the US Army, Air Force and Navy for more than 20 years. The company currently is under contract to the Navy's Office of Naval Research for development and experimental flight test of a Ship-Tethered Aerial Lifting Platform (STAPL) concept. Two autogyro-type vehicles are being prepared for testing.

Under the contract, Kaman will design, fabricate, flight test and evaluate two unmanned autogyro aircraft equipped with automatic flight control systems and data recording equipment. The self-contained automatic flight control system engineered by Kaman will provide three-axis stabilization and automatic flight path control and contain the necessary redundancy for mission reliability.

Kaman performed concept analysis, feasibility studies and preliminary design planning on STAPL under an initial $78,000 ONR contract several years ago. The tethered system has potential for several applications requiring an elevated platform.

Additionally, Kaman is conducting independent design studies and mission analyses of rotary wing RPVs aimed at the US Army's remotely piloted aerial observation and designation system (RPAODS) real-time target designating requirements (see Entry **1820.391**, above).

Kaman has pioneered in the development of drone helicopters and rotorchutes, producing the world's first remotely-controlled free flying helicopter in 1953 and world's first electrically powered tethered helicopter in 1957. The Kaman QH-43G, a drone version of the HH-43 Huskie helicopter, accumulated several hundred flight hours as a shipboard-based tethered drone, raising a 10,000-foot VLF antenna vertically from a communication ship while underway at sea.

Kaman remotely-piloted drone helicopter under test

Kaman also has designed and developed numerous remote control and automatic control systems for helicopters and other vehicles, including target boats and armoured tanks.

MANUFACTURER:

Kaman Aerospace Corporation, Old Windsor Road, Bloomfield, Connecticut 06002, USA.

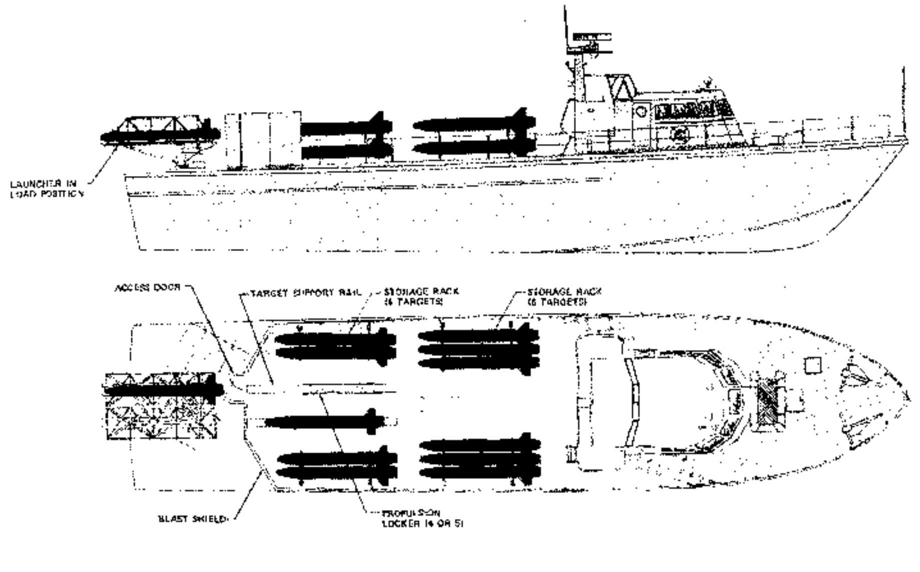
1540.391
SPT-B SELECTABLE PERFORMANCE TARGET-BALLISTIC (BATS)

DESCRIPTION:

Also known as Ballistic Aerial Target Systems (BATS) the SPT-B has been designed as a safe, reliable, and low-cost system principally for troop training with low-altitude air-defence systems. It consists of three major subsystems: Target, Launcher, and Fire Control.

A Naval Ballistic Aerial Target System has been designed to provide low cost, high performance targets for ships at sea and at over water ranges where a sea launch is required.

The system consists of the Improved Ballistic Aerial Target (SPT-B2A), a twin stabilized launcher, and a utility boat mounting the launcher, storage racks and a propulsion storage locker. The target has the same performance and augmenta-



Target Utility Vessel – General Arrangement tion capabilities as the land launched version.

The system is designed to be installed on an 85 ft utility work boat and operated by a crew of 6 men. This configuration has the capability of providing up to 20 targets without resupply. The system can be installed on other customer furnished boats of similar size and construction.

The target airframe is a monocoque structure with an all-metal exterior for radar enhancement and ease of handling. The centre section is a thin rolled metal skin, reinforced with ring frames and polyurethane foam. The nose, aft body and fins are aluminium. Propulsive thrust for the BATS is provided by two to five standard 2.75-inch Low-spin Folding Fin Aircraft Rockets (LSFFAR) for boost and by a sustainer motor using two MXU-4A/A jet engine starter cartridges. The 2.75-inch LSFFAR motors are internally mounted in the aft body and canted so that the thrust vector passes through the target's centre of gravity to provide the minimum safety area requirements. During flight the target is spin stabilized. Spin is induced by the cant of the fins, the cant of the sustainer motor nozzles, and the scarfing of the 2.75-inch LSFFAR nozzles. Three levels of thrust nozzles are available to provide varying flight profiles.

IR, radar, and visual augmentation have been used with the BATS target as well as two types of scoring devices. Visual and IR augmentation may be either nose or tail mounted depending on the weapon and engagement profile used. Radar augmentation is provided by replacing the aluminium nose cone with a plastic cone containing a passive reflector.

Two types of scoring devices are available. An externally mounted miss distance indicator for use with missiles has been successfully used which provides a miss distance in feet. The second, a much less expensive hit indicator, is mounted internally in the nose cone and provides a visual indication of hit by guns or a near hit by a supersonic missile.

Launch control of the targets is provided by the Fire Control Master Unit, the Fire Control Slave Unit, and associated transmission lines and power supplies. The Fire Control Master Unit provides the versatility of selecting any or all of six targets for firing.

The BATS provides the user with a wide selection of flight parameters:

Velocities from 275 to 550 knots, in 75-knot increments

Range to 7,300 metres

Altitude to 6,700 feet (2,042 m)

Flight times to 43 seconds

All parameters are selectable at the launch site with no system modification required. The desired flight performance is achieved by the selection of from two to five booster motors; low, medium, or high thrust sustainer nozzles; and the launch angle.

OPERATION:

A crew of three is required for efficient operation of each BATS launcher installation. Training for total system operation requires less than eight hours. All system components are transportable on a standard US Army 2.5-ton, 6-by-6 truck and are light enough to be man loaded.

STATUS:

Orders to date exceed 24,000 units for delivery to the US Army, US Navy, United Kingdom and Australia.

MANUFACTURER:

Teledyne Brown Engineering, Research Park, Huntsville, Alabama 35807, USA.

2798.391
ROADRUNNER

DESCRIPTION:

Roadrunner is a low-altitude supersonic target drone made by Rockwell International for the US Army. Ramjet-powered and rocket-launched, it is designed to fly at speeds in the region of Mach 1 and at altitudes from 90 to 4,500 metres. It is being used for missile research and development and for training Hawk missile crews.

LEADING CHARACTERISTICS:

Power Plant: Marquardt MA-74 ramjet

Guidance: Radio command. Automatic altitude hold system which can be overriden by ground controller

Launch: From Little John rocket launcher. Boosted by Rocketdyne jettisonable solid-propellant booster rocket

Recovery: Parachute system. Automatic recovery on fuel exhaustion or system failure. Command recovery on ground initiative. Retro-rocket slows missile just before final touchdown

Speed range: Mach 0.9 to 1.4

Altitude range: 90-4,500 metres

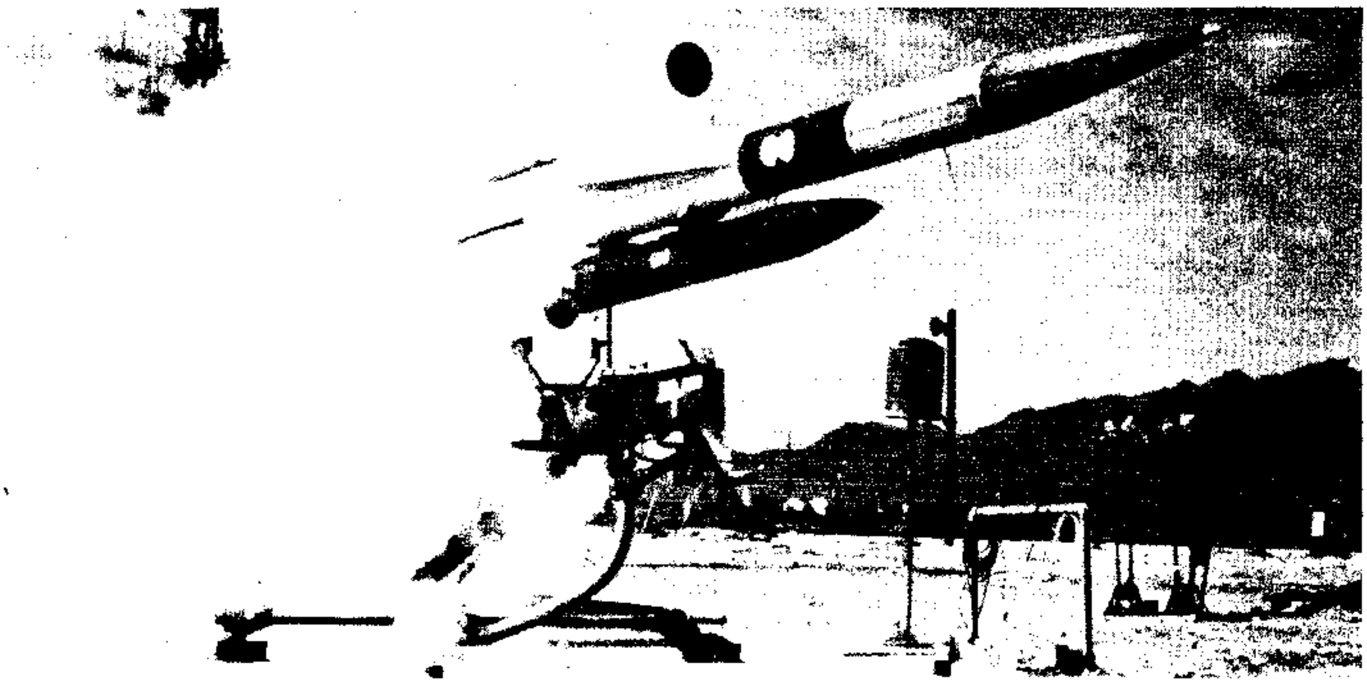
Endurance: 60-90 km

REDHEAD

The Redhead/Roadrunner is a target drone similar to the Roadrunner but has a different Marquardt ramjet, has a speed range from Mach 0.9 to Mach 2.0, an altitude range from 90-18,000 metres and an endurance of some 400 km.

MANUFACTURER:

Rockwell International, Missile Systems Division, Columbus, Ohio, USA.



Redhead/Roadrunner launched at White Sands Missile Range

RECONNAISSANCE SYSTEMS

1504.351
COMPASS RECONNAISSANCE PROGRAMMES

DESCRIPTION:

A number of USAF aerial reconnaissance programmes initiated in response to SE Asia Operational Requirements are known under designations which start with the word 'Compass', e.g. Compass Dawn. The second word is changed to denote differing functions or elements of systems within the overall programme. Although the disengagement of US Forces from Vietnam will have brought many of these programmes to an end, the 'Compass' designation is retained for certain current and planned reconnaissance programmes and projects.

Compass Arrow was a drone reconnaissance programme covering areas of China, and now suspended. Ryan AQM-91A drones were used to carry varying payloads for photo, infra-red and Elint missions.

Compass Bin was a low-altitude photo-reconnaissance drone programme in SE Asia, using AQM-34L drones. The experience gained and some of the hardware and technology are being applied to successor programmes.

Compass Bright is the name of a passive intelligence project which includes the development of an airborne system for automatic direction finding and ranging on a passive basis from both manned and unmanned aircraft. The Compass Cope high altitude drone and the U-2 reconnaissance aircraft are probable vehicles. Funding for Compass Bright is provided under Programme Element 31011F – Cryptologic Activities, and of the several projects under this heading Compass Bright is Project 1148. In January 1974 it was revealed that E-Systems, Inc had been selected to provide the direction finding and ranging system.

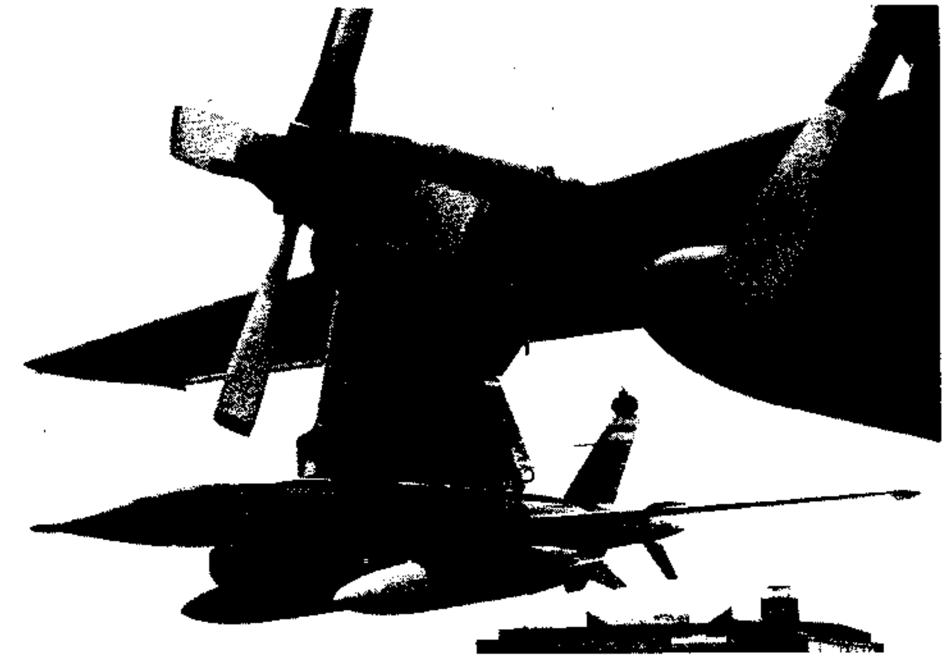
Compass Cope is a programme for the development of high-altitude, long endurance (up to 36 hr), multi-purpose, unmanned, reconnaissance aircraft. These vehicles will accommodate a variety of payloads such as cameras, side-looking radar, time-of-arrival (Elint) receivers, communications relays or Sigint receivers. Unlike current reconnaissance drones, Compass Cope aircraft will be launched and recovered on a runway, instead of air launch and recovery by DC-130 aircraft. Competing designs have been produced by Boeing and Teledyne Ryan.

The initial test flying, preparatory to competitive evaluation, began in Summer 1974. It is funded under Programme Element 64732F which is concerned with reconnaissance and electronic warfare drones and RPVs.

Compass Counter is a USAF project with the objective of pin-pointing a large number of hostile emitters (radar and radio) on a near real-time basis, by means of time-of-arrival techniques. Several aircraft would be used and data would be relayed to ground processors. Seven RB-57 aircraft will be assigned to the test programme, if it is sanctioned.

Compass Dart was developed in 1968-9 for use in Vietnam. HF direction finding techniques were used against specific enemy communications transmissions to determine the positions of targets for air strikes. The major contractor was Sanders Associates.

Compass Dawn superseded Compass Dart although the general principle remains similar. Higher frequencies and coverage of a larger portion of the spectrum were important differences, and the system was intended for the accurate location of enemy radiating sites to provide target designation for a counter air strike. This programme was cancelled, and replaced by TEREC (Tactical Electronic Reconnaissance). This programme, itself, is part of the wider Tactical Information Processing and Interpretation (TIPI) project, funded under Programme Element 64701F, for which $13,400,000 was requested in the FY 1973 budget. There are four functional segments of TIPI.



A Teledyne Ryan Aeronautical Model 147 drone beneath the wing of a launch and recovery DC-130A aircraft. Drones of this category are used for Elint operations of the Compass Dwell programme. Note antennae at fin-top and nose

(1) Image Processing – This is being performed by existing equipment.

(2) Image Interpretation – Development is completed and evaluation started in December 1972, with production following in 1974.

(3) Display and Control / Storage and Retrieval – A four-year prototype development programme was initiated in September, 1971, when Systems Development Corporation was awarded an $11.25 million contract for software, with RCA as major sub-contractor for hardware integration. The Sperry Rand Univac AN/UYK-7 digital computer was selected.

The data storage and retrieval elements of TIPI, constructed and integrated by RCA's Government Communications & Automated Systems Division, were shipped to Langley AFB in July 1974 for Category 2 testing following successful demonstration at RCA's Burlington, Mass, facility. The data segment, called Display and Control / Storage and Retrieval, is housed in 18 integrated shelters, 11 of which will be used by the USAF and seven by the USMC. Hardware development and integration were carried out by RCA under a $12-million contract from SDC.

(4) Tactical Electronic Reconnaissance Processing and Evaluation – A prototype of this segment is to be developed during FY 1973, and TEREC is the sensor element of this segment, and will include sophisticated receivers for the detection and location of radars tracking friendly aircraft. These receivers will be installed in RF-4C aircraft. Litton received a $3-million contract for the TEREC monitoring system in August, 1971.

Compass Dwell designates a programme under which photographic and Elint reconnaissance missions of long duration are performed by Teledyne Ryan 147 drones flying at high altitude. A major objective is the accurate location of hostile radar sites.

Compass Ghost was the name assigned to a programme originated in 1971-72 to investigate and develop electro-optical counter-measures systems and equipment for USAF tactical aircraft. Contractors involved were Systems Research, Electro-Optical Systems, and Holobeam.

Compass Home is the designation given to another method of locating hostile ground radars. Development was undertaken by Westinghouse, and the technique entails the use of an F-4 aircraft's A1 radar which is locked onto the transmissions from the ground radar.

Compass Link is the code name allocated to a secure data link for the relaying of reconnaissance information from Vietnam to Washington via the Initial Defence Communications Satellite System. Because of the distance between the terminals, data was sent in two 'hops', with a relay facility at Hawaii where there were also facilities for readout of the information.

Film returned from a reconnaissance flight is scanned by a laser system and the analogue signals are converted into digital format before encrypting. The encrypted form is used for multiple frequency shift keying of the RF carrier.

The system was developed by Philco-Ford under a $4.6 million USAF contract, and went into operation in December 1968.

Compass Matrix, although associated with reconnaissance programmes, is essentially an Electronic Warfare project. It entails the development of a sophisticated and comprehensive system of management for aircraft ECM equipment in response to the nature of the threats detected and encountered. In March 1974 the USAF Avionics Laboratory selected companies to undertake studies of methods of making more efficient use of available jamming energy, while conducting with Westinghouse studies of power management techniques for the ALQ-119 jamming pods carried by F-4 fighter-bomber aircraft. In June 1974 it was announced that a fly-off evaluation of competitive power management concepts proposed by Loral and Itek was being planned by the USAF.

Compass Quick is also connected with electronic warfare and is the code-name of an updating programme for the Elint systems and equipment of EC-135 aircraft.

Compass Robin is a little-known sensor system for the collection of Elint on certain threat systems, and employs a so-called "implant" type of sensor. The USAF sponsored a $1.5-million development effort during FY 1973.

Compass Sight is a system by means of which infra-red reconnaissance information gathered by RF-4C aircraft is sent via data link to a ground station. The video data link is produced by the Cubic Corporation and probably operates at C-band frequencies. The system also has provision for relaying data via a second, higher aircraft as an alternative to direct air-to-ground transmission. The system was developed in response to SE Asia Operational Requirement 45, and three RF-4Cs are believed to have been equipped with sensors, and two B-57Es with relay equipment.

Compass Strike is a system of locating radars from two or more aircraft by means of time-of-arrival techniques. The broad principle employed is that two aircraft, a precisely defined distance apart, measure the difference in respective times of arrival at each of a pulse from the radar to be located. Lines of constant time difference are parabolas, and the initial measurement will locate the emitter on one of these. A second measurement taken after the other will produce another parabola, which, where it cuts the first one, defines the position of the emitter in two co-ordinates.

While simple in principle, this technique clearly calls for considerable equipment sophistication, when it is considered that the measuring platforms are moving at high speed and need to know their relative and absolute positions with considerable accuracy. Other problems are the provision of synchronisation facilities to provide an accurate timing reference and a means of ensuring that the same transmitter signal is timed. This is further complicated by the high data rate presented by the target radar and what this means in terms of ambiguity. To resolve these problems calls for powerful data processing and computational facilities, and digital processors are employed.

The original Compass Strike project began as QRC-334 and was fitted to F-4 aircraft. These had to fly close to each other because of the need to resolve the ambiguity problem just mentioned. The later programme, QRC-385, incorporated techniques evolved by IBM which removed this requirement and the use of larger aircraft, such as the EC-135, at greater separations is a possibility.

1397.151
IGLOO WHITE SURVEILLANCE SYSTEM

DESCRIPTION:

Igloo White is the code name given to an ingenious concept for the remote detection of transport vehicles and other military traffic from the air with the objective of initiating and directing air strikes against such traffic. It was employed by American forces in South Vietnam and the results obtained have led to similar systems being contemplated for other theatres, such as Western Europe. For this reason the following description of the SE Asian system is retained although it is now almost certainly completely dismantled.

The three principal elements of the system are: (1) air-dropped sensors, (2) a loitering aircraft that monitors the outputs of these sensors, and (3) an Infiltration Surveillance Centre (ISC) to which data is relayed by the aircraft. The information thus obtained is used to direct strike aircraft, either immediately against the moving traffic flow, or later at an area containing a computed concentration of vehicles.

Four types of sensor are employed, two based on acoustic principles and two relying upon seismic effects. The first two are based on sonobuoy technology, but with modifications appropriate to use on land, in particular the replacement of the underwater sonar transducers by microphones. One type, the Spikebuoy, is dropped from the aircraft, and aided by a pointed nose, penetrates the ground to the extent that only the radio antenna is left above the surface. The other acoustic sensor is the Acoubuoy, which is parachuted from the aircraft and is designed to suspend itself amongst the foliage of trees.

The most widely employed sensor is the ADSID (Air Delivered Seismic Detection Sensor), which is deployed in a similar fashion to the Spikebuoy but incorporates a seismic detector in place of the microphone. This sensor is stated to be capable of presetting to activate the associated radio transmitter only when vibrations of specific amplitudes and characteristics have been detected.

The fourth type of sensor, Acousid, combines seismic detection with a microphone which can be remotely activated to provide either confirmatory acoustic information, or additional data that can be provided by a microphone after initial detection by seismic means.

A further type of sensor, which has not been identified positively with Igloo White but which is likely to be associated with it is EDET. This is an air-dropped remote sensor for the detection of internal combustion engine ignition systems. It was added to the US inventory in Fiscal Year 1971.

The emplacement of sensors is planned in accordance with other intelligence information such as aerial photographs, observation flights, battle reports, etc.

The relay aircraft employed originally was a version of the Lockheed EC-121R. This aircraft, a military variant of the four-engined Constellation, is large and relatively costly to operate, and it was later joined in this role by other types.

One of these was a special version of the Beech Debonaire, a single-engined commercial aircraft, and another was the Beech Bonanza, these being equipped under the programme code-named Pave Eagle. The smaller capacity of these machines limited their use to that of a relay platform only, whereas the EC-121R can carry the crew and equipment necessary to permit analysis of sensor data and possibly the direction of air strikes. The Beech Bonanza aircraft were converted for a form of drone operation, though in fact carrying crew, and were designated QU-22B aircraft. In operation they had an unfortunate safety record which led to changes in their use.

The Infiltration Surveillance Centre is equipped with communications and control systems for the collection of relayed sensor data and the direction of relay aircraft and strike forces. It also has extensive computer and data processing facilities for the analysis, display, and interpretation of results. In support of this complex, a Deployable Automatic Relay Terminal (DART) facility has been developed. This is air transportable, but is less sophisticated than the ISC proper, and relies upon human interpretation of data as it is received.

A more sophisticated version of this, with computer facilities and capable of integration with the Tactical Air Control System was under development in mid-1971.

DEVELOPMENT:

Development was directed by the US Defence Communications Planning Group, and the concept originated within the Institute of Defence Analysis. The system became operational in Vietnam in December 1967. Total cost of Igloo White to mid-1971 was $725 million.

STATUS:

Following the US withdrawal from Vietnam, Igloo White is assumed to have been dismantled, but plans to evolve a similar system or systems for possible deployment in Europe have been initiated. This is known as REMBASS (Remotely Monitored Battlefield Sensor System) and is based on use of sensors used in SE Asia, modified for use in Europe. In advanced development by early 1974, REMBASS may enter full-scale development in 1975, depending upon a decision by the end of 1974. A sum of about $10.6 million would be required.

1899.351
PAVE STRIKE PROGRAMMES

DESCRIPTION:

Pave Strike consists of eleven distinct projects which have been selected for special and co-ordinated treatment to improve the USAF tactical all-weather strike, defence suppression and night attack capabilities. Each of the eleven systems is part of the composite group of capabilities needed for effective night and all-weather strike capability. The Fiscal Year 1975 plan envisaged a total expenditure of $40-million on the eleven programs, which are (with their Programme Element and Project Numbers, where known):

(1) Modular Guided Glide Bomb II (PE 63741F, Project 1901)
(2) EO Glide Bomb – EOGB II (PE 64733, Project 2076)
(3) DME Guided SUU-54 Dispenser, Pave Storm Cluster Bomb (Project 5974)
(4) Precision Emitter Location and Strike System – PELSS (PE 64742F)
(5) Deployable Data Base (Project 2106)
(6) Airborne Locator and Strike System – ALSS (Project 1949)
(7) EF-111A Manned Support Jammer Aircraft (PE 64220F)
(8) Advanced Development of Imaging Infra-Red Guidance (PE 64709F Project 2144)
(9) Laser-guided Maverick (PE 64608F)
(10) Pave Tack Pod (FLIR and laser target designator pod for F-4 and F-111) (PE 64709E Project 2056)
(11) Multi-mission RPV (PE 64732F Project 2107)

Five of the eleven projects are concerned with target detection and acquisition, items (4), (5), (6), (10) and (11) above.

The Deployable Data Base is a photogrammetric target data base which incorporates a facility for putting DME co-ordinates onto photographs to provide precision target location information. On this data base, with computer processed information, it will be possible to overlay a variety of reference grids and to rapidly convert co-ordinates from one reference frame to another to suit the strike system to be employed.

The airborne Locator and Strike System (ALSS – also officially translated in US Government publications as Advanced Location and Strike System) has been under test since October 1972 and has involved the use of DME guidance for a variety of air-to-surface munitions. Although limited in frequency and capacity, ALSS has located emitters (eg radars) at ranges of 150 miles. Employing DME guidance, weapons have been delivered to simulated enemy emitters at stand-off ranges.

The more advanced PELSS will provide a capability for precision location of emitters by Time-Of-Arrival and Distance Measuring (TOA/DME) techniques. Compared with ALSS, this system will have enhanced capabilities for the location of targets (probably in the face of ECM or ECCM) and for the direction of a wider range of munitions.

The Pave Tack pod is a combined Forward Looking Infra Red (FLIR)/laser ranging/target designator pod to provide a night search and track capability for laser-guided, Imaging I/R-guided, and free-fall weapons delivery.

The Multi-Mission RPV programme provides for the modification of the BGM-34C drone, by modularising the nose section to allow for either a Reconnaissance Module or an Electronic Warfare Module to be carried, in conjunction with a variety of wing and fuselage store stations for the deployment of air-to-surface weapons appropriate to the category of target to be attacked.

1898.351
US NAVY OCEAN SURVEILLANCE PROGRAMME

General:

US Navy programme directed toward effective global ocean surveillance embraces four main lines of research and development:

(1) EPX, which is a very high altitude surveillance and reconnaissance aircraft
(2) An ocean surveillance satellite system, using available technology
(3) An advanced satellite sensor system
(4) A geostationary satellite system to relay reconnaissance and surveillance data to ships of the Fleet directly.

In these programmes there is co-operation with the USAF, but the precise extent of this collaboration is not known. Most of the USN activity in the area of ocean surveillance is funded under one or other of the following Programme Elements, for which the Fiscal Years 1974 and 1975 allocations are indicated ($ millions, FY 1975 figures in brackets):

63516 N	Radar surveillance equipt	2.5	(7.3)
63522 N	Advanced sub surveillance equipt	4.7	(4.9)
63763 N	Aerospace ocean surveillance	25.8	(24.1)
63717 N	Integrated ocean surveillance information	5.7	(4.5)
64508 N	Radar surveillance equipt	8.3	(10.9)
64515 N	Sub surveillance equipt	8.4	(9.4)

Related Programme Elements which may provide funding for some part or associated facility for ocean surveillance are:

63519 N	Advanced command data system	3.9	(5.1)
28010 N	Joint tactical communications	1.8	(15.2)
33109 N	Satellite communications	41.5	(27.3)
33401 N	Communication security	3.3	(4.3)
63520 N	Advanced communications	2.6	(2.2)
35111 N	Project W37X3: Satellite Data Processing System.		

In the context of the total USN space programme, the surveillance aspects have been officially outlined as follows:

The Navy Space Programme will provide better and more rapid ways of gathering information over broad areas of the Earth by satellite; the information will be correlated and evaluated, then transmitted via satellite to the commander at sea for consideration in his decision-taking process. Orders to subordinates arising from this will be transmitted to them by satellite. The objective is to provide near real-time surface ocean surveillance to task force commanders world-wide. Neither local assets (aircraft) nor wide coverage assets (satellites) can meet all requirements all the time in a cost-effective manner. Space sensors which provide broad area coverage at reasonable re-visit intervals are appropriate in times of increasing tension. Airborne sensors providing greater accuracy and more frequent contact are needed closer to a task force during heightened tension or actual conflict. A concept of complementary air and space-borne sensors to accomplish this is in advanced development. The space segment, formerly Programme 749 has been combined with very high altitude aircraft sensor experiments under the new and comprehensive Aerospace Ocean Surveillance programme element (63763 N).

The programme will provide the necessary air and space sensors which will be integrated with data processing and display systems to present required data in near real-time. These systems will also be interfaced with the National Command Authority to provide information as desired. Information derived from the space and airborne sensors will be combined with complementary data on an all-source basis available from the automated intelligence data base. This will remove most of the burden of analysis from field commanders and provide filtered information to permit rapid combat or action decisions.

As part of the programme of sensor evaluation, the USN for a period of about two or three years has been obtaining USAF reconnaissance satellite data. It has been suggested that the USAF data is used for comparison with and evaluation of data obtained from experimental USN satellites which are thought to include a variety of thermal imaging and infra-red sensor packages. Radar is another form of sensor which is known to be under examination for the ocean surveillance satellite.

The airborne sensor development part of the programme began in 1974 with a $3.4 million contract for the modification of a high-altitude U-2 aircraft by Lockheed, into an advanced version of the EPX surveillance aircraft. This followed successful flights of an experimental ocean surveillance aircraft (based on a U-2 loaned by the USAF) during 1973.

The new EPX aircraft is planned to begin trials off the Southern California coast early in 1975. Among the sensors selected is a dual electro-optical surveillance system comprising an infra-red imaging sensor and a low-light-level television camera, which is being developed by Xerox. These sensors will be mounted on a common stabilised platform contained in a 20-inch (51 cm) diameter sphere in the nose of the U-2. The EPX will also carry an Elint receiver (which had not been selected at the time of going to print) and an ASV radar, which will probably be the APS-116 which is standard on the USN P-3C Orion maritime aircraft. The earlier test vehicle employed a modified RCA commercial weather radar for this function.

In July 1974 it was reported that conflicts of schedules were creating difficulties for the Navy in maintaining the pace of flight programmes connected with the EPX project and it was suggested that the options available were changing to an alternative type of aircraft (if a suitable type could be found) or re-starting the U-2 production line.

Although no details apart from those given above have been obtained, some indication of the scope is given by the titles of specific projects contained within the Programme Elements listed above. Some of these are given below:

33401 N	Communication Security:	
	Project X3291	Clarinet Vallor
	Project X3299	Clarinet Plato
63763 N	Aerospace Ocean Surveillance:	
	Project W3518	Aircraft Systems
	Project W3519	Space Systems
	Project W3520	Advanced space systems
	Project W3521	Space systems applications

1624.351
AMERICAN SATELLITE PROGRAMME

General:

American military satellite launches identified for the year 1973, as summarised in the adjacent table, show an impressive consistency in comparison with the programme for 1972, which year was notable for the contrast in numbers of satellites required to fulfil the US requirement compared with the much higher numbers needed in earlier years. This feature of the American satellite programme and the historical background to the various development projects were discussed at some length in Jane's Weapon Systems 1973-74. The following paragraphs are intended to summarise the present position and outline future developments.

The USAF is concerned with four satellite programmes for current operational requirements, these being concerned with communications, missile launch early warning, reconnaissance, and meteorological data collection. A fifth area which involves collaboration between the USN and USAF is that of satellite navigation systems.

Meteorological Satellites:

The Defence Meteorological Satellite Programme is managed and operated by the USAF. Two satellites are required on-orbit to continuously collect visual and infra-red data on weather conditions around the world. The data is processed by the Air Force Global Weather Central for distribution to both military and civil users. Two generations of Satellite are current, those of later design having a longer orbital life than their predecessors.

Built by the Lockheed Missiles and Space Company for the USAF, the Agena space vehicle has been the carrier of numerous classified Earth orbiting missions

Infra-Red Missile Warning Satellites:

The infra-red early warning satellite series is a principal component of the US deterrent complex. Appropriately sited geostationary satellites ensure that no long-range missile can be launched from any part of the Earth without the event being signalled to the US military authorities. The system also provides an element of impact prediction.

Reconnaissance Satellites:

Short duration photo-reconnaissance satellites have virtually disappeared from the American launch tabulations, having been replaced by the Big Bird series which have typical durations of two or four months, and others which are assumed to be for reconnaissance purposes and which have a life of four or five weeks. Either or both types may include an Elint capability.

Communications Satellites:

The DOD has two basic and independent types of satellite communication system included as elements of WWMCCS (World-Wide Military Command and Control System). One type provides long-distance, point-to-point, high data rate traffic using large ground and shipboard terminals. This system, in general, carries 'strategic' command global traffic, as well as intelligence data, high priority warning, and special communications. The second type provides the essential command and control communications needed for the employment of forces to carry out the Single Integrated Operating Plan (SIOP). Because of the requirement to support many mobile users equipped with smaller terminals, such as aircraft and dispersed naval units, this type of communication system provides low data rate traffic at a very low bit-error rate. The Defence Satellite Communication System (DSCS) provides the first type of service. The Air Force Satellite Communication (AFSATCOM) system and the Navy Fleet Satellite Communication (FLTSATCOM) System provide the second type. The DSCS is managed by and is under the operational control of the Defence Communications Agency, and the USAF is responsible for acquisition and orbital servicing of the space element of DSCS. The system consists of four satellites which between them provide a global capability. The planned orbital life of these satellites is three years.

The AFSATCOM system is managed and operated by the USAF and consists of: the Satellite Data System (SDS); the Air Force portion of FLTSATCOM; and the user terminal equipment and backup transponders which are placed in orbit as pickaback payloads on other host satellites orbited by the DOD.

The FLTSATCOM is managed and funded by the US Navy, but the USAF is responsible for procurement of the spacecraft.

The original procurement of DSCS satellites was for six Phase II models, and the first two were launched in November 1971. These developed trouble in orbit and eventually failed. The remaining four satellites were modified to correct all the deficiencies detected in the first two, and the second two spacecraft were launched in December 1973. Results were reported as satisfactory and the remaining two are planned to be sent up in the first half of 1975.

NAVIGATION SATELLITES:

For several years past both the USN and USAF have been studying alternative satellite navigation systems to meet future multiple user requirements, and for a longer period the USN has maintained an operational system variously known as Transit or Navsat. Although the desirability of combining the USN and USAF efforts into a single system has long been acknowledged, this objective has not been easy to attain. But a fresh programme has been presented for approval, which offers reduced cost and a solution which is apparently compatible with both USAF and USN needs.

The new programme is designated the Global Positioning System, but has already attracted the alternative popular name of Navstar. It is intended to enable various types of user, such as ships, aircraft, land vehicles, or soldiers, to obtain high-accuracy, three-dimensional fixes, reportedly within about 10 metres. Velocity measurements would also be possible.

A night picture of the Eastern States of the USA, the Great Lakes and part of Canada taken by moonlight from the USAF Defence Meteorological Satellite. The sensors and ground processing equipment which produced this picture were developed by Westinghouse Systems Development Division

The DoD has given approval for the first phase of the programme which will run until 1978 at an estimated cost of $150-million. This includes design and development of user equipment, the production of a cluster of satellites, their launch, and extensive test and evaluation programmes.

US MILITARY SATELLITE LAUNCHES IN 1973

Designation	Launch Date	Launcher	Inclination (deg)	Perigee/ Apogee (km)	
1973-13	6.3.73	Titan IIIC	0	33533/35901	Integrated Missile Early Warning Satellite
1973-14	9.3.73	Titan IIID	96	152/270	Big Bird reconnaissance satellite 71-day duration
1973-28	16.5.73	Titan IIIB – Agena D	110	135/352	Photo-reconnaissance 5-week duration
1973-40	12.6.73	Titan IIIC	0	35570/35890	Integrated Missile Early Warning Satellite
1973-46	13.7.73	Titan IIID	96	156/269	Big Bird reconnaissance satellite 91-day duration
1973-54	17.8.73	Thor-Burner II	99	813/851	USAF meteorological satellite
1973-56	21.8.73	Titan IIIB – Agena D	63	460/39330	
1973-68	27.9.73	Titan IIIB – Agena D	110	131/385	Reconnaissance satellite 32-day duration
1973-81	30.10.73	Scout	90	893/1150	US Navy navigation satellite
1973-88	10.11.73	Titan IIID	97 96	146/275 486/509	Reconnaissance satellite 4-month duration Unidentified pickaback payload
1973-100	14.12.73	Titan IIIC	2	35340/36290	Defence Communications Satellite(s)

1625.351
COSMOS SERIES SOVIET SATELLITES
GENERAL:

Soviet Cosmos satellite launches in 1973 were appreciably more numerous than in 1972: 85 as compared with 72 in the preceding year. Of this total no less than 35 were of the now familiar (ie in terms of orbital characteristics) reconnaissance series with a general orbital duration of about 15 days. The comparable number of launches for this category in 1972 was 29, and the general pattern of distribution between the various orbital inclinations employed is very similar for both years. The one exception is the significantly increased use of the 73 degree slot in 1973 when launches were more than twice as numerous as in the preceding year – thirteen compared with five. Although there is little doubt that the Middle East conflict of 1973 accounted for some of the increased Soviet reconnaissance satellite activity (in October there were launches on the 3rd, 6th, 10th, 15th, 16th, 20th and 27th) this period accounts for only half the additional 73 degree satellites.

No official information whatsoever is published by the Soviet authorities concerning military satellite activities and the information that can be assembled is the result of analysis of the satellite orbital data tabulations published by various official and semi-official bodies in the West. A comprehensive review of this information, and of the surveys carried out by a number of authoritative observers, was published in the last edition of Jane's Weapon Systems, and readers are referred to this and preceding editions for the historical and statistical record of the complete Cosmos programme.

LAND BASED AIR DEFENCE SYSTEMS

2177.181
INTRODUCTION

In this section are described some of the surveillance and control systems that are either installed or being developed or on offer for installation in several countries. Not all existing or proposed air defence systems are described; partly because information on some is not available and partly because others consist of standard equipment, purchased from major supplier countries, which is already described elsewhere in this book. Because of this some well-known systems have been omitted and some systems that are known or believed to be impending are at so early a stage that virtually nothing useful can be said about them.

Inevitably the section covers systems of a wide range of sizes and complexities but the main purpose of all is the same – the acquisition of information concerning potentially hostile aircraft, missiles or other objects in space and the organisation of that information in a way that will enable positive action to be taken if necessary.

AUSTRALIA

2016.181
HUB CAP

DESCRIPTION:

Hub Cap is a sophisticated mobile control and reporting unit (CRU) for air defence designed by Plessey and based on a specification written in close collaboration with a team of Royal Australian Air Force officers. It is currently deployed in Australia.

The system provides three-dimensional airspace surveillance and control of supersonic fighters to intercept hostile targets over a wide area from fully mobile air conditioned shelters designed for deployment by C-130 aircraft.

The use of digital computing permits automatic tracking of targets from the primary radar while plot extraction from the secondary radar returns is used to reinforce the primary radar auto-tracking. For the RAAF requirements, the computer is programmed to take account of the Mirage III characteristics, performs an assessment of an interception situation when supplied with the relevant data on weapon availability, and provides a number of alternative intercept solutions for selection by a controller. The computer can be reprogrammed to enable the system to operate equally effectively with other types of fighter. Comprehensive communication facilities are provided with Hub Cap enabling operational personnel to communicate with each other, with aircraft under control, and with units external to the system.

SYSTEM ELEMENTS:

Major elements of the system are:-

1. A Westinghouse TPS-43 (**2517.153**) 3-D primary radar with comprehensive anti-jamming and clutter rejection facilities.
2. IFF secondary radar.
3. A digital computer system, with redundancy, using two Marconi "Myriad" digital data processors, together with Plessey digital interface equipment, bulk data storage and programming.
4. An operations room complex using Plessey TDS Mk V data handling equipment with labelled plan and tabular displays.
5. UHF, VHF, HF and telephone communications equipment controlled by Plessey "Minicom" communications control equipment.
6. Diesel primary power generators.
7. Microwave link for data transmission between radar and operations sites.

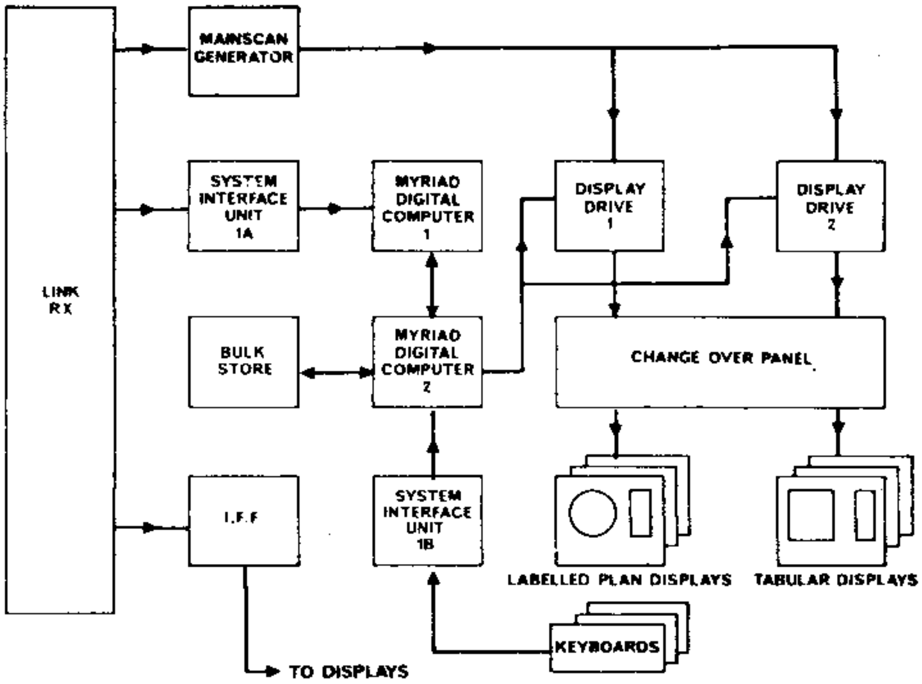
SYSTEM FACILITIES:

The operational organisation, upon which the capabilities of the system depend, has in overall command the air battle commander. Under him the organisation divides into two groups:-

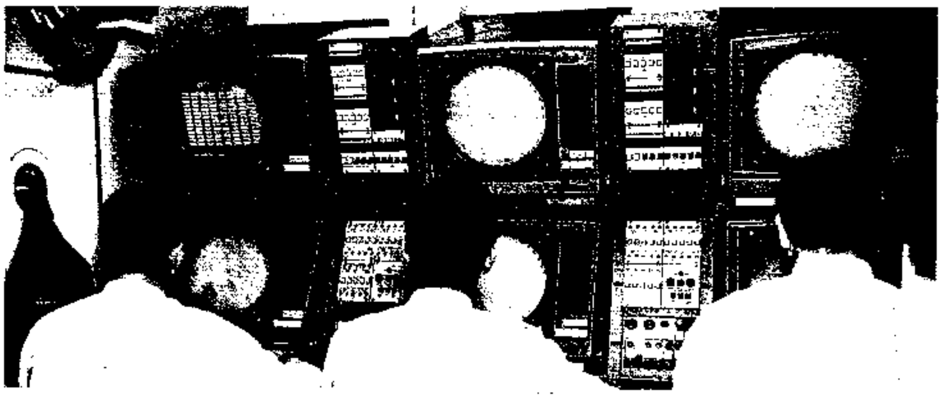
The tracking group: comprising a tracking supervisor and identification and tracking operators.

The weapon control group: comprising a weapons assignment officer in charge of fighter controllers, surface-to-air missile and anti-aircraft fire controllers.

With the exception of the trackers and the weapon assignment operators who require only labelled plan displays and tabular displays respectively, all other positions in the display complex are provided with identical consoles each comprising:



Schematic of the Hub Cap display and data processing equipment



Hub Cap displays

Plessey TDS Mk V labelled plan display
Plessey TDS Mk V tabular display
Rolling ball symbol position control
Tabular keyboard for symbol selection
Tabular keyboard (general purpose) for insertion of alpha-numeric data to computer, and for call-down of data from the computer.
Plessey 'Minicom communications control.

Thus flexibility in operating positions is maintained, allowing for changes in operational philosophy and graceful degradation in the event of equipment failure. The provision of data input and output facilities and communications facilities at each operational position, together with solutions to each concurrent interception computed at every phase of the fighter's profile, permits instant assessment of a tactical situation. This provides accurate figher control of each interception with minimum delay.

The system is capable of controlling engagements by surface-to-air missiles and air-to-air weapons to the point of firing.

Under normal conditions each tracker will handle several targets simultaneously using the automatic tracking facilities of the computer, his task being to monitor the performance of the automatic tracking with reference to targets allocated to him. However, the facility is retained for a tracker, under adverse conditions, to revert to manual initiation and rate-aided manual tracking in which his task is to initiate tracks and to correct these tracks as target manoeuvres occur.

MOBILITY:

All Hub Cap equipment, with the exception of the radar and the primary power generators, is housed in fully air-conditioned cabins with running gear suitable for second-class roads. The cabins all have a standard width, being suitable for storage aboard C-130 aircraft, and are tailored in length to accept their requisite equipment with a minimum of redundant space, yet retaining excellent access to the equipment for maintenance purposes. Two cabins containing communications, data link and workshop, are located at the radar site.

Five cabins containing communications, tracking control, data processing, command and workshop are located at the operations site.

The workshops need not form an integral part of the system and may be deployed separately depending on transport priorities.

The primary radar is housed, complete with the necessary transmitters, receivers and IFF equipment in an inflatable radome; while the primary power supplies are free-standing in the open with their own covers.

DEVELOPMENT HISTORY:

As already noted this system had its origins in a RAAF requirement and the first design study was carried out in 1965. The equipment went into service with the RAAF in 1969. No other immediate customers are known for Hub Cap as such, but the basic system principle is capable of being realised in a variety of different ways.

MANUFACTURERS:

Prime contractor: Plessey Radar Ltd., Addlestone, Surrey.

BRAZIL

2166.181
DACTA ATC AND AIR DEFENCE SYSTEM

DESCRIPTION:

In October 1972 a $70 million contract was concluded between the Brazilian Ministry of Aeronautics and Thomson-CSF, France. The agreement related to the construction of an air traffic control/air defence radar system in Brazil.

Details of the agreement are not known; but it is understood that a substantial element of licensed manufacture in Brazil was included – thus committing the French company to building up a substantial electronics manufacturing industry in the customer country.

Another agreement signed in 1972 involved the French and German joint developers of the Roland I missile system (**2218.131**) with the Brazilian Army's Central Missile Commission. Here again manufacture under licence was involved: in this instance, however, it is understood that the licence related to final assembly only.

It is evident that the Brazilian authorities are intent on strengthening the country's capabilities in the manufacture of arms and other defence equipment. Brazilian capabilities in the naval and aviation fields are well-known as also are some of their activities in the development of weapons for their land forces. Developments in electronics have been less prominent, but in addition to those mentioned above it is understood that there will shortly be an announcement of a joint-venture programme of computer manufacture.

CHILE

2167.181
AIR DEFENCE SYSTEM – CHILE

DESCRIPTION:

Late news as we go to press is that the Chilean Government is considering the desirability of setting up an air defence system incorporating radars that can survey the air space above and adjacent to the country's northern territory. Chile's right to this territory has been disputed ever since it was taken from Peru a century ago; and the Chilean authorities are worried by the increasing strength, in aircraft and weapons, of the Peruvian armed forces.

It appears that, if the authorities decide to proceed with the project, the system would probably be formed by integrating five existing civil ATC radar stations, believed to be equipped with Texas Instruments surveillance radars under a single co-ordinated command and control system.

STATUS:

Government consideration

CHINA (PEOPLE'S REPUBLIC)

2052.181
CHINESE AIR DEFENCES

No detailed information on Chinese air defences is available, but there are some known statistics on their magnitude.

Until comparatively recently the Chinese were reported to have in service about fifty surface-to-air missile sites and some 4,500 anti-aircraft guns of various types. Associated with all of these were about 1,500 air defence radars, but to what extent and in what way these are organised in air defence systems was not known. More recent information, while still leaving much open to question, suggests that the country's defences are being substantially modernised: new radars, it seems, have been designed and improved versions of the SA-2 Guideline missiles (**2942.131**) which the Chinese originally acquired from the Russians are being produced.

It should also be noted that at least one very large phased-array radar aerial has been constructed in Western China, presumably as part of a missile warning system. No details are available.

FRANCE

2106.151
MIDAS AIR DEFENCE SYSTEM

DESCRIPTION:

This code-name is used by the manufacturers for a mobile air-defence centre which can be associated with Matador (**2012.153**) or a similar radar.

The MIDAS operations centre comprises a single cabin, transportable by road, rail or cargo aircraft, in which are assembled the display processing equipment, the computer and its peripherals, telecommunications equipment, and four operator positions.

Three of these positions have display consoles, each equipped with:

a PPI display for the presentation of raw video, synthetic video, tracks, electronic map, vectors (aid to navigation), etc.,

two microtabular displays for the presentation of interception data provided by the computer and the operator,

a designation device (rolling-ball unit),

an order keyboard,

a radio control panel.

The fourth position is for a telecommunications operator who assigns radio devices to the other operators and manages a teleprinter. This position includes a telephone exchange.

OPERATION:

The three consoles, which may have any assignment, are in principle distributed as follows:

1 master controller position,
1 tracking controller position,
1 interception controller position,

The master controller supervises the whole station and is particularly in charge of identification, of the threat evaluation, of the decision to initiate an interception, and of the choice of weapons. In case of need he can also control a maximum of two interceptions.

The tracking controller is in charge of establishing the general air situation. In particular, he has to initiate manually designated tracks, which then are followed automatically by the computer; he assists the computer when tracks cross or run into clutter or interference. He can also assist the master controller in his task of identification (especially when the master controller has to control interceptions).

The interception controller can control two simultaneous interceptions.

The system can also be supplied in a five-console configuration thus –

1 chief controller position
2 tracker positions
2 intercept controller positions

CAPACITY:

Automatic following of 20 tracks,
4 simultaneous interceptions,
Remoting of tracks (2400 bauds),
Remoting of 200 primary or secondary plots (2400 bauds).

TRAINING:

The computer incorporates a simulation programme capable of creating a synthetic air situation which can be superimposed on the real situation to permit the training of operators with real aircraft.

STATUS:

The system is in production

MANUFACTURERS:

Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222 Bagneux (France)

Thomson Visualisation Traitement, 40, rue de la Grange Dame Rose 92360 Meudon (France)

2115.151
MINISTRIDA AIR DEFENCE SYSTEM

DESCRIPTION:

MINISTRIDA is the name given by the manufacturers to a dual-purpose computerised air defence/ATC system of medium capacity conceptually derived from the French national air defence system STRIDA.

Inputs to the system can be taken from a variety of primary radars provided height is included in the input data. Typically suitable radars, bearing in mind the mobility of the system, are Matador (**2102.153**), TPS-32 (**2516.153**) or TPS-43 (**2517.153**) 3-D radars or any of a number of 2-D radars in conjunction with a mobile nodding height-finder – the latter combination being appropriate when the main object is the automation of an existing system. IFF/SSR inputs are also required: these can come from either independent or on-mounted sources.

A vital feature of the system is the elaborate computer programme which consists of a common trunk and two branches. The common trunk has a bias towards military requirements but the branches are specifically military and civil in their objectives. Information processed by the two branches can be either separately displayed or brought together on a common display or displays. This flexibility could, of course, be useful if circumstances required an increased concentration of effort on military rather than civil operations.

The system can be built as a mobile station or installed in a fixed ground centre. It can be installed as original equipment in Air Defence or Air Traffic Control Systems or introduced later for improving the capabilities of an existing system.

MOBILE STATION:

The main functions of a mobile station are to present the air situation, to evaluate threats, select targets and weapons, taking account of resources, and to guide interceptors and provide for their recovery. The station can also alert threatened centres, provide close control and navigation aid for aircraft in operational flight, detect conflicts (anti-collision) and train controllers in interceptor guidance.

The basic version of the station provides for automatic processing of 50 tracks and 4 simultaneous intercept/recoveries. It comprises 8 air-ground voice transmission links (8 VHF or UHF transceivers). This mobile station can also be used for ATC functions with appropriate programmes.

The basic version of the station consists of 2 air-conditioned cabins; one cabin housing 4 operational positions, each of which provides display (labelled situation display and alpha-numeric screen) dialogue and communications facilities (radio communications, intercommunications and telephone links). The display equipment presents superimposed the raw radar video and the synthetic picture. An extended version of the system can incorporate 5 operational positions.

The second auxiliary or technical cabin contains data processing equipment (extractor, processing system) and radio transmitters. The cabin also contains positions for auxiliary functions e.g. technical testing, piloted aircraft simulation and data gathering.

The station also contains:

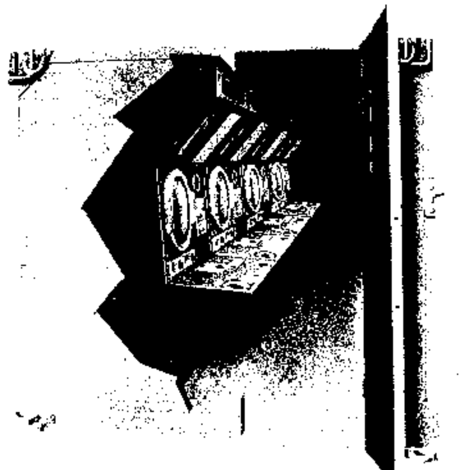
- a radio reception centre stowed in the technical cabin during transportation, an air conditioning unit for the 2 cabins, a CPU

The main characteristics of the cabins are:

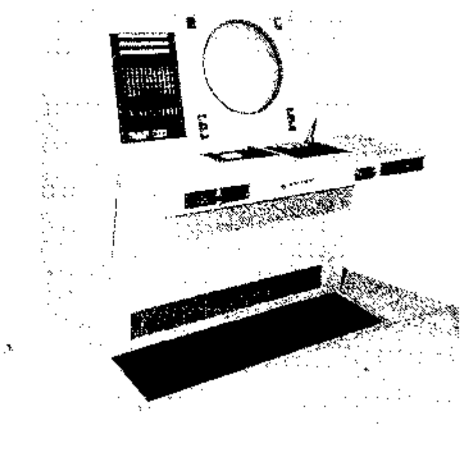
- overall dimensions: 4.1 × 2.5 × 2.1 m,
- weight 2,800 kg approximately,
- consumption: 15 kVA per cabin approximately.

The use of modern technology has made it possible not to sacrifice any of the power and flexibility of the processing and display equipment required. All the equipments are derived from those used in the most recent centres (VISU IV generation) of the French Air Defence Systems STRIDA:

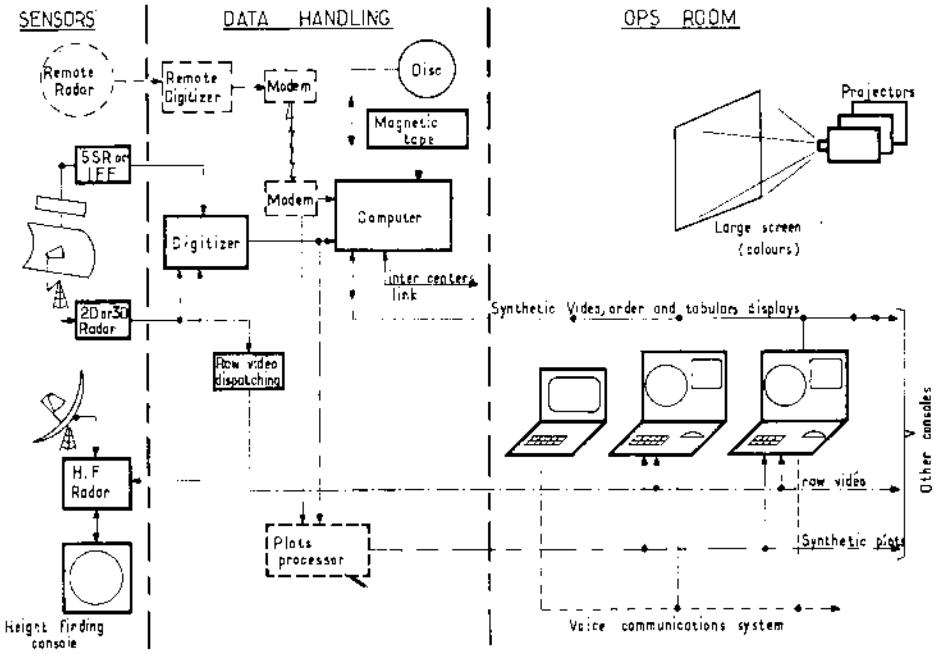
- medium power data processing system used in a bi-processor configuration and suitable for expansion (the memory capacity can reach 224 K bytes),
- comprehensive display system in which each position includes a PPI, Plan View Display screen, an alphanumeric screen, a complete set of keyboards (selection, order and alpha-numeric keyboards) and a rolling ball. The display system incorporates its own refresh memory providing a very large display capacity without overloading the processing system or the link between this system (located in the technical cabin) and the display equipment (in the operations cabin).



MINISTRIDA operations cabin



A MINISTRIDA display console



MINISTRIDA – schematic diagram

EXTENSIONS OF THE BASIC STATION

The possibilities of the basic station can be expanded in several ways:

- by increasing the processing capacity, principally by switching to 100-track processing,
- by increasing the number of controller positions from 4 to 5 positions in the cabin,
- by increasing the number of operational cabins: the station can include up to 3 operations cabins each housing 4 consoles.
- by extending the functions to permit interstation track transmission and to form networks (groups of interconnected stations)

Because of the modularity of the processing and display equipment and the programmes, all these extensions can be implemented without detracting from compatibility with the basic version in any way.

FIXED-POSITION GROUND CENTRES

The system can be built as fixed-position installations. The display facilities can be extended considerably and displays can be presented in colour on the consoles or on large screens.

The system can be built into a network of stations with Reporting Centres, Control and Reporting Centres and Combat Operations Centres. These systems use mainly the same elements as the mobile stations, but the elements are laid out differently.

DEVELOPMENT

The system has been developed by SINTRA on a French Government contract. The contract is administered by the Service Technique des Télécommunications de l'Air.

The system entered into operational evaluation by French Air Force in 1973.

MANUFACTURER:

SINTRA – 26, rue Malakoff 92600-Asnières France.

2161.181
STRIDA AIR DEFENCE SYSTEM

DESCRIPTION:

STRIDA is the French Air Defence Data Processing and Presentation System. The system consists of a network of stations covering French territory with the following main functions:

- detection and identification of aircraft moving in French air space,
- threat evaluation and transmission of alerts.
- In particular, the air situation is centralised and synthesised in the Operational Command of the Air Defence (CODA),
- weapon selection, engagement and intercept guidance. This function obviously implies updating of availabilities and interconnections with air bases.
- control of operational military flights and training flights,
- coordination with the Air Traffic Control system to ensure identification and spacing of operational military flights with respect to general air traffic.

HISTORY:

Studies for the STRIDA system began in 1956 under the responsibility of Service Technique des Télécommunications de l'Air (S.T.TA)

The first stations were fitted with specialised IBM/CAPAC computers and SINTRA VISU II and later VISU III consoles. They have been in operation since 1963. Beginning in 1965, the French Air Force carried out experiments on a new gene ration of stations fitted out with standard IBM Series 360 and later 370 computers and a SINTRA VISU IV display system. These stations are currently in series production phase.

DEPLOYMENT:

The STRIDA system consists of a group of stations in which the control functions (weapon selection, intercept guidance, flight tracking) are decentralised. The interconnection of the centres is carried out in such a way that the automated network is immediately reconfigured in the event of any one of the stations failing.

The system exploits signals from 2 D (23 cm), 3 D (Palmier) and height finding radar (nodding beam or SATRAPE type electronic scan radar) manufactured by TH-CSF.

The Detection Centres are either separated from the Control Centres or incorporated in them. The most complete "CDCS" centres combine detection, control and sector command functions. The CDCS transmit their data to a single Air Defence Operational Command which collects all information on air defence at national level and sends it to the Command (presentation on large AGEC screen).

The STRIDA network is connected to the NADGE network (**1181.181**) to the 412 L (**2533.181**) and to the LINESMAN (**2443.181**) to provide total coverage of Western Europe. It is also connected to the ATC CAUTRA system to permit coordination between military and civil control.

COMPOSITION OF A STATION:

The processing and presentation equipment of a CDCS station mainly consists of:

- an EMIR radar data extractor using a programmed extraction concept,
- a high power processing system using series 370 computers in the stations produced currently,
- a display and control system incorporating from 20 to 30 operational positions (see below).

In some centres, special equipment is found:

- in the Air Defence Operational Command, there is a large AGEC display screen,
- In a centre for controller training, there is a piloted moving aircraft simulator (SAC-HA) delivering a video signal incorporating simulated echoes corresponding to piloted moving aircraft.

OPERATIONAL POSITIONS:

Each operational position or console designed for one controller and his assistant comprises:

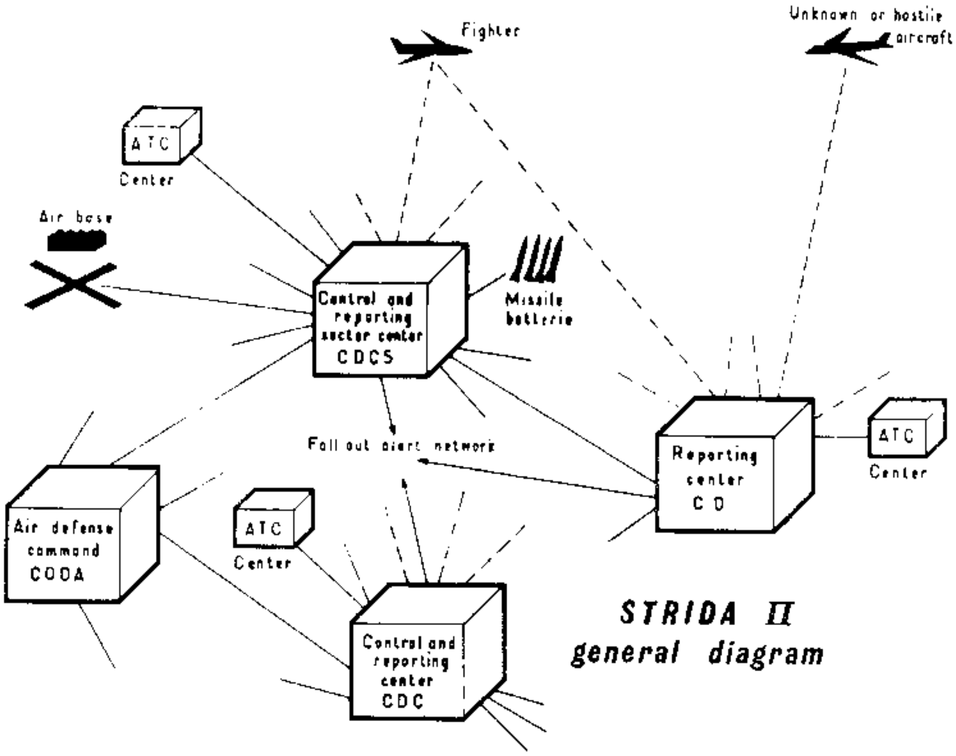
- a plan view display screen for presenting raw video (local radar raw video) and data generated by the processing system (synthetic video). This screen presents a synthetic view of the air situation (mainly tracks). A 16-inch diameter screen is used,
- one or several monochrome or polychrome screens measuring diagonally from 5 to 14 inches (up to 4,000 characters displayed) for presenting detailed information on certain subjects (tracks, intercepts) or data received in alphanumeric form (operational availabilities, flight schedules),
- keyboards and a rolling ball (or a joystick) for compiling orders, entering data, selecting the data presented,
- control keyboards or units for communications (radio, telephone, interphone) and for presenting secondary radar data.

MANUFACTURERS:

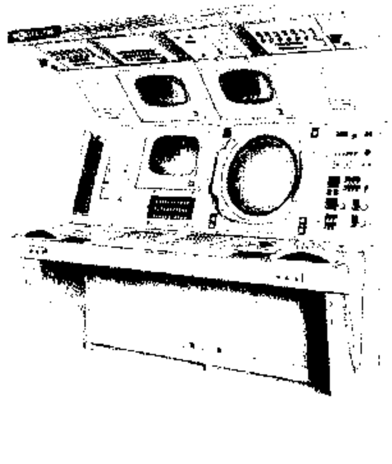
The system was designed and built for the French Air Force under the direction of the Service Techniques des Télécommunications de l'Air. The main manufacturers who participated in the design and production are:

- IBM France – Division des Systèmes Spéciaux et Militaires – 36, Avenue Raymond Poincaré – 75116 – Paris: extractor, data processing system, programming.
- SINTRA 26, Rue Malakoff - 92600 – Asnières display, operational positions, large screen display, simulator.

STRIDA operations room with Visu III consoles

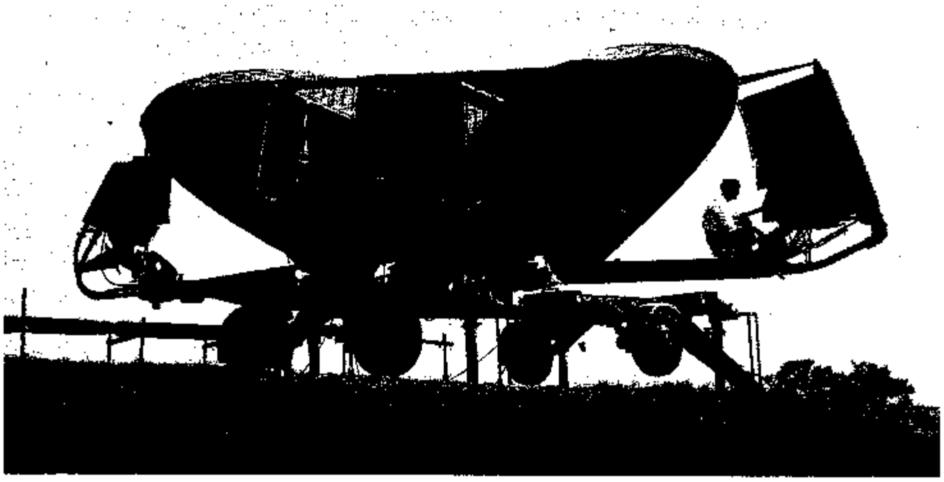


STRIDA II general diagram



Visu IV 2 operator console for Strida

IRAN



Marconi mobile tactical surveillance radar of the type believed to have been specified by Iran

2199.181
AIR DEFENCE SYSTEM
DESCRIPTION:

A substantial radar network is being constructed as part of a United States Military Assistance programme. When complete the Iranian radar network will provide coverage to the North and West and over the Persian Gulf. It is believed that the network includes Westinghouse AN/TPS-43 transportable S-band 3-D radars (**2517.153**). Prior to the commencement of this programme, the Iranian early warning system consisted mainly of AN/FPS-88 surveillance radars (**2512.153**) supplied under CENTO auspices some years previously as part of LORIDS (Long-Range Iranian Detection System) and located around Tehran, Mashad and Tabriz.

It is expected that the next step will be the installation of an integrated command and control system that will bring this radar and communications network and the expanded Iranian ground and airborne defence forces all together in a comprehensive air defence system. Included in this system, it is assumed, will be equipment supplied against a large order for radars, displays and computers which was placed with Marconi Radar Systems in mid 1970.

This order covered the supply of complete mobile systems including power generators, workshop vehicles, spares vehicles and personnel carriers as well as the operational data acquisitions data processing and communications equipment. The primary radars are believed to be the high-power S-330 surveillance and S-404 heightfinder radars originally developed to meet a British Army requirement: the computers were Myriad is as used in the Australian Hub Cap system (**2016.181** and see also **1437.063**).

The programme for the integration of all the radars into a semi-automated air defence system bears the designation **Peace Crown** but it is not known that definite arrangements have been made for its implementation – though there is little doubt that they will be. Late in 1972 a prediction of $30 million of potential business in this area was made by an official of Hughes Aircraft.

It is understood that when the programme is complete it will link up most, if not all, of the increasingly extensive anti-aircraft missile forces with the radars and, by tying into the Imperial Iranian Air Force's **Peace Sceptre** communications system – which covers all the IIAF's air defence sites – form a most comprehensive countrywide system.

ISRAEL

2226.181
AIR DEFENCE SYSTEM

A computer-controlled air defence system has been installed in Israel. It comprises a main control centre and a number of control and reporting centres. No details of the equipment are available, and it is believed that no public statement regarding the existence of the system has been made by either the Israeli authorities or the prime contractor, but it appears to be generally accepted that Hughes Aircraft Company were awarded the contract after completing a study for the new system and it is also understood that the system is based on the TPS-43 Westinghouse radars (**2517.153**) already purchased by the Israeli authorities. It is believed that the data-processing system used is substantially similar to, and uses the same language as other Hughes systems – such as NADGE (**1181.181**) and Florida (**2373.181**). The system is believed to be operational.

ITALY

2250.131
SPADA SHORT/MEDIUM RANGE AIR DEFENCE SYSTEM

DESCRIPTION:

Spada is an all-weather, short reaction time point/area missile system designed to defend relatively small strategic areas (airports, harbours, factories, bridges, rail junctions etc) from low and very low altitude attacking aircraft flying singly, in close formation or sequentially. The system is designed to inflict severe losses on such aircraft even when they are taking advantage of terrain masking and making use of sophisticated ECM devices.

Designed to employ semi-active homing missiles, and particularly the Aspide IA (**1656.331**) missile now in advanced development under an Italian Government contract, the system is modular in concept and its configuration can be adapted to optimize its deployment according to the nature of the surrounding terrain of the targets and of the threat.

SYSTEM DESCRIPTION:

The Spada system comprises the following principal sub-systems:

an Operational Control Centre (OCC), including automatic data processor and display sub-system;

a number of Detection Centres (DC), each including a low coverage search radar, IFF equipment and associated data processor;

a number of Firing Sections, each including a tracking/illuminating radar, a number of missile launchers and semi-active homing missiles.

The number and deployment of these units will depend on the threat density and characteristics. The types of possible configurations range from the maximum deployment, including the Control Centre, Detection Centres and Firing Sections, down to the simplest configuration making use of a single Firing Section.

OPERATION:

The Detection Centre performs the detection, local identification and target data updating, and is connected via a two-way data link to the Operational Control Centre whose tasks include data correlation, local/ADC, identification acknowledge, threat evaluation, target allocation and designation and fire control. The Operational Control Centre is connected via two-way data links to Air Defence Centres (ADC) and to the Firing Sections. The Firing Section performs target acquisition, tracking and illumination, computes the missiles pre-launch data, launches the missiles and carries out the kill evaluation.

When the target area configuration allows for the use of a single DC, this centre is connected directly to the Firing Sections and ADCs and performs the OCC functions in addition to its own.

Isolated Firing Sections are able to perform autonomous search and fire control in addition to their normal functions. This same capability can also be used as a reversionary mode in case of failure of the data link to the OCC.

The system is designed for easy transportability (road, rail or air transport) and for quick deployment.

DEVELOPMENT:

Feasibility studies, as well as system design and computerized simulations have been carried out under an Italian government contract. A prototype is under development and will be delivered to the Italian Armed Forces for evaluation in 1974.

MANUFACTURERS:

Systems and Ground Equipment:

Selenia, Industrie Associate SpA, Via Tiburtina Km 12,400 Rome, Italy.

Missile:

Selenia, Rome; SNIA Viscosa, Rome; Microtecnica, Turin; Elsag, Genoa; Nuova Saca, Brindisi.

JAPAN

2253.181
BADGE – AIR DEFENCE SYSTEM
DESCRIPTION:

BADGE – Base Air Defence Ground Environment – is a computerised air defence system designed to provide the information gathering data processing and display functions required for umbrella protection against aerial attack on Japan. The system comprises radars that will automatically detect, track and identify airborne targets over Japan and a large area of the surrounding ocean; computers to process the radar data and evaluate threats; and other computers to process and furnish data on weapon availability, intercept geometry and related measures, all of which is displayed, together with the processed radar data on complex displays to the appropriate interceptor or missile controllers.

This $56 million system was largely built in Japan for the Japanese Self Defence Force. The prime contractor was the Hughes Aircraft Company of the USA and they supplied much of the equipment of the first installation as well as being responsible for system and equipment design. Most of the subsequent manufacture, however, was carried out by Japanese manufacturers.

BADGE is similar in many respects to ADGE (**2211.181**) and Florida (**2373.181**) and reference may be made to the latter for more detailed information.

MANUFACTURERS:
Prime Contractor: Hughes Aircraft Co, Fullerton, California USA
Japanese Manufacturers: Nippon Aviotronics, Nippon Electric.

2256.181
SECOND GENERATION AIR DEFENCE SYSTEM

DESCRIPTION:
Some time ago it was reported that the Japanese authorities were considering an extension to the BADGE system (**2253.181**) which would both increase its coverage and provide for the integration of the Japanese Hawk and Nike Hercules surface to air missile batteries with the existing defence system.

It was then understood that there were likely to be five phases to this operation although the precise order was not known. The phases were:-
(a) Updating and expanding BADGE to improve coverage of the main Japanese islands.
(b) Linking BADGE to the Nike/Hawk batteries via the JAN/TSQ 51B distribution systems then being built by Nippon Electric under licence from Hughes.
(c) Developing an airborne early warning system.
(d) Further extending BADGE to cover other key areas such as Okinawa.
(e) Introducing improved (three-dimensional) radars for BADGE to replace the FPS 20 surveillance radar (**2528.153**) and FPS-6 heightfinders (see **2523.153**) then used.

STATUS:
We first reported this programme in the 1972/73 edition of this book, and late in 1972 an official of Hughes Aircraft estimated that there was a potential of $20 million of business in computerised air defence radar systems for Okinawa. Since then nothing definite has been heard of this project - which could in any case proceed to some extent on a piecemeal basis.

NATO

1181.181
NADGE - NATO AIR DEFENCE GROUND ENVIRONMENT
DESCRIPTION:
This is a multi-national programme involving 14 NATO countries (so far as funding and contracts are concerned) in the updating and co-ordination of the air defence systems of nine European members of NATO. They are Norway, Denmark, W. Germany, The Netherlands, Belgium, France, Italy, Greece and Turkey. The British air defence network interfaces with NADGE. French participation is limited to use of, and contribution to the reporting and control functions, and that country's defence forces will not be directed against hostile targets by NATO.

NADGE, which is now fully operational, was conceived not as an entirely new air defence installation, but rather as an overall plan for the improvement of some existing hardware and the provision of new equipment in certain areas either to fill gaps in the pre-existing systems or to improve their performance. NADGE represents, in scale, about 20 per cent of the existing NATO investment in European air defence. The cost of the operation has been approximately £120 million.

Funding of the project was based upon a balance of payments system aimed at providing work for the industry of each participating country in accordance with its contribution to the total programme cost.

Estimated contributions are as follows:-

USA	31.83%	Netherlands	3.74%
W. Germany	19.5%	Denmark	2.45%
France	11.7%	Norway	2.31%
UK	11.24%	Turkey	1.07%
Italy	5.82%	Greece	.65%
Canada	5.12%	Portugal	.27%
Belgium	4.13%	Luxembourg	.17%

Precise details of the equipment included in the project have not been revealed, but it is understood that the following equipments form part of the system.

US 412L System Units (AWCS, QUICK-DRAW) (GE). Updated FPS-88 3-D radars (ex Marshall Aid) (GE) Strida II units.

ADGE/IPG units (see below)

Thomson CSF TH.D 1955 3-D radars (**2155.153**).

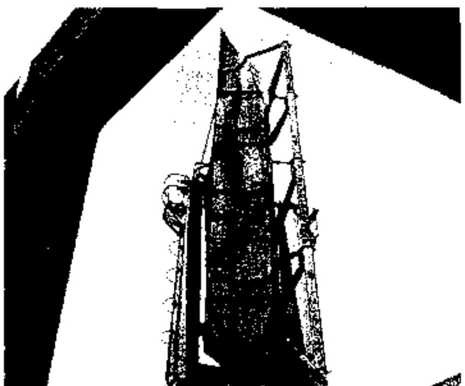
Marconi nodding height finders and 2-D surveillance radars (type unknown).

In addition the system contains considerable amounts of new data-processing, display and data communications equipment. Improvements to existing radars include the addition, where necessary, of video extractors; and there has been considerable emphasis on ECCM equipment.

Taken as a whole, the system is designed for air

Artist's impression of the radar coverage provided by NADGE

An Anglo-Dutch gap filler search radar under test by Marconi Radar Systems in Britain. The aerial and turning gear are made by N.V. Hollandse Signaalapparaten and the associated electronics equipment is by Marconi. This radar is located at two NADGE sites



A Marconi S269 heightfinder radar undergoing test at the Marconi test site. 14 of these radars are installed in NADGE defence against aircraft flying at heights up to 100,000 ft (30,480 m). There is no provision for the detection and countering of missiles or low-level, sub-radar threats. Against air threats, NADGE is to be used for the control of interceptor aircraft and surface-to-air missiles.

Equipment is arranged in five basic configurations. Every installation contains the equipment necessary for functioning as a Sector Operations Centre (SOC). By the addition of further standard sets of equipment any installation has been expanded where appropriate to operate as one of the following: Reporting Post (RP), Command Reporting Post (CRP), Command Reporting Centre (CRC), or combined CRP and CRC. Each installation is provided with the means of exchange of data from one site to another.

The complete NADGE system comprises 84 sites of which 37 contain data processing complexes. The latter contain multiple general-purpose digital computers for the real-time processing, analysis and distribution of target information from its own sensors, and the correlation of data from other stations received by data links and conventional communications channels.

Advanced data display equipment serves the functions of data gathering (detection, tracking, height-finding, target identification, and target-size analysis); and data utilisation (threat analysis, weapon assignment, and weapon control). Once a target is acquired by radar, the information is transmitted by data link to the Command Reporting Centre, where it first appears on a display console as a conventional target 'blip'. The data is simultaneously transmitted to a video processor which determines whether the blip is a genuine target, enemy jamming, or simply video clutter.

The information is next passed to a correlator, or computer memory unit, the function of which is to generate target tracks for genuine radar returns. These are returned to the original display as synthetic tracks in the form of digitised track symbology. This is superimposed upon the raw radar, providing the operator with two means of tracking the target. Target identification can be accomplished by IFF, voice identification, or by computer comparison of target characteristics. Potential target co-ordinates are transmitted automatically to surface-to-air missiles batteries, and this information is also available at interceptor airfields.

DEVELOPMENT:

Agreement was reached within NATO in the early 1960s that automation and integration of the member countries' air defence systems was necessary to meet the increasing scale and sophistication of the threat, and operation requirements were eventually drawn up. It was decided that the work should be performed by an international consortium of electronics concerns, and calls for bids went out on this basis. None of the proposals which resulted was capable of meeting the requirements within the stipulated costs, and a protracted period of re-bidding and adjustment of the requirement followed. In the final stages there were three consortia contesting the contract. Once more the target cost could not be met, and it was ultimately decided to eliminate some of the more advanced facilities called for in the original specification. The winner of this competition in June 1966, was the Hughes-headed group which subsequently formed itself into an international company called Nadgeco, with headquarters in London.

During the prolonged competition three countries, W. Germany, Belgium and The Netherlands, decided that they were unable to await the completion of NADGE before providing improved facilities for the air defence forces they were already operating, and concluded an agreement with Hughes for the provision of a system – successfully known as TAWCS (Tactical Air Weapons Control System), IPG (Interim Planning Group), and ADGE (Air Defence Ground Environment), which is now integrated into NADGE.

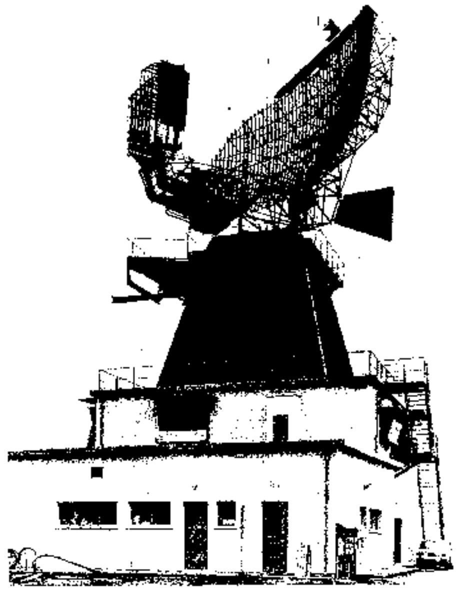
Nadgeco was formed in January 1967 and planning started. This involved the definition of hardware specifications, work schedules, and contractual negotiations with about 140 equipment suppliers, 70 customer authorities, and a similar number of contractors and material suppliers.

STATUS:

Although the system, as first conceived, is complete, except for a large number of administrative and other tidying-up processes which will probably keep Nadgeco busy to the end of 1974, it is generally agreed that there is a need for further extensions. Desirable additions include extension of cover – by the addition of new sites in Italy, Greece and Turkey – to the NATO naval forces in the Mediterranean, addition of low-level coverage, improved links with the UK Linesman system and further updating of some of the older equipments in the system.

Some of this work has already been put in hand. Hughes Aircraft Systems International (HASI) and Advanced Electronic Systems International (AESI), both Hughes subsidiaries, are engaged in a coverage extension programme involving the construction of four new sites and the modification of three existing NADGE sites in Greece. HASI also is upgrading three national air defence centres in Turkey to NADGE standards. Selenia is upgrading parts of the Italian system with HASI as sub-contractor.

Nadgeco as such, however, will be wound up on completion of the end-processes mentioned above. The consortium countries have set up a new organisation called Eutronics, which is based in Brussels, and this will be competing with other potential suppliers both for further NADGE business and for similar business elsewhere.



The first ARES long-distance radar for NADGE in Italy. The radar is manufactured by Thomson-CSF and is among the most powerful in the world

MANUFACTURERS:

The members of the six-nation consortium and their main equipment contributions to NADGE are listed below. There are also numerous other sub-contractors from the other participating countries which are receiving orders in relation to their own country's contribution to the funding of the project.

Hughes Aircraft Company, Fullerton, California, USA: Computers and specialised software.

GEC-Marconi Electronics, Chelmsford, Essex, England: Height-finder radars, improvements to existing radars, height-strength measuring consoles, manual tracking posts and reporting posts.

AEG-Telefunken, Ulm, West Germany: Video link equipment for Norway, Denmark and Turkey, part of the medium-power radars under sub-contract from Thomson-CSF.

Thomson-CSF, Paris, France: Medium-power radars.

Selenia, SpA, Rome, Italy: Data displays and video link equipment for Italy.

NV Hollandse Signaalapparaten, Hengelo, The Netherlands: Gap-filler radars, two-dimensional extractors, display system modifications.

SOUTH AFRICA

2321.181
SOUTH AFRICAN AIR DEFENCES

DESCRIPTION:

Details of South Africa's air defence system are not available. It is known, however, that there is a modern early-warning radar network supplied by Marconi, England, and covering the north-eastern and north-western approaches to the Republic and that this system has its headquarters at Devon in the Eastern Transvaal.

This system is linked to the South African Air Force Strike Command base at Waterklorf near Pretoria at which are located the Command's Mirage IIICZ interceptor and Mirage IIIRZ reconnaissance squadrons. Also located at this base are the Mk 50 Buccaneer squadron when they are not being employed in support of the maritime forces.

The batteries of the Cactus surface-to-air missile system (**2341.131**) which is now in service with the Air Force are also linked to the early-warning system and are assumed to be charged primarily with the defence of Air Force installations.

All these measures are aimed at countering what is to South Africa the obvious major threat of an attack by relatively short-range aircraft based on airfields in the African continent. There appears to be no land-based air defence system designed to deal with an attack from aircraft carriers off the southern coast: presumably the intention is to rely, for the time being at least, on early warning by maritime patrol aircraft and shipborne radar.

SPAIN

2322.181
COMBAT GRANDE AIR DEFENCE SYSTEM

DESCRIPTION:

Combat Grande is the name which has long been associated with a proposed automation of the Spanish air defence system which is now in process of being implemented. The system is being processed by the US Air Force for the Spanish Government and is to be supplied by a jointly owned Spanish-American company registered in California.

The new system will absorb the earlier Spanish manual air defence system and create an automated system of modern design to provide early warning of air attacks and control Spain's interceptor aircraft and Hawk missiles. Operations involved in the programmes include:

(a) development of a combat operations centre and a sector operations centre
(b) an improvement and modernisation programme for seven long-range radars and associated communications equipment
(c) extension of existing microwave link facilities.

It is expected that the modernisation techniques will resemble those applied to some of the older systems which were updated during the NADGE development programme (**1181.181**); and although, so far as is known, there is no definite intention to link the Combat Grande system with NADGE at present, it is a near-certainty that the new system will be so designed as to make such a linking-up operation a simple matter if and when the need is established.

STATUS:

Development.

MANUFACTURERS:

Prime contractor is COMCO Electronics Corporation, a company jointly owned by Hughes Aircraft and the Compañia de Electronica y Communicaciones SA (CECSA). Each of the two parent companies has a 50% holding in COMCO.

Hughes will build the computers and design the communications equipment for the new system. CECSA will manufacture the communications sub-systems and manage the civil engineering construction.

SWEDEN

2350.181
AVISTA AIRCRAFT TRACKING AND DATA-REPORTING SYSTEM

DESCRIPTION:

Avista is the name given to a system for providing radar warning systems with a back-up system based on visual observation.

The idea behind the development of this system is the vulnerability of radar systems to ECM and other interference. While the contribution that can be made by direct visual observation is necessarily limited by darkness or bad weather, the same conditions also impose limitations – albeit less severe – on the capabilities of intruding aircraft. This is a changing situation, and aircraft attack – particularly at low level – in conditions of bad visibility will become progressively more probable as the installation of more sophisticated airborne equipment progresses; for some time to come, however, there will be a significant contribution that can be made by an organised visual detection and data reporting system.

The essential characteristics of such a system are that it be capable of covering a wide area of territory – because visual ranges are short – and that it be capable of reporting accurately and rapidly to the control centres that otherwise are served by radar. Since many observation posts will be required to satisfy the first requirement the system, to be a practical proposition, must employ low-cost equipment; satisfaction of the second requirement calls for an effective and accurate telemetering system coupled with terminal equipment that can rapidly translate the multiplicity of reports into a readily intelligible form.

In the Avista system observation posts, spaced up to 20 km apart, are equipped with data transmitters by which information on the bearing of observed aircraft is transmitted rapidly by telephone or by radio transceivers to SOC's. In the SOC the information is presented on a map by means of lamp displays in such a way that the observed aircraft gives rise to a lighted track. When telephone network transmission is used, three observation posts can share one telephone line without mutual interference. Normally, the aircraft is displayed on the map 5 to 10 seconds after the observation is made.

MANUFACTURER:

AGA Aerotronics AB, S-181 81 Lidingö, Sweden.

2358.181
STRIL 60 AIR DEFENCE SYSTEM

DESCRIPTION:

STRIL-60 is a fully automatic air surveillance and operations control system operated by the Swedish Air Force.

Inputs to the system come mainly from radars – both air surveillance and coastal radars – but a back-up visual reporting service is included to supplement the radar data and to replace it if the radar input is blocked.

Information from all these sources is fed into a central data store; whence it is extracted for selective presentation to controllers having specific functional responsibilities and/or specific territorial assignments.

OPERATION:

When a threat is detected the STRIL-60 controllers, who also have available to them state-of-readiness information on available forces and weapons, decide with what kind of available weapon the threat can best be countered and assign that weapon to the task. In appropriate cases – for example, surface-to-air missiles – they will also control the operation. Currently the forces controlled by the system are the SAAB Draken interceptors (to be replaced from 1978 by the JA37 Viggen) and six squadrons of Bloodhound 2 surface-to-air missiles (**2406.131**).

The STRIL-60 centre is also linked up to the civil defence organisation, and can both alert them and warn industry or the civilian population.

If the threat cannot be countered by the forces under the control of one centre but can be countered by those of another centre, the system provides both voice and video transmission links for giving information to other centres.

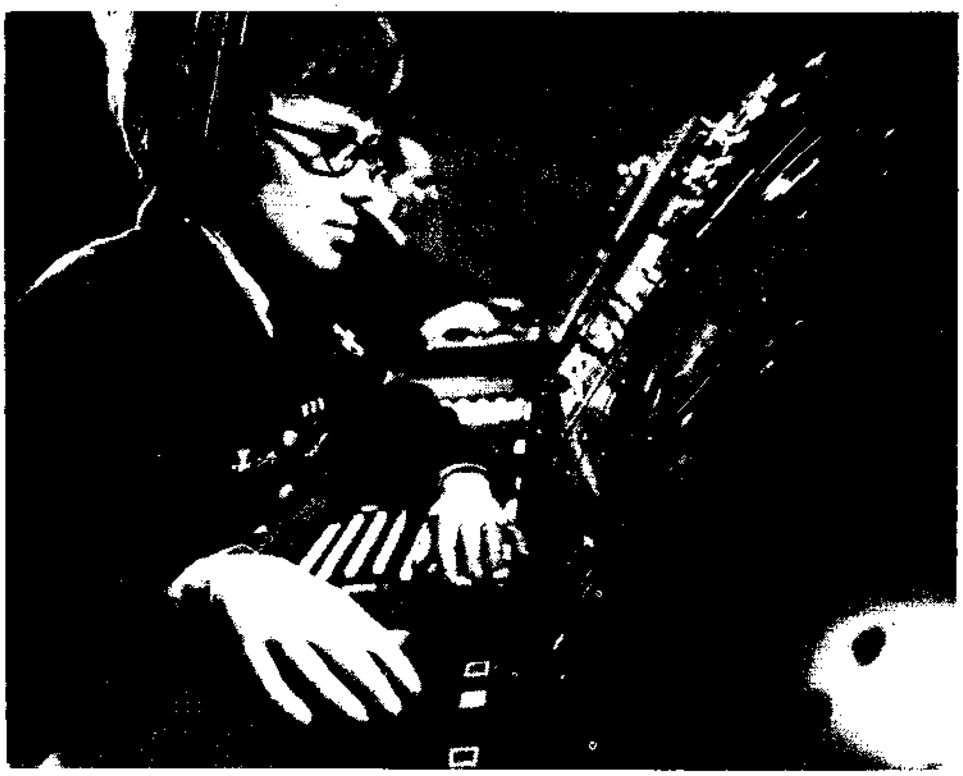
Although primarily an air defence system STRIL-60 is linked to coastal as well as to anti-aircraft artillery.

STATUS:

STRIL-60 is currently an operational system. It is expected, however, that in the near future a major overhaul and updating programme will be put in hand – probably by the newly formed ITT Telekommunicatione – a company jointly owned by ITT, SAAB and the Swedish Government.

MANUFACTURERS:

Prime contractor for the system was Standard Radio & Telefon AB, (SRT), Bromma, Sweden. SRT were also responsible for the creation of a similar system in Denmark.



Operators at work with Standard Radio and Telefon displays at a Swedish air defence centre

SWITZERLAND

2373.181
FLORIDA AIR DEFENCE COMMAND CONTROL SYSTEM

DESCRIPTION:

FLORIDA is the name given to a computerised air defence command and control system that was accepted and declared operational by the Swiss military authorities in April 1970. General contractor for the system was the Hughes Aircraft Company.

DESCRIPTION:

The system consists of several military radar stations with 3D radar and air defence direction centres, including computers, display consoles and associated equipment. Information from the radar station is fed into conversion equipment in underground Air Defence Direction Centres and processed in turn by a high-speed Hughes general-purpose computer.

This computer automatically establishes speed, heading and altitude of an unidentified intruder. Display consoles present a constantly updated picture of the aircraft's flight track as well as information on the various weapons available, their launch ranges, velocities, armament, restrictions and time-to-k .

Should the target be identified as an immediate threat, the air defence commander can electronically request all-weather interceptor aircraft or surface-to-air missiles to intercept and destroy, and can a ert the c vil defence organisation.

SYSTEM COMPONENTS:

The radar used is a long-range three dimensional radar, with a planar array aerial using the Hughes elevation frequency scanning technique. This provides simultaneous range, bearing and altitude data. An FF system s associated with the radar.

The system includes video extractors that analyse radar returns, with the help of a real-time computer, and extract actual aircraft tracks from spurious returns such as clouds and ground returns. Track acquisition and updating is automatic.

This processed information is fed to Air Defence Direction Centres where it is accepted by a computer. This takes in information from the missile sites, airfields and other military installations and stores it for use in se ecting defensive measures.

It can also simulate air battle situations for training and instruction, and can be used as a general purpose data processing centre.

The computer may be required to provide information on weapons available, their launch ranges, velocities, armament, restrictions and time-to-ki... Numerals and symbols are used to provide this intelligence to the contro er and to depict the battle area, the threat and the defences, the problems and their solutions. The computer, the Hughes H-3324 is of the same type as those associated with the radars but has a much larger storage capacity. Typically it might be called upon to execute between 50,000 and 550,000 instructions in a second.

In the Direction Centre the display consoles are arranged to display only that information which is pertinent to the tasks of the operator concerned. The principal functions are:

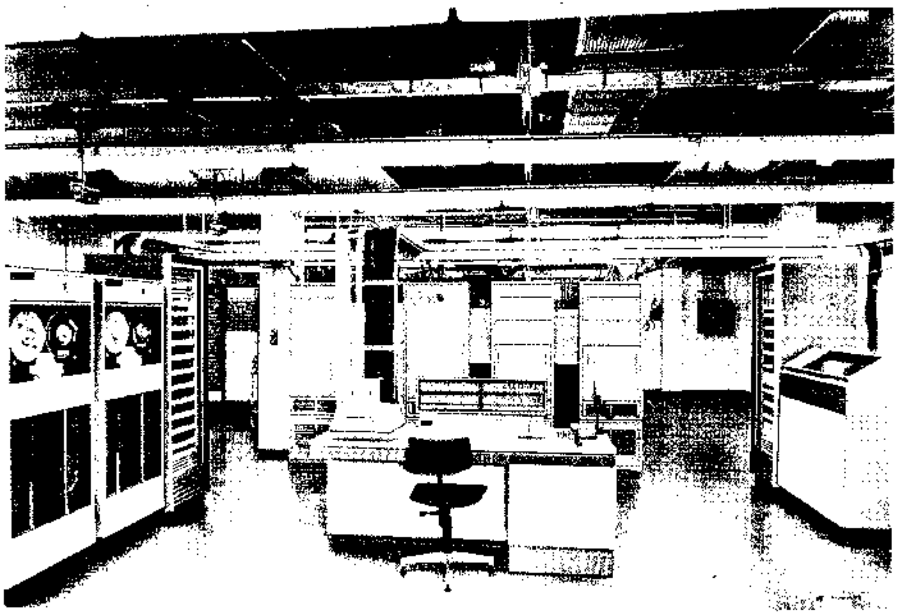
Identification officer responsible for designating radar tracks as friendly or hostile aircraft.

Interceptor director – interested in his own controlled interceptor and the assigned hostile aircraft. To him, specific data about this intercept is presented including attack geometry, altitude, speed, time to intercept, etc.

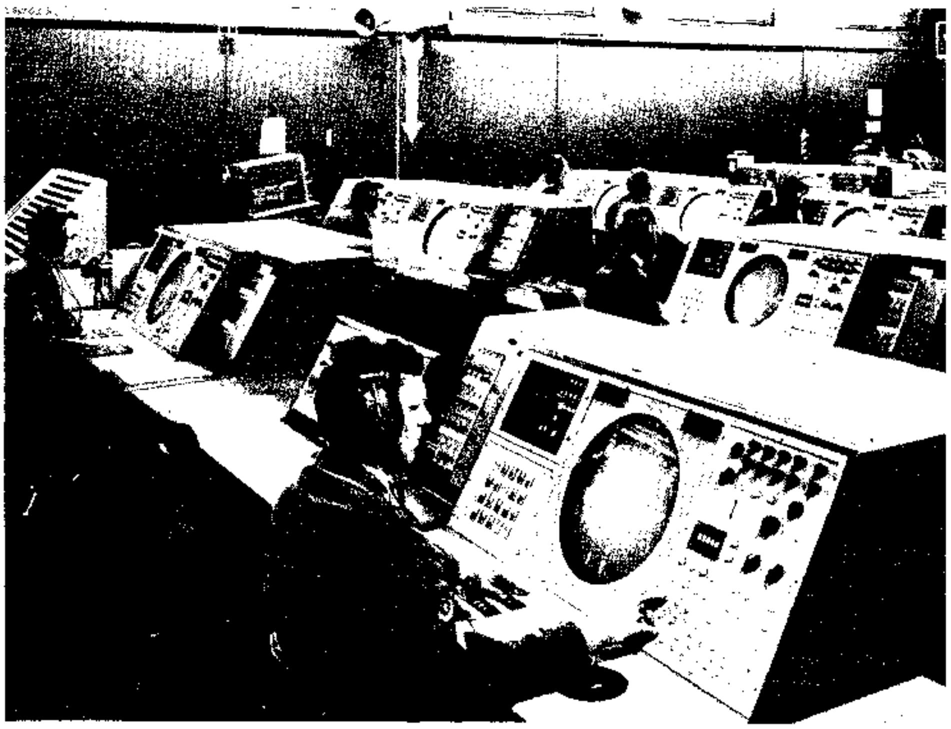
Air traffic coordinator – concerned with military aircraft requesting clearance to cross civilian airways.

Missile officer – (surface to air) in close contact with the missile batteries and assigns targets to the appropriate site.

Chief of air defence concentrates on deployment and the threat. Total composite air situation and threat boundaries are important to him.



Computing and data handling centre for the Florida system



The display console used in the Air Defence Direction Centre

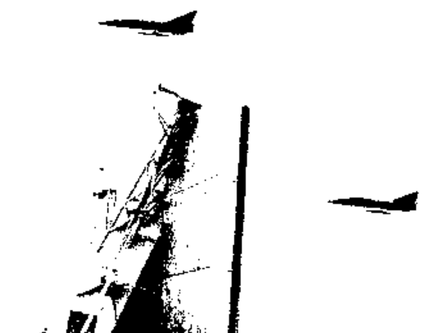
Aircraft and missile forces currently under control are two Mirage III S interceptor squadrons and two Bloodhound 2 surface-to-air missile battalions (**2406.131**). There are also 45 batteries armed with Oerlikon twin 35 mm cannon.

DEVELOPMENT:

The contract for Florida was let to the Hughes Aircraft Company in January 1966 following preliminary negotiations in the previous year. The contract required Hughes to design, build, install and test a semi-automatic air surveillance and guidance control system for military aircraft. System acceptance by the Swiss authorities was to take place after Florida had been integrated into the Swiss air defence system and verified by a lengthy test process. It is this process that had been completed when the system was declared operational in April 1970.

MANUFACTURERS:

System contractor: Hughes Aircraft Company, Fullerton, California, USA.



Aerial of the 3D radar for Florida

THE UNITED KINGDOM

2417.181
HUB CAP DEVELOPMENTS

Hub Cap is a sophisticated mobile control and reporting unit (CRU) for air defence designed by Plessey and based on a specification written in close collaboration with a team of Royal Australian Air Force officers. It is currently deployed in Australia and is described in entry **2016.181**.

NEW DEVELOPMENT:

Technological advances have enabled considerable reductions in size and weight to be made on such systems as Hub Cap, while still retaining the capacity and facilities of the latter.

A modular display and data handling system has been evolved by Plessey which can be deployed to meet a variety of operational requirements. It may be used in a static or mobile role and is designed in modular form to allow the facilities to be readily expanded.

Modules are built into transportable cabins, each of which weighs less than 1,800 kg and occupies approximately 10 cubic metres. The system is designed for transport by helicopter (slung) or freight carrying aircraft (such as C130), and can be transported by road vehicle, road mobiliser or train.

From a single module two or three manual interceptions can be performed with the assistance of manually initiated automatic tracking or rate aiding facilities. Track information is presented as a prediction vector on the controller's display, along with digital read-out of height and identity. This intercept capacity can be increased by adding a second display module and/or automatic data processing module to give, for example, computer aided interceptions, 100 tracks, and other facilities such as strike, flight following, etc.

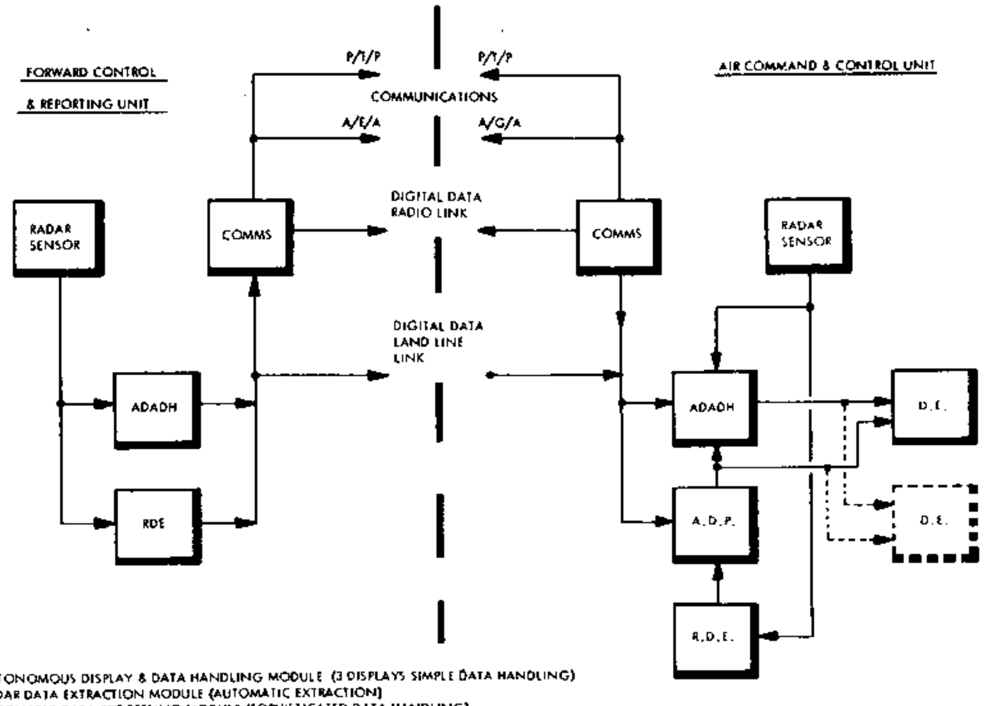
Initial mobility trials have already been carried out, and the time into action of a typical system is estimated as less than one hour.

To enable the operational capability to be matched to the particular air defence need and to the available transport, the system has been arranged so that a phased build-up capability or system re-configuration can be readily implemented in the field.

The accompanying block schematic diagram shows a typical mobile tactical data-handling system.

MANUFACTURER:

Plessey Radar Ltd, Addlestone, Surrey, England.



LEGEND

ADADH - AUTONOMOUS DISPLAY & DATA HANDLING MODULE (3 DISPLAYS SIMPLE DATA HANDLING)
R.D.E. - RADAR DATA EXTRACTION MODULE (AUTOMATIC EXTRACTION)
A.D.P. - AUTOMATIC DATA PROCESSING MODULE (SOPHISTICATED DATA HANDLING)
D.E. - DISPLAY EXTENSION MODULE (6 DISPLAYS)
COMMS - COMMUNICATIONS MODULE UHF/VHF/HF

Typical Data Handling System

2443.181
LINESMAN AIR DEFENCE SYSTEM

DESCRIPTION:

Linesman is the code name given to the military part of the joint civil/military complex of radar data-processing and display equipment known as Linesman/Mediator. Until recently it was the principal focus of the British air defence system.

Linesman was originally conceived as an anti-bomber defence supplementing the anti-missile defence – such as it was – provided by BMEWS (**2525.181**) and the United States' capacity for 'massive retaliation' at the time when the NATO strategy was based on the 'tripwire' concept. Before the system came into operation, however, both the NATO policy and the nature of the threat changed; as a result there has been a gradual evolution in system thinking while the people and equipment of the system have been more concerned – in practical terms at least – with anti-reconnaissance and anti-ECM operations than with preparing to intercept what appeared to be an unlikely medium-level or high-level bomber offensive.

Broadly speaking, the main elements of the system and of its associated systems are, first, a set of radars peculiar to Linesman and intended for use as main data input devices; secondly, a further set of early warning and data handling devices – the Standby Local Early Warning and Control (SLEWC) Centres – whose function was to supplement the primary air defence system and at the same time offer the possibility of independent operation in the event of a system failure; thirdly, other radars in the joint military/civil complex whose outputs were processed by both parts of the combined systems; fourthly, inputs from the NATO long-range radars and the NADGE network (**1181.181**). The UK network is not in fact a part of NADGE but there are close links between the two systems.

Processed data from all these inputs was supplied – in appropriate form – to the RAF Strike Command HQ and to the joint civil/military control centre at West Drayton. It was at Strike Command that a decision was taken to intercept, for example, an unknown intruder into British airspace; but it was at the West Drayton control centre that the tactical controllers were located and it was these controllers who had the task of controlling the aircraft or missile formations engaged in any particular operation once it had been initiated by Strike Command.

As a result of internal evolution and external criticism of the system the whole Linesman concept can now be regarded as having been eliminated from the UK air defence system. It has been replaced by what is to all intents and purposes a new system (described below in entry **2444.181**) but since the name 'Linesman' is as yet far from obsolete as a general reference description for much of the equipment in the new system it seems advisable to retain a reference to it in the present volume.

2426.181
MARCONI TACTICAL AIR DEFENCE SYSTEMS

Based on the Marconi S600 Series of radars (**1168.153**) and associated equipment, a number of different tactical air defence control and reporting systems have been supplied or are on offer to a variety of customer countries.

A "building-block" approach has been adopted by the manufacturers who offer in particular a number of preferred configurations of equipment – although obviously variants lying outside these preferred configurations can be devised. In order of complexity the preferred configurations are:

(i) Early Warning Post

(ii) Track Reporting Station
(iii) Control and Reporting Station (single surveillance radar)
(iv) Control and Reporting Station (extended cover using two surveillance radars)
(v) Control and Reporting Station (expandable to computer control)
(vi) Area Control Station (full computer control)

Apart from physical limitations due to earth curvature, the absolute range performance of each station is limited by the aerial dimensions and transmitted power available in a transportable system. To offset these limitations it is recommended that a tactical defence system be obtained by integrating a number of elements, each capable of local autonomous control of a limited number of weapons as well as early warning and reporting into a central area control station. The use of several stations has a number of advantages including

(a) wider spread of frequencies to combat ECM
(b) better low cover
(c) greater reliability by overlapping cover thus allowing for the loss of one element at any time
(d) maintenance of overall cover during redeployment of individual stations
(e) smaller stations are inherently easier to redeploy
(f) standardisation of modules eases spares and training requirements

TRACK REPORTING AND EARLY WARNING STATIONS

Track reporting stations, suitable for tactical use in forward battle areas to provide low cover surveillance or for use in a gap-filling role in more extensive systems, can be provided by the smallest configurations. Within the limitations imposed by siting conditions, the radar cover provided by such stations ensures detection of small fighter/bomber aircraft out to ranges in excess of 120 miles and larger medium bomber aircraft to ranges of 160 miles. To obtain optimum performance and minimise problems caused by weather conditions, frequency allocations and geographical features, variants of the S600 range are available for operation on S-band or L-band.

In the basic station the radar responses are displayed on a single 406 mm PPI display unit housed within the transmitter cabin. Track reporting from this position is carried out manually by voice communication over a VHF radio communications link. The PPI incorporates range expansion and off-centring facilities for detailed examination of areas of importance, range markers at 5 or 10 mile intervals and a range/bearing cursor line.

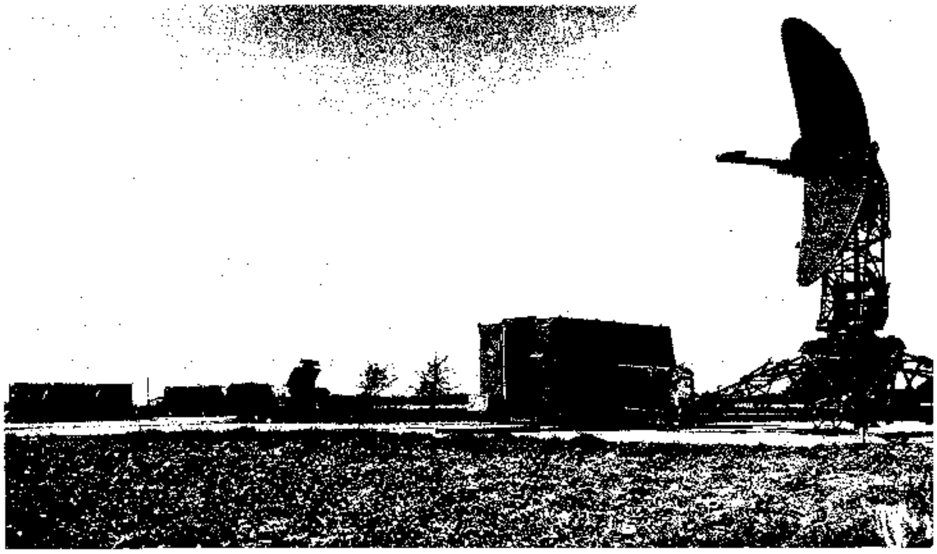
OPERATIONS CABIN

A station of greater capacity can be provided by the addition of an operations cabin type S5013 to the basic track reporting station. This contains three operational displays similar to that in the track reporting station but incorporating semi-automatic track reporting by digital data link. Track positions are precisely marked by electronic markers superimposed on the radar responses, the markers being controlled by rolling ball on the operators' desks. Each operator can maintain up to four tracks simultaneously, giving a total capacity of twelve tracks to the cabin. IFF facilities for identification of aircraft responses may be fitted to any of the variants depending upon the requirement.

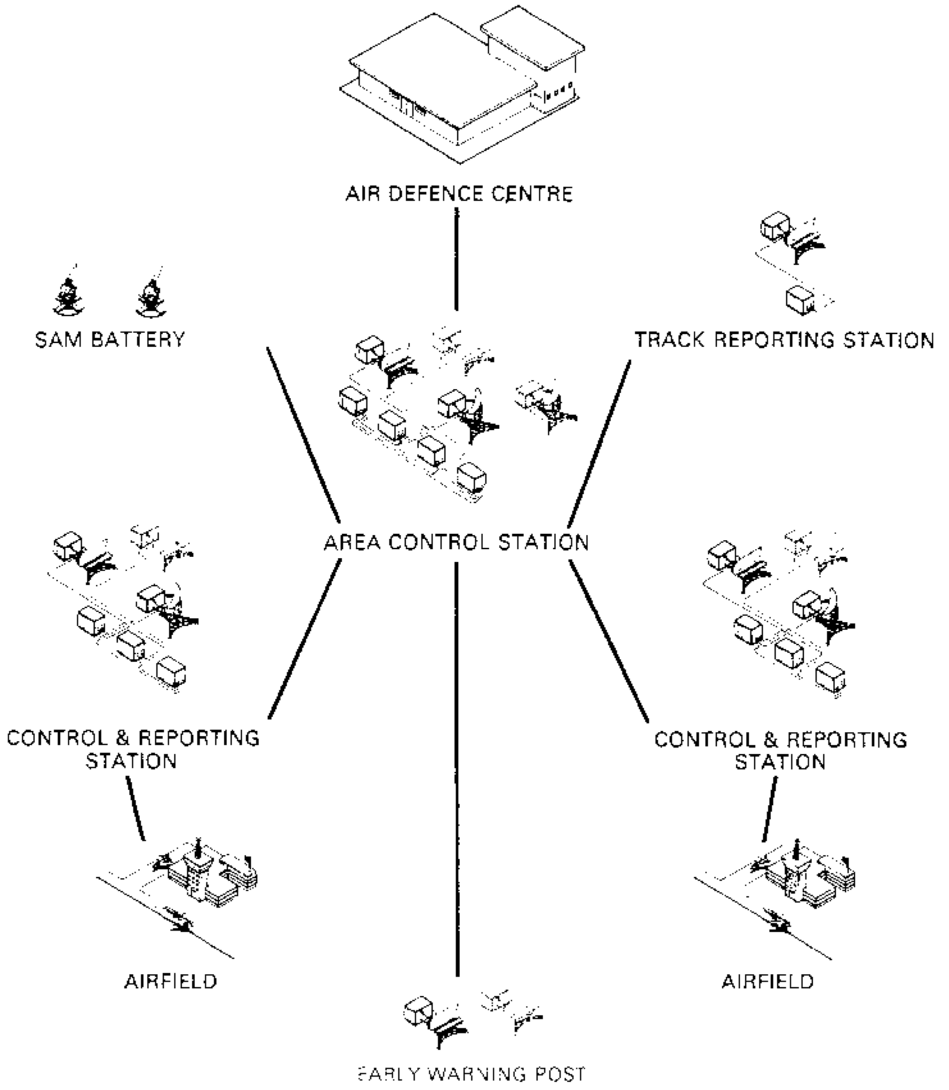
CONTROL AND REPORTING STATIONS

A control and reporting station for ground control of interceptor aircraft and close support strike aircraft in a tactical situation is provided by combining a height finding radar with one or two surveillance radars. Detection of small fighter/bomber aircraft out to ranges of 120 miles and medium bomber aircraft up to ranges of 160 miles is then supplemented by height information of high accuracy. The performance of the height finding radar is matched to that of the surveillance radars. Furthermore the height finding radar has a useful capability in a volumetric scanning role to maintain radar cover in the event of surveillance radar malfunction.

With these radars, one or two operations cabins may be deployed. If it is assumed that the threat



Units of the Marconi tactical air defence systems. Heightfinder in the foreground; surveillance radar with on-mounted IFF aerial in the background



Typical layout of an integrated tactical control system

only justifies deployment of a single operations cabin, then the operational functions may be used in any of the following roles

(a) Primarily in a reporting role, manned by a master tracker and two trackers, increasing under periods of peak activity to three trackers
(b) As an early warning unit with a capability of handling two manual interceptions from one position with track reporting from the two remaining positions
(c) As an early warning unit with a capability of handling four manual interceptions from two positions with "broad brush" reporting from the remaining position
(d) Solely as a control unit capable of handling six manual interceptions from three positions and no raid reporting.

AUTOMATIC DATA PROCESSING

Where a control and reporting station is to be part of a major tactical air defence network, the introduction of automatic data processing techni-

ques is a major factor in reducing reaction time and improving operational effectiveness. For this purpose the type of operations cabin described above may be exchanged for a different type (S5014) in which the 406 mm displays are accompanied by 300 mm tabular displays which operate in conjunction with light-pen modules to give a programme dissected entry panel for communication with a computer. Organisation of the displayed data and interpretation of the light-pen entries from the operators' desks are effected by a smaller processor contained within the cabin. This small processor also gives this kind of system considerable added capacity as an autonomous unit, as well as making it compatible with a central computer. Functions that can be performed include:
(a) Control of the heightfinder.
(b) Inter-console marking.
(c) Track storage for up to 20 tracks.
(d) Transmission of track data to remote sites via digital data link.
(e) Display of relative range and bearing.
(f) Labelled radar display.
(g) Rate aided manual tracking with track smoothing, hopping strobe and automatic sequencing.
(h) Generation of area gate strobe for active SIF code on selected targets; validation of decoded returns and display of code information.

INTEGRATED TACTICAL AIR CONTROL SYSTEM:
For over all cover of a forward battle area an entire air support control complex is necessary. The air defence centre represents the section of field headquarters responsible for over-all command of the air battle. This centre must be in constant communication with the area control station from which executive control of all aircraft is exercised and whose functions include:
(a) Co-ordination of the individual air support control elements within the system.
(b) Assembly, correlation and distribution of data relating to aircraft movements, status of air defence elements and tactical allocations.
(c) Assessment of hostile air activity and allocation of defence elements.
(d) Control of aircraft on interception and strike missions.
(e) Integration of manned interceptors and surface-to-air weapons defence systems.
(f) Feedback of information to the air defence centre.

The control and reporting stations extend the radar cover over wider areas, and in addition to feeding information back to the main centre provide a facility for local control of limited forces engaged in interception and strike functions. If situated adjacent to airhead support bases, the control and reporting stations can also perform a military air traffic control role for all arriving and departing aircraft.

The track reporting stations are the smallest surveillance configurations; these are deployed in forward areas, charged with detection of enemy movements and passing this information up the chain of command for action.

AREA CONTROL STATIONS:
This configuration incorporates extensive facilities, including computer assistance, for full control of the air battle in a tactical situation. A complete air defence system in transportable form becomes available by adopting the S600 Series of Data Processing cabins which are designed to operate in conjunction with the S600 Series radars and operations cabins.

In its fullest configuration the Area Control Station employs:
(a) Two surveillance radars, typically one S-band and one L-band with suitable aerials to give both high cover and long-range low cover.
(b) Two height finding radars giving a data rate of 40 heights/minute.
(c) Four operations cabins providing twelve display positions.
(d) One data processing cabin.
(e) Up to six digital data link terminals for the automatic transfer of data.
(f) Ground-to-air and ground-to-ground communications equipment.

To make greatest use of the available hardware the computer operates with an adaptive programme and the universal display positions allow changes in operational functions to meet differing requirements in a tactical situation. The following data processing services are available in a typical system to meet the demands for tactical air control:
(a) Tracking capacity of sixty tracks, using manual initiation with subsequent automatic track following on data from a plot extractor. All tracks are presented on marked radar displays.
(b) Automation correlation of secondary radar data with tracks for identification purposes.
(c) Flight plan storage for information received from movement control centres.
(d) Display of stored flight plans.
(e) Control of height finder sequence and correlation of extracted heights with track stores.
(f) Threat assessment and weapon assignment for allocation of interceptors and for missiles.
(g) Trial intercept calculations and control of fighter aircraft for up to sixteen simultaneous engagements.
(h) Calculations for recovery of up to twelve aircraft simultaneously.
(i) Calculations for planning and controlling aircraft on strike missions.
(j) Simulation of target and fighter tracks for training exercises.
(k) Data recording for assessment of operational efficiency.
(l) Video indication of selected airfields and beacons.

Each display position may be programmed to perform any of the designated operational functions and the system may be re-structured by programme change to overcome the loss of service from any position. Intercommunication equipment is provided to link all positions for voice contact. Also, each position is connected by an electronic pointer facility for hand-over of positional data observed on the p.p.i. displays. Ground-to-air and ground-to-ground communications connections are available in each cabin and can be selected by operators and controllers as required.

STATUS:
Available. Various systems have been supplied to customers outside the UK but details are not available for publication.

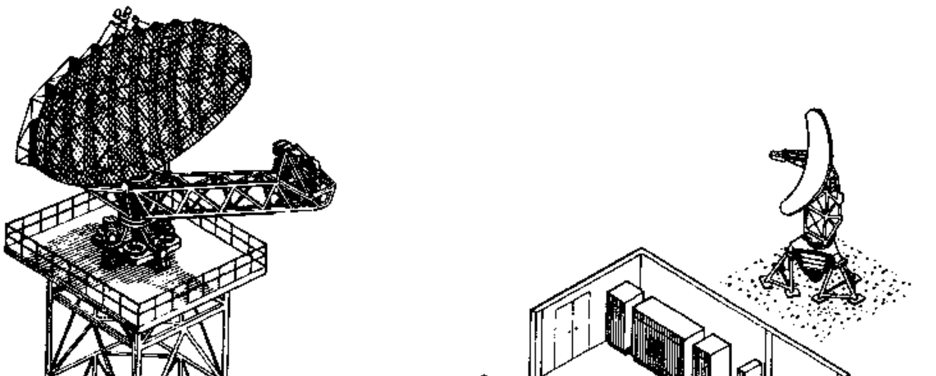
MANUFACTURER:
Marconi Radar Systems Ltd, Chelmsford, England.

2429.181
MARCONI STATIC AIR DEFENCE SYSTEMS

DESCRIPTION:
Static air defence systems manufactured by Marconi are based on the same general principles, and the company offers equipment reflecting the same modular approach to the problem as in their tactical systems (**2426.181**). Indeed, for the simpler types of installation the basic equipments used may well be the same; in which case the differences are likely to reside only in the substitution of permanent structures for mobile supports, cabins, cableways and the like.

For more sophisticated systems, however, the designers of a static system can take advantage of the wider range of equipment that becomes available when the mobility requirement is dropped. As examples of such complexes there are considered below: a limited capacity control and reporting station, an area control station and an air defence operations centre.

Control and Reporting Station – limited capacity
A control and reporting station for ground control of interceptors could be provided by combining an S637 heightfinding radar with one or two S600 series surveillance radars. For example, using an S654 L-band 2mW dual-beam surveillance radar with the 1mW heightfinder it should be possible to detect small bombers out to 150 nm and medium bombers out to 200 nm and to determine their heights with an operationally sensible degree of accuracy. The suggested combination uses two radars that are well matched in performance so that heights should be obtainable on all aircraft detected; furthermore the



Arrangement of a control and reporting station heightfinder can be used for volumetric scanning if the surveillance radar is out of action.

A high ECCM capability is achieved by the use of two frequency bands (L and C), by the low side-lobe level of the two aerials and by the use of anti-jamming receivers and signal processing.

This configuration is adequate where the threat is limited. In this situation it is capable of a stand-alone role and for this purpose is equipped with two three-display console suites. General situation assessment is achieved by plotting on a vertical edge lit perspex general situation map from track data supplied by two trackers, with the third position on the console suite allocated to a master tracker who is also responsible for the identification of tracks.

The other three-display suite is manned by a chief controller and two interception controllers who direct the interception and recovery of the fighters to base through u.h.f. or v.h.f. ground-to-air radio links. A communication system also links the operator positions to each other and to fighter bases and other remote units of the defence organisation.

All positions obtain height data through demands made by a tracker ball control which actuates the automatic height extraction equipment. The same marking system is also used to obtain relative range and bearing information and to 'point' between operational positions.

Area control station

In situations where it is desirable to exploit the full long range high cover capability of large static aerial systems and in order to provide a pivot for a complex air defence system extending over a large geographical area, a more complex configuration of equipment is appropriate.

Alternative primary radar systems are available to satisfy this requirement.

1. 2D fan-beam surveillance radars, with single or back-to-back dual frequency aerial systems in conjunction with one or more nodding heightfinder radars.
2. 3D multi-beam volumetric radars. The choice between these alternatives is made by consideration of the operational requirements of the air defence organisation. Each has advantages and disadvantages which influence the choice in a particular situation, but, broadly speaking, the 3D volumetric system is considered appropriate where high traffic densities occur.

The processed signals from the surveillance radar system are fed into primary and secondary radar plot extractors, whereby all valid plots are expressed as digital quantities and correlated with secondary plots from the same target. Secondary radar signals are decoded at this stage.

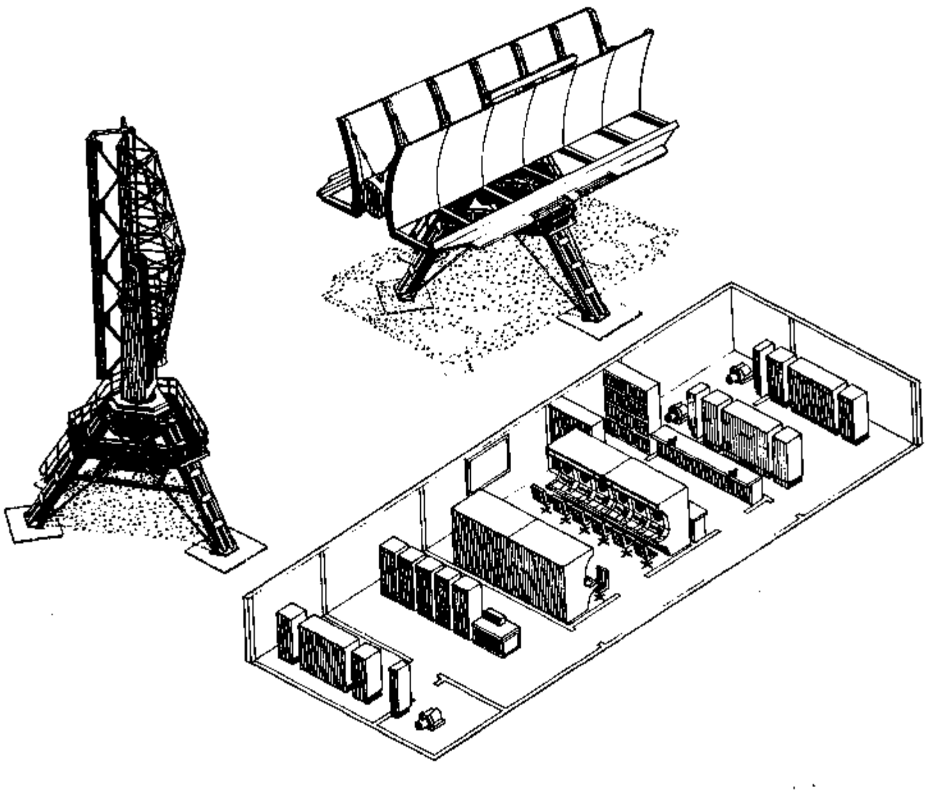
The heightfinder radars respond to demands from the display and data processing system and the signals received from the selected targets are analysed in the automatic plot extraction equipment and the height values computed.

As control signals to the radar aerial equipment and the data therefrom can be expressed in a form suitable for transmission over narrow bandwidth data links, it is possible to locate the aerials for optimum radar cover at sites remote from the display and data processing systems.

Air Defence Operation Centre (ADOC)

Up-to-date information on the deployment of forces, availability of resources and the extent of engagement is an essential ingredient of an efficient operational centre. The following description assumes the provision of data processing and display equipment from the Marconi range.

In an air defence operations centre, a Myriad computer, with specialised peripheral equipment, accepts data entering from a number of remote control centres via narrow band digital data links. The data link messages are reassembled and checked for parity errors as the information is collected together in the data store. Where messages are received from a number of remote stations, co-ordinate conversion is carried out to allow the positional information to be referred to a common reference for presentation purposes. A large-screen projector or rapid processing photographic machine provides conference facilities. In addition, individual user's displays from the S3000 range provide information in both graphical and tabular form allowing the higher command staff to call down further information on any aspect of the defence situation. Extension of the system is possible to embrace such matters as availability of transport, logistics data on maintenance, reserves and effects of force re-configuration. Gathering of data and exercising the system under practice conditions is an important feature and these systems may be programmed for simulation studies to establish effective co-ordination of the entire defence organisation.



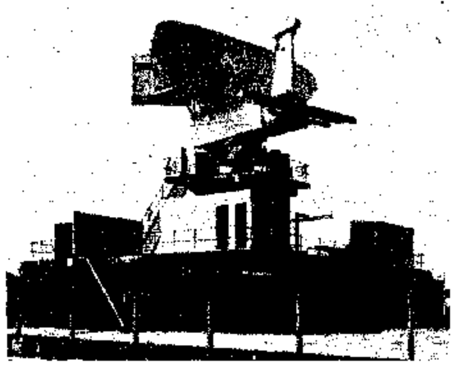
Arrangement of a static area control station

Display and data processing system

Utilisation of the radar data occurs in the underground operations centre where a computerised display and data handling system speeds the transfer of data, filters out extraneous signals, calculates the threat and advises the operating personnel on the best defensive measures. The extent of the equipment in the centre is determined by the assessment of the threat in terms of tracks to be handled and the extent of the defensive structure in terms of hostile engagements.

The computer complex is based on the Myriad III. Display requirements are met by adopting a modular approach; six displays (three plan-position indicators and three tabulars) are served by a local processor which acts as a display controller. In this way, the display refresh rate is kept at 25 Hz to avoid flicker. Up-dating of tracker ball control information, display format control, category selection and interpretation of light-pen data entries are also carried out with minimum load on the central processor.

The displays themselves employ digital techniques throughout to improve stability and minimise setting-up procedures. All display positions use identical equipment, their operational role being determined by the computer programme, which selects the relevant portion of its adaptive routine to meet the desired role. Operational organisations may be altered with minimum disturbance when new facilities are required.



40-series volumetric radar for static air defence systems

The total display content for a particular system is provided by assembling the appropriate quota of display modules. For example, a display system having eighteen operational displays is met by use of six modules. This design philosophy ensures that malfunction in a module affects a limited part of the system and realises a high level of operational reliability.

The computer complex automatically services digital data links feeding data to adjacent sector operations centres, surface-to-air missile sites and air defence headquarters. Similarly, incoming data is accepted from digital data links, checked for transmission errors and entered into the display read-out routines where required.

Without the restrictions imposed by considerations of transportability, the system can be extended to meet virtually any level in capacity, but the operational facilities available are generally as for the S600 Series transportable Area Control Stations. The computer programmes incorporate the same software packages, so that operational procedures can be similar throughout defence organisations where static and mobile installations co-exist.

MANUFACTURER:

Marconi Radar Systems Ltd, Chelmsford, England.

2421.181
NOMAD

DESCRIPTION:

NOMAD is a fully air-portable data handling system designed to operate in conjunction with either 3D radars or 2D plan radars supported by heightfinding radars which, with ground-to-air plus ground to ground communications facilities and secondary radar, provide a complete tactical air control system.

On site, the equipment comprises two main sections – the operations centre, which contains displays and display drive and back-up equipment, and the computer complex. Both sections are housed in inflatable shelters.

Digital computing is used to process the input data from primary radars thus permitting the semi-automatic tracking of targets. Simultaneous control of multiple fighter interceptions and surface-to-air missile engagements is possible, the SAM launch control post being fully integrated into the system by digital data links.

OPERATION:

The operational organisation of the Nomad system can be divided into groups under the Air Defence Commander, who is in overall command:

Executive group – comprising the Chief Fighter Controller, the Chief SAM Controller, and various liaison executives, for other services.

Operational group – comprising Fighter Controllers, SAM Controllers, trackers and heightfinder operators.

The system provides semi-automatic tracking of targets, with track storage, and simultaneous control of a number of fighter interceptions and surface-to-air missile engagements. Identification of aircraft is assisted by the use of secondary radar (IFF).

Fighter interceptions are dependent on the characteristics of a particular aircraft, such as its performance in climb, cruise, acceleration, turn, etc. The characteristics of up to four fighter types can be held in the computer as stored data. The Nomad system can accommodate new or revised types of fighter characteristics by means of a small programme change. To effect an interception, the fighter controller must supply the computer with the following data via his keyboard:

Target track number
Fighter/weapon combination.
Fighter bases available.

The computer will calculate an interception profile for the selected fighter from this data together with the stored fighter performance data and will indicate to the controller on his tabular display:

if an interception is possible;
predicted kill point;
recovery probability;
command instructions to direct the fighter on the optimum flight path.

The tabular display will also indicate

Fighter/weapon choice;
Selected fighter/weapon base.

Should the interception be shown to be impossible or recovery to be marginal the fighter controller may immediately select a different fighter/weapon combination or fighter base and read the information on the re-calculated situation. Throughout the interception a continuous calculation is made of the amount of fuel which the fighter will retain for recovery to a given airfield after the interception.

When effecting surface-to-air missile engagements, the SAM controller is presented with a threat priority list of SAM targets. He decides from this in which order to engage the targets: the range, bearing, elevation and range-rate of the target is automatically fed to the selected SAM site via the digital data link for use by the target illumination radar (TIR) in locking on to the target. After lock-on is achieved, a check reply is sent back to the SAM controller who may then, after verification of target identity, order the firing of the missile salvo.

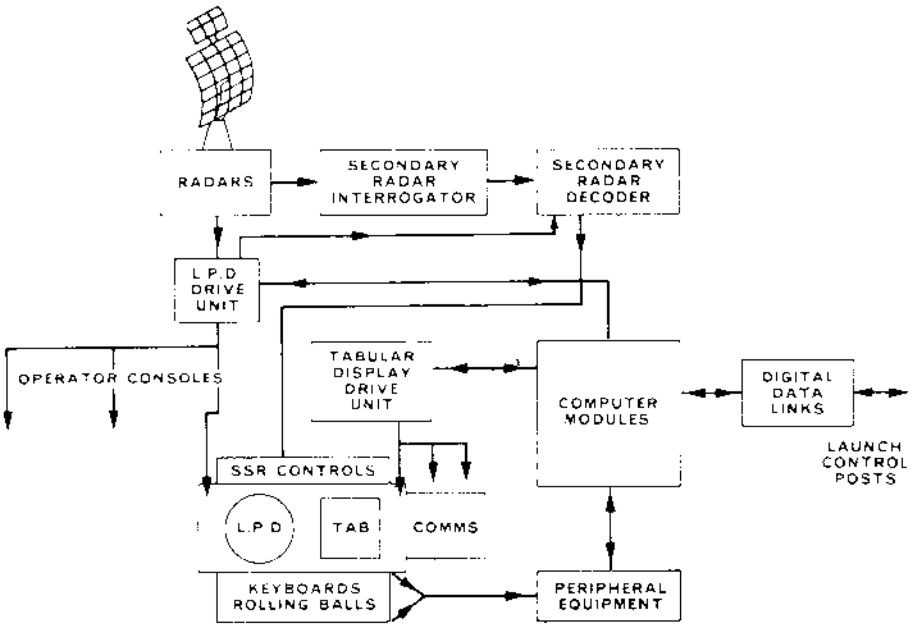
The display equipment used by all controller/tracker pairs is identical, being built on a modular basis. This provides a continued though reduced operational capability in the event of a technical failure, since a chief controller can take over a controller tracker position with a loss to the system of the capacity of the position taken over. The controller/tracker pairs use dual consoles comprising:

Plessey TDS Mk 5 Labelled Plan display (LPD)
Plessey TDS Mk 7 Tabular display
Rolling ball symbol position control.
Two keyboards (general purpose) for insertion of alpha-numeric data to computer, and call-down of data from the computer.
Plessey 'Minicom' Communications Controls.
Secondary radar controls.

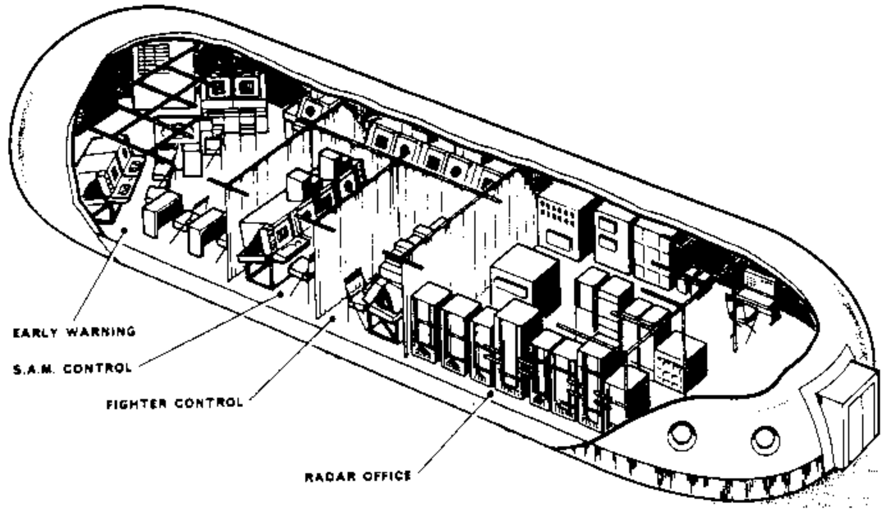
The air defence commander shares a display with the display controller and the control executive. This is a 53 cm conference labelled plan display, complete with rolling ball controls, keyboards, communications control and secondary radar controls.

SEMI AUTOMATIC TRACKING:

In a semi-automatic tracking system the operator participates in the track generation process to the extent that is necessary to select targets for tracking and to ensure that targets are not lost or confused; while the computer functions to reduce the operator's workload and produce a smooth track. Tracking is initiated by an LPD operator by marking with a moving electrical marker and setting the computer to work on this input data. The computer generates a track from this input and predicts the target's future position: its prediction is in turn connected by the operator whereupon the computer makes a further prediction, and so on. Height information – whether derived from 3D radar or a separate heightfinder – is also supplied to the computer to aid it in its track pre-

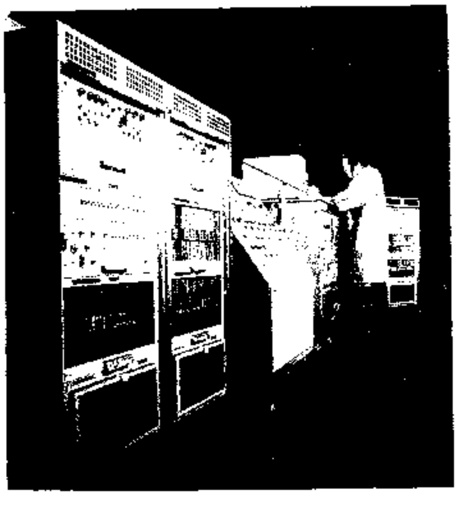


Schematic showing part of the Nomad system and its relationship with primary and secondary radars and SAM launch control posts



OPERATIONS ROOM SHELTER

Typical layout of Nomad operation room shelter



Marconi-Elliott computer equipment for Nomad in production diction. This technique makes it possible for one operator to track several targets simultaneously if required.

DEVELOPMENT HISTORY:

The command of air battles at continually changing forward locations presents a difficult task when using orthodox fixed-site control and reporting units. Flexible and effective control can only be obtained when using readily transportable and highly reliable control centres which can be deployed and made operational in a short space of time. The British Government required a number of such units and in 1965 awarded a contract to Plessey Radar to work with Elliott-Automation (now Marconi-Elliott Avionic Systems Ltd) in the design and manufacture of a number of systems. From this joint effort came the idea of developing a further system for commercial sale, and Nomad was the result.

The system has been specified as the central data processing and control complex of the British Aircraft Corporation's Thunderbird 22 system (**2461.131**) which they are offering for commercial sale.

MAJOR SYSTEM ELEMENTS AND SUPPLIERS:

i A digital computer system, with built-in redundancy, permitting further expansion, using Marconi-Elliott 920B computers, together with display/computer interface equipment.

ii Plessey TDS Mk 5 Labelled Plan radar displays.

iii Plessey TDS Mk 5 Height Finder radar displays.

iv Plessey TDS Mk 7 Tabular displays.

v Plessey Display Drive Distribution and Character Generation equipment.

vi Secondary Radar Decoding equipment produced by Elliott-Automation.

vii Solartron high resolution Video Map generators.

viii Plessey 'Minicom' Communications Control equipment.

MANUFACTURER:

Plessey Radar Ltd, Addlestone, Surrey, England.

2461.181
THUNDERBIRD 22

DESCRIPTION:

Thunderbird 22 is the name given by the British Aircraft Corporation to the comprehensive Air Defence System which includes basic Thunderbird 2 firing units.

Facilities provided by the complete system include detection and identification of friendly or hostile aircraft, threat evaluation, engagement of medium-level and high-level attacks by Thunderbird batteries and GCI control of fighter aircraft. The units of the system are linked by a comprehensive command communications network.

Operational centre of the system is the Nomad Missile and Fighter Control centre. This is a complex data-processing and data-display arrangement built round a high-capacity digital computer. Data inputs to the system come from a Tactical Control/Early Warning Radar and a Height-Finding Radar and from an associated secondary radar (IFF) interrogator responsor and decoder. This information is presented on displays that permit the semi-automatic tracking of targets; the resultant tracks for hostile targets are stored by the computer and processed to provide advisory information to enable the Air Defence Commander to decide how to meet the threat. In presenting this information the computer draws on other stored (and periodically updated) data such as weapon availability and state of readiness for interceptor performance and availability. When the engagement decision is taken, control of the engagement is assumed either by the surface-to-air Missile Control Centre or by the Fighter Control Centre as appropriate. Both centres are located in the Nomad complex and are served by the same radar and computer system; but in other respects their functions and procedures are similar to those of independent GCI or missile control centres – e.g. the Battery Command Post of Thunderbird 2 – except insofar as procedures prior to the engagement decision are concerned.

SYSTEM COMPONENTS:

Major components of the system (excluding aircraft) are listed below, together with the names of the manufacturers principally concerned with them. More detailed information can be found in the entries for the system components.

COMPLETE SYSTEM	British Aircraft Corporation Ltd.
MOBILE TACTICAL CONTROL AND EARLY WARNING RADAR	Marconi Radar Systems Ltd
MOBILE HEIGHT-FINDING RADAR	Marconi Radar Systems Ltd.
NOMAD MISSILE AND FIGHTER CONTROL CENTRE	Plessey Radar Ltd. Marconi Radar Systems Ltd. Marconi-Elliott Computer Systems Ltd.
THUNDERBIRD 2 SAM BATTERIES	British Aircraft Corporation Ltd. Ferranti Ltd.
RAPIER SAM BATTERIES	British Aircraft Corporation Ltd.
COMMAND COMMUNICATIONS SYSTEM	Marconi Radar Systems Ltd.

Launch of Thunderbird missile

2444.181
UK AIR DEFENCE SYSTEM

DESCRIPTION:

It was decided in 1972 that British air defence policy, which for some time had been based on a "trip-wire" concept of reaction to an air-launched nuclear attack coupled with anti-reconnaissance operations conducted by a small interceptor force, would be changed to include provision for defence against conventional attack. The implications of this policy change are summarised below.

Radar Coverage. Existing radar coverage was primarily to the North and East and primarily provided by three major radar stations. Coverage in other directions was provided to a lower standard by smaller military radars and, to some extent, by civil/military ATC surveillance radars.

To provide defence against conventional attack, which may come from any quarter, greater use of existing civil radars would have to be made. In addition a new military radar station was to be established on Benbecula in the Scottish Western Isles. Further coverage could be provided by airborne early warning radar (AEW), initially by converted Shackleton maritime patrol aircraft and subsequently by an AEW conversion of the Shackleton's successor Nimrod, for which a British AEW radar was to be developed.

Systems Survival. Once a conventional attack was contemplated the centralised Linesman (**2243.181**) control system was evidently excessively vulnerable. Instead, a "ring main" type of decentralised control would be used, for which techniques had been developed by the RAF. These techniques included the use of in-flight refuelling which, with adequate AEW cover, enabled interceptions to be made at distances up to 1,250 km from the coast.

Interceptors. Manned interceptor strength would be increased by retaining the existing Lightning aircraft in service instead of retiring them when the new Jaguars become operational. A significant number of the new MRCA, also, would be purchased for use in the air superiority role. What steps would be taken to provide improved surface-to-air missile coverage was less clear; but evidently the British Army's Rapier systems would be able to make a contribution and it was known that the British Government had been contemplating authorising the development of a medium-to-high altitude anti-aircraft missile.

The rearrangements described or implicit in this change of policy are not yet complete, but the description which follows is believed to be reasonably representative of the present situation.

The United Kingdom Air Defence Region is part of NATINA (NATO Integrated Air Defence) and the UK air defence system is coupled into the continental air defence systems by its links with six NADGE stations (**1181.181**). The UK data terminal for these links is the West Drayton complex which was originally intended as the heart of Linesman. Incoming data is relayed from West Drayton to the Air Defence Operations Centre (ADOC) at High Wycombe and thence to the Sector Operations Centres (SOC) at Buchan, Bulmer and Neatishead. These SOCs and the ADOC form the "ring main" described above.

Each SOC consists of a radar system and a control and reporting centre. The main types of radar used in the all-military elements of the system are the pre-Linesman Plessey (formerly Decca) Type 80 200 nm 2D L-band surveillance radar, the Linesman Types 84 and 85 (3D, entry **2457.153**) and the two mobile and transportable radars developed originally for the Thunderbird system (**2460.131**) the Type 88 S/L-band surveillance radar and the Type 89 C-band heightfinder (**2463.153**). Heightfinding facilities for the Types 80 and 84 surveillance radars are provided by Plessey HF200 height-finders (**1142.153**).

Inherited from the Linesman scheme is the possibility of requisitioning surveillance facilities from civil ATC radars such as the Plessey AR-5D installations (**2416.153**) at Burrington, N. Devon, and Clee Hill in Shropshire. Further back-up or early warning radar data is supplied to the system by Shackleton AEW aircraft carrying APS-20F radar.

THE UNITED STATES OF AMERICA

2533.181
AIR WEAPONS CONTROL SYSTEM 412L

DESCRIPTION:

Air Weapons Control System 412L is a very substantial defence complex which automatically performs the functions of air space surveillance, identification, and weapons control for air defence, strike, and reconnaissance missions with only nominal manual assistance. It is located in West Germany.

AWCS 412L integrates sensors, communications, processors, displays, and operators into a total air weapons control and management system. Many existing sensors and radio sets from the inventory were incorporated into the system, and additional automatic detection equipment processors, displays, switching centres, and peripherals were developed as necessary to provide the total system capability and integration required.

The system performs the functions of data acquisition, data processing and display, and communications in an operational environment which includes Reporting Posts, Control and Reporting Posts, Control and Reporting Centres, and a Combat Operations Centre. The Data Acquisition Subsystem, which serves as the sensor head for the system, is made up largely of existing radar and IFF equipment. General Electric developed a Radar Signal Processor Group for this subsystem that combines, processes, and distributes target video information, timing references, and gating signals. Data from this group is transferred to the Data Processing and Display Subsystem by equipment of the Communications Subsystem. The Data Processing and Display Subsystem provides automatic detection, tracking, storage, and display functions for data obtained from the Data Acquisition Subsystem, for cross-told data from other sites, and for manually inserted data. In addition this subsystem processes, correlates, and displays overall weapon and weather status information within the surveillance area. The collection, dissemination, and display of track data by AWCS 412L results in a threat evaluation. If an intercept is ordered or a surface-to-air missile (SAM) launch is commanded, AWCS 412L computes and transmits the necessary intercept data.

The Reporting Post is the lowest element in the AWCS 412L operational hierarchy. It provides the functions of automatic detection and tracking of targets within its designated surveillance area, passing the track data on to its parent Control and Reporting Post.

The Control and Reporting Post also acquires and tracks targets, and it has the additional function of target identification for its own tracks and those of subordinate RP's. This information is passed to the next higher echelon, the Control and Reporting Centre (CRC), and the CRP also has delegated weapons control facilities for its specific area of responsibility.

The CRC possesses all the capabilities of the CRP, including its own radars, but it has additional capabilities and facilities for surveillance, identification, situation display, weapons assignment and control, and jammer tracking.

The highest level of the AWCS 412L operational hierarchy is the Combat Operations Centre. Overall command of the air situation is exercised from this centre. Information inputs include processed data from the RP's, CRP's and CRC's, intelligence data, weapon status information, force deployment, and readiness data. AWCS 412L provides for the collection, processing, and display of this information and for communication to lateral or higher echelons and to other elements of the system.

DEVELOPMENT:

In providing the Systems Management and Integration Engineering Services for AWCS 412L, the General Electric Company integrated the equipment and services provided by other prime equipment contractors and provided interface equipment to ensure a compatible operational system. As an additional element of these services, the test programme to validate the system's operational capability was also formulated and implemented.

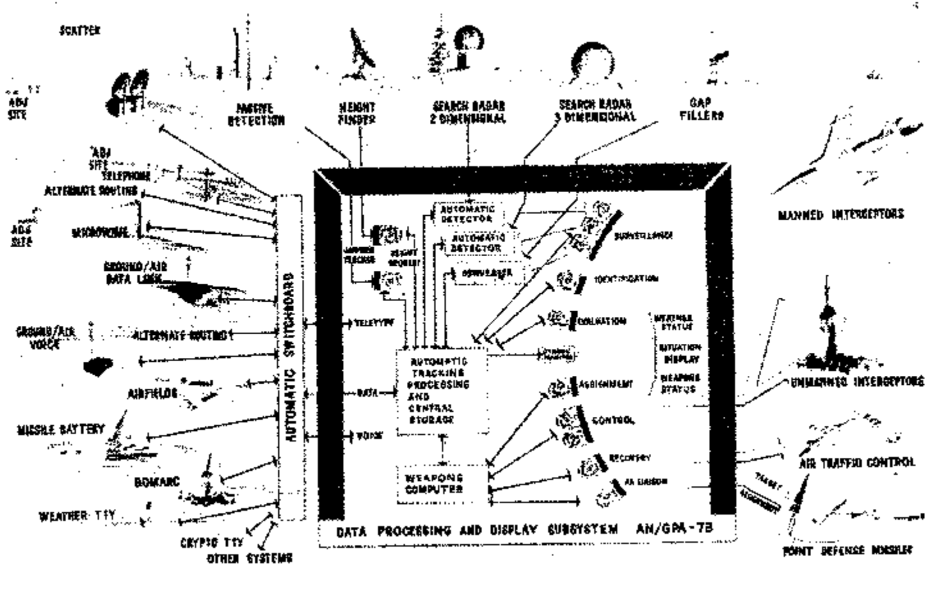
In its role as prime equipment contractor for the Data Processing and Display Subsystem of AWCS 412L, the General Electric Company designed, manufactured, and tested the AN/GPA-73 Radar Course Directing Group. This equipment provided real-time automatic detection, tracking, storage, correlation, data transfer, interrogation, evolution, control calculation, and display functions.

STATUS:

AWCS 412L is located in the Federal Republic of Germany and consists of seven sites digitally netted together to perform the functions of surveillance, identification, evaluation, weapon assignment, and weapon control. It is currently being used by NATO, the German Air Force, and the United States Air Force.

MANUFACTURER:

System Contractor: General Electric Company, Heavy Military Electronics Systems, Syracuse, New York, USA.



Air Weapons Control System 412L

Air Weapons Control System 412L Operations Room

2525.181
BALLISTIC MISSILE EARLY WARNING SYSTEM (BMEWS)

DESCRIPTION:

The BMEWS system comprises a small chain of very large radars for the detection of a ballistic missile attack on North America from the general direction of Russia. There are three operational sites – Site I in Thule, Greenland, Site II in Clear, Alaska, and Site III on Fylingdales Moor in England.

Three types of radar are used. At Sites I and II there are AN/FPS-50 radars (**2511.153**); these are described in Section 3 but it may briefly be noted here that they use large static arrays that are scanned by an organ-pipe scanner. At Sites I and III there are AN/FPS-49 radars (**2509.153**) which are large tracking radars with parabolic reflectors. At Site II there is an AN/FPS-92 which is similar to the FPS-49 but is a more modern version.

Information on BMEWS targets is transferred by a communications network to the North American Air Defence (NORAD) Combat Operations Centre.

STATUS:

Operational and likely to remain so although the suggestion has been made recently that when the early warning satellite network becomes fully operational – probably before the mid-1970s – the sites at Thule and Clear may be shut down. The

BMEWS Site III in England

development of satellite interception techniques, however, seems to make it unlikely that the US authorities would lightly dispense with the back-up warning system that BMEWS can provide – at least so far as trans-Arctic missiles are concerned.

Additional information on ground-launched ballistic missiles will be provided by the new forward-scatter, and forthcoming back-scatter, Over-the-Horizon (OTH) radars (**2750.181**) which will also probably supersede – at least in part – the DEW radars (**2567.181**). Information on submarine-launched missiles is already available from the now-operational System 474N radars (**2810.181**). The BMEWS system number is 474L.

MANUFACTURERS:

Main contractors for the BMEWS radar systems were RCA, General Electric and Western Electric.

2567.181
DISTANT EARLY WARNING SYSTEM (DEW LINE)

DESCRIPTION:

One of the earlier parts of the complex of radar systems designed to warn the US military authorities of the approach of enemy aircraft or missiles, the DEW Line, is an array of radars that stretches across the northern areas of North America from Alaska to Greenland.

Main radars of the line are the AN/FPS-19 and AN/FPS-30. The number of radars in the DEW Line has been reduced in recent years and is now 31. Information from these radars is conveyed by way of a communications network to the North American Air Defence (NORAD) Combat Operations Centre, together with data from the other warning networks described in this section.

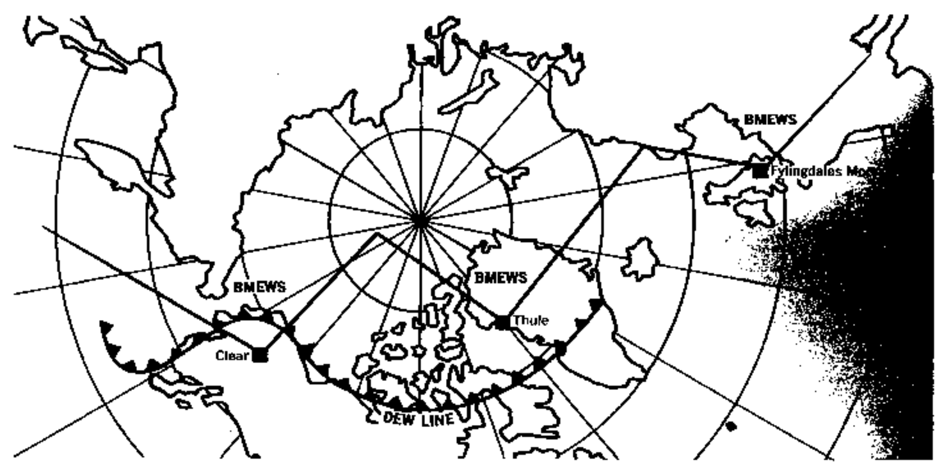
STATUS:

Operational, but likely to be progressively replaced operationally by more modern systems (see, however, **2750.181** below).

The system reference number of the chain is 413L.

MANUFACTURERS:

Many manufacturers were involved in the supply of equipment for and the construction of the radar chain. Prime system contractor was Western Electric. Radar main contractors were Raytheon, Budd and Sperry.



Deployment of Ballistic Missile Early Warning System (BMEWS) and the Distant Early Warning (DEW) Line

2750.181
OVER-THE-HORIZON (OTH) RADAR SYSTEMS

DESCRIPTION:

There are currently two programmes under the control of USAF Systems Command for the provision of extremely long-range radar data for air defence purposes. The more advanced of the two is system 440L for which hardware exists and which is a forward-scatter system: the other is a backscatter system.

Hardware development for the backscatter system has been proceeding. RCA have constructed an AN/FPS-95 OTH radar for the USAF for the purpose of gaining experience with backscatter HF systems. The FPS-95 uses a giant log-periodic antenna whose elements are several hundreds of metres long. Other experimental equipment has been produced by the ITT group (see below).

One of the problems to be explored has been the effect of ionisation in the auroral belt on backscatter systems. This is unimportant for the eastward and westward-looking OTH backscatter systems that are planned as the Conus-OTH-B system, but it is vitally important for the northward-looking NORAD-OTH-A system. However, preliminary investigations up to mid-1971 gave encouraging results and further experiments (see below) were put in hand.

The forward-scatter system is associated with BMEWS (**2525.181**) and is concerned with the detection of ballistic missile attack, including particularly attacks from directions other than over the North Pole and depressed trajectory and FOBS attack. The backscatter system is intended largely for the detection of airborne attack and is expected to replace most of the current DEW/SAGE/BUIC operations.

In May, 1972, it was announced that the US and Canadian defence departments would conduct a joint evaluation of OTH radar in the auroral belt of the Canadian Arctic, starting mid-1972.

Basis of the evaluation programme was the installation of a radar transmitter and two receivers, and the experiments and investigations are to cover both the operational performance of the equipment so far developed and the technical and logistical problems of installing and operating radars of the sort in these Arctic regions and particularly, of course, the auroral problem.

Starting in June, 1972, the USAF set about installing a transmitter and receiver at Hall Beach on the Melville Peninsula north of the Arctic Circle. The project name for this operation was Polar Cap III. At the same time a second receiver was installed by the Canadian Defence Research Board at Cambridge Bay on Victoria Island, some 900 km westwards from Hall Beach. The two receivers were closer to Thule than to Clear; nevertheless their coverage to some extent complemented that of BMEWS (**2525.181**) and it has been observed that the Hall Beach radar is ideally located for the observation of trans-Polar flights.

The purpose of the second, Canadian, receiver was said to be that of enhancing the probability of target detection by giving data from two directions instead of one. The Cambridge Bay receiver is also substantially closer to the North Magnetic Pole than is the equipment at Hall Beach. Experiments were expected to start in October 1972 and to continue until August 1973, and it was proposed that a number of remotely controlled beacons be set up at sites in high Arctic latitudes to simulate targets for the radar tests.

Total cost of the project is unknown but the Hall Beach operation was reported to be costing $8 million. Prime contractor for the Polar Cap III radar is the ITT subsidiary, Electronic Physics Laboratory.

STATUS:
In his annual report for FY 1975 the US Defence Secretary said that the US authorities propose to continue development of OTH-B ($12 million in the FY 1975 budget) and that three such radars would give adequate early warning of bomber attacks from all directions except the north. Mr Schlesinger went on to say that for the northern approach "we will have to retain the 31 DEW line radars until such time as we can perfect an OTH radar, or some other system, which can operate successfully in the presence of the intense electrical disturbances which characterise the northern auroral zone". From this it is evident that the northward-looking experiment was less successful than their preliminary investigations had led the scientists to expect.

2801.181
SAFOC SEMI-AUTOMATED FLIGHT OPERATIONS CENTRE

DESCRIPTION:
This is an automatic system which is being built by the Hughes Aircraft Company under a US Army contract. Its purpose is the automatic monitoring of the positions of all aircraft under its control.
Manual regulation of military air traffic is not only time-consuming, it is also subject to human error. The new system will provide a collision-avoidance capability, pin-point the location of distressed or downed aircraft, identify friendly aircraft, provide ground-to-ground co-ordination of aircraft movement, and disseminate air-warning information to pilots.
MANUFACTURER:
Hughes Aircraft Company, Fullerton, California.

2803.181
SAGE (SEMI-AUTOMATIC GROUND ENVIRONMENT) AIR DEFENCE SYSTEM

DESCRIPTION:
Developed and installed throughout the USA and in part of Canada during the 1950s, the SAGE system is the longest established element of the North American air defences. It is still operational but – at least so far as the main bulk of the system is concerned – it must now be regarded as obsolescent.
The design of the SAGE system was initiated by the Lincoln Laboratories of the Massachusetts Institute of Technology in conjunction with the Air Defence Command of the USAF. The underlying concept of the system is centralised data processing: the system receives surveillance data from a network of radars and controls air defence weapons over areas substantially greater than the coverage of a single long-range search radar. System inputs, however, go far beyond the simple provision of target data from two-dimensional surveillance radars. They include data from heightfinding radars and from airborne and shipborne early warning systems, meteorological data, weapon status information and flight plan data for military and civilian aircraft movements within the area of interest.
The organisation of SAGE and associated systems has been extensively revised in recent years. Currently the Continental United States and part of Canada is divided into six Air Defence Regions, each of which has one Region Control Centre. In addition there is one Air Defence Region in Canada and one in Alaska – the Canadian region also having a Region Control Centre backed up by a BUIC-III (Back-up Interceptor Control) centre plus a manual control centre in Labrador. The Alaskan region has a manual Regional Control Centre.
All SAGE Region Control Centres are tied directly into the North American Air Defence (NORAD) Combat Operation Centre and will range the air battle in the region as well as conducting the actual intercepts.
STATUS:
The programme number of the basic SAGE system is 416L. BUIC system number is 416M. Some other relevant programmes are SEED CLEAR for updating the AN/FPS-27 SAGE radars (which in turn replaced the FPS-10 radars phased out in 1963); system programme 416Q (Common Digitiser) – a data processing system to be employed at USAF, Canadian and USAF/FAA joint-radar sites to replace the AN/FST-2 data transmission system and provide primary and secondary radar data to SAGE/BUIC and FAA National Airspace Systems; system programme 425L for the NORAD Combat Operations Centre, improvements to which are still being made; system programme 427M for the NORAD Cheyenne Mountain Complex (CMC) to provide adequate capability up to 1980; and system programme 433L for the provision of meteorological data.
MANUFACTURERS:
The list of manufacturers for the whole SAGE/BUIC system is obviously very long. Principal contractors for 416L, however, were Western Electric, SDC and Burroughs. Radars for SAGE were provided by General Electric (FPS-7, FPS-24) Bendix (FPS-20, FPS-64, FPS-65, FPS-66, FPS-67) Avco (FPS-26) Westinghouse (FPS-27) Raytheon (FPS-28) and Sperry (FPS-35).

2810.181
SLBM DETECTION SYSTEM – SYSTEM 474N
DESCRIPTION:
This system, which became operational in 1971, is designed to detect missiles launched by submarines operating either in the Atlantic or in the Pacific Ocean. It consists of seven radars located three on each coast of the USA and one in Texas. The main radar used is the AN/FSS-7 (**2538.153**), which is made by Avco; in 1972, however, it was decided to supplement these radars with about 20 per cent of the surveillance capacity of the AN/FPS-85 radar (**2546.153**) which is otherwise assigned to the SPACETRACK programme (**2825.181**) and which can provide coverage over most of Central America and the Caribbean.
STATUS:
Operational with the AN/FSS-7 since 1971. Scheduled to be operational with the AN/FPS-85 by mid-1974.

2825.181
SPACETRACK
DESCRIPTION:
Spacetrack is the system code-name for System 496L, the USAF worldwide system for the detection, tracking and identification of all objects in space. It is composed of large radar optical and radio-metric sensors located around the globe and its control centre maintains a catalogue of all objects in space.
Main sensors of the system are the AN/FPS-85 radar (**2546.153**) and the AN/FSR-2 passive optical sensor. The FPS-85, of which the FPS-46 was the prototype, is an electronically steerable array radar (ESAR) operating in the UHF band and giving three-dimensional information on all satellites and similar objects passing over it. FSR-2 is a passive optical surveillance system.
SPACETRACK data forms part of the input to SPADATS – the NORAD space object detection system.
STATUS:
Operational.
MANUFACTURERS:
Numerous. Some of the principal ones have been Bendix, Cutler-Hammer, General Electric, Philco-Ford, RCA, SDC.

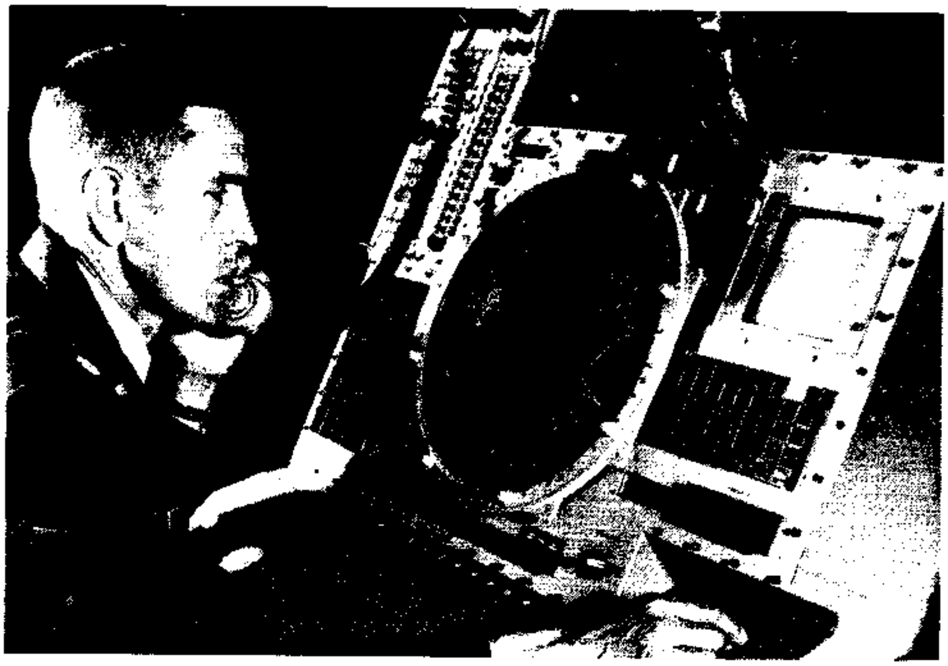
2824.181
TACTICAL AIR CONTROL SYSTEM – TACS
DESCRIPTION:
Designated as System 407L, TACS is a highly mobile communications and electronics system for command and control of tactical air operations. It is a modular system that can be deployed by transport aircraft, helicopters or land vehicles and can be adapted to suit particular military or environmental conditions.
The system will provide radar and communications facilities both for the support of land forces and for military air traffic control. Units of the system include radars, computers, displays and communications equipment.
Typical of the equipment being supplied for the system is the AN/TPS-44 radar (**2518.153**) which forms part of the Forward Air Control Post (FACP). Each of these radars comprises three main packages – an equipment shelter, a power pallet, and an antenna pallet. All three are easily transportable by truck, helicopter sling-lift, cargo aircraft, or wheeled transporters.
The equipment shelter houses radar display scopes, transmitter, receiver, and other electronic equipment. All electronic units are rack-mounted on slides so that they can be pulled out and tilted for convenient servicing. Extensive use of plug-in modules, monitoring of power circuits, and numerous accessible test points provide a high-degree of maintainability. A self-contained air conditioner and heater unit allows efficient operation of the equipment in both arctic and tropical climates.
The power pallet consists of two gas-turbine generator sets and connecting power cables. The third pallet contains the antenna-pedestal, collapsable tower support stand, and stabilisation outriggers.
The antenna reflector incorporates two removable wing tip sections, two hinged inner wing sections, and a centre section. Both the antenna reflector and feedhorn are mounted on a pedestal. Four separate stabilising jacks on the antenna pallet provide a firm platform for the pedestal without the use of guy wires or ground stakes even in winds up to fifty-two knots. The pedestal has a built-in levelling system to ensure proper alignment of the antenna.
A feature of the system that aids mobility and shortens time into action of the system is the use of inflatable shelters of a size great enough to accommodate a wide range of display and data processing equipment such as is required for sophisticated tactical air control operations.
Apart from the TPS-44 radar, with which are associated sophisticated lightweight display units, other major sub-systems of TACS are:

AN/MRC-107	Mobile communications centre for forward ATC
AN/TCC-30	Electronic switching centre
AN/TPN-19	Air transportable ground landing control

AN/TRC-97A	Air transportable tropospheric scatter communications terminal
AN/TSC-53	Transportable FACP communications centre.
AN/TSQ-47	(FOUR WHEELS) Air transportable ATC/communications system
AN/TSQ-61	Transportable FACP communications centre
AN/TSW-7	Transportable UHF/VHF ATC tower
AN/TVN-1	Air transportable airfield lighting system

STATUS:
Procurement and implementation. A follow-up system (485L) TACSI – TACS Improvements – is largely at the R & D stage.

MANUFACTURERS:
General Systems analysis and management is by the Mitre Corporation. TPS-44 radars are by Cardion Electronic, communications by RCA and General Dynamics, landing control equipment by LFE and Raytheon, display equipment and inflatable shelters by Hughes. This list is not, of course, exhaustive.



TACS display console by Hughes. These light-weight multi-purpose consoles can display both raw radar data and computer generated material for surveillance tracking and ATC

2835.181
TSQ-73 AIR DEFENCE SYSTEM
DESCRIPTION:
AN/TSQ-73 is an air defence missile control system that is being developed by Litton Industries to meet a US Army requirement. It is expected, however, that it will also be supplied to the land forces of other countries.

The AN/TSQ-73 will be deployed world-wide with army air defence units. The system performs area radar surveillance and co-ordinates the action of a number of Hawk and Nike missile batteries against enemy aircraft. The system is highly automated to permit rapid reaction to destroy enemy aircraft before they reach tactical positions.

Designed for tactical operations in any climate, the system is housed in small shelters which can be quickly moved by aircraft, helicopter or truck. Much of the equipment is also used by the US Army's TACFIRE artillery control system (**2827.163**) so that there will be considerable savings in testing, support and training, in addition to the lower procurement costs.

The system consists of high-speed digital computers, advanced tactical display consoles and digital communications terminal equipment.
STATUS:
Development (on a $8.5 million contract).
MANUFACTURER:
Litton Industries, Data Systems Division.

THE UNION OF SOVIET SOCIALIST REPUBLICS

2899.181
AIR DEFENCE SYSTEMS – GENERAL
The total air defence capability of the USSR is enormous – far in excess of that of any other country. Detailed information on the Russian air defence systems is in short supply – even more so than information on the missiles, guns and radars that go to make up these systems: it has been estimated, however, that the USSR has around 10,000 surface-to-air missile launchers and thousands of air defence radars to go with them. The entries that follow provide a little information on some specific systems.

The development and deployment of Russian ABM systems is of course vitally affected by the US-USSR ABM agreements. Exactly how the Russians will interpret these is of course unknown at present; but certainly with their existing scale of radar and missile development and deployment it seems unlikely that they will suffer hardship as a result of the treaty.

2945.181
MOSCOW AIR DEFENCES

Reports – mainly from US sources – indicate that there are two air defence systems deployed in the Moscow area. One of these, strictly an anti-aircraft system, is based on the Guild (**2944.131**) surface-to-air missile, also known by the US code SA-1; and it would appear to be more appropriate to a system of defence against mass bombing raids, such as those employed in the Second World War, than to modern low-level attacks for which the Goa (**2938.131**) missile is the best known to be available in the Soviet Union.

The other defence system is an anti-ballistic missile system based on the Galosh (**2932.131**) ABM missile. Unlike the US Safeguard (**2798.131**) system with its long-range and short-range missiles, the Moscow ABM system appears to be intended for use with only one kind of ABM missile but possibly with more than one variant of this missile. Associated with this missile are early warning acquisition and tracking radars. The early warning radar is an enormous equipment with an aerial measuring about 275 metres by 30 metres and apparently performs both warning and acquisition functions: it has been christened Hen House (**2879.153**) by the US authorities. A typical detection range for one of these radars is believed to be 6,000 km. Additional acquisition functions are apparently performed by a smaller, but still enormous, radar known as Dog House (**2864.153**). Finally it appears that target tracking and missile guidance are performed by large dome-covered tracking radars, known as Try-Adds, which are located at the four sites round Moscow. The Try-Add radars are believed to be relatively short-range high-precision devices, but the Dog House radars are credited with a range capability in the region of 3,000 km.

2989.181
TALLINN AIR DEFENCE SYSTEM

Information on the Tallinn air defence system has to be treated with some reserve. It is reported that the system is designed for use both against aircraft and against missiles, and that it is based on the missile known to the US authorities as the SA-5 of which it is said that there are about 1,000 in the system. This missile is sometimes referred to by the NATO code-name Griffon (**2940.131**) but it has also been identified with one called Gammon. It has also been said that Griffon, as a project, is thought to have been abandoned.

Setting aside the question of which missile is which, however, it does appear, from persistent US reports, that a large surface-to-air missile is deployed in quantity in the Tallinn area. The view generally taken is that this defence system, while clearly suitable for the interception of high-speed high-altitude aircraft, is so little better for this purpose than comparable systems employing the SA-2 Guideline missile (**2942.131**) that it is probably intended also to be an ABM system. If the missile used is indeed the one that is commonly identified as Griffon it certainly seems possible that this might have an interception capability not so different from that of Spartan (**2811.131**), as to rule out the ABM possibility altogether; and this possibility is reinforced by the suggestion that the giant Hen House/Dog House radars may be deployed – or be intended to be deployed – in a manner that would enable any shortcomings of the Griffon missile vis-à-vis Spartan to be overcome. Many people would disagree with this hypothesis, however, pointing to the use of aerodynamic control surfaces for in-flight guidance of the missile as suggesting insufficient manoeuvrability for missile interception.

LAND BASED ANTI-AIRCRAFT FIRE CONTROL SYSTEMS

ITALY

2233.151
INDIGO INTEGRATION KIT

DESCRIPTION:

The purpose of this integration kit is to augment the facilities provided by the Superfledermaus fire-control system (**2376.151**) to provide the additional target acquisition and missile control facilities required for an Indigo anti-aircraft missile system.

Included in the kit are the following major sub-systems:

1. X-band pulse doppler acquisition radar Type LPD-20
2. Command transmitter
3. Infra-red tracker
4. Guidance computer
5. Launcher computer
6. Launchers and power units

– all except the first and last of which are mounted in the Superfledermaus trailer.

OPERATION:

The target acquisition radar has a detection range of approximately 20 km on a two-square-metre target, and is used to put on the Superfledermaus radar. The infra-red tracker and command transmitter are mounted on the antenna of this tracking radar so that if at any time during the operational sequence interference or equipment malfunction causes the tracking radar to lose the target or the missile's beam-riding guidance to fail, the infra-red tracker and command transmitter are already laid on the target and the Indigo missile's alternative command guidance can be brought swiftly into action.

Data from the tracking radar is processed to provide signals that are used to train the launchers so that the missile comes rapidly into the radar beam for beam-riding guidance. For command guidance the guidance computer processes the data from the tracking system to produce signals for the command transmitter.

Details of the Indigo missile and a schematic illustration of the complete system can be found in the Indigo entry in Section A2b (**2235.131**).

DEVELOPMENT:

Development of the Indigo system was started as a private venture by Contraves Italiana SpA in 1962. In 1969 the missile project was transferred to Sistel SpA but development of the fire control system was continued by Contraves. The Superfledermaus, of course, was developed by Contraves AG, Zürich.

A prototype of the integration kit has been tested by the Italian Army with a Contraves fire control system. The manufacturers are now ready to put it into series production.

MANUFACTURER:

Contraves Italiana SpA, Via Tiburtina 965-00156 Rome.

THE NETHERLANDS

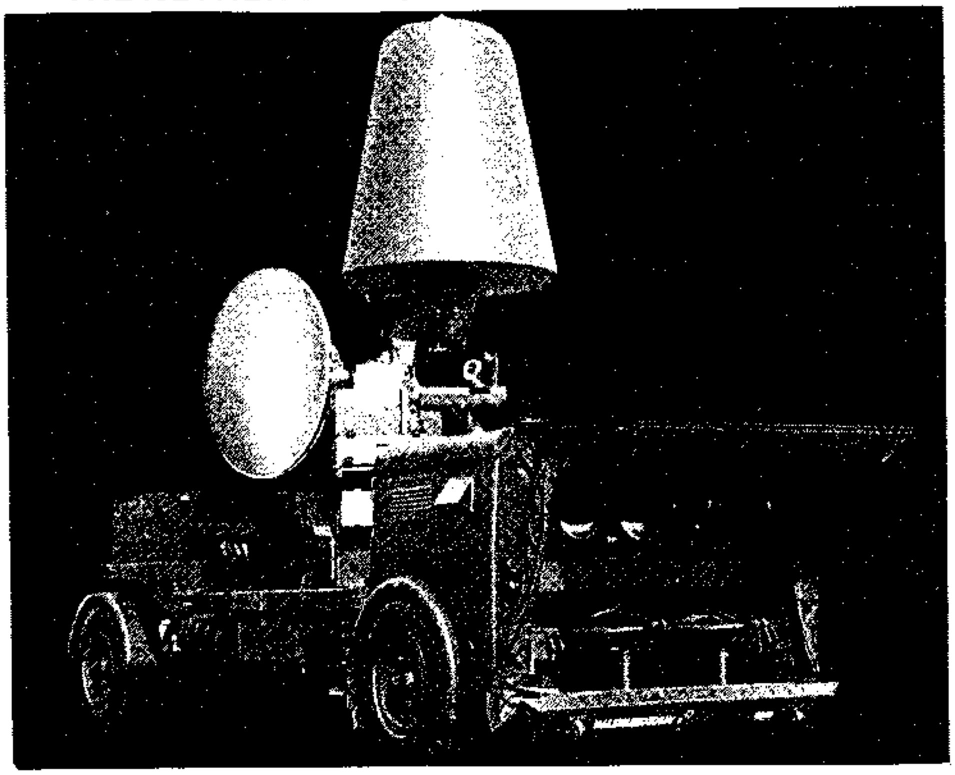
2300.151
L4/5 WEAPON CONTROL SYSTEM

DESCRIPTION:

Signaal's L4/5 Weapon Control system has been developed for the close air defence of vital points such as airfields or bridges. It incorporates a digital computer and a high-power radar; and although it was originally designed to control 40-mm AA guns it can easily be adapted to control guided missiles or for remote control target indication by inter-console marking.

An important feature of the system is understood to be its FASCAN search principle which is said to ensure the detection of even very low-flying aircraft. Other features include a short over-all reaction time, resulting from the use of a digital computer, and a high degree of mobility comparable with that of the 40 mm guns that it was designed to control.

The complete system is mounted on a four-wheeled trailer, the antenna pedestal, which carries both surveillance and tracking radar heads and optical sights, being mounted in the centre of the trailer. The remainder of the electronic equipment is located at the rear of the trailer. In transit the surveillance aerial is hinged down to the horizontal and the equipment cabin is closed. In operation the equipment cabin opens to provide a platform with two seats for the operators and a small canopy; normal practice being to shroud this with a cover so that the operators can work in near-darkness.



L4/5 Weapon System

DEVELOPMENT:

Extensive field trials of the system were carried out in 1962-3 and 1965 and proved highly successful and the system is in series production.

Signaal are working on more mobile versions of this system for guided missiles and towards complete self-propelled weapon systems (see also **2350.181** below).

MANUFACTURER:

N.V. Hollandse Signaalapparaten, Hengelo, Netherlands.

2301.151
FLYCATCHER (VL 4/41) AA WEAPON CONTROL SYSTEM

DESCRIPTION:

Flycatcher is a versatile AA radar weapon control system designed to detect, identify and automatically track aircraft flying at very low to medium altitudes. It can be used to control either guns or missiles.

Main elements of the system are a dual retractable search and track antenna system, a radar transmitter-receiver, a radar display and control assembly, a fire control assembly and a digital computer. The whole system is housed in a transportable rectangular container. Power consumption is about 6kVA.

Full performance details are not available but it appears that the system is intended to engage targets in a zone of 10-20 km radius. Up to three gun or missile installations can be controlled independently by the computer.

The radar is an X-band system and features track-while scan, a high data-renewal rate and a multiplicity of ECCM and anti-interference facilities. The search antenna is a slotted waveguide; the tracking antenna is parabolic with a Cassegrain reflector and a monopulse feed horn.

The computer can handle targets with horizontal speeds up to 500 m/sec and vertical speeds up to 300 m/sec and can perform ballistics computations for light-calibre guns.

CHARACTERISTICS:

Function: All-weather point and area defence with AA guns and S/A missile against medium- to very low-level air attacks

Sensors: X-band search and tracking radar, optical target indicator

Weapons: Up to three weapons, being either all guns (30, 35, 40 mm) or guns and one S/A missile (command line-of-sight or semi-active homing); parallax distance up to 500 m

Search Coverage: Up to 20 km (1 m^2 target) track while scan

Display: PPI, North oriented, clutter-and interference-free, scales 10/20 km

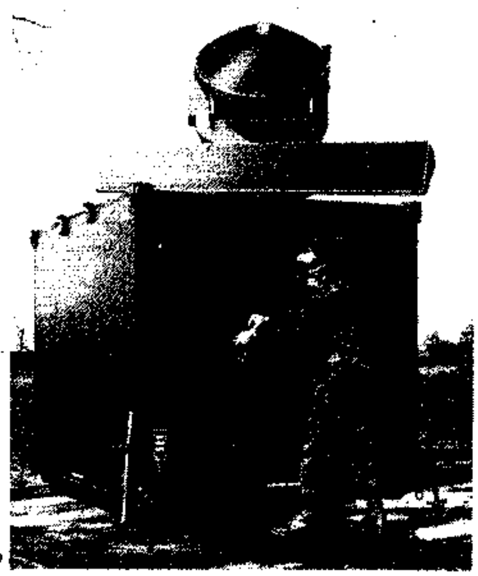
Target engagement: Joystick indication, automatic acquisition and tracking, highly automated weapon control

ECCM: Simultaneous with clutter rejection, (details classified)

System design: Container construction, retract-

able antennas, self-contained petrol-driven power supply, removable wheel-train, micro-miniaturised solid-state electronics
Dimensions: Length 2.73 m, width 2.12 m, height (antenna in): 2.13 m (antenna out): 3.65 m
System weight: 2,300 kg (approx)
Environmental: Operating temp. −40° to +52°C, storage temp. −55° to +71°C, operating height up to 2,500 metres above sea level; others according to MIL-STD-210A, ground equipment, worldwide; vibration and shock capabilities based on MIL-S-52059A

MANUFACTURER:
N.V. Hollandse Signaalapparaten, Hengelo, Netherlands.



VL4/41 AA Weapon Control System

SWEDEN

2378.151
BOFI ANTI-AIRCRAFT FIRE CONTROL SYSTEM

DESCRIPTION:
BOFI is the name of a fire-control instrument developed by Bofors, which is intended for their 40 mm L/70 mobile gun (**5528.103**) of which large quantities have been produced. BOFI is an abbreviation of Bofors Optronic Fire-control Instrument. The equipment in its entirety is mounted on the gun, and is integrated with its functions. The system is of the clear-weather type, and can be used for combating targets both in daylight and darkness.

The main parts of the system consist of a combination day and night sight, a laser range-finder, a computer, and control devices with panel. The major portion of the equipment is placed in a cab, which can be provided with heating and air-conditioning equipment. The power required is obtained from a power-supply unit mounted on the gun. A separate power-supply unit can also be used.

The sight consists of a conventional, monocular sight, combined with a passive night glass. The same ocular is used for both sights. The operator can quickly switch from one sight to the other, which is an advantage at dawn and dusk. The night glass consists of receiver optics, followed by a 3-stage light amplifier. The range-finder consists of a neodymium laser with a pulse frequency of 10 pulses per second. The laser is provided with devices for blocking off echoes at close range, and the receiver has a gate which is controlled from the computer, which gives excellent anti-jamming properties. The computer is of a hybrid type, and calculates supporting signals to the aiming system, so that the operator need only make minor corrections.

BOFI system mounted on 40 mm gun

The system can receive target data either from an optical target indicator deployed in connection with the gun, or from a separately deployed search radar.

This fire-control equipment is designed in such a way that it can also be used on existing 40 mm L/70 guns on field carriages.

STATUS:
User trials of the system were carried out during 1972, in co-operation with the Swedish Armed Forces, and it is now operational.

MANUFACTURER:
AB Bofors, S-690 20 BOFORS, Sweden.

SWITZERLAND

2376.151
SUPER-FLEDERMAUS

A member of the series of anti-aircraft fire control systems produced by Contraves in Switzerland, the Super-Fledermaus Type Dix with MTI is an advanced radar optical tracking and computing system suitable for use with medium calibre anti-aircraft guns and missiles. Extreme operational versatility coupled with compact and rugged design make it suitable for use in a wide variety of combat situations, and it and its forerunners are used by more than twenty nations.

The main equipment is compactly mounted on a four wheel cross-country trailer and comprises a radar/visual tracker for target acquisition and tracking; an electronic computer for continuously determining the firing data for up to three separate gun emplacements; and a muzzle velocity indicator for measuring the muzzle velocities of up to three guns. A separate power supply unit, mounted on a two-wheel trailer, generates power for the fire control unit. Available as auxiliary equipment are a signal box for use by the Fire Control Officer and an optical putter-on for rapid visual acquisition of unexpected targets.

A detailed description of the system was published in the 1970-71 edition of Jane's Weapon Systems

CHARACTERISTICS:
Type: Combined radar/visual tracker and computer for remote control of medium calibre anti-aircraft guns or missiles
Target Detection: Up to a range of 50 km
Target Acquisition: All-weather operation with five options:
(a) by selectable programmed scanning motion
(b) by optical putter on
(c) by optical tracker

(d) by tactical radar
(e) by radar/visual combination

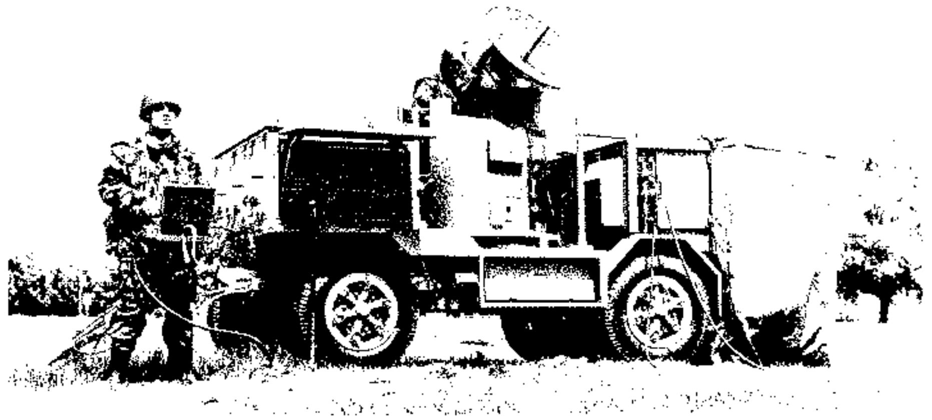
Target Tracking: Up to a range of 40 km with five options:
(a) automatically by radar
(b) automatically by regenerative control
(c) automatically by memory
(d) visually by tracker operation
(e) automatically in range: visually in angle

Firing Data Computation: Continuous computation individually for three gun emplacements
Muzzle velocity and meteorological connections included
Special modes selectable for diving or curved flights

Muzzle Velocity Measurement: Separate measurement by built-in equipment for each gun

ECCM:
High transmitting power
Narrow main beam
High sidelobe attenuation
Two independent transmitting channels
Jump changes of frequency over wide band
IAGC
STC
FTC

Clutter Suppression: MTI data processor
Mobility: Cross-country trailer
Maintenance: Built-in test and calibration equipment. Use of modular plug-in units



Super-Fledermaus anti-aircraft fire-control system

MANUFACTURERS

Complete system	Contraves AG, Zurich, Switzerland
Fire Control Radar	Siemens-Albis Aktiengesellschaft, Zurich.
MTI Equipment	Telefonaktiebolaget LM Ericsson, Göteborg.
Muzzle Velocity Measuring Equipment	Oerlikon Machine Tool Works Buehrle AG, Zurich.

The system is also manufactured by Contraves Italiana SpA, Rome, Italy, and under licence in India and Japan.

2377.151
SKYGUARD ANTI-AIRCRAFT FIRE CONTROL SYSTEM

Skyguard is the name now given to the miniaturised fire control system that Contraves have been developing for some time as the successor to the Superfledermaus (**2376.151**) system that they have marketed so successfully in various versions for many years.

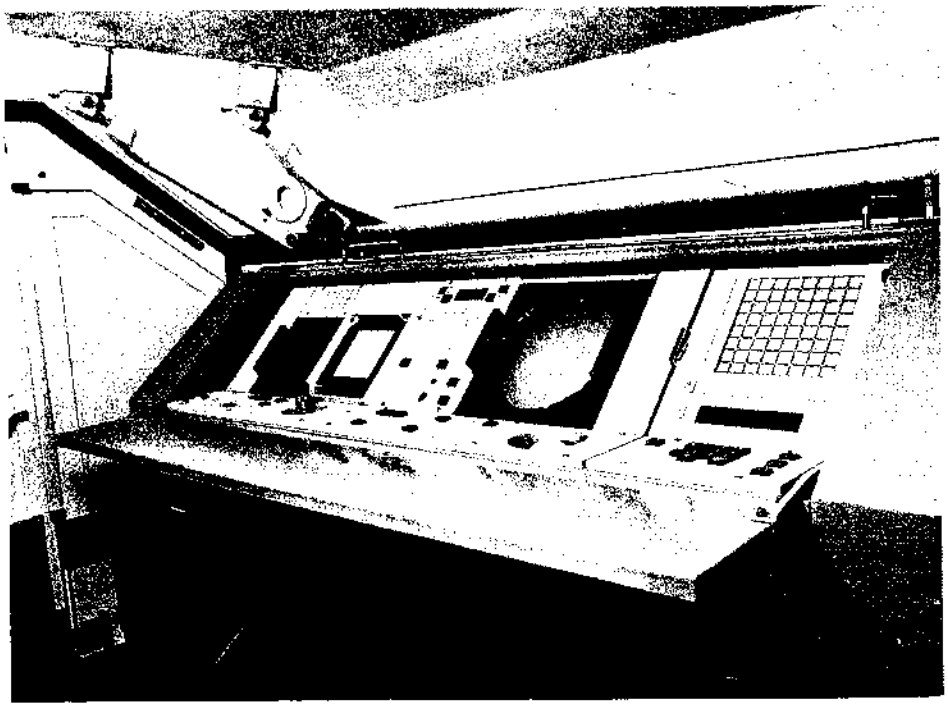
Major differences between Skyguard and its predecessors – apart from a general modernisation of design techniques – are the provision of two radars (one for search and one for track) in place of one and the use of a digital instead of an analogue computer. Another important difference is the use of pulse-Doppler type radars in place of pulse radars.

DESCRIPTION:

Main system components are a pulse-Doppler search radar, a pulse-Doppler tracking radar, a TV tracking system, a digital computer, a control console and a power supply system. The whole is contained in a fire resistant reinforced fibre-glass-polyester cabin that can be mounted on a trailer or a wheeled or tracked prime mover, and is air transportable. The power supply system is built into the main equipment but can be removed for external operation and is automatically refuelled directly from cans.

The search radar is a fully coherent pulse-Doppler equipment, the transmitter of which is common to the tracking radar. Working in X-band with a mean power of 200W it offers fast frequency change and fast p.r.f. change facilities and a choice of 1 and 0.3 microsecond pulses. A Cassegrain cheese antenna gives a beam width of 1.7 degrees in azimuth and 35 degrees in elevation and scans at 60 rev/min. The receiver has range-gated Doppler filters and offers an MTI improvement factor better than 50dB. The PPI display has switched ranges from 0.3 km to 20 km and can present simultaneously processed MTI video and raw video. Radar search range is 20 km and range resolution 160 metres. The system is IFF-compatible and special features include automatic target alarm, automatic lock-on and computer-controlled symbol markers on the PPI.

The tracking radar is a fully-coherent monopulse-Doppler equipment with a Cassegrain paraboloidal antenna having a 2.2 degree beam-width. Signal processing circuits provide 80-metre acquisition gates around the tracking gate, all gates having Doppler filters, and the total acquisition range is 1,120 metres. The MTI im-



Skyguard control console showing, right to left, Input-output panel with matrix-field; PPI Display presenting all necessary information to the commander; Rolling-ball for manual target assignment; Tactical numerical display (top); *Weapon control panels* (bottom); *TV Monitor and video-processor; TV Controls; Joy stick for manual control of tracker; ECCM-Panel* (bottom)

Skyguard in operational configuration on M584 carrier

Skyguard in trailer-mounted version, showing method of folding away radar antennas provement factor is better than 50dB. The display is an A/R trace, displayed on the TV monitor, for tracking supervision and ECM monitoring but target acquisition and tracking is automatic and includes memory tracking and automatic alarm facilities. Special features include fast target exchange, automatic noise jammer tracking and a second independent tracking system for range and angular error measurements.

A closed-circuit TV system provides for optical tracking and automatic TV tracking. An optical sight on a rotating chair is provided for visual target acquisition with provision for target indication by means of a flashing strobe on the PPI.

The Cora II M computer is a third generation equipment working in real time to perform threat evaluation functions, calculate ballistic data for guns and command signals for missiles, aid the target tracking operation and monitor and check-out the entire system.

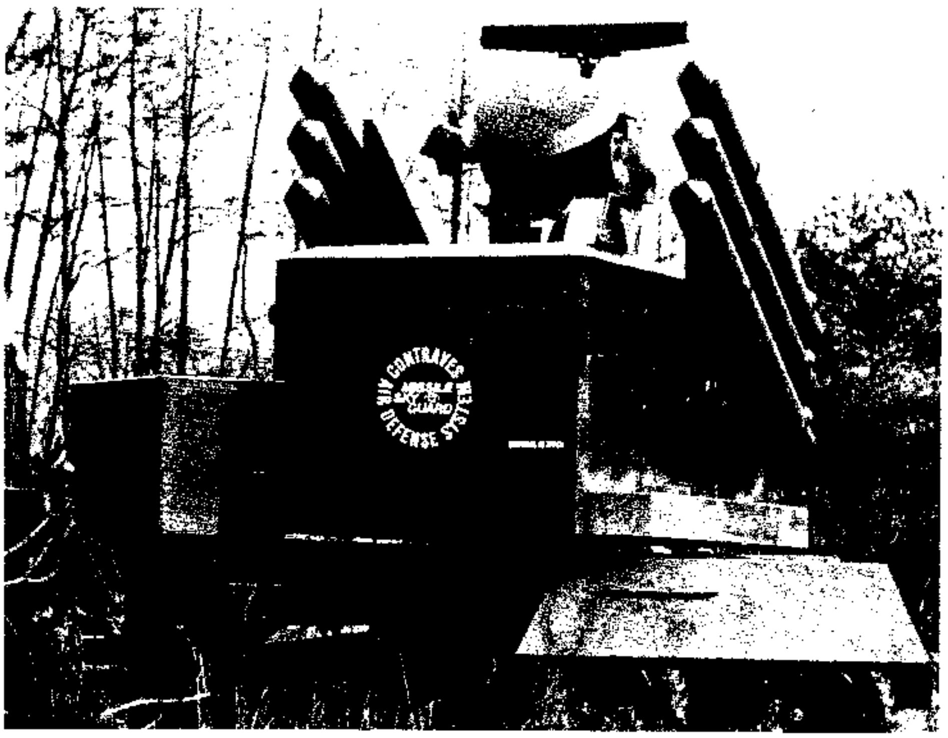
In addition to the PPI and A/R displays already mentioned, the control console incorporates a tactical display with numerical read-out, the TV tracking monitor, rolling-ball control for PPI markers, joystick control for manual tracking and a matrix panel for data input and output.

OPERATION:

The console is designed so that one or two operators can control Skyguard according to the tactical requirements of the situation.

STATUS:

Skyguard has been developed by Contraves as a private venture and was evaluated by the Swiss Armed Forces for several months in technical and tactical trials. In addition to the developed fire control system, Contraves have made proposals for an integrated weapon system called Skyguard-M which incorporates suitable missile launchers on the same tracked vehicle as that carrying the basic Skyguard.



Engineering model of Skyguard-M integrated weapon system

MANUFACTURERS:

System and Computer: Contraves AG, Zurich, Switzerland.

Radars: Telefonaktiebolaget L.M. Ericsson, Göteborg, Sweden.

NAVAL FIRE CONTROL AND ACTION DATA AUTOMATION SYSTEMS

BRAZIL

1665.281
NITEROI CLASS AIO

DESCRIPTION:

Following a contract signed in 1971, Vosper Thornycroft Limited are designing and building four 3,500 ton Mark 10 Frigates for the Brazilian Navy, and supplying all materials and components for a further two to be built in Rio de Janeiro. There are two different versions of the Mark 10 an Anti-Submarine (A/S) ship and a General Purpose (GP) ship, the major differences between the two being in the weapon outfits. Vosper Thornycroft are responsible for the design, integration and functioning of the complete Weapon and Action Information Systems, for which Ferranti Limited (Digital Systems Division) are the major subcontractor. Each ship is to be fitted with three FM 1600B computer systems (**1433.063**): one for Action Information Organisation and two for Weapon Control. More details of these appear in Entry No. **1524.281** in this section.

Artist's impression of Brazilian Niteroi Class Vosper Thornycroft Mk 10 frigate. Three Ferranti computer systems will be used for AIO and Weapon Control

ACTION INFORMATION ORGANISATION (AIO):

The AIO and sensor outfits are almost identical for both versions of the Mark 10, except that an Edo 700E Variable Depth Sonar (**2581.253**) is fitted to the A/S Ships.

A Plessey AWS-2 E/F band diversity surveillance radar (**1751.253**), with a stabilised antenna, provides long range above water surveillance. A Mark 10 IFF system is fitted in conjunction with this set.

For navigation, surface search and helicopter control, a Hollandse Signaalapparaten ZWO-6 I-band radar (**1555.253**) is fitted to the top of a foremast, giving clear all-round surveillance and a long horizon-limited range. Video from both these radars is processed by the AIO computer, which also controls the IFF system to give auto-decoding facilities. Auto extraction techniques allow a large number of targets to be tracked simultaneously with the primary radars.

The AIO system displays the tactical picture on six Deccascan CA1600 combined radar and synthetic PPI viewing units. Each of these units contains a horizontal CRT viewing surface incorporating a reflection plotter, and a keyboard unit by means of which data from the computer may be selected for display, and new information and orders injected. Radar selection and normal picture controls are also incorporated. The display is normally operated by two men, each of whom is provided with a tote read-out area on the PPI. This is used for read-in checking as well as output data display.

Passive detection of radar transmissions is provided by a Decca RDL 2/5 system (**1341.253**). This locates and analyses external radar signals, and also incorporates an automatic warning system which is triggered by reception of transmissions corresponding to certain preset characteristics.

Underwater surveillance and target tracking is performed by an Edo 610E panoramic medium-range hull sonar (**2580.253**) and, in the A/S ships, a compatible Edo 700E Variable Depth sonar.

A complex 'status interface' with the AIO computer permits maximum use to be made of the flexible Edo system, which provides a number of transmission and reception modes, selectable by the operator to suit environmental and tactical conditions.

Sonar information is supplied to the Weapon Control Systems as well as the AIO, where it is evaluated, corrected for propagation delays and other factors, and may be presented synthetically on the AIO displays. The Prediction for A/S Weapons is performed by the Weapon Control Computers.

The AIO System also solves tactical problems and provides information for the guidance of helicopters in MATCH anti-submarine attacks. Each ship carries one Westland WG13 'Lynx' helicopter (**1587.302**).

Data on target tracks selected manually for engagement by the ships' weapon systems are passed by inter-computer Data Highway to the Weapon Control Systems.

WEAPONS AND WEAPON CONTROL:

All frigates are armed with a Vickers 113 mm Mark 8 automatic gun (**6011.203**), two Bofors 40 mm guns (**6015.203**) and two triple Seacat AA missile launchers. In addition to the A/S helicopter, a Bofors twin 375 mm rocket launcher (**2368.203**), side launched torpedoes and a depth charge rail are fitted.

In addition to this, A/S ships are fitted with an Ikara anti-submarine missile system (**6002.241**), while GP ships are to have Exocet missiles (**1156.221**) as well as a second 113 mm gun.

Two Selenia RTN10X tracking radars (**1368.253**) are provided, one of which is fitted with CCTV for control of Seacat missiles (**1019.231**), in addition to the normal pedestal director. A stabilised Optical Look-out and Aiming Sight (LAS) (**1340.293**) is fitted in conjunction with each 113 mm gun, and may be used either as a Visual Director in conjunction with the computer system, or as a means of direct emergency control of the gun.

Control of the various weapons is divided between the two fire control computers in such a way as to minimise the tactical consequences should one computer fail.

A special version of the Ikara system is being developed for the Brazilian Navy and is known as 'BRANIK'. This system is the subject of a joint development programme by Vosper Thornycroft, Hawker Siddeley Dynamics and Ferranti. It incorporates a light-weight, semi-automated missile handling outfit and a special purpose missile tracking and guidance system, which is fully integrated with one of the FM 1600B fire control computers.

With the exception of the 40 mm guns, all the weapons mentioned above are deployed under full computer control. The 40 mm guns may be assigned to targets by means of a training signal derived from the AIO system. Thereafter engagement takes place under on-mounting operator control, aided by line of sight gyro stabilisation.

Operational control of weapons is carried out at special consoles situated in the Operations Room. Extensive use is made of Electronic Data Displays (EDDs) for data display and input of data and orders by light pen. This substantially reduces the number of special purpose controls, eases the operator's task, and improves reliability.

Medium speed data links are incorporated so that positions and supplementary track data may be exchanged between the computer systems of similarly equipped ships. Thus for example the 'BRANIK' system or A/S helicopter may engage targets which are not visible to the ship's sensors but are being tracked by another friendly unit.

STATUS:

The first of the "Niteroi" class is due to be launched in 1974, and an extensive programme of weapon system proving trials will commence in 1975.

MANUFACTURER:

Vosper Thornycroft Ltd, Vosper House, Paulsgrove, Portsmouth, England, PO6 4QA.

CANADA

2046.261
CCS-280 COMMAND AND CONTROL SYSTEMS (DDH-280) CLASS

DESCRIPTION:

A shipborne automatic data-handling and display system based on the Litton L-304 single processor version digital computer. Designated AN/USQ-501(V) Data Processing Set, it comprises one digital computer, eight multifunction displays and other peripherals as shown in the accompanying picture. Equipment was designed to and meets MIL shipborne environmental specifications. Solid state components are used throughout with extensive use of integrated circuits in computer and display modules.

The computer is fitted with a 40K 32-bit word memory capable of expansion to 80K words by addition of plug-in modules to the existing processor mainframe. Increased I/O capability can be achieved by adding units to the existing data bus using available minor channels in the I/O modules. The system includes radar signal simu lation, which provides superimposed or separate radar targets variable in size and brightness for training. Displays are multipurpose and identical. Quick action buttons (QAB) provide mode selection and independent selection of up to seven separate radar videos with independent offset and range scales 1-152 miles in binary increments. Category selection of symbology is programmable on-line, independently, at each display.

Basic operating software has been provided by the manufacturer. In the case of the CCS-280 the Canadian Armed Forces chose to write all the operational software in a programme generation facility provided by the contractor.

OPERATION:

The operational programme was designed and produced by a team of military officers, experienced in Anti-submarine Warfare. This programme blends the speed and processing power of the digital computer, the comprehensive, flexible display and the automatic data link equipment, into a system which provides real time co-ordination of sensors and weapons by the Command at the unit and force level to:

a. collect, process and display tactical information from all sensors.
b. control aircraft and other remote surface units.
c. direct own ship's and force weapons.
d. control own ship manoeuvres.
e. exchange information and orders within own ship and force.

DEVELOPMENT:

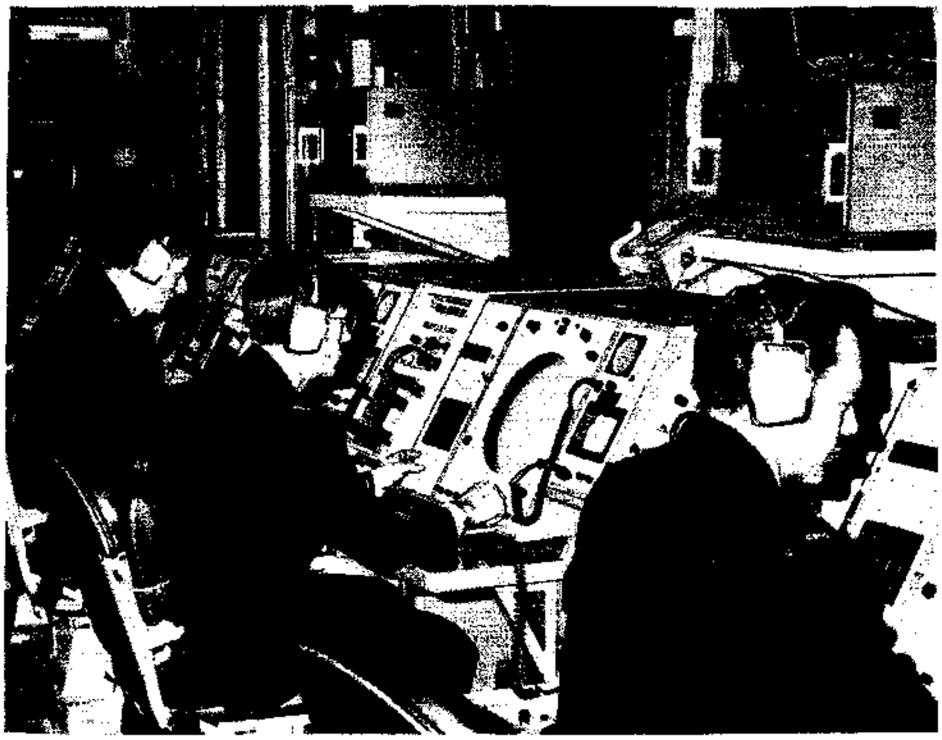
The hardware was developed and built by Litton Systems (Canada) Limited in conjunction with the Data Systems Division of Litton Industries to meet the functional requirements specified by the Canadian Armed Forces.

STATUS:

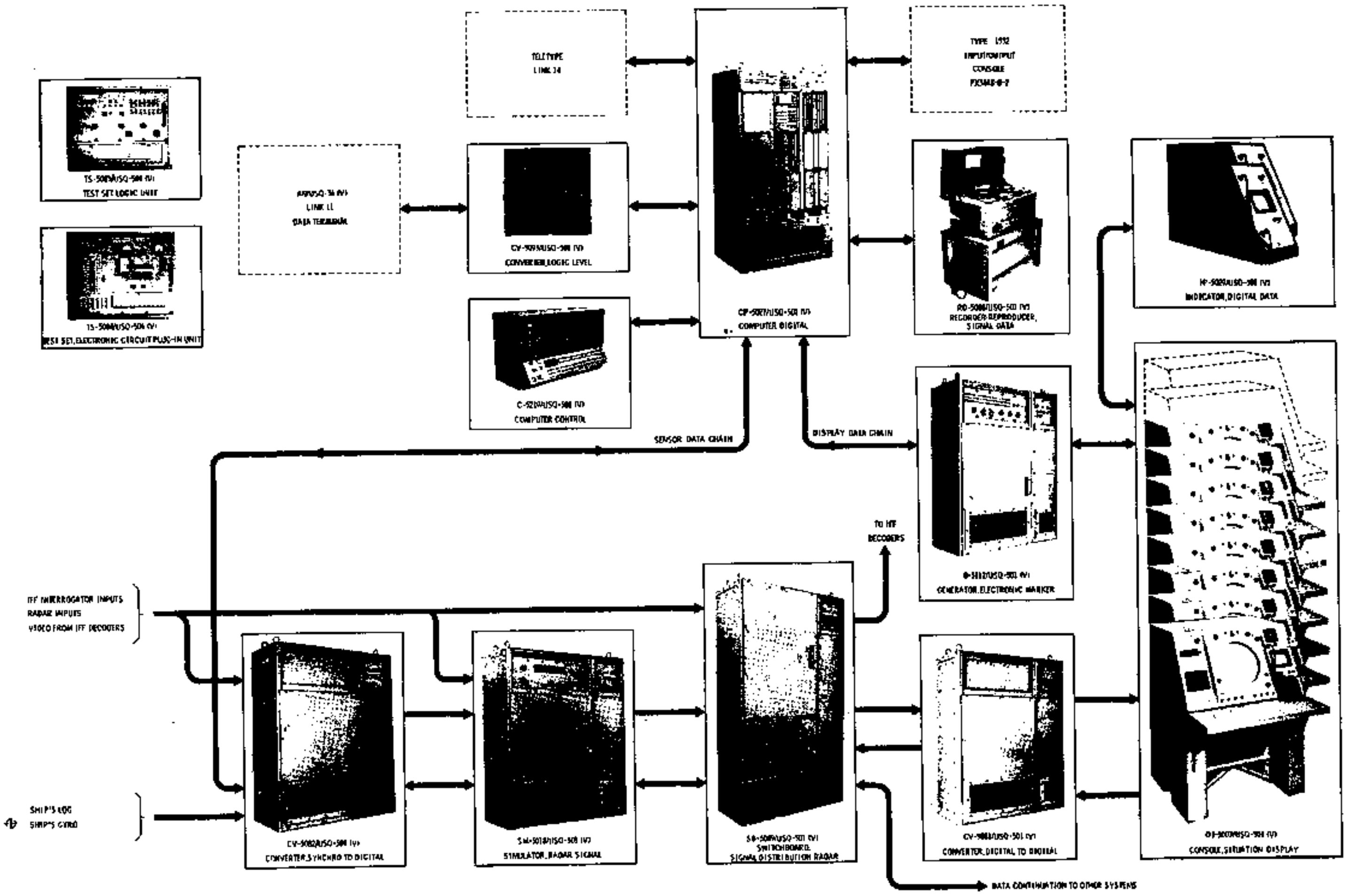
The system is currently operational at sea in HMC Ships, Iroquois, Athabaskan, Huron and Algonquin. A shore installation for training and programme maintenance and generation is fitted in the Combined Support Divisions, Halifax.

MANUFACTURERS:

Litton Systems (Canada) Limited.
Collins Radio (Automatic Link Equipment).



A group of situation display consoles of the CCS-280 Command and Control System on board HMCS Iroquois



2047.261
UNDERWATER COMBAT SYSTEM (UCS) 257/280

DESCRIPTION:

The UCS 257 and/or UCS 280 comprises two AN/SQS-505 Sonar Sets (**2038.253**), an Anti-Submarine Warfare Data System (ASWDS) and ancillary equipment for both Hull-Mounted (HMS) and Variable Depth Sets (VDS). Both AN/SQS-505 sonars are electronically identical and comprise a transmitter group, a receiver group, a control indicator group, and a transducer. The ancillary equipment for the hull-mounted set consists of a retractable hull outfit with dome. The ancillary equipment for the variable-depth set consists of the AN/SQA-502 hoist group (including tow cable) and a variable-depth body (including gyro compass).

The ASWDS is an action data system designed to accept primary target information from hull-mounted and/or variable depth sonars and secondary target information from radars. This information is processed by a high speed general purpose computer to provide action information to the command, computation of fire control solutions and weapon control.

A prototype of the system has been installed and evaluated in HMCS *Terra Nova*. Production models are fitted in HMC Ships *Terra Nova, Gatineau, Kootenay* and *Restigouche* all of which are anti-submarine DDE "Restigouche" Class destroyers commissioned to take ASROC. The AN/SQS-505 sonar system is installed in the four new DDH 280 class anti-submarine destroyers which have two helicopters, and in addition Mk 32 torpedo tubes fitted instead of ASROC

MANUFACTURERS (Production Units):

Canadian Westinghouse Co Ltd, Hamilton, Ontario, Canada – Transmitter, Power Supply, Sonar Transmission Control, Generator-Indicator and Range-Doppler Indicator.

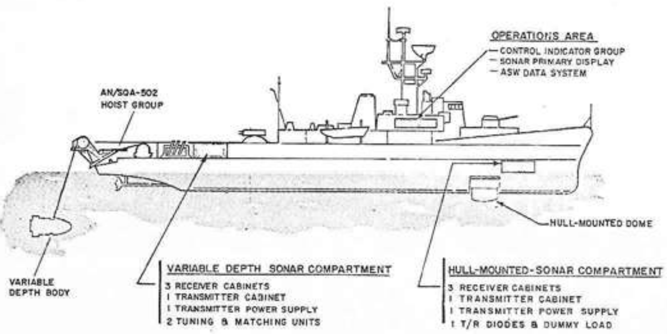
Edo (Canada) Ltd, Cornwall, Ontario, Canada (No longer in existence) – Receiver and Transducer.

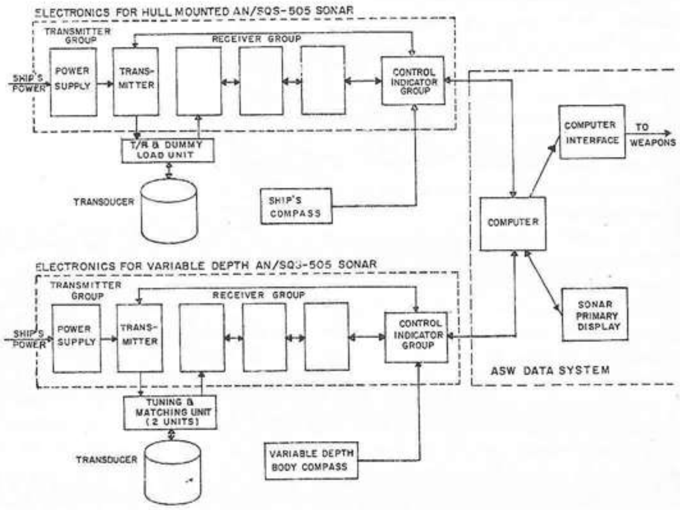
C-Tech Ltd, Cornwall, Ontario, Canada – T/R & Dummy Load, T/M Unit, Underwater Telephone Transfer Control Unit.

Standard Telephones and Cables Ltd, Newport, Monmouthshire, Wales – Tow Cable 5.

Fleet Industries Division, Ronyx Corporation Ltd, PO Box 400, Fort Erie, Canada L2A 5N3 – Hoist, body and VDS hoist mechanism.

N.V. Hollandse Signaalapparaten, Hengelo, Netherlands – ASWDS (Computer, Sensor Weapon Converter, Sonar Primary Indicator, Sonar Signal Injector).





FRANCE

1053.281
VEGA SERIES SHIP'S SURVEILLANCE AND WEAPON CONTROL SYSTEMS

DESCRIPTION:

Under this designation, Thomson-CSF produces a range of modular integrated naval systems.

The basic elements of a Vega system comprise:

- a choice of four combined air and surface surveillance and target designation radars
- a choice of two tracking radars
- a choice of two tactical information units
- one or more linked computers, according to the ship's radar, ASW and weapons fit.

Auxiliary and ancillary apparatus or other systems complementing the ship equipment are also integrated or associated with the Vega systems, namely: IFF, navigation radar, ECM, sonar, plotting table, optical sights or directors, vertical and heading gyros, log, etc.

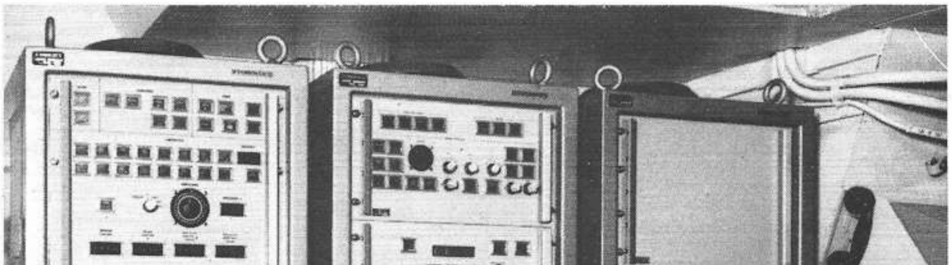
The weapons controlled can include:

- artillery of any calibre and rate of fire
- anti-ship missiles (Exocet, Otomat, Harpoon, Teseo, Penguin)
- surface-to-air missiles
- surface torpedoes
- ASW torpedoes
- ASW rockets.

RADARS:

Triton is a C-band combined air and surface surveillance radar (**1062.253**) especially designed to equip small tonnage ships. Its MTI version gives it a sea-skimmer missile detection capability. Its polarisation is linear horizontal.

Saturne II is an S-band air and surface surveillance radar (**1237.253**) incorporating an MTI receiver. It can be fitted with either one or the other of two antennae with both switchable linear and circular polarisation. One with a 3 m span, 10 and 20 rpm rotation rate and roll and pitch stabilisation, the other with a 4.5 m span, 12 and 24 rpm rotation rate and roll stabilisation. The transmitter features high peak and average power, two pulse



Operational console of a typical Vega Fire Control system for ships' guns and other weapons durations and two PRFs. The Saturne II detection capability includes sea-skimmer missiles.

Sea Tiger is a combined air and surface surveillance radar (**1687.253**). It incorporates a high average power, fully coherent transmitter for improved MTI performance, with two pulse durations and two PRFs. Its other important features are pulse compression, digital post integration, random frequency transmission for better anti-jamming performance. The antenna is roll stabilised, has a span of 4.5 m and switchable linear and circular polarisation. The Sea Tiger is particularly suited to the detection of sea-skimmer missiles.

Pollux is an X-band fast scanning fire control radar (**1064.253**). Its MTI version is provided with two PRFs and a filter with two switchable transfer characteristics. Its polarisation is circular.

Castor II is a monopulse X-band fire control radar (**1063.253**) with incorporated MTI receiver making it capable of acquiring and tracking a sea-skimmer missile of very small radar cross section within heavy sea clutter echoes. As Pollux, in its MTI version, it is fitted with two PRFs and two switchable filter transfer characteristics. Its polarisation is linear horizontal.

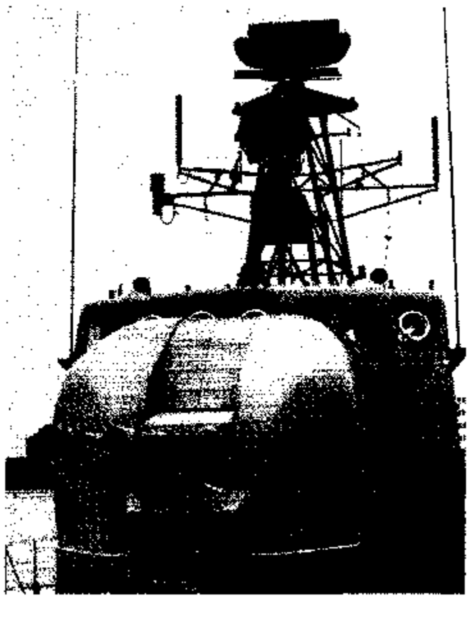
TIU:

Vega I and Vega II (**1779.281** and **1780.281**) are the two alternative tactical information units.

COMPUTER:

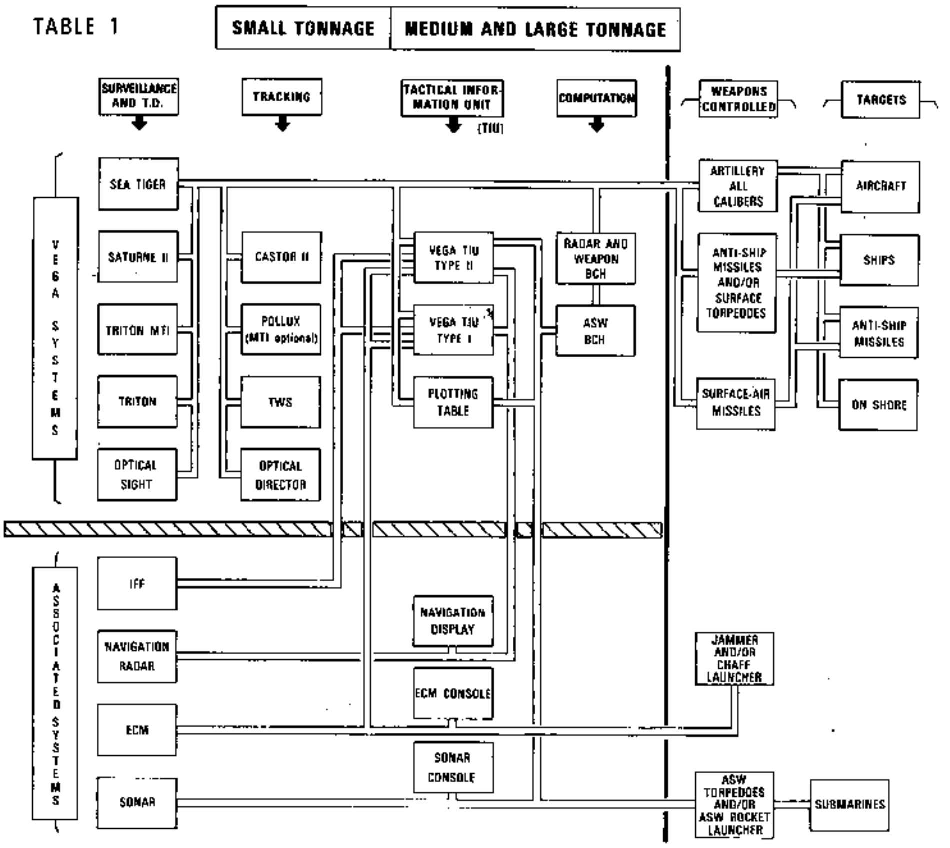
The Computer is the modular BCH which performs all the computations for the system, including some auxiliary functions such as azimuth stabilisation of display when an unstabilised surveillance antenna is used; control and stabilisation of the tracking radars in autonomous search mode; memory tracking; constant altitude tracking; elevation search; and ship speed compensation for MTI receivers.

In all instances, the surveillance and tracking radars are dissociated physically and in frequency range in order to reduce the vulnerability of the system and its basic susceptibility to jamming and to optimise each function. This also increases the range of possible surface or low altitude detection by allowing a higher location of the surveillance antenna. The MTI receivers are all of the linear digital type with a wide rejection bandwidth to cope with the speed and wide spectral distribution of the kinds of clutter encountered at sea. They incorporate an own-ship's speed compensation device.



Typical Vega-Pollux fire control system radar installation

Possible combinations in the VEGA SYSTEMS



VEGA SYSTEM TYPE I-43

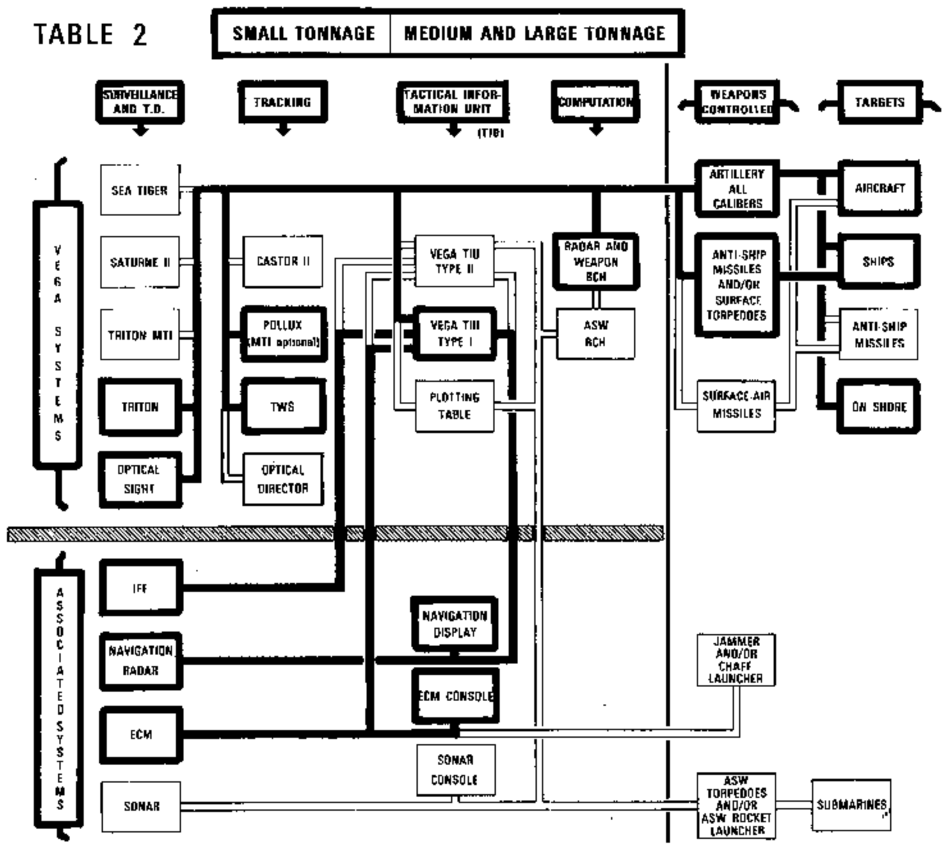


TABLE II: The Vega type I-43 system, intended for small tonnage ships or as a complementary system on a larger vessel. It consists mainly of the combination of a Triton surveillance radar, a Pollux tracking radar, TWS, optical sight, Vega I tactical information unit, and computer. It controls artillery and the launching of anti-ship missiles and/or surface torpedoes. The possible targets are aircraft and on shore for artillery and ships for missiles and artillery. Only an ECM analyser and alert receiver are associated with this example of system, but this could be extended to a jammer and/or chaff launcher. Also included are an IFF and a navigation radar

The tracking radars are designed to avoid the need of a radome, which makes possible the addition of TV cameras or TV tracking devices which are also available for integration with the fire control systems. According to the weapon fit, the tracking radars, tactical information units and computation means can be chosen independently of the ship's tonnage, when the surveillance radar and sonar are more closely linked to it.

The possible combinations of equipments and weapons are summarised in Table I. Three Vega configurations are also shown as typical examples in Tables II to IV.

STATUS

Development of the Vega systems started in 1967. The first system manufactured, a Vega type I-43, controls the following weaponry: two guns, Exocet missiles and AEG SSi4 torpedoes. It has been operational since the end of 1971. From the early Vega systems, mostly adapted to small tonnage ships, to the systems presently available, the evolution has been towards an enlargement in the choice of basic equipments to meet the requirements of a broad range of tonnage and missions, with a particular emphasis on the self defence capability against sea-skimmer missiles. To date, more than sixty Vega systems are either operational or in production.

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

VEGA SYSTEM TYPE II-73

TABLE 3

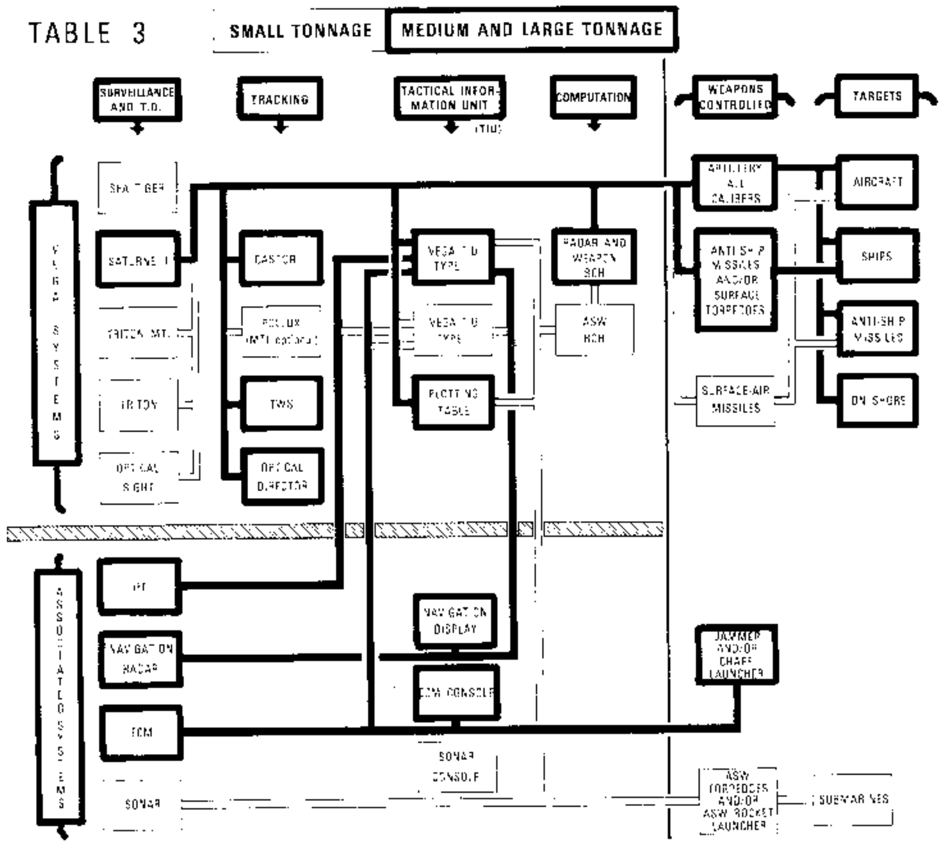


TABLE III: The Vega type II-73 intended for a medium to large tonnage ship. It includes a Saturne II surveillance radar, Castor II as tracking radar, an optical director, TWS, Vega II tactical information unit and a computer. An IFF, a navigation radar and ECM sub system are associated. The controlled weapons are artillery, anti-ship missiles and / or surface torpedoes. This system has the capability of artillery fire control not only against aircraft, ships, or shore targets, but also against sea-skimmer missiles, by the use of the Saturne II surveillance radar and Castor II tracking radar

VEGA SYSTEM TYPE II-89

TABLE 4

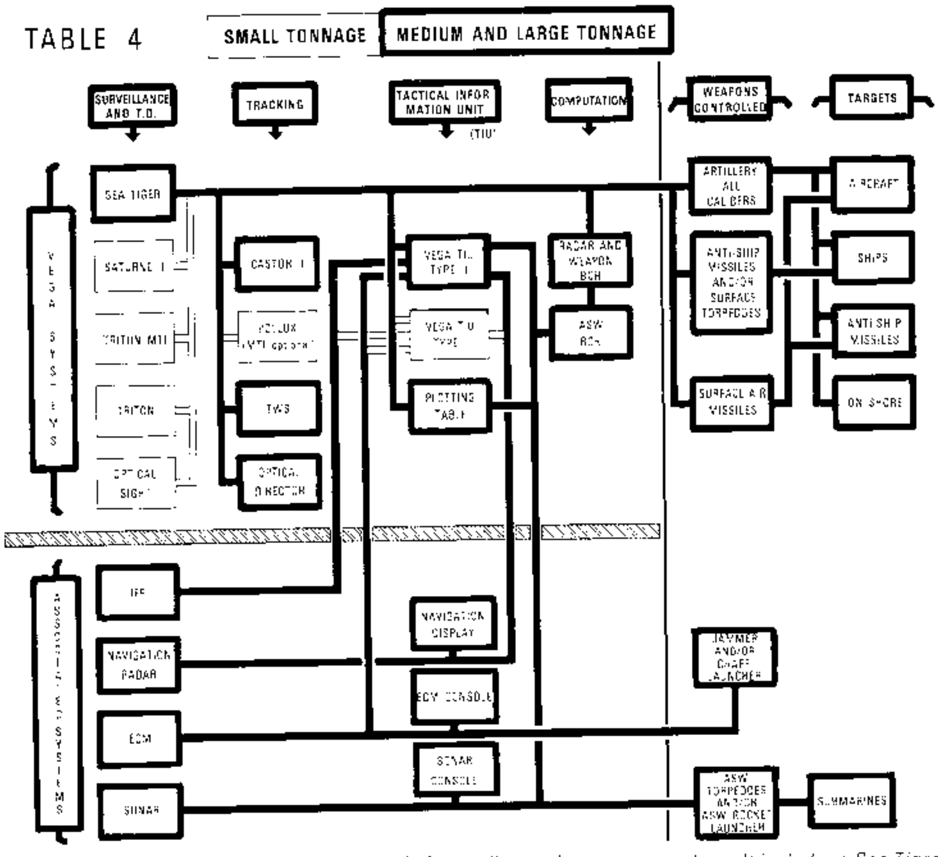


TABLE IV: The Vega II 89 system, is suitable for medium to large tonnage ships. It includes a Sea Tiger surveillance radar, one or more Castor II tracking radars, the Vega II tactical information unit, one or more surface weapon computers according to the number of tracking radars, optical director, plotting table IFF, navigation radar, ECM and ASW are associated. This system controls artillery, anti ship missiles and / or surface torpedoes and surface-to-air missiles. It can handle all kinds of targets, including sea-skimmer missiles with the detection and tracking capabilities of respectively the Sea Tiger and Castor II radars, and submarines through the association of a Sonar, ASW computer and ASW weapons

1779.281
VEGA TACTICAL INFORMATION UNIT TYPE I

DESCRIPTION:

This code name has been given to the operational use equipment employed in Thomson-CSF Vega systems for radar data display and system operation. The Vega tactical information unit Type I comprises conventional display consoles for manual operation and for automatic plot tracking of 1 or 2 surface targets. Vectors and electronic markers represent data delivered by the TWS, units, the fire-control radar, ECM devices, optical sight units, etc. Manual target designation is achieved by electronic marker. Presentation can be of either the relative-motion or the true-motion type. Data processing is carried out by the BCH computer of the Vega system.

STATUS:

Entry into operational service in 1969.

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

1780.281
VEGA TACTICAL INFORMATION UNIT TYPE II

DESCRIPTION:

The Vega tactical information unit Type II is an automated data processing system for use on board all-tonnage ships, in place of the Vega Tactical Unit Type I, for the purpose of improving decision making and shortening the overall reaction time of the system. It permits the following actions:

- acquisition of data describing the real-time situation;
- shaping, sorting and display of these data, aids to situation evaluation;
- designation of targets to weapon systems and transmission of engagement orders;
- resolution of tactical problems;
- transmission and reception of data to and from external ships (or aircraft).

OPERATION:

The following data sources are exploited: radar, IFF, sonar, passive detection (ECM), optical detection, gyrocompass, log, and external sources. To reduce manual filtering and plot linking operations, the system performs automatic tracking of 16 air or surface targets or, in difficult conditions, rate-aided manual following of radar tracks. The display of the tracks followed is completed with symbols, identification letters and numbers, velocity vectors, etc.

To facilitate and speed up the operator's decision making, the system offers such operational facilities as true motion, target designation and reports, and enables the resolution of a number of tactical problems: azimuth-range, interception time, CPA (anti-collision) track extrapolation (time to go), etc.

The Vega Tactical Information Unit Type II comprises 2 to 6 operation consoles which are multipurpose and hence interchangeable, this making it possible to adapt operational facilities to the actual situation at any moment, by designating each position for a well defined use, eg: command, surface surveillance, air surveillance, weapon allocation, etc. The consoles are fitted with a 16-inch high-quality display, and control panel with selection devices: numerical keyboard, order keyboard, electronic alidade vector control devices.

The Vega TIU Type II is controlled by the digital computer of the Vega system, this being fitted with supplementary input/output facilities and supplementary programs.

STATUS:

Under development.

MANUFACTURERS:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

Thomson-CSF, Visualisation et Traitement des Informations, 40 rue de la Grange-Dame Rose, 92-Meudon, France.

1522.261
SENIT NAVAL TACTICAL DATA HANDLING SYSTEMS

DESCRIPTION:

The French Navy's naval tactical information systems for surface vessels are identified under the acronymic designation SENIT (Systéme d'Exploitation Navale des Informations Tactiques), and five systems of this kind have been identified. All five have the broad functions of gathering, coordinating and distributing sensor data and other information, presentation of information on appropriate displays, and certain weapon system control functions. A digital computer, or computers, provides the central processing facilities. The five systems differ in accordance with the nature and operational role of the vessel fitted and the sensors and armament installed.

SENIT 1:

This version is fitted to the two "Suffren" Class guided missile frigates, *Suffren* and *Duquesne* (D602 and D603), which are armed with a twin launcher for Masurca surface-to-air missiles (**1177.231**), a single Malafon anti-submarine weapon launcher (**1179.241**), two single 100 mm AA guns, two single 30 mm guns, and four torpedo tubes. Sensors fitted include a DRBN 32 surveillance/navigation radar, a DRBI 23 three-dimensional air surveillance and target designation radar, two DRBR 51 target tracking and missile guidance radars for the Masurca system, an X-band gun fire control radar, two visual tracking sights, a DUBV 23 hull sonar, and a DUBV 32 variable depth towed sonar.

Three computers are employed in the SENIT 1 system. An IBM machine accepts data from the DRBI 23 radar and carries out air target threat evaluation and presents target position and height information to displays in the operations room. Target data is also available to weapon systems. Another IBM computer is used as the Masurca launch computer. A version of this system is under development for the anti-aircraft cruiser *Colbert* (C611) which will be armed with a twin Masurca launcher, two single 100 mm AA guns, and six twin 57 mm AA guns. Sensors will include a navigation radar, DRBV 23 air surveillance and target designation radar, surface surveillance radar, height finder radar, two DRBR 51 Masurca fire control radars, one fire control radar for 100 mm guns, and two fire control radars for 57 mm guns. The *Colbert* will also have a hull-mounted sonar.

SENIT 2:

This version is to be produced in two forms to equip vessels intended for (1) fleet air defence, or (2) as radar picket ships in support of the French STRIDA national air defence network. The SENIT 2 system employs one computer only, probably a Hughes machine. Known fittings, completed or in progress, are the four ships of the T 47, "Surcouf" Class; converted to carry the Tartar surface-to-air missile system (**6006.231**), D622 *Kersaint*, D624 *Bouvet*, D625 *Dupetit Thouars*, and D630 *Du Chayla*; three radar picket ships of the T 53R class, D634 *Le Bourdonnais*, D636 *Tartu*, and D637 *Jaureguiberry*; and A633 *Duperre*, which is now classified as experimental.

The Tartar fitted vessels have Hughes SPA-72 air surveillance and target designation radars which incorporate their own digital computers, and fire control radars for missiles and guns. The radar picket ships have DRBI 10 and DRBV 22 search radars, and X-band fire control radars. Five other vessels of the T 47 class are being modernised and equipped for anti-submarine duties but it is not yet known if these are to be provided with SENIT systems. SENIT 2 was developed in collaboration with the West German Navy.

SENIT 3:

The SENIT 3 system is fitted to the corvette Aconit and is planned for the two Type C67 A corvettes *Tourville* and *Duguay-Trouin* derived from the *Aconit* and now under construction. The *Aconit* is armed with Malafon anti-submarine weapons, one quadruple A/S mortar, torpedoes, and two 100 mm AA guns. The later vessels will carry a total of 13 Malafon missiles, six MM 38 Exocet anti-ship missiles (**1156.221**), two torpedo launchers (12 anti-submarine L5 torpedoes), and three 100 mm gun mountings. Each vessel will carry two WG 13 helicopters which will be capable of use in an anti-submarine role with Mk 44 torpedoes and grenades, or against surface targets with AS 12 missiles (**1174.311**). Sensors fitted to C67 A ships include a combined surveillance radar DRBV 13, one fire control radar N 32, one navigation radar, a helicopter deck landing radar, bow and variable-depth towed sonars, and electronic counter-measures.

The SENIT 3 is intended principally for use in the anti-submarine and anti-shipping roles, but will also provide for quick reaction against air targets for defence. Two computers are employed, with expanded memory facilities. The computer equipment is provided by Univac, and it works in conjunction with a display sub-system by Hughes which is produced under licence in France by Thomson-CSF.

SENIT 4:

This version, and the SENIT 5, are new systems now under development and both employ computers of French design and manufacture. SENIT 4 employs the IRIS 55M (**1422.063**) computer in conjunction with ten Vizir displays developed by SINTRA. Each of these display consoles has a potential capacity of up to 130 track symbols with speed vectors, an information display with twelve lines of 18 characters, four circles, 23 lines or target vectors. The consoles are provided with tracker balls and keyboard data entry facilities. The synthetic information display has a character repertoire of 96 different symbols.

Vessels to be fitted are the aircraft carriers *Clemenceau* and *Foch* and the new C 70 class of corvettes.

SENIT 5:

SENIT 5 has a somewhat lower overall capacity than SENIT 4 and is intended for handling the tactical data requirements of small and medium tonnage ships, in which neither the cost nor the capacity of the larger system can be justified. The computer used is the IRIS 35M (**1423.063**) with a variety of peripheral and additional storage options. The display sub-system comprises the same Vizir display consoles as used in SENIT 4, but in this case they are connected to the IRIS 35M via an interface unit which also provides a similar service for the sensors. A typical complement is five display consoles and two sensors. Up to 40 targets can be accommodated by the system, and there are provisions for the presentation of supplementary data in alpha-numeric and symbolic form. A PLAD automatic data plotter can also be connected to the system, and there is provision for the use of data link between consorts, aircraft or the shore.

A total of fourteen vessels of the *Aviso* C 70 class of coastal protection and surveillance ships is expected to be fitted with the SENIT 5 system. Two versions of this class have been projected, for coastal protection and for anti-submarine duties. Weapons will include Exocet, sextuple A/S mortars, twin torpedo tubes and 100 mm guns.

1353.281

HIRONDELLE AIR DEFENCE SYSTEM

DESCRIPTION:

Hirondelle is a naval air defence system with the protection of ships from attack by very low-level air- or ship-launched missiles as its principal design objectives. For this role, it is essentially a short range system, with all-weather capability.

The main elements of the system are surveillance and tracking radar to provide for target designation and illuminating of targets at heights of a few metres; a fire control system and associated data processing facilities; one or more missile launching ramps, each equipped with four or eight missiles in watertight containers. The system would also include provision for the direction and control of ship's guns in addition to Hirondelle missiles. The latter will be a version of the Matra Super 530 air-to-air weapon (Entry No. **1349.331**).

Design of the system permits its use on ships of 200 tonnes or above.

STATUS

It was stated that the system had reached the design stage in May 1971, this being performed by Electronique Marcel Dassault. No hardware details have been released.

Model of French CMN Combattante II class vessel with Hirondelle short-range surface-to-air missile system. (Mid-ships launcher/containers are for surface-to surface missiles)

1232.281

ALCATEL DLT-L-4C TORPEDO LAUNCH CONTROL SYSTEM

DESCRIPTION:

The DLT-L-4C system has been designed for the launching of L.3 type torpedoes from surface ships, a typical application being escort vessels of the French Navy. These ships have two triple launching platforms, one on each side, and two triple cases for the storage of reserve torpedoes.

The system performs the following functions

Reception of target data provided by sonar and conversion of this data into parameters suitable for launch calculations.

Geometric and kinematic resolution of the launch, and development of parameters required for the L.3 torpedo.

Selection of the platform and tube to be used for launch.

Transmission and checking of remote control commands to the selected torpedo.

Control and monitoring of firing.

A complete DLT-L-4C system comprises a torpedo launch control station (PCLT), and a number of interface boxes distributed throughout the launch tube platform assemblies. The latter provides the requisite electrical supply and control links between the PCLT and the various mechanical elements of the system.

The PCLT is located in the ship's operations centre, and groups all the controls and indicators needed for launching. Two modes of launching are provided for: Normal – automatic calculation of launch parameters. Emergency – parameters displayed.

Data employed in the calculation of launch parameters includes, azimuth, inclination, target speed, distance and bearing.

The parameters transmitted to the torpedo are gyro-deflection angle, time of trajectory, reference submersion depth.

MANUFACTURER:

CIT-ALCATEL, Division Marine, 33 rue Emeriau, 75 275 Paris Cédex 15-France.

1739.461

DLT-D-3A SUBMARINE TORPEDO FIRE CONTROL SYSTEM

DESCRIPTION

The CIT-Alcatel DLT-D-3A torpedo fire control system is designed as a replacement for the DLT-S-4 system in French "Daphne" Class submarines. It is intended for firing most of the old and new types of torpedoes employed by the French Navy. The Daphne class submarines have eight forward torpedo tubes for firing eight types of torpedoes, and two groups of two aft tubes; two pairs of external tubes each firing two types of older mode, torpedoes.

Target data is fed to the system from on-board sensors, which comprise fore and aft sonars; fore and aft microphone clusters; the DUUX 2 acoustic range-finder; attack and surveillance periscopes.

Data processing and distribution is carried out by an IRIS 35M digital computer (Entry No. **1423.063**), the principal functions of which are as follows From the sensor information, target components such as azimuth, range, speed and course are computed, and the determination of target elements can be performed by any of three different methods. It can be carried out simultaneously for two targets. Two firing paths can be computed simultaneously, for the direction of two different torpedoes against a single target, or towards two different targets.

Provision is made for remote setting of torpedoes prior to firing, consisting of on-off presetting as well as continuous (servo) presetting. Other facilities are fire command and control, and automatic and manual guidance of wire torpedoes.

The above operations are performed by means of the IRIS 35M computer and a display and command console. The latter provides for manual input/output functions and constitutes the sensor-calculator interface. The unit has three CRT displays, for tactical situation, firing path presentation, and tabular data, respectively. Two control keyboards provide for overall control over the complete system.

The various units of the DLT-D-3A system are located in three areas; operations room, forward tube section, and aft tube section. In the operations room are:

Display and command console. VIC.1

Calculator QTD X

Ancillaries (junction box BJG3, azimuth relay RZ1, tape reader LEC1, computer control desk PCQ1, cut-out CDG3)

In the forward tube section the equipment consists of ancillaries and the PAT 2 tube control and selection desk. This permits torpedo checking and maintenance, and includes signalling preparatory to firing and selection facilities for the eight tubes

A similar arrangement of equipment is made in the aft tube section, where the PAT 3 tube control and selection desk provides facilities for the operation of four tubes employing old-model torpedoes only.

STATUS:

At late development stage. Another version, based on the DLT-D-3A will be fitted in 1,200-ton class submarines.

MANUFACTURER:

CIT-ALCATEL Division Marine, 33 rue Emeriau, 75 275 Paris Cédex 15-France

1309.481

SUBMARINE TORPEDO FIRE CONTROL SYSTEM DLT-S-4E

DESCRIPTION:

This system has been designed for installation in the French Navy Daphne Class of submarines for the control of French torpedoes such as the Z16, E12, E14, and L3. It is stated to be suitable for adaption, to other submarines and types of torpedoes.

The elements of a DLT-S-4E installation are located at three stations in the submarine: Central Operations, Bow tube sections, and Aft tube section. The principal units at the Central Operations station are:

ALG1-2. Power Supply and Data Drive: This provides the power supplies for synchro circuits and other signalling functions from the ship's main 115V three-phase 60 Hz supply. It also includes provision for torpedo fire control under the following conditions: Stop, Reheating, Navigation, Surveillance, and Combat.

RZ-1 Azimuth Relay: This provides azimuth reference information for the complete system, derived from the ship's data sources.

GZ-2 Azimuth Plotter This gives a record of all the azimuth data derived from the submarine's detection sensors, and also has arrangements for the presentation of certain selected bearings on the relative-track plate (plotter).

PRR-2 Relative-track Plate This permits the display of relative track-axis determined on the basis of the data supplied by the azimuth plotter. It processes and transmits the parameters of this axis to the QFZ 1 computer, and the CONJ-1 conjugator for determining target vector by the azimetric method

CONJ-1 Conjugator: This unit receives the target position, bearing and range data from the shipboard detection equipment, and can process target speed and course vector by manual stabilisation, tachymetric, or azimetric methods. Computed target data is transmitted to the trajectory computer, QTL-3.

QTL-3 Trajectory Computer This computer calculates the firing parameters from the data supplied by the conjugator and the displayed torpedo elements. It computes the trajectories for various torpedoes that can be used. These are, linear for the E-12, E-14, and L.3 torpedoes, and linear with or without a sinuous trajectory for the programmable Z 16 torpedo.

Both the fore and aft tube sections are provided with AL 2 Power Supply units which provide power, signal interconnections, and emergency firing facilities. The bow tube section also has a Bow Combiner CAV-3 for the assigning of tubes to the several launch channels.

OPERATION:

Detection sensors providing inputs to the system are, the surveillance and attack periscopes, fore and aft sonars Type GCO2, the DUUX-2 listening set, and probably a radar such as the Thomson-CSF Calypso (which see). Range and bearing data available from these sensors are recorded simultaneously on the azimuth plotter where they are plotted as a graph against time, and also transmitted for navigational purposes. The trace produced by successive bearings of a designated target on the azimuth graph permits its relative track to be determined and this is displayed by the Relative Track Plate.

Target information and relevant own ship data are transmitted to the Trajectory Computer which performs the launch calculations on the basis of the type of torpedo selected. In the case of the Z.16 weapon, it computes all the parameters needed for the execution of the torpedo's sinuous trajectory, while for the acoustic L.3, E.14, and E.15, torpedoes, the optimum approach trajectory is computed. Torpedo preparation orders are transmitted to the weapons in their tubes.

Attack methods by the three categories of torpedo are.

A. Use of programmed Z.16 torpedoes against isolated or convoyed surface vessels:

Gyro-controlled steering enables the target to be attacked at the most effective angle of incidence.

The optional sinuous trajectory increases the probability of a hit.

Tele-control of torpedo depth as a function of target draught.

Magnetic proximity detonations, or inertial contact detonation.

Electric propulsion gives a speed of 30 knots over a distance of 10,000 metres.

Group firing of two Z.16 torpedoes enables a substantial danger zone to be produced.

B. Use of passive acoustic torpedoes E.14 and E.15 against snorkel submarines and surface vessels:

Linear approach and search trajectory.

Pursuit trajectory by passive auto-director using target-generated noise.

Tele-controlled, constant depth.

Magnetic proximity and contact detonation.

Electric propulsion gives a speed of 25 knots over distances of 10,000 metres (E.15) or 5,000 metres (E.14).

C. Use of the active L.3 torpedo against submerged submarines:

Linear approach trajectory without transmission from the acoustic homing head.

Activation of the homing head and sinuous search trajectory increases the probability of target detection.

Tele-controlled search depth according to estimated target depth.

Underwater acoustic pursuit in the horizontal plane.

Proximity and contact detonation.

Electric propulsion gives a speed of 25 knots over a distance of 5,000 metres.

MANUFACTURER:

CIT-ALCATEL, Division Marine, 33 rue Emeriau, 75 725 Paris Cédex 15-France.

GERMANY (FEDERAL REPUBLIC)

1824.291
AGIS COMBAT INFORMATION SYSTEM

DESCRIPTION:

AGIS (Automatisiertes Gefechts- und Informationssystem für Schnellboote) is a fully integrated command and fire control system which has been developed for the West German Bundesmarine's new Type 143 fast patrol boats. The principal sub-systems of AGIS comprise: radar, optical and probably EW sensors; computer; display; data link; and fire control system. The ship's weapons consist of four single fixed launchers for Exocet surface-to-surface missiles (**1156.221**), Seal wire-guided torpedoes (**2000.441**), and two Oto Melara 76/62 compact dual-purpose guns (**5533.203**). It is intended that Type 143 ships will operate as flotilla leaders, in consort with Type 142 and Type 148 fast patrol boats for instance, and the scale of data processing, display and communications facilities provided reflects this. Within the last of these categories are HF and VHF transmitter receivers, UHF encoding transmitter/receivers, and teleprinter links. Display arrangements provide for two torpedo control consoles, a gun control console, a horizontal conference-type tactical display and a vertical tactical plot.

The radar sensors are those of the Hollandse Signaal M27 integrated fire control system (**1359.281**) which forms a large part of the overall AGIS installation. Within the single spherical radome that is characteristic of this series of FCS are stabilised antennas for air and surface search and target tracking, and with integrated IFF/SIF facilities. The Type 143 is provided with a separate navigation radar, other navigation equipment including an echo-sounder, log, Decca Navigator and horizontally stabilised gyro-compass. The optical director is a Galileo type OGR-7/3.

STATUS:

The first of ten Type 143 vessels was laid down at the Lürssen yard in Bremen-Vegesack in April 1972 and has since been launched and begun trials. This ship is due to be handed over to the Bundesmarine in November 1975, "operationally and functionally ready for service".

To ensure this, and because of the particular significance of the electronic systems and equipment, AEG-Telefunken was appointed main contractor.

MANUFACTURERS:

AEG-Telefunken, 7900 Ulm, Elisabethanstrasse 3, West Germany – Main contractor.

N.V. Hollandse Signaalapparaten, PO Box 42, Hengelo, Netherlands – M27 FCS.

1825.281
SATIR ACTION INFORMATION SYSTEM

DESCRIPTION:

SATIR (System zur Auswertung Taktischer Informationen auf Raketenzerstören) is the tactical data automation and display system fitted in the three Lütjens Class guided missile destroyers of the West German Bundesmarine. These ships are a modified version of the American Charles F Adams type and are fitted with US radars such as the SPS-52 three-dimensional search and target designator, SPS-10 surface warning set, SPS-40 air surveillance, and SPG-51 fire control radars for the Tartar surface-to-air missiles. Weight and space considerations decided the Bundesmarine against the installation of the US NTDS (Naval Tactical Data System) and SATIR was developed in its stead to meet the German requirement and in general compliance with the B-2 Concept, a NATO standardised system for destroyers and above. Beyond the participation of Univac, no other reliable details have been obtained.

ITALY

1823.281
ITALIAN NAVY MULTI-PURPOSE ROCKET CONTROL SYSTEM (UCLAR)

DESCRIPTION:

The UCLAR control system, with the Breda rocket launcher and Snia Viscosa chaff and illuminating rockets, forms the SCLAR multi-purpose rocket system recently fitted in some Italian Navy ships and due for installation in others. The main functions of the system are: (a) passive defence against radar-homing missiles by the 'chaff-rock' technique, and (b) visual fire-control in night surface operations with small and medium calibre guns through the use of 'star-rock' illumination. Basic features of the overall system are summarised as follows:

Rockets:

Multirole 105 mm rockets, with folding tails, designed for carrying chaff warheads and, on request, HE-type warheads.

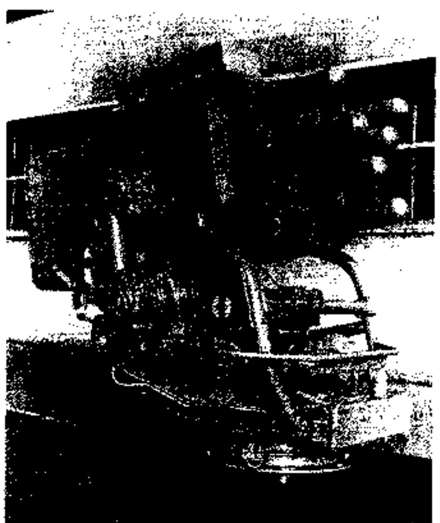
Range: up to 12 km.

The rockets are loaded each packed in a fibreglass launching container, the pre-fragmented hard plastic cap of which is broken by the projected rocket when fired. In so doing, the rocket cannot be affected by environmental conditions and at the moment of firing leaves in the same condition as when finally tested at the factory.

A high precision electronic fusing system (Italian Navy fuse) makes it possible to fulfil the programmed explosion figures at any preselected range and height.

Rocket launcher:

Two rocket launchers, installed on board symmetric to ship centre-line, each with 20 launching tubes, arranged in four horizontal rows and with its own Fire Sequence Programme Unit on the mount rotating part.



Breda launcher for Italian Navy SCLAR multi-purpose rocket system

ULCAR – Rocket Launcher Control Unit:
This receives from the designation sources the available data concerning the launching to be effected; operates launching data computation as a function of target range, ship motion and rocket ballistics. It operates two launching programmes:

Manual for long-range chaff dispensers;
Automatic for short-range chaff dispensers.

ULCAR:

The ULCAR provides launching data computation as a function of target designation data, ship motion and rocket ballistics, taking into account the launcher stabilisation as a function of deck-tilt and wind effect on the rocket flare. Rocket fuse setting is continuously and automatically operated.

The following data has to be manually introduced by the UCLAR operator in order to obtain the required computations: flare burst height; chaff dispenser burst height; spotting corrections for illuminating launches; absolute wind intensity and true bearing; train changes for programmed long-range chaff dispenser launches; increment of range (beyond target) for illuminating mode.

The UCLAR enables its operator to have overall control of the SCLAR by means of the following indications of the operational state:

Launcher servo "on"
Launcher under remote control
Launcher loading
Launcher ready
Numerical display of rockets on "pad" and type of rockets loaded on each row of "pad"
Selected launcher
Designation from Combat Information Centre, Electronic Warfare Centre or Target Indication Sight
Rocket launcher on "train mechanical limits"
Recommended ship course (to port or starboard)
Firing modes: Illuminating mode – Single long-range chaff mode – Programmed long-range chaff mode (multiple launching) – Short range chaff mode (multiple launching).

Having given orders for loading or completing the loading of the launchers, with indication of type of rocket and row to be loaded, and having accepted the automatic designation from CIC or EWC or TIS or having set manual input of target data, the UCLAR operator can, by pushing a button, fire one rocket or a sequence of rockets according to the preselected firing mode.

Launching of illuminating rockets:
The target is designated by the TIS's or the radar repeaters in CIC or from any other source by either direct or phone communication. The UCLAR operator sets star rocket burst height, increments range and wind correction, and then provides for starting of launcher servos and firing of rockets.

During firing, spotting correction can be added manually.

Launching of long-range chaff dispensers:
The target is designated by the radar repeaters in CIC or by the passive interceptors in EWC.

Two different modes can be selected:

(a) Single launching: a single launch for each firing order from UCLAR is accomplished. In this case, range and bearing of the target are taken into consideration.
(b) Programmed launchings: a number of consecutive launchings (up to five) for each launcher is accomplished. The launching sequence is range programmed by the UCLAR operator, who can also manually introduce a shifting in bearing to obtain a deception chaff pattern.

Launching of short-range dispensers:
The target is designated by the interceptor in EWC or by the TIS's. The UCLAR operator introduces head burst height and provides for chaff dispenser firing.

Four fixed-range launches are automatically accomplished: two right hand and two left-hand with respect to target bearing.

A four-point chaff pattern is thus obtained, with the diagonal axis at +45° to target direction.

The pattern is obtained a short time after fire button operation by the UCLAR operator.

LAUNCHER:

The Breda multi-purpose rocket launcher mount is designed for easy fitting in most types of ship and for the launching of rockets for different tasks: illuminating rockets, long and short-range chaff dispenser rockets, HE warhead rockets.

The launcher consists of:

Servoed mount, remote controlled for training and elevation.

The elevating launcher "pad" with its trunnion axis supports 20 tubular track cells. These cells are arranged in four horizontal rows, and are suitable for launching 105 mm rockets with folding tails, each loaded complete with individual watertight containers.

The "pad" is easily interchangeable with others suitable for launching rockets of a different type.

In the 20-cell "pad" the rockets are loaded as follows:

1st row: 5 illuminating rockets or long-range chaff dispensers.
2nd row: 5 illuminating rockets or long-range chaff dispensers.
3rd row: 5 long or short-range chaff dispensers.
4th row: 5 long or short-range chaff dispensers.

In each row, every rocket is electrically connected to the SCLAR by means of one plug-in multicontact connector which provides for firing circuit, for input to electronic fuse system and for signalling the type of rocket loaded in the row. An electronic device, Fire Sequence Program Unit, placed on mount rotating part provides for the selection of rockets to be launched, in accordance with the UCLAR orders, and the firing of rockets loaded on that row, for the counting of the rockets loaded when so ordered by the UCLAR operator.

In addition, the FSPU operates, in the SCLAR, as an automatic self-control device, allowing the system to fire only the rockets corresponding to the preselected types. In each row, the rockets not conforming to the preselected type are not reported as present in the numerical display on the UCLAR and on the Local Control Panel, and the firing input by-passes the rockets which do not correspond to those preselected, as in the case of misfired rockets.

The launcher has electric servo-systems for controlling bearing and elevation, employing solid-state servo-amplifiers.

ROCKETS:

The type of rocket used is a surface-to-surface ballistic vehicle, and was developed by Snia Viscosa to Italian Navy requirements. There are two versions: (a) long-range for chaff, illuminating and bombardment roles, and (b) short-range for chaff only. A high precision electronic fusing system receives continuous data direct from the firing director and initiates at the pre-selected time payload ejection from the flying rocket or head burst.

DEVELOPMENT:

The SCLAR system is the latest development in the field of rocket systems sponsored by the Italian Navy. The work was carried out in collaboration by Elettronica San Giorgio, Breda Meccanica Bresciana and Snia Viscosa.

STATUS:

The first operational installations, aboard the Italian "Audace"-class frigates were made in 1972, since when progressive fittings to other ships are understood to have taken place.

MANUFACTURERS:

ELSAG – Elettronica San Giorgio SpA, Via Hermada, 6-Genova-Sestri, Italy – ULCAR.

Breda Meccanica Bresciana SpA, Via Lunga, 2-Brescia, Italy – Launcher.

Snia Viscosa, BPD Division, SpA, Via Lombardia, 31-Rome, Italy – Rockets.

1020.281
NA9 SHIP'S FIRE CONTROL SYSTEM

DESCRIPTION:

Designed to provide fire control facilities for cruisers, frigates, corvettes and light vessels for the control of small and medium guns against air, sea or land targets. It is also capable of the control of missiles such as Seacat.

OPERATION:

The radar normally used is the Selenia Orion 250 which is used to provide range, bearing and elevation data on sea or air targets. This is normally used for automatic tracking, but a secondary tracking mode using manual methods is possible, using the raw target information provided by the radar. Operating frequency is in the X-band and a conical scan pattern is employed. Two-axis stabilisation is provided for the scanner. Radar tracking is supplemented by a pair of binocular telescopic sights, each of which can be remotely controlled by a joy-stick at the operator's position. The sight lines of radar and both optical sights are under the control of a computer which provides compensation for ship's pitch and roll. The computer also is responsible for the radar scanning pattern according to the mode of operation selected.

A crew of three is normally employed, one man for each optical sight and one for the radar. However, if the optical search mode is dispensed with, automatic operation is possible with one man only, whose main function is that of decision taking. All target information from other sources such as the ship's surveillance radar etc are supplied automatically. Target co-ordinates can be inserted from either stabilised sources or can be indicated relative to the ship's deck. Once the target has been aligned by the operator, using PPI, B and Az-El displays, automatic tracking is initiated by depressing a foot pedal.

Special measures taken by the designers to increase the effectiveness of the system when used for controlling conventional guns against aircraft targets include, automatic aiming correction as a function of distance and the intruder's flight parameters; self-checking and error correction facilities; and the use of special circuitry to overcome the problems inherent in low-angle target acquisition and tracking.

Quoted performance figures state that, with a target approaching at speeds up to 600 metres/sec and an angular velocity of 6/deg sec, the average miss distance at ranges between 1,000 and 4,500 metres is of the order of 8 m.

DEVELOPMENT:

The NA9 fire control system was derived from the ARGO system designed for the Italian Navy for installation on some of its newer vessels, in particular its guided missile cruisers.

STATUS:

The first of some 23 NA9 systems ordered for the Italian Navy and certain other navies entered service in 1964, and production of the NA9 series was completed by 1969. The successor system is the NA 10 (**1550.281**).

MANUFACTURER:

Elettronica San Giorgio – ELSAG – SpA, Via Hermadan, 6, Genova Sestri, Italy.

1550.281
ARGO NA 10 FIRE CONTROL SYSTEM

GENERAL:

In the light of the good performance in service over the past few years by 23 Argo NA 9 Systems installed on ships of different classes, the Italian Navy awarded a contract in 1969 to ELSAG – Elettronica San Giorgio (formerly Nuova San Giorgio) for another 13 Argo Fire Control Systems of the second generation, to be installed on new ships under construction. The systems, called ARGO NA 10, represent the natural evolution of the NA 9 FCS and a further development of it. Leaving unchanged the basic operational and technical features, already extensively evaluated, the Argo NA 10 System was achieved in accordance with the latest advanced technology to obtain further major benefits:

(a) to face more efficiently the increasing new threats (Sea Skimmers and ECM)
(b) to increase system operating modes (track-on-jam; TV, IR and laser sensors; missile guidance capability)
(c) to decrease weights and space requirements

Argo NA 10 Systems (at present, more than 25 systems are under manufacture or in the course of delivery, for the Italian Navy and for foreign Navies) are made in two versions:

NA 10 Mod 0: for installation on ships where several weapons of different natures may be controlled by the same FCS, also against different targets (air and naval targets).

NA 10 Mod 1: specifically designed for small craft equipped with surface-to-surface missiles and small-calibre guns.

ARGO NA 10 Mod 0:

DESCRIPTION:

Main characteristics of the NA 10 Mod 0 System are:

Use of three stabilised lines of sight (two optical and one radar), with provision for a third line of sight, for autonomous low level sectorial programmed search and independent tracking;

Use of closed circuit TV, day-light or low-light-level, according to customer requirements for monitoring automatic radar tracking or optical manual tracking;

Automatic target acquisition capability;

Double ballistic sections for guns of two different calibres;

Double fire control mode for shore bombardment (open and closed loop);

Control of three sets of guns;

Easy integration with data handling systems;

Easy reciprocal integration of two or more Argo Systems on same ship, so as to achieve an immediate quick action "network" against targets detected directly at close range.

The NA 10 System is equipped with an Orion RTN 10X type Radar, manufactured by the Selenia company. This is a pulse radar, X-band, narrow beam, fully transistorised, with ECCM capability. As an alternative to Orion RTN 10X Radar, the Orion RTN 16X monopulse Radar can be supplied.

The Main Control Unit provides a compact housing for: operational console with the radar displays and TV monitor; ballistic computer for air firing and surface bombardment; programming section for autonomous search and a complex array of data acquisition and data processing equipment specifically designed for enhancing the performance of the FCS, in quick acquisition and tracking of low flying targets also in natural interference or intentional ECM.

From the experience gained in retrofitting the previous Argo NA 9 System in order to make it suitable for Sea Sparrow missile control (Albatros project), The NA 10 Mod 0 System has been designed for easy integration, by simple addition of kits, with units relating to the control of missiles with semi-active guidance modes. The CW radar, provided for Sea Sparrow guidance and installed in the same tracking radar antenna pedestal, can also be employed in the general operating modes of FCS for enhancing the performance in point defence and anti-missile firing.

OPERATION:

The inputs to these fire control systems are: target data from radar and optical directors, true wind data from true wind computer, own ship speed and course from log and gyrocompass, roll and pitch data from a vertical reference, designation and tactical instructions from a target designation system or more sophisticated data action system. The outputs are gun orders for simultaneous pointing of guns, also of two different calibres, and signals for missile control system. A second target can be engaged using the raw target information provided by a search radar and optical tracking, performed by a periscopic optical sight. A crew of three is normally employed when the FCS is equipped with two periscopic optical sights, for autonomous search, independent optical tracking and missile optical guidance such as Seacat. However, a single operator at the Main Control Unit may perform acquisition, tracking and firing in manual or in automatic mode.

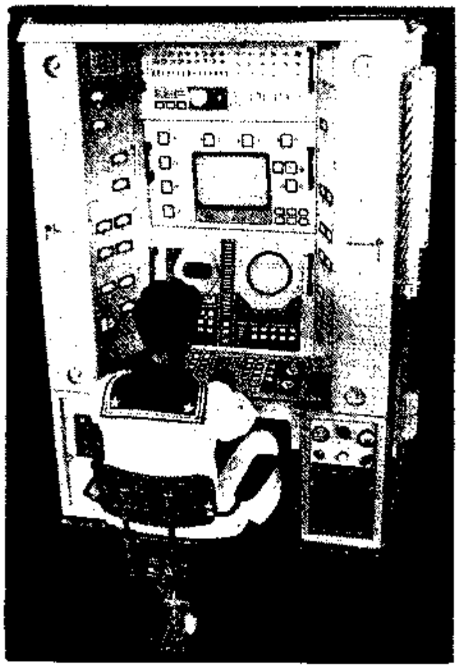
STATUS:

The first Argo NA 10 Mod 0 FCSs had been delivered at the beginning of 1971.

ARGO NA 10 Mod 1:

DESCRIPTION:

This version has been specifically developed in order to fulfil both operational and technical requirements of small craft, where the reduction of sizes and weights is a necessity. The FCS is intended mainly for anti-air and naval firing, but one mode of shore bombardment has been retained (open loop). In the NA 10 Mod 1 systems some functions and provisions of growth capability have been reduced in number with respect to the MOD 0. The radar employed is the Orion RTN 10X Radar, but the antenna mounting is lighter than in the MOD 0 system because it has been designed to carry only a radar antenna, a TV camera and a boresight with no provision for other sensors such as infra-red or laser sensor and CW radar for anti-air missile guidance. The periscopic optical sights are no longer part of the system; the programmed sectorial optical search can be performed by means of TV camera. The computer and other unmanned equipments, which in the MOD 0 system were included in the operational cónsole, have been located on MOD 1 in a separate cabinet so as to provide the maximum installation flexibility and conveniently suit any space available on board.



NA 10 MOD 1 Main control console

The total weight of the Argo NA 10 MOD 1 system is kept well within limits in line with small ship requirements. Should the armament so require, the NA 10 MOD 1 computer and console can be used in conjunction with the NA 10 MOD 0 radar antenna mounting.

Main functions are:

Programmed search

Manual or automatic acquisition

Tracking and firing control, by means of different operative modes, according to the type of targets and environmental conditions

Remote control of one or two sets of guns (single ballistic section and two output sections)

Designations and information (target speed data) to a surface-to-surface missile system

Special features are, high performance radar, low reaction time, high dynamic accuracy, and low flying target acquisition and tracking facilities.

STATUS:

The first ARGO NA 10 MOD 1 Fire Control System, ordered by the Italian Navy in 1971, was fitted in the Italian Navy PHM hydrofoil and later orders cover equipment for fast patrol boats of other navies. In early 1974 total sales of both versions of the NA 10 amounted to about 50 systems.

MANUFACTURER:

Elettronica San Giorgio – ELSAG – SpA, Via Hermadan, 6, Genova Sestri, Italy

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1920.281
DARDO SHORT RANGE DEFENCE SYSTEM

DESCRIPTION:

The Dardo system is a collaborative programme being carried out by Elettronica San Giorgio (Elsag) and Selenia, with the co-operation of Breda-Bofors. The latter concern is providing the weapon and special ammunition while the two former companies are jointly responsible for the radar, fire control, and digital computation elements of this ship's point defence system. Specific operational functions of Dardo include:

Defence against sea skimming anti-ship missiles.

Defence against diving missiles.

Defence against manned aircraft.

Effective ranges 300 metres to 3 km.

Few details have yet been obtained, but some of the special features of the system have been ascertained. Among them are the following:

The weapon employed is a Breda-Bofors 40/70 mm twin machine gun having a high rate of fire with specially developed ammunition for anti-missile applications and which is of the 'pre-fragmented' type. Further details of Breda-Bofors guns of this type will be found in Entries Nos **2258.203** and **2259.203** in the Equipment Section (Three) of this volume. Another entry which may contain information of some relevance to Dardo is **2349.131**, (Bofors 40 mm Anti-Aircraft System 75) which appears in an earlier part of this book dealing with land-mobile surface-to-air weapon systems.

In Dardo a radar of advanced design and optimised for tracking low-flying targets is employed. The system is stated to be designed for fully automatic operation by means of:

(1) Direct use of search radar information, with automatic data evaluation and target selection
(2) Automatic target acquisition
(3) Target tracking, automatically and with high performance in the presence of noise
(4) Automatic gun fire control

DEVELOPMENT:

The Dardo system had reached an advanced stage of development by October 1974 and the first contractual deliveries are scheduled for the end of 1976.

MANUFACTURERS:

Elettronica San Giorgio – ELSAG – SpA, Via Hermanda n.6, Genova Sestri, Italy.

Selenia – Industrie Elettroniche Associate SpA, Via Tiburtina km 12.4, Roma, Italy.

Breda Meccanica Bresciana SpA, Via Lunga 2, 25100 Brescia, Italy.

2230.281
AUTONOMOUS NAVAL FIRE CONTROL SYSTEM

DESCRIPTION:

Oto Melara are developing this system for use with small- and medium-calibre naval guns as a private venture.

Few details are as yet available, but the general principle of operation is clear. The basic idea is to provide, directly associated with the concerned gun, an electronic system that acquires target data, processes it and supplies appropriate control information to the gun, without reference to other systems on the ship. The system thus eliminates train-roller path plane tilt correction and parallax computations; it has lower weight than conventional fire control systems and offers improved reliability since only direct damage to the system can cause a shut down, whereas the usual FCS is vulnerable to damage to the links between FCS and gun.

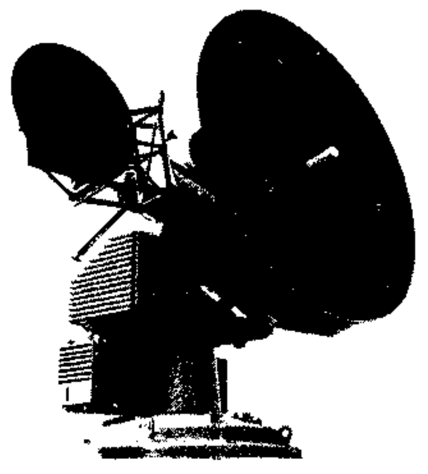
The system comprises a search and tracking radar located in the upper part of the turret; an optional tracking system using a television camera with display adjacent to the radar display; and a computer. The computer processes the target data to stabilise the radar and optical lines of sight – eliminating the effects of the ship's motion – provides regenerative tracking and produces fire control data. Only one operator is required to man the system.

All system units use solid-state components so that the equipment is of low weight. The manufacturers also say that the system cost is low.

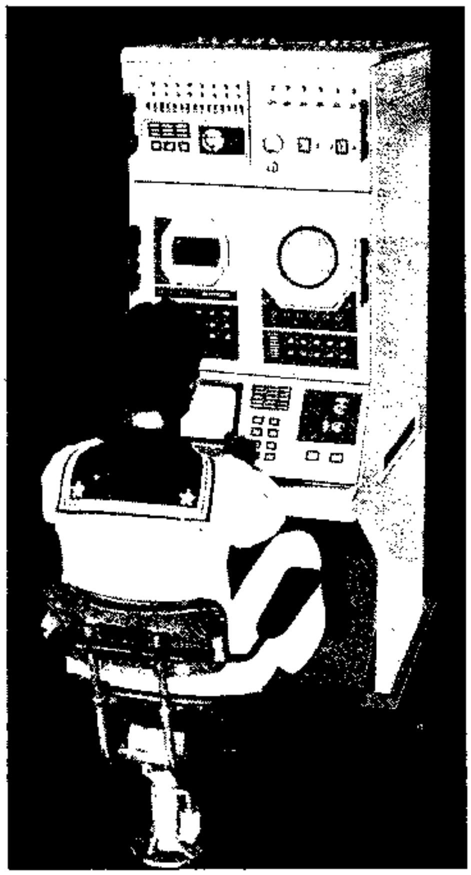
Test equipment will be supplied by the manufacturer.

MANUFACTURER:

Oto Melara, Via Valdilocchi, 15-La Spezia, Italy.



Sea Sparrow CW guidance radar on integrated antenna pedestal



NA 10 MOD. 1 Main Control console

1244.281
DLB-1 ANTI-SUBMARINE WEAPON CONTROL SYSTEM

DESCRIPTION:

The DLB-1 system is designed to accept data from anti-submarine sensors, correlate and display this information, accept the tactical decisions of the operator and exercise ASW weapon control functions in accordance with the attack decided upon.

The equipment consists of a Main Control Unit, a Fire Pattern Programmer, and an Anti-Submarine Tactical Display. The first of these units supplies to sonars "aided tracking" data, and stabilising signals to the sonar transducer. It supplements the data provided by the sonar for delivering train, valve opening and fuse setting commands to an anti-submarine bomb-thrower. It also controls torpedo tubes. The computer is an analogue equipment.

The Fire Pattern Programmer computes and provides sequence signals for the firing of a salvo. The A/S Tactical Display presents all relevant data on the bridge.

The bomb-thrower employed is the K-113 manufactured by the Motofides company. This is a single-barrel weapon designed to throw depth charges for medium range operations. It is fully automatic and remotely controlled.

Sensors employed have all been American dual-purpose sonars such as the SQS-11, SQS-4, SQS-36, and SQS-29.

DEVELOPMENT:

First design studies were carried out in 1964, and the first fitting was on the Italian corvette *De Cristofaro*, in 1965. Studies now in progress are concerned with the provision of facilities for the control of anti-submarine rockets.

STATUS:

Twelve sets of the latest version of the DLB-1 are on order and nine have been delivered to the Italian Navy.

MANUFACTURER:

Electronica San Giorgio – ELSAG – Spar Via Hermadan, 6 Genova Sestri, Italy.

1622.281
SEA KILLER INTEGRATION KIT

DESCRIPTION:

With the designation Sea Killer "Integration Kit", is generally meant those system units which have to be added to the Sea Hunter Naval Fire Control System, to provide missile launching and guidance capability for Sea Killer Mk 2 ship-to-ship missiles.

Such an integration kit has been designed and manufactured by Contraves Italiana, and consists of the following major sub-systems:

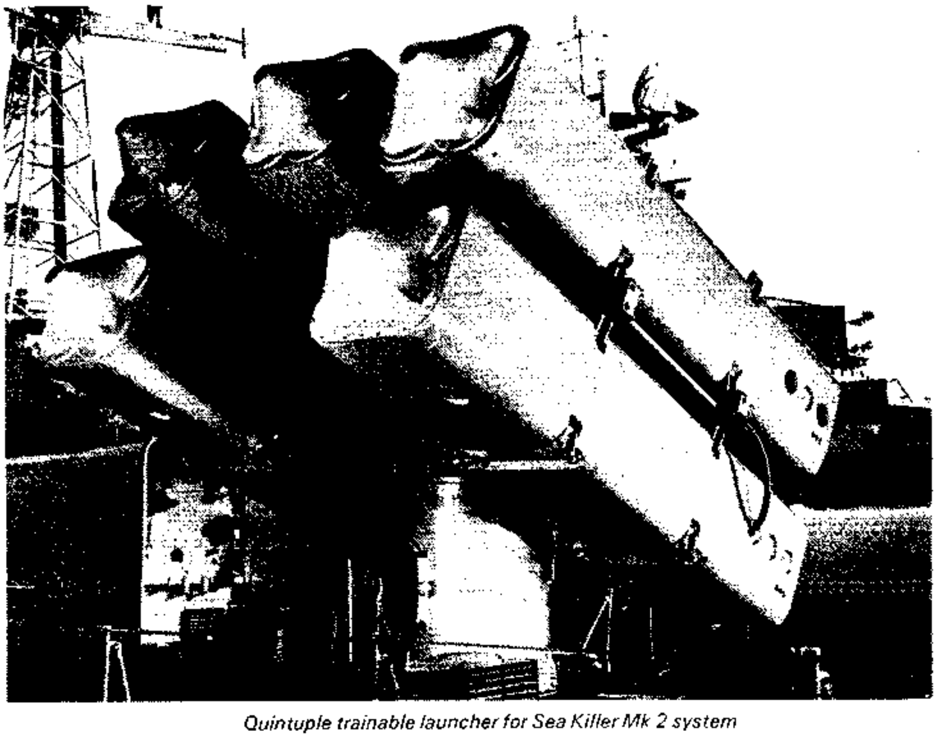
(1) Command Transmitter
(2) Quintuple trainable launcher or deck-fixed launchers
(3) Missile Control Console

The Quintuple Trainable Launcher serves to accommodate and launch the missiles, which are fitted to the launcher itself, located in their launching ramp/containers. The launcher is movable in two coordinates, training and elevation. It consists of a column fixed to the deck of the ship, over which the trainable section of the unit is mounted. A structure movable in elevation, supports the group of five cells, containing the missiles. The covers of each end of the missile containers are jettisoned automatically before firing.

MAIN FEATURES:

Training:

Arc: 360 deg (apart from blind arcs due to ship's superstructures etc)



Quintuple trainable launcher for Sea Killer Mk 2 system

Speed: approx 30 deg/sec
Acceleration: approx 30 deg/sec²
Elevation:
Arc: −15 deg to +30 deg
Speed: approx 20 deg/sec
Acceleration: approx 30 deg/sec²
Weight (with missiles and containers): approx 5 tonnes

While the quintuple trainable launcher allows a ship to launch missiles without changing course, deck-fixed launchers are more suitable for Fast Patrol Boats and similar light craft, due to their lower weight. In the case of deck-fixed launchers, the ship will have to be steered toward the target. This manoeuvre can be easily performed due to the high manoeuvrability of these light craft. In this configuration, additional minor units are required, such as the pilot's display unit, anemometric unit, and deck fixed ramps. A typical outfit is 4 ramps per ship. These units are supplied by SISTEL Sistemi Elettronici SpA, Rome, manufacturer of the Sea Killer Mk 2 missiles.

From the Missile Control Console, the whole Sea Killer Mk 2 system is operated by a single operator. The main functions are:
Selection of missiles for launch
Selection of guidance mode
Monitoring of system
Launching of missiles
Monitoring of the beam rider guidance
Guiding the missile optically with TV and joy stick

Manufacturer
Contraves Italiana SpA, Via Tiburtina 965, 00156 Rome, Italy.

Missile control console for Sea Killer Mk 2 system

1551.281
ALBATROS WEAPON SYSTEM

Albatros is an all-weather missile and gun shipborne weapon system designed for defence against aircraft and anti-ship missiles, including those flying at very low altitudes or having high diving angles. The system can also perform surface engagements by both missiles and guns, while the guns retain their usual capabilities (shore bombardment, illuminant firing, decoy dispensing etc).

The system can be installed in any type of vessel down to small escort units of some hundred tons displacement.

System Description:
The complete weapon system includes the following major sub-systems:
—missile and gun fire control system
—a missile launching system
—naval guns
—missiles: Sea Sparrow RIM-7H or Aspide

The missile and gun fire control system consists of a dual channel radar (pulse and CW), an operator's control console, a gun fire control system and a missile fire control system.

The pulse radar with its displays and control panel is the Selenia Orion RTN 10X, whilst the continuous wave radar Sirio RTN 12X, has been specially designed and developed by Selenia for missile guidance by the target illumination (semi-active homing) system. The two antennas are mechanically co-located and mounted on a single pedestal. The gun fire control system can be either digital (Ferranti WSA-4) or analogue (Elsag NA-10), the missile fire control system, designed and developed by Selenia, has been physically and functionally integrated in the gun fire control system.

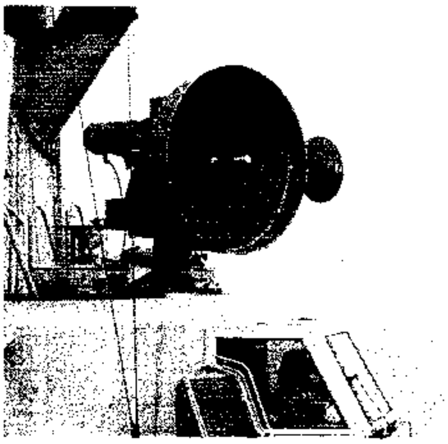
The missile launching system consists principally of an eight cell launcher capable of long term missile storage.

The mechanical parts of the launcher, the related power drives, the missile cell climatisation and the fire extinguishing unit have been designed and developed by Oto-Melara (**2247.293**), whilst the electrical and mechanical interfaces with the missile and the deck launcher control panel were designed and developed by Selenia.

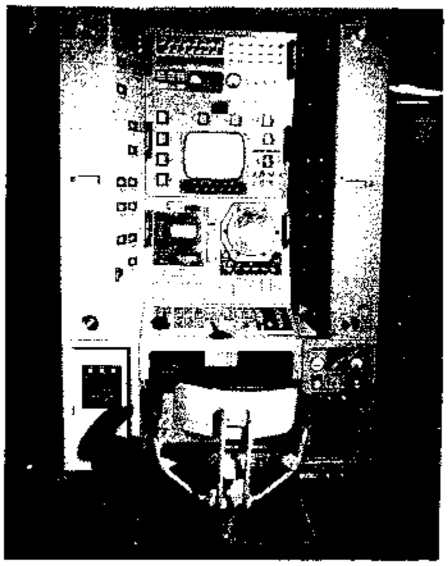
If the ship's operational role calls for more than eight missiles, they can be stored in a magazine close to the launcher and loaded into the cells by means of a semi-automatic system designed by Selenia.

The naval guns may be of any type. Three different groups of guns, even of two different ballistics can be controlled by the fire control system, not only in the anti-air and anti-ship role, but also for shore bombardment, illuminant firing and decoy dispensing.

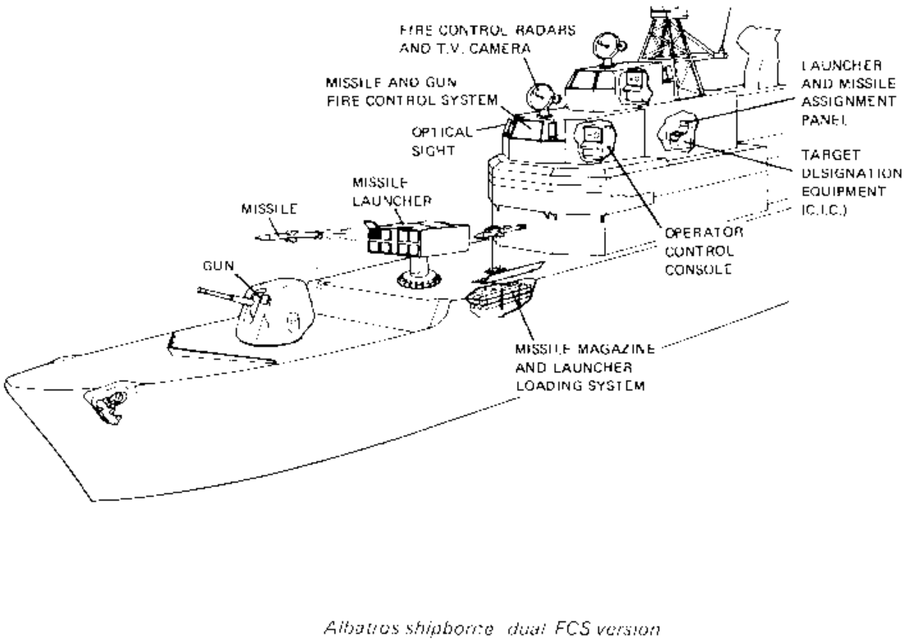
The missile used is the Sparrow III modified for the shipborne role by the use of folding wings and clipped tail and the addition of a rapid run up capability. This missile has been renamed Spar-



Albatros dual-channel tracking radar



Albatros Mod 3 Operator's control console



Albatros shipborne dual FCS version

row RIM-7-H (**1106.331**). A new missile, named Aspide (**1656.331**), now under development by Selenia under an Italian MOD contract, has been designed to be fully compatible with the Albatros system to which it will give improved performance.

The whole system can be checked by the use of built-in test equipment.

The Albatros system is offered in two basic configurations: Mod. 2, with the Ferranti WSA-4 gun fire control system (**1524.281**); Mod. 3, with the Elsag NA-10 gun fire control system (**1550.281**). Both use the Selenia tracking radar of the new Orion RTN 10X series. The system is available in two versions: with one or two fire control systems respectively, the latter having the ability to engage two targets simultaneously. The entire missile portion of the Albatros system is also available as a retrofit for integration with other gun fire control systems already installed on board.

Operation:

The functions performed by the Albatros system are:
- low elevation autonomous search and self acquisition;
- automatic and/or manual acquisition of designated targets;
- automatic target tracking and illumination;
- automatic target track shifting to anti-ship missile launched by a platform (aircraft or vessel) already being tracked;
- missile and launcher control;
- provision of firing data to guns.

Only one operator is required to carry out radar control functions, missile launches and gun fire control. One or two optical directors as well as a low light level TV equipment form part of the fire control system to provide the Albatros system with an auxiliary mode of search, tracking, target identification, engagement of targets in close formation, kill assessment etc. Either guns or missiles or both simultaneously can be used to engage a target and the system is designed to combine missile and gun capabilities so as to permit target engagement from maximum missile range (more than 15 km), down to minimum gun range (about 200 m). System reaction time is particularly low to counter sudden and multiple threats and the use of two radar channels, both capable of acquiring and tracking the target, enhances the system flexibility and the ECCM capabilities. The system's high kill probability permits the adoption of the shoot look-shoot firing doctrine in the majority of cases.

Development

The first feasibility and design studies were made by Selenia in late 1966. System development, under Italian MoD contract, started in early 1968. Selenia was responsible for the overall system design and coordination in development. Firing tests against guided air and surface targets were successfully conducted at the Salto di Quirra Sardinia, missile range, in July 1971.

Technical and operational evaluation firings were carried out in 1972 and 1973 by the Italian Navy with a prototype of the Albatros system installed on an operational ship. The evaluation was aimed to test the system in its natural environment and included launches against air and surface targets in situations which reproduced the most important operational conditions that the Albatros system was designed to meet.

Status

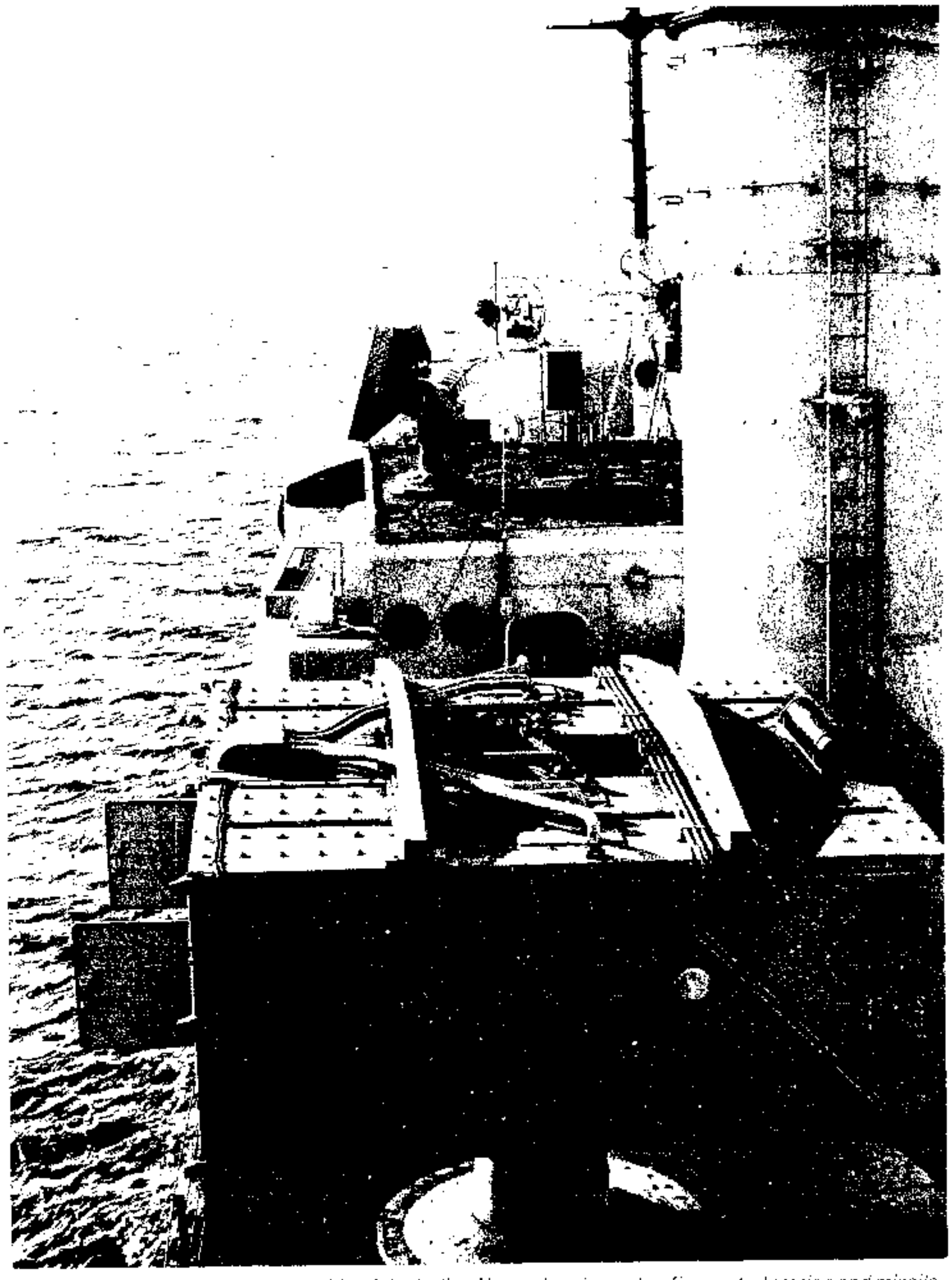
Systems are now being installed in ships of a number of navies, including the Italian Navy. The first systems are expected to be operational by the end of 1975.

Manufacturers:

Selenia – Industrie Elettroniche Associate SpA, Via Tiburtina km 12.4 Roma, Italy – Overall system design and coordination, radar, missile fire control system, launching system, missile.

Elsag – Elettronica San Giorgio SpA, Via Hermada, 6-Genova Sestri, Italy – Gun fire control system.

Oto-Melara SpA – Via Valdilocchi, 15-La Spezia, Italy – Launcher (mechanical and electrical parts).



The Albatros weapon system on a ship of the Italian Navy, showing radar, fire control station and missile launcher

THE NETHERLANDS

1359.281

M20 SERIES FIRE CONTROL SYSTEMS

Description:

The M20 Series comprises a range of integrated ships' fire control systems for use with guns, missiles and torpedoes, and designed for fitting in vessels ranging in size from fast patrol boats to destroyers. Principal applications are to medium/close-range air defence and close range surface defence. Simultaneous engagement of several targets is possible. A further use is for shore bombardment.

Computation and control is based upon a central digital computer, and the range of available sensors includes separate search and tracking radars, and optical trackers. The use of TV trackers is a further option.

One of the most notable features of this series is the advanced search and target tracking radar sub-system.

Separate radars are used for each function, but both are mounted on a common stabilised platform, with one radar on the upper surface and the other below. The whole assembly is housed in a weather proof radome. The stabilisation arrangements consist of a series of gimbal rings, with a common vertical axis about which the two radars rotate, passing through the centre of the two horizontal axes of the gimbals. The assumed method of operation is for the radar rotational axis mounting to carry suitable vertical sensing devices, the output of which is used to apply control signals to the two horizontal gimbal rings to maintain both horizontal under pitch and roll conditions. In this way the rotational axis of the radars is kept vertical and no other compensation need be applied to their respective elevation movements to correct for ship's motion.

Various combinations of two basic radar types (one of these appearing in two versions) are employed in several types of M20 series fire control systems which have been produced. The choice is principally governed by the weapons to be controlled by the system. The different radar combinations lead to the use of two basic radome configurations, one roughly spherical in shape, and the other more nearly hemi-spherical with a flat base.

Of the two main radar types one has a circular dish antenna which is apparently of the Cassegrain type. This is mounted in the upper position in systems where two radars are employed, and is for air search and target tracking. The other radar, mounted below the gimbal ring, has a paraboloid segment scanner illuminated by a horn feed. In two-radar systems, this sensor is suspended beneath its turning gear, while in single radar installations it is mounted above the stabilised mounting.

In the following paragraphs those details of specific M20 Series systems which have been obtained are listed.

M20:

This version has been designed as an integrated torpedo and gun weapon control system for use on small ships against air and surface targets. It can control two light or medium calibre guns against one air and one surface target either simultaneously or separately; or two torpedoes (wire-guided or free-running) against two targets simultaneously. The dual radar system provides for surface warning and tracking and air target tracking. One air target and three surface targets can be automatically tracked simultaneously. This can be accomplished in an ECM environment or adverse weather conditions. Digital computation is employed. Additional target data is available from an optical sight.

Separate display and operating consoles are provided for gun and torpedo control, respectively. Range scales on the former PPI presentation are 60, 30, or 10 km, and for the torpedo display 24, 12, or 6 nautical miles. True motion, relative motion, or off-centred display can be selected.

Installed system weight is approximately 3,300 kg, and the radar antenna assembly contributes 600 kg of this total.

M22:

This is a simpler version which is intended for use on larger vessels than the M20, such as frigates, in conjunction with long-range warning radars, or as an autonomous weapon system. It may also be integrated in an automated action information system. The operational function is the direction of two light or medium calibre guns against one air and one surface target simultaneously.

The dual radar configuration is employed, and helical or horizontal scan patterns can be used for the search mode, with monopulse tracking for air targets, and track-while-scan (PPI-autofollow) for surface targets. Display arrangements include PPI, A-scope, B-scope, and digital readout. Additional target data can be derived from an optional sight.

M25:

This system has been designed to control one semi-active homing missile, one surface-to-surface missile, and medium calibre guns. It is capable of tracking simultaneously either one air target and two surface targets, or one air target, one surface target and one shore target. The M25 system was designed especially for low-level air defence, and utilises the integrated system concept combined with anti-clutter and anti-jamming features to this end.

Facilities and functions of the system include: continuous air and surface surveillance; sensor data handling; data exchange with an action information system; display of tactical information; weapon control. The dual radar configuration is employed, with choice of search patterns and pulse doppler tracking of air targets and track-while-scan tracking of surface targets.

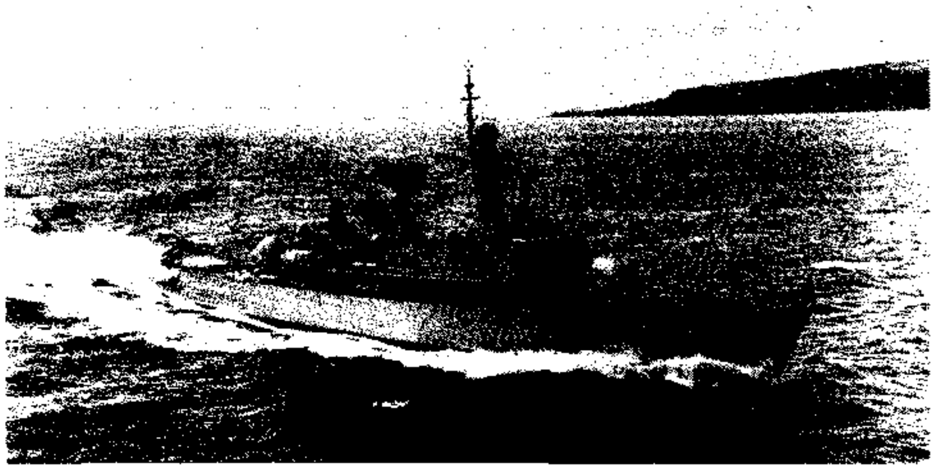
The X-band search radar has digital MTI and circular polarisation facilities and extensive ECCM provisions are incorporated as standard. Other sensors are a TV director and two optical target designation sights. The former sub-system has provisions for low light-level TV and infra-red target tracking. An SMR digital computer is employed and this is a micro-min, stored programme general purpose machine.

The M25 operates as a self-contained system on board small or medium-sized ships. On ships of destroyer size or larger, it can function as an autonomous weapon cell, backed by long-range air warning radar(s) and can be integrated into an automatic combat information system.

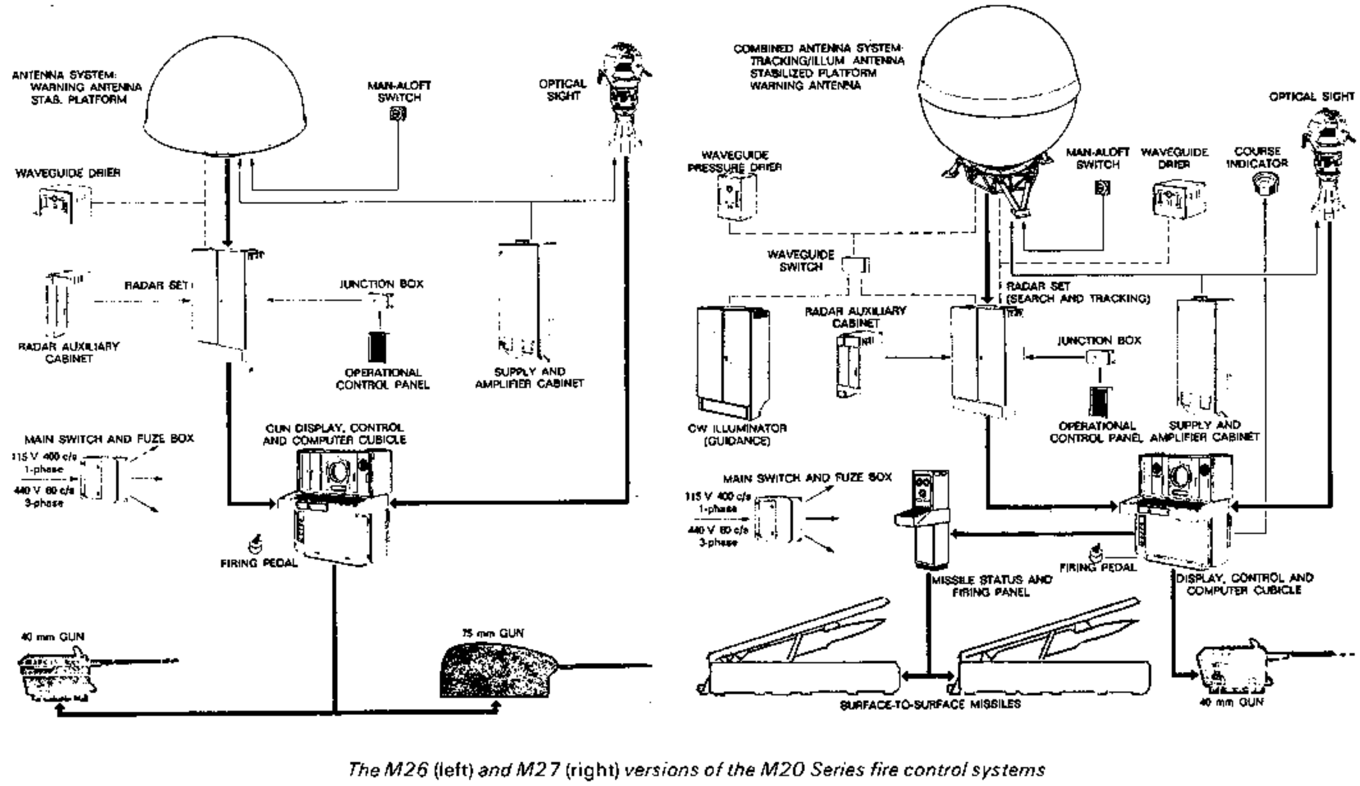
M26:

This system is designed as a gun weapon control and navigation system, providing for continuous air and surface warning, radar aid to navigation, combat information. Target indication to weapons, and weapon control. One gun can be controlled for surface action and target indications for a light AA gun under local control are also available.

A single radar system is provided giving search and track-while-scan facilities for one surface or shore target. The latter facility can be automatic or rate-aided. PPI, B-scope and digital readout dis-



The recently commissioned Royal Thai Navy Yarrow frigate HTMS Makut Rajakumarn. The M22 fire control radar is on the mainmast with the LW 04 search radar aft of it. Aft of funnel is M44 fire control radar



The M26 (left) and M27 (right) versions of the M20 Series fire control systems plays are provided. Radar data is supplemented by an optical sight. Installed weight is approximately 2,300 kg, of which the scanner assembly contributes 400 kg.

M27:

This version is designed as a weapon control system for surface-to-surface missiles and guns on board small vessels. Sensors employed are the dual radar installation and an optical sight. Weapons controlled are one light or medium calibre gun against an air or surface target, and one medium-range surface-to-surface missile of the semi-active homing type against a surface target. The two targets can be tracked automatically and simultaneously. For missile operation the air target tracking antenna is slaved to the surface target tracking programme and connected to a CW transmitter to provide target illumination. Weight and other details are similar to those for the M22.

M28:

The M28 system has been designed to control one surface-to-surface missile and two light or medium-calibre guns. The system can track one air and one surface target simultaneously. Engagement capabilities depend upon the post-launch control requirements of the missile employed. If the SSM need not be controlled after launch, the system can engage one air target with one gun and one surface target with either the other gun or the SSM. Alternatively, if the missile does require control after launch, the system can engage one surface target with one gun and another surface target with the SSM, or, one air and one surface target with one gun to each.

The dual radar configuration is used with horizontal or helical search patterns, monopulse tracking of air targets, and PPI-autofollow for surface targets.

An optical target designation sight is included. The system has its own digital computer and can be employed as a self-contained system on smaller ships or incorporated into more sophisticated automated combat information complexes on larger vessels.

STATUS:

Known M20 Series fittings, completed or projected, for various classes of ships of different navies include the following:

Argentina:

Two new construction fast patrol boats. The M20 FCS will control surface armament and will be associated with an M 11 torpedo FCS.

Australia:

"Daring" Class (twin installation) in *Vampire* and *Vendetta*; projected DDL destroyers; modernised "River" Class destroyers *Swan* and *Torrens*.

Belgium:

Four new construction *Westhinder* Class escort vessels.

Canada:

"Iroquois" Class missile destroyers (twin installation); support ship *Protecteur*.

Finland:

Corvettes *Karajla* and *Turunmaa*.

Germany—Federal Republic:

Type 143 fast missile boats; "Jaguar" Class fast patrol boats.

Malaysia:

Yarrow frigate *Rahmat*.

Netherlands:

Two new construction DDGs; "S"-Class frigates.

Nigeria:

Two Vosper Thornycroft Mk 3 corvettes.

Norway:

Five "Oslo" Class frigates; "Storm" Class fast patrol boats.

Singapore:

Three Type B Vosper Thornycroft fast patrol boats.

Sweden:

Two "Halland" Class destroyers; four "Visby" Class anti-submarine frigates; "Spica" Class torpedo boats.

Thailand:

Yarrow frigate *Makut Rajakumara*.

USA:

The M20 has been supplied to the USN for evaluation, and licence production arrangements have been made with Sperry Rand in the USA. The US designation is GFCS Mk 87.

MANUFACTURER:

N.V. Hollandse Signaalapparaten, Hengelo, Netherlands, PO Box 42.

1661.261

ASWDS – ANTI-SUBMARINE WARFARE DATA SYSTEM

DESCRIPTION:

The ASWDS is a data handling and fire control system for anti-submarine warfare. It can be operated in conjunction with a ship's overall weapon and command system and the necessary functions of data coordination and presentation etc are handled by a Signaal SMR digital computer. The overall ASWDS functions include: collection, collation, processing, storage and display of tactical ASW information for the Command Team; distribution of data to various users; fire control of ASW weapons for selected targets.

Three sub-systems comprise the ASWDS:

(1) Computer Sub-system – consisting of an SMR computer and standard peripherals.

(2) Sensor Weapon Converter Sub-system – which interfaces weapons, sensors and processor, and includes the converter unit (located with the computer) and a number of remote control panels, such as those for weapon status and weapon control.

(3) Display Sub-system – this integrates the sonar system with the computer system. The display is directly linked with the computer and provides for the presentation of panoramic sonar data.

A sonar signal injector provides a shipboard training facility, able to record and play back real and injected simulated target signals, either mixed or not.

Types of weapons controlled include Asroc, anti-submarine mortars etc. In a typical ASWDS installation the computer and sensor weapon converter sub-systems will be housed in one equipment rack and separate digital type display consoles will be provided for primary and remote sonars.

DEVELOPMENT:

Development was initiated in 1967-68 in collaboration with the Royal Canadian Navy, which subsequently ordered a series of nine ASWDS for use in the DDE 259 and DDH 280 ship construction programmes. The systems for the latter class of ships are designated UDS-280, and further details will be found in Entries Nos. **2046.261** and **2047.261** earlier in this Section.

STATUS:

The ASWDS is in production and deliveries have commenced.

MANUFACTURER:

N.V. Hollandse Signaalapparaten, Hengelo, Netherlands, PO Box 42.

1663.261

CIDIS – COMBAT INFORMATION DISPLAY SYSTEM

DESCRIPTION:

CIDIS is a modular display system designed for use in ships' Combat Information Centres, where data from a number of external sources such as search radars, IFF, data link, has to be processed by digital computer and organised and presented for use by the Command Team. The normal computer is a Signaal SMR machine, but other types may be employed. The combination of CIDIS and digital computer produces DAISY, Digital Action Information System.

The equipment comprising a CIDIS installation consists of a Display Central Unit and a number of Display Consoles appropriate to the operational functions of the system. The former unit contains a sensor data distribution unit which acts as the interface between the various sensors and the displays, and a computer data distribution unit which interfaces the displays to the computer.

There are two types of display console, vertical and horizontal or 'conference' type. The former is produced in two versions, one for the presentation of radar video and for sonar data display; in each case the console has two indicators, a 40 cm labelled plan display and a smaller alpha-numeric 'tote' indicator. The horizontal display has a 40 cm labelled position display for radar data with two operator positions and a third supervisory position. An optional 'tote' display can be associated with each horizontal display for the presentation of supplementary alpha-numeric information.

Functions of the CIDIS include:

Display of raw video from ship's sensors on labelled position display (LPD).

Display of synthetic data from the computer in two forms: (1) as synthetic data consisting of symbols superimposed on raw radar video on the LPD, with or without track labels, at the operator's discretion. The operator can also select the category of information to be displayed, or (2) as alpha-numeric information on the 'tote' display.

Communication with the computer by means of control panels with push-buttons and a rolling ball.

STATUS:

Among ships fitted or to be fitted with systems of this type are improved "Leander" Class frigates for the Indian Navy, the Malaysian Yarrow frigate *Rahmat*, and a new construction Yarrow frigate for Thailand.

MANUFACTURER:

N.V. Hollandse Signaalapparaten, Hengelo, Netherlands, PO Box 42.

1664.281

SEWACO – SENSOR, WEAPON AND COMMAND SYSTEM

DESCRIPTION:

Under the SEWACO designation Hollandse Signaalapparaten produces ships' action data automation and command and control systems of varying configurations, but mostly comprised of Signaal sensor, processing and display equipment. Four versions of the system are known to exist, SEWACO I which has been designed for the Royal Netherlands Navy's new guided missile frigate; SEWACO II for which no user has been spesified SEWACO III for the new S Class of Netherlands frigates; and SEWACO IV for the four new Belgian Westhinder Class of escorts which are now under construction. The principal differences relate to the sensors and weapons fitted in the classes of ship concerned.

The nucleus of the SEWACO system is a single digital computer which performs both combat information and weapon control functions, and which constitutes the DAISY-I command system. The following description of this part of the SEWACO complex refers specifically to SEWACO I but apart from a few detail differences the part played by DAISY in other SEWACO installations is broadly the same.

The hardware of the DAISY I command system, as well as the hardware of entailed software, was developed and produced by Hollandse Signaalapparaten in consultation with the RNethN, while the operational software of the system was developed and produced by the Centre of the Automation of Weapons and Command Systems of the RNethN. In addition to processing the sensor information and building-up a complete above and under water synthetic plot, this programme performs a number of technical functions, such as control of the 3D radar (SEWACO I only).

The DAISY-I command system offers direct and indirect interfaces with the sensors and weapons. Direct interface is by means of 24 bit input/output channels and indirect interface by means of digital-to-digital, analogue-to-digital and digital-to-analogue converters.

These capabilities have made it possible to insert into the SEWACO I system newly-developed computerised sub-systems as well as proven analogue systems.

In defining the system the aim was a configuration guaranteeing, at any time, a rapid and efficient counter attack with the ship's complete potential against above- and under-water threats, even with reduced manpower at quarters.

This design goal was achieved by rapid and, where possible, automatic collection of all the necessary data from sensors and automatic and non-automatic data links, and the processing and display of these data, threat evaluation and target designations to weapon systems.

The display sub-system comprises vertical labelled-position displays and tabular displays, grouped into double and triple indicator groups, as well as a horizontal conference display. The displays offer interlaced presentations of both raw radar pictures and synthetic information available from the computer memory. For its purpose, displays are fitted with the normal PPI viewing facilities together with communication links with the computer programme.

The operator can himself specify the quantity of synthetic information to be written on his display labels alongside the tracks give additional information such as track number and category; other additional information can include track history and bearing lines representing passive sensors and EW weapons. Tabular displays are used for specific tote pages providing supplementary information, computer recommendations and answers to problems posed by the operators.

Each display is multi-functional and, theoretically, can perform all operational tasks. In practice, however, each display has a special operational mode depending on the location of related special purpose panels, remote-control panels, etc.

SEWACO I:

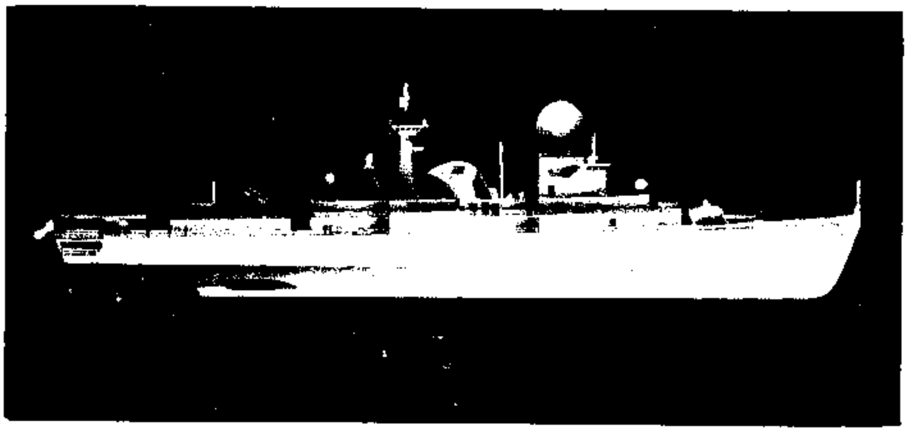
The principal sensors of the SEWACO I system in the new RNethN guided missile frigates will be the Signaal 3D multi-target tracking search and target designation radar (Entry No. **1589.253**) and the combined search and tracking radars of the WM 25 fire control system (Entry No. **1359.281**) which is integrated into SEWACO I. The 3D radar incorporates a slotted wave guide antenna for IFF/SIF facilities also. Navigation and helicopter control functions will be provided by a dual Decca Transar radar system, with port and starboard scanners to ensure gapless 360 deg coverage. There is also a secondary radar system as a further aid to helicopter operations. Long-range sonar is fitted. In addition the two SPG-51 fire control radar groups for the ship's Tartar surface-to-air missiles will also be linked with the system. Among the weapons associated with SEWACO I will be Tartar, the NATO Seasparrow point defence system and a twin 4.7 inch gun turret. At mid 1974 no decision had been reached on the choice of surface-to-surface missile, but the SEWACO I system has provision for the inclusion of such a weapon.

SEWACO II:

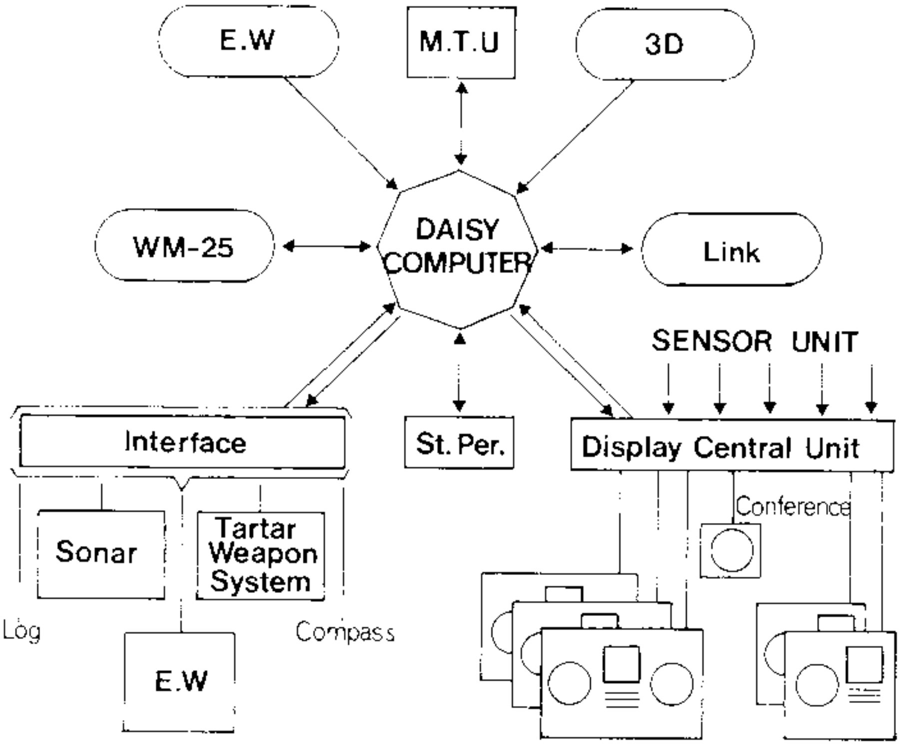
There are no details of the ship(s) for which SEWACO II is intended and it is possible that this designation refers to a system proposal by Hollandse Signaalapparaten. Sensors include Signaal ZW.06 and LW.08 radars, the combined search and tracking radars of a WM 25 fire control system forming part of the SEWACO system, a separate tracking illuminator radar, passive direction finding equipment, two optical target designation sights, a TV director, IFF, data link and the AN/SQS-505 sonar set. Weapons listed include guns, Exocet surface-to-surface missiles, NATO Seasparrow, and A/S weapons.

A total of twelve operator consoles are detailed, allocated to the following functions:

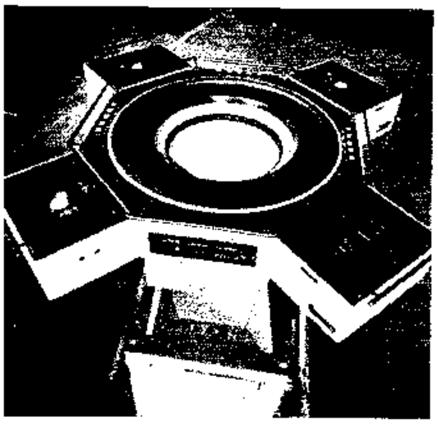
(1) Air situation display
(2) Surface situation display
(3) Electronic warfare and data link control
(4) Command and control
(5) Weapon direction
(6) Helicopter control
(7) Anti-submarine warfare
(8) Hull-mounted sonar
(9) Variable depth sonar
(10) Sonar Signal Injector
(11) Weapon control console
(12) TV console



Model of Royal Netherlands Navy guided weapon frigate equipped with SEWACO I system



Block diagram of DAISY-1 (Digital Action Information System) processing and display portion of SEWACO system



Typical conference type display console of SEWACO system. Three-position and single position displays also are used

This system has been described as being for installation in a frigate but the class and nationality have not been identified.

SEWACO III:

This designation has been allocated to the SEWACO system for the newly announced S-Type frigates for the RNethN. This class is thought likely to contain several variants for differing operational roles, and consequently weapons fits may differ. For this reason it is considered likely that the SEWACO III configuration has not yet been finalised. A typical weapon fit includes: surface-to-surface missiles, NATO Sea Sparrow, ASW torpedoes, OTO-Melara 76/62 Compact dual-purpose gun, and helicopter. The sensor complement could well be very similar to that of the new Belgian escorts which are to have SEWACO IV systems (see below)

SEWACO IV:

This is the designation of the SEWACO system being supplied for the new "Westhinder" Class of escorts under construction for the Belgian Navy. No official details have been revealed but the following data derived from published sources corresponds with what is known of these new vessels and their weapons and equipment fits. Functions of the SEWACO system include:

Air, surface and sub-surface warning;
Compilation and display of tactical air, surface and sub-surface situations;
Threat evaluation and automatic air target selection for engagement by the appropriate weapon system;
Weapon assignment and fire control by the WM 25 FCS against air, surface, sub-surface, and shore targets;
Anti-submarine warfare;
Electronic warfare;
Data link operation;
Assistance in tactical operations, including ASW-helicopter direction and navigation;
Target simulation for training purposes.

Sensors comprise a DA.05 air and surface warning and target indication radar, WM.25 combined search and tracking radars, a ZW.06 surface search/navigation/helicopter control radar, IFF/SIF, helicopter transponder, MEL Equipment Co. Ltd. SUSIE passive ECM system, data link, radar/optical director, and sonar. Weapons controlled by the SEWACO system include surface-to-air missiles, surface-to-surface missiles, dual-purpose gun, anti-submarine rocket launcher, ASW torpedoes, and ECM systems. The weapon control and combat information equipment consists of the WM.25 FCS for missiles, gun and A/S rockets, three horizontal displays for combat information functions and each with its own separate alpha-numeric 'tote' display, a sonar display console, radar plotting table with true-motion computer, and one video extractor for automatic air and surface tracking.

MANUFACTURER:

N.V. Hollandse Signaalapparaten, Hengelo, Netherlands, PO Box 42.

1261.281
M40 SERIES FIRE CONTROL SYSTEMS

DESCRIPTION:

The M40 Series of fire control systems comprises a range of combined radar and optical directors for the control of short-range missiles and gun fire against air and surface targets. Target designation is performed by one of the ship's other search radars. The 44M is used with the Seacat missile (which see) and the M45 is for the control of medium and light calibre guns.

STATUS:

M40 Series FCS have been fitted or specified for: the Netherlands "Van Speyk" class frigates; Indian "Leander" class frigates; the Malaysian frigate *Hang Jebat;* the Thai frigate *Makut Rajakumara;* Australian "River" class anti-submarine frigates.

MANUFACTURER:

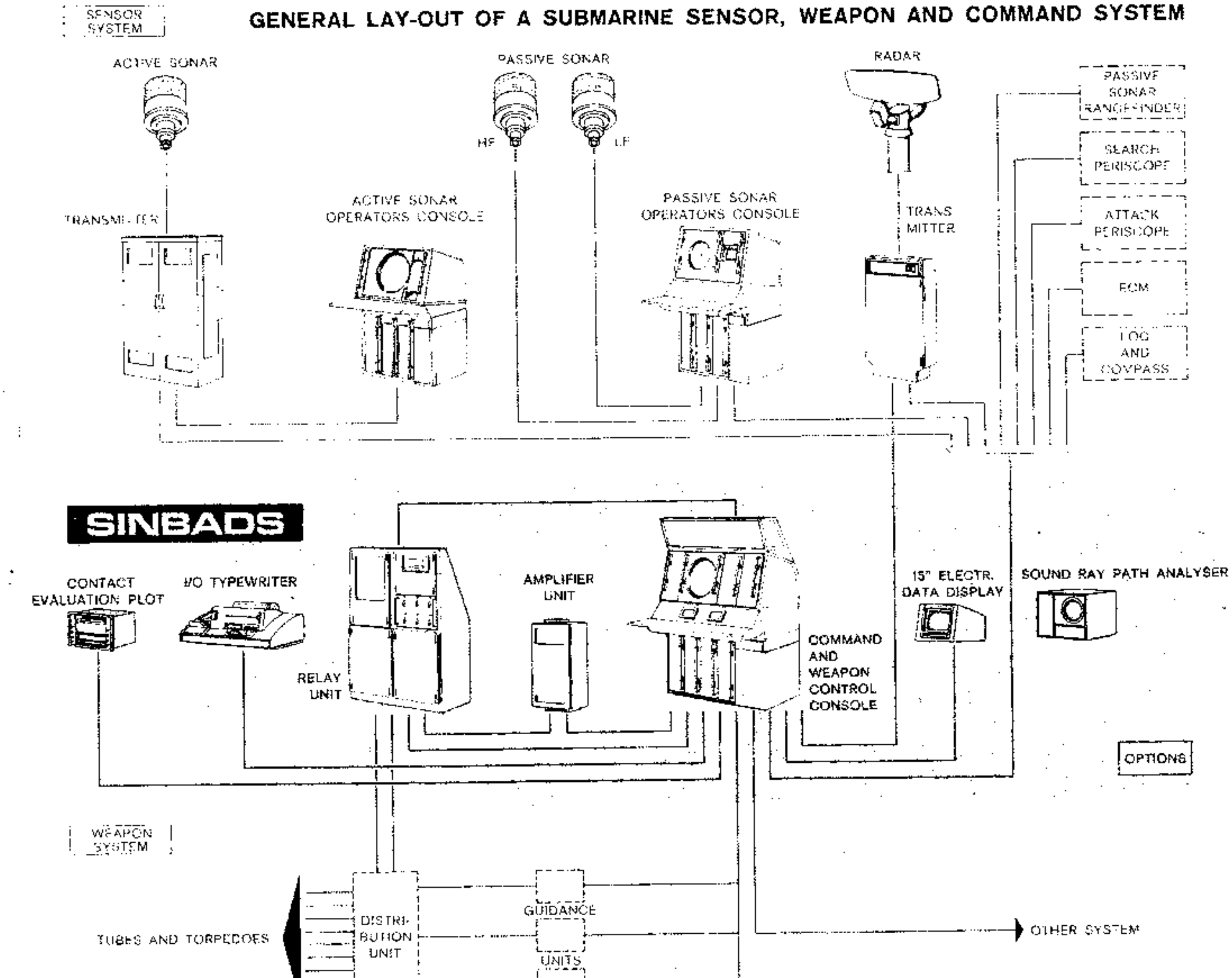
Hollandse Signaalapparaten, Hengelo, Netherlands, PO Box 42.

1662.481
SINBADS – SUBMARINE INTEGRATED BATTLE & DATA SYSTEM (M8/41)

DESCRIPTION:

SINBADS is a compact data handling and weapon control system suitable for use in submarines of the small coastal type and up to the larger, ocean-going type. It represents the latest stage of development of the HSA M8 Series of torpedo FCS (**1375.481**) and forms an integral part of a submarine's sensor, weapon and command system and it incorporates the display, computer and interface equipment. The computer used is the Signaal third-generation general purpose machine, SMR-S and the complete system combines the weapon control and data handling

GENERAL LAY-OUT OF A SUBMARINE SENSOR, WEAPON AND COMMAND SYSTEM



functions. Input data from sensors are collected, stored and processed for the calculation of target parameters, prediction and torpedo control. An important feature of the system philosophy is the processing of "bearings-only" information, derived from new generation fast-scanning pass ve sonars capable of multi-target tracking, such as the Van der Heem Electronics LWS-30.

The Tactical and Weapon Control Display is a 16-inch (40 cm) CRT which operates in two modes:

Mode 1. Plan Display, giving a geographical presentation of the tactical situation. This synthetic picture consists of symbols, alphanumeric characters, lines and dots. When using the submarine's radar, the radar video is presented together with the synthetic picture.

Mode 2: Time-Bearing Display; when only sonar bearings are available, the time bearing curves of a number of targets are presented, showing the target motion with respect to 'own ship' movement.

Complementary displays on the console include a target evaluation display, which is a graphical display used as a visual aid to determine the target parameters of one sonar target, and an electronic data display for the display of alphanumerics in tabular form for computer read-out and manual input.

OPERATION:

Principal operational facilities of SINBADS include:

Integration with a number of sensors, to accept and process all available information.

Simultaneous tracking of targets: five time-bearing tracks from passive sonar data, of which three targets can be selected for position tracking based on additional data from other sources.

Presentation of information for evaluation of the tactical situation and monitoring torpedo trajectory.

Prediction for weapon control, and simultaneous guidance of up to three wire-guided torpedoes.

Control of wire-guided, non-guided homing, programmed and straight-running torpedoes.

Comprehensive data recording.

Weapon simulation for training.

Navigation.

MANUFACTURER:

N.V. Hollandse Signaalapparaten, Hengelo, Netherlands. PO Box 42.

1375.481

M8 SUBMARINE TORPEDO FIRE CONTROL SYSTEM

DESCRIPTION:

The M8 is a digital computer based fire control system for use in submarines for the direction of torpedoes against either surface shipping or submerged targets. It is produced in several versions with designations ranging from the M8/0 of the mid-1950s prototype to the newest M8/41. The basic system comprises a torpedo display control and computer console; a sound path display unit; amplifier and supply unit; distribution box; local control panel(s); and gyro angle setting units. Complete system weight is about 900 kg. The system may be operated by one man, or two men if the submarine is operating with consorts.

The system will accept target data inputs from a range of sensors which includes radar, sonar, passive sound detection systems, periscope observation and consort reports. Ship's own navigational data is also fed into the M8 computer. The display, which has range scale settings for 20, 10 and 5 km, presents the positions of all contacts from all sensors, simultaneously. One or more sensors may be connected to the computer for torpedo engagement, and up to three targets may be attacked simultaneously. The computer is programmed to provide firing data for wire-guided, programmed, conventional and other types of torpedo, and performs automatic calculation of target position, course, and speed. The CRT display can give true motion, relative motion or off-centred presentation of the tactical situation.

DEVELOPMENT:

The M8 Series originated in a RNethN contract awarded in 1955 for the development of a torpedo FCS for the "Dolfijn" Class submarines. West German interest in the system gave additional impetus to subsequent development and led to the successful development of systems for use in both submarines and surface ships. Two types of torpedo were involved, the AEG Seal and Seeschlange, for use against surface vessels and submarines, respectively. This successful collaboration with the German industry continued and M8 Series systems are standard fitting on all submarines produced by Howaldswerke Deutsche Werft in Kiel. The ultimate development is the SINBADS system described in Entry No **1662.481**, but other related developments are the M9 systems in the West German "Köln" and "Thetis" Class vessels, and the M11 systems for two new Argentinian fast patrol boats.

STATUS

At mid-1974 a total of 85 M8 Series systems had been ordered of which nearly 70 were for submarine fittings in 11 navies. The following list is believed to accurately record the known installations.

Argentine	Type 209 (2)
Colombia:	Type 209 (2)
Denmark:	Narhvalen Class (2)
Germany (Fed Rep):	Wilhelm Bauer (1)
	Type 205 (11)
	Type 206 (18)
Greece:	Type 209 (4)
Israel:	Type 206 (2)
Netherlands	Dolfijn Class (2)
	Potvis Class (2)
	Zwaardvis Class (2)
Norway:	Modified Type 205 (15)
Peru	Type 209 (2)
Turkey:	Type 209 (2)
Venezuela	Type 209 (2)

MANUFACTURER

N.V. Hollandse Signaalapparaten, Hengelo, Netherlands. PO Box 42.

SWEDEN

1541.281

TORCI TORPEDO FIRE CONTROL SYSTEM

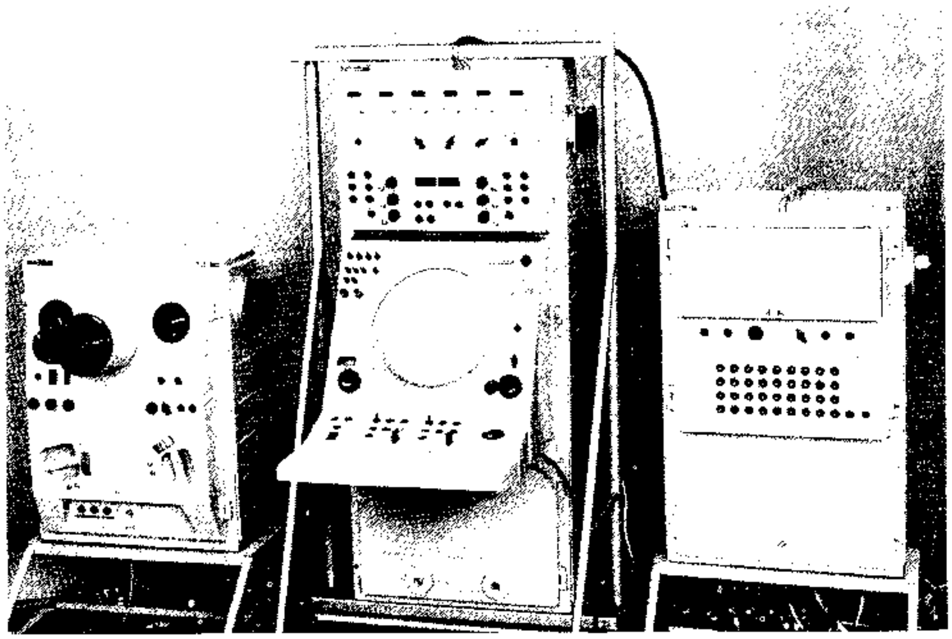
DESCRIPTION:

The TORCI torpedo fire control system is produced in several versions by Philips Teleindustri AB (PTAB) for the operation of guided torpedoes against surface targets from fast patrol boats. It is normally supplied with a PTAB X-band frequency-agile surface search radar, but is capable of use with other radars. The principal tactical functions of the system are

(1) Presentation of search radar information
(2) Presentation of the combat situation for the direction of surface engagements
(3) Rapid designation of surface targets
(4) Automatic or manual target tracking
(5) Guidance of two simultaneous torpedo salvoes.

The equipment comprises three units, the main display console, target tracker console, and an electronics/power supply unit. The last of these can be located remote from the two manned consoles. Modular construction with solid-state circuitry is used throughout and comprehensive self-test facilities are incorporated.

The main display console is provided with a PPI for the presentation of search radar data, synthetic symbols for tactical data, and relative or true motion presentation can be selected by the operator. The console also carries controls for operation



TORCI torpedo fire control system equipment. The main display console is in the centre, with the target tracker console on the left of the system and for target designation. The latter function is performed by means of a rolling ball which is used to position an electronic marker over the selected target on the main PPI display. Transfer to the target tracker is by operation of a push button. The main console also houses the torpedo computer and the programme selector.

Either manual or automatic target tracking is possible, and the torpedoes can be fired in salvo with chosen dispersion as well as one by one. One of two types of guidance can be selected. The controls and indicators for these functions are on the target tracker console. The electronics cabinet contains the co-ordinate converter and the necessary power supplies.

DEVELOPMENT:

The TORCI system has been developed from the RATSI system used on Swedish ships in the mid-1950s, and the first TORCI was delivered in 1959, since when it has been progressively improved.

STATUS:

Swedish vessels equipped with TORCI systems include the "Spica I" class of fast torpedo boats, in which TORCI is used with an HSA M22 radar/fire control system (Entry No. **1259.281**), and the new "Spica II" class. In the latter class, TORCI is used in conjunction with another PTAB fire control system, RAKEL, which provides for gun fire control against surface and air targets. A number of foreign navies also use TORCI.

MANUFACTURER:

Philips Teleindustri AB, Fack, 175 20, Järfälla-1, Sweden.

1542.281

9 LV 200 FIRE CONTROL SYSTEM

DESCRIPTION:

The 9 LV 200 has been developed as a fire control system for use on small ships, from 80 tonnes and upward, basically for the direction of dual-purpose guns (40-120 mm) but with provision for extension to other weapons such as anti-ship missiles (Exocet, Penguin, Otomat, etc) or torpedoes. In its basic form the system has the capability for directing one or several guns against one or more targets simultaneously.

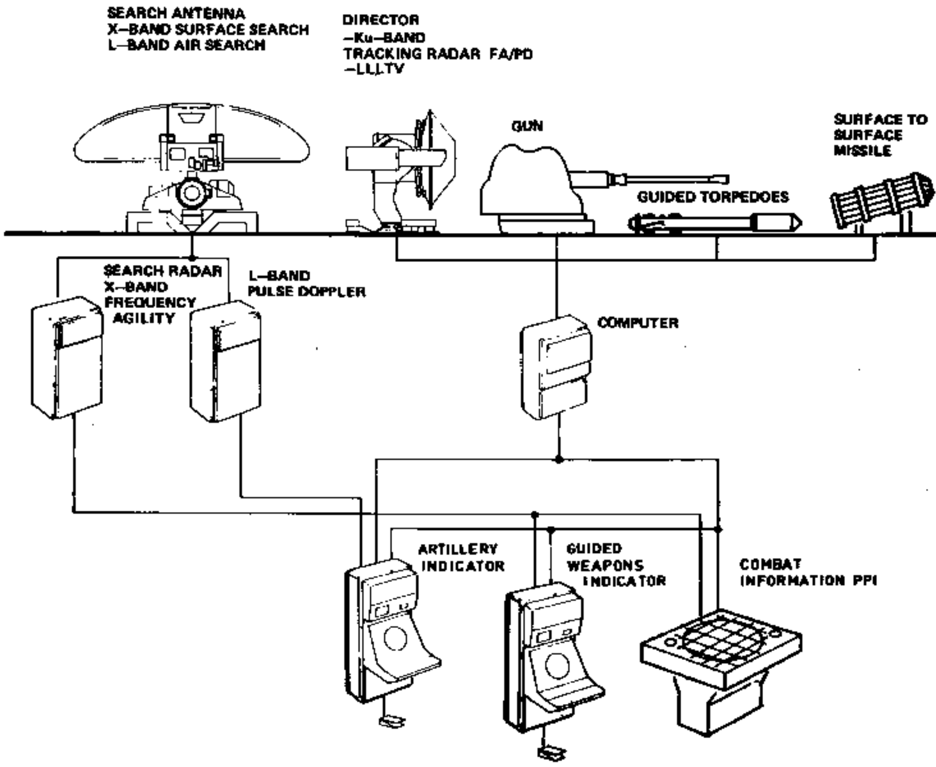
Target data is obtained from an X-band search radar and a Ku-band tracking radar, and there is provision for L-band air warning radar with IFF to be incorporated also. The X-band equipment in the 9 LV 200 is used for both search and tracking of surface targets and for air search. If the L-band, pulse-doppler radar is included, a combined antenna system for X-band, L-band and IFF Mk 10 is then used. The Ku-band tracking radar can also be modified with a separate pulse-doppler function to improve performance in adverse clutter conditions against small low-flying targets.

The search radar is of the frequency-agile type, incorporates comprehensive ECCM facilities, and is provided with a stabilised mounting. A helical scan pattern is used. The director radar is a monopulse equipment, with frequency agility, and the mounting also carries a TV camera.

Below deck equipment consists of the radar transmitter/receivers, computer, gun fire control console, and a combat information PPI. The gun console is equipped with a PPI for search, target designation and tactical situation functions, A-scope and TV monitor for tracking supervision, and tactical controls for director and gun functions. The guided weapons console has a B-scope for precision presentation of target data and tracking, a rolling ball for manual tracking, and tactical presentation and controls for guided weapons. The combat information PPI is of the 'conference' type and has full facilities for the display of search and tactical situation information, and controls for target designation to the weapon consoles.

Operational functions include:

- Simultaneous search for air and surface targets.
- Display of search radar data on the 40.6 cm combat information PPI with true motion presentation (surface), and on a 30.5 cm PPI in the main console with north-stabilised relative motion display (air).
- Rapid target allocation from search to tracking radar.
- Rapid changeover between targets.
- Automatic target acquisition and tracking of one air or surface target by the Ku-band radar.
- Manual or automatic tracking of one target by TV.
- Manual tracking of one target in range and bearing from search radar data displayed on a large B-scope (track-while-scan).
- Automatic computation of two target tracks to give independent control of gun and missile systems.
- Simultaneous engagement of one air and one surface target.
- Fall of shot observation by B-scope and/or TV and tracking radar A-scope.
- Use of TV and/or Ku-band radar in back-up mode.



9 LV 200 fire control system diagram

Examples of back-up operation include the use of the TV system to assist tracking of two air targets flying close together; tracking a very low-flying target giving radar multi-path problems due to sea returns; and making fall of shot observations. The Ku-band radar offers a back-up if the X-band unit is jammed or otherwise unusable.

DEVELOPMENT:

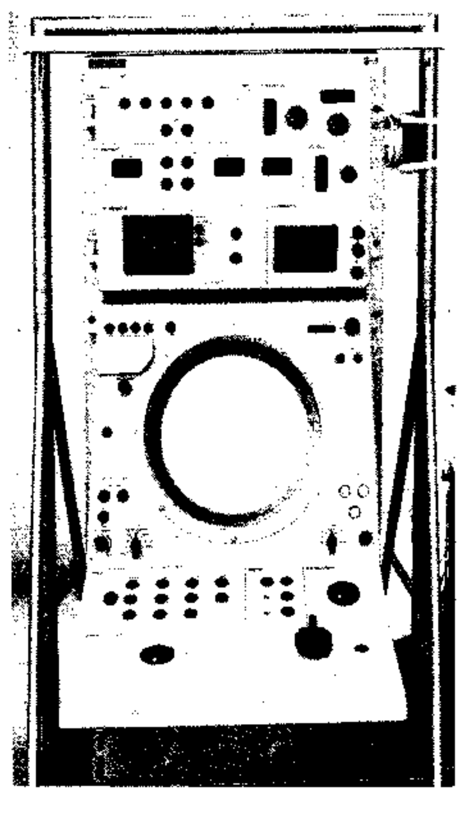
The 9 LV 200 is based on Philips Teleindustri AB long experience in naval fire control systems, and represents the most recent practice of this concern.

STATUS:

The first version of this system entered service in 1972. It has been specified by a number of foreign navies.

MANUFACTURER:

Philips Teleindustri AB, Fack, 175 20 Järfälla-1, Sweden.



Gun fire control console of 9 LV 200 system

1543.281
SEAFIRE WEAPON CONTROL SYSTEM

DESCRIPTION:

Seafire is an integrated weapon control system for motor gunboats armed with one or more surface to surface weapons such as, 75 or 40 mm guns, 57 mm flare rocket launcher, surface-to-surface missiles of the launch-and-leave type. Design objectives include, high resistance to jamming and mutual interference; a total system accuracy comparable to that of the weapon controlled, controls for firing preparations and ballistic correction shooting; rapid (tactical) change between three different ballistic programmes for the 75 mm gun.

Sensors for the system are a frequency-agile X-band radar and a periscopic sight. The former uses a helical scan pattern to provide both surface and air search functions. The periscopic sight is a 3 axis stabilised unit serving for both optical tracking and as a back-up to the radar for target designation. A television camera is an optional alternative sensor. A vertical gyro provides data to the system for stabilisation and computation purposes. All computations are referred to a north-oriented fixed-horizon co-ordinate system.

Indicators with large display screens and high resolution are used for the presentation of radar information, and displays are provided in the operations room and on the bridge. Evaluated target data (range, bearing, speed and course) are presented on easily read scales. The bridge PPI can be used for navigational use of the radar in addition to monitoring the tactical situation.

Tactical functions of the Seafire system are:

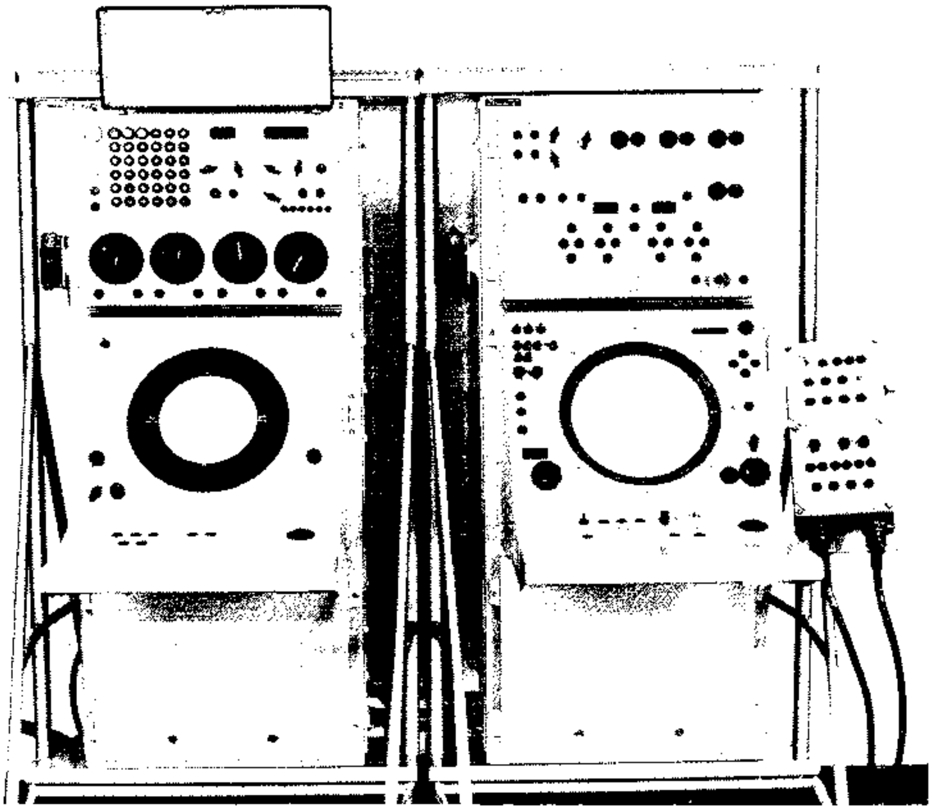
Continuous air and surface search.

Presentation of surface tactical situation and direction of surface action.

Indication of air and surface radar targets.

Continuous tracking by radar of one surface target, with quick target change facility.

Direction of lower-register fire with 75 mm gun at one surface target.



Philips Seafire weapon control system control consoles

Direction of coastal bombardment (direct or indirect) with 76 mm gun.

Fall-of-shot observation on B-scope.

Radar navigation.

Passive ECM-mode (direction finding) in X-band.

STATUS:

The Seafire system was at the advanced project stage in early 1972.

MANUFACTURER:

Philips Teleindustri AB, Fack, 175 20, Järfalla 1, Sweden.

1544.281
9 TCI 210 SUBMARINE TORPEDO FIRE CONTROL SYSTEM

DESCRIPTION

The 9 TCI 210 is a submarine torpedo fire control system for the detection, acquisition, tracking and engagement of surface targets by guided torpedoes. The principal sensor is normally the Philips 'Subfar' submarine radar (Entry No. **1545.453**). In addition to the radar, the other major items of equipment comprising the system are a tactical display unit, radar remote control unit, computer, sonar designation unit and plotting unit. These are all located in the Combat Information Centre (CIC). In the conning tower is a slave data display for the Captain's use and an antenna control unit. A torpedo control unit is housed in the torpedo compartment.

Operational facilities provided are:

Long range radar search against surface and low-level air targets.

Precision target acquisition and tracking.

Intermittent acquisition or continuous tracking.

Simultaneous engagement of two targets.

Tactical situation presentation.

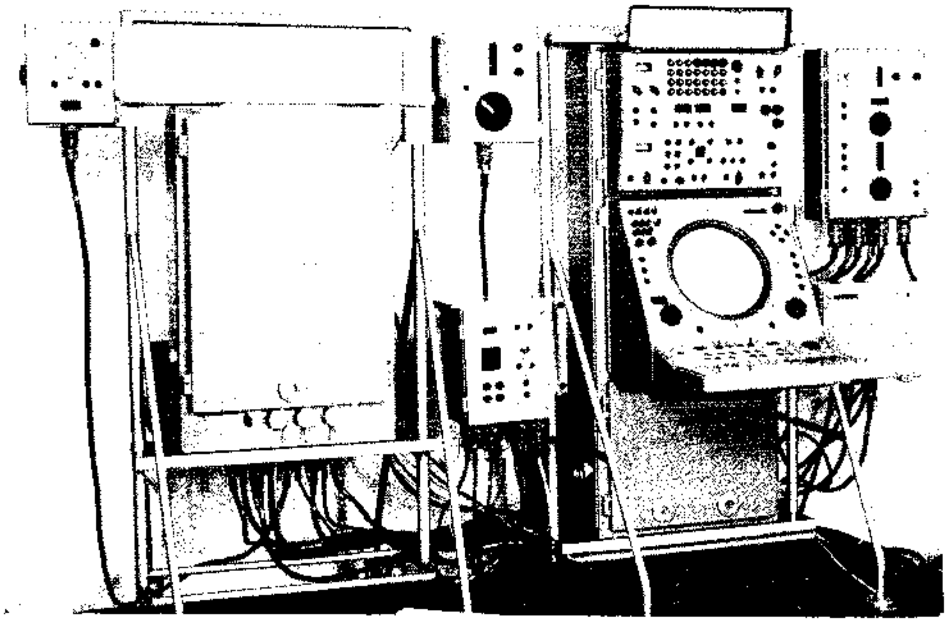
Target designation (range and bearing) to sonars or periscope.

Presentation of target bearing for plotting.

Captain's display.

Firing and automatic guidance of one to four torpedoes in the same attack, or firing of one to four pre set angle torpedoes.

Radar navigation.



9 TCI 210 Submarine torpedo fire control system equipment

DEVELOPMENT

The 9 TCI 210 system has been developed from the TCI 101 system of the 1950s.

STATUS:

In production. Philips TCI systems equip submarines of the Royal Swedish Navy and other navies.

MANUFACTURER

Philips Teleindustri AB, Fack, 175 20 Järfälla 1, Sweden.

SWITZERLAND

1552.281
SEA HUNTER-4 FIRE CONTROL SYSTEM

Based on the experience gained from production of more than 2.000 fire control systems for land- and ship-borne use and the results of extensive research work, Contraves A.G. Zurich developed a new generation naval fire control system designated Sea Hunter-4.

DESCRIPTION:

The system is designed for fitting in small to medium-sized surface vessels in conjunction with guns and missiles. Among the weapons controlled are

- guns ranging from 30 mm to 5 inch
- the Sea Killer Mk 2 ship-to-ship missile in deck fixed or trainable launcher mountings
- the Seacat ship-to-air missile

Other weapons can be accommodated, such as the Exocet ship-to-ship and the Sea Indigo ship-to-air missiles. Besides air defence and surface actions the system also provides for shore bombardment. Several targets can be engaged simultaneously.

One of the most notable features is the advanced target search and tracking capability. Two independent high power radars and a low light-level television system are used for these functions. The track and search antennae as well as the television camera are mounted on a common gyro-stabilised platform.

Targets can be acquired either with the search radar or with the track radar operating in an automatic helical search programme, or with other radars available in the ship, such as navigation and early warning radars. To this effect the picture of such external radars can be presented on the Sea Hunter PPI. The system also accepts target designations from optical sights and from a central tactical designation unit.

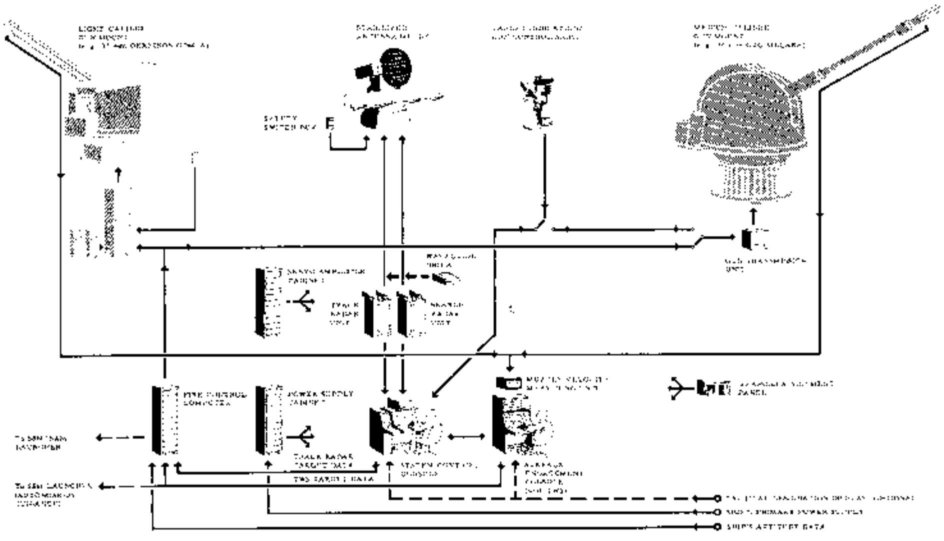
The television is of particular importance as a supplement to the track radar to assist in tracking of very low altitude airborne targets where radar becomes uncertain. It provides additional benefits in connection with shore bombardment, target acquisition, identification and kill assessment. It operates in lighting level conditions down to about quarter moon.

Assignment of the available weapons to the different fire control channels is selected at the weapon assignment panel. This is done by means of push buttons which are arranged and illuminated internally to show the combination of assignment in force. The state of operation of each weapon is indicated on the weapon assignment panel. Also on this panel is an open fire push for each weapon giving the Weapon Officer overriding control of the firing circuits.

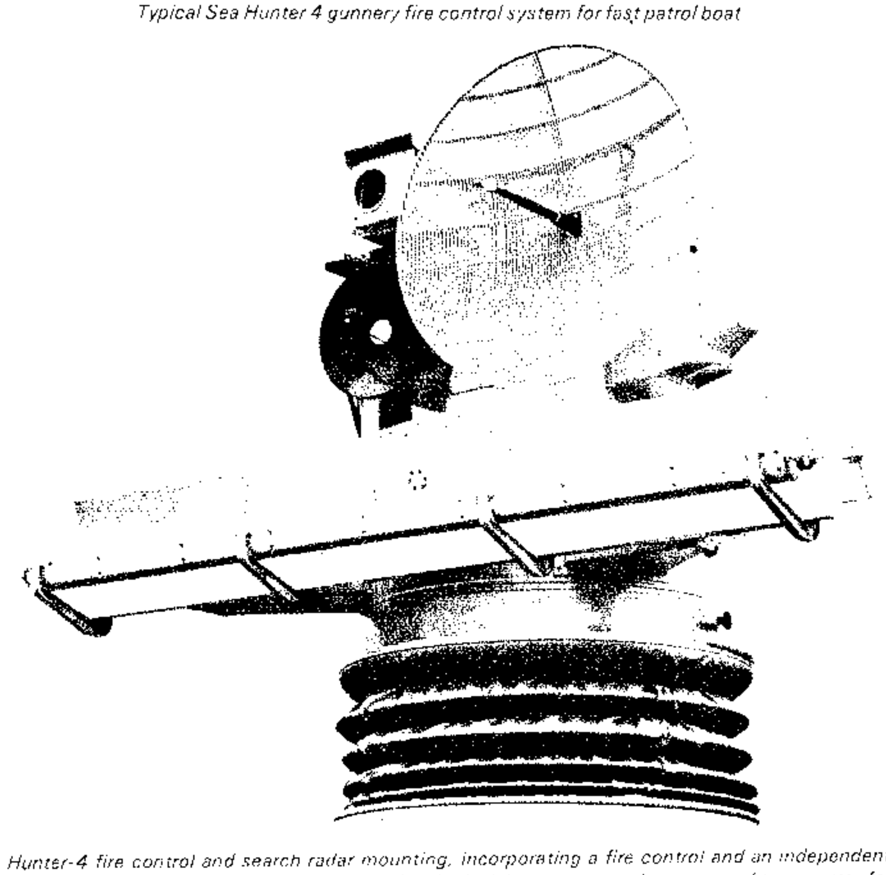
When a target has been acquired, prediction and aiming of the linked weapons are automatic, only the firing controls need to be operated. To assist in firing the weapons to best effect, "within range" lamps indicate when the predicted impact point is within the firing range of the weapons. The time required for target acquisition and computer setting is very short, thus a considerable amount of spare time is available between decision taking to acquire a target and opening of accurate fire.

All system units use solid state and miniaturised electronic components. The compact and lightweight design makes the system particularly suitable for installation in small vessels.

A typical Sea Hunter-4 gunnery system for fast patrol craft comprising a light and a medium calibre gun mounting is shown in the block diagram. The system allows simultaneous automatic controlled fire against two targets. Target number 1 can be an air, surface or shore target engaged by the system control operator with the track radar and/or television. Target number 2 is a surface target engaged by the operator at the surface engagement console in the "track while scan" mode, using the search radar. In emergency the medium calibre mounting can also be fired with the target indication/gun control sight in remote control.



Typical Sea Hunter 4 gunnery fire control system for fast patrol boat



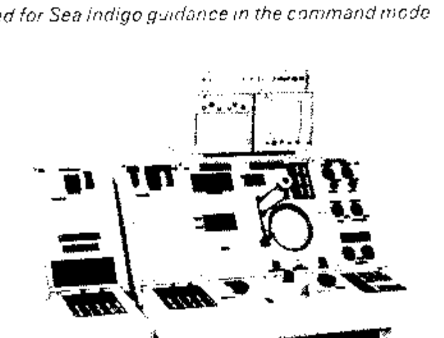
Sea Hunter-4 fire control and search radar mounting, incorporating a fire control and an independent search radar antenna, together with a low light level television camera and a command transmitter for missile guidance. An infra-red sensor can also be added for Sea Indigo guidance in the command mode

For the addition of missiles to the gun fighting power, launcher control data can be provided as indicated in the block diagram. These are either derived from track radar data or from the automatic track-while-scan prediction system, depending on the type of missile. Readily available complementary equipment for missile integration with the system includes all necessary launching and guidance units for the Sea Killer Mk 2 sea skimming SSM and a Seacat dark fire control console.

As a member of the Oerlikon-Bührle group of companies, Contraves are in a position to supply the Sea Hunter-4 fire control system together with the weapons, such as the Oerlikon 35 mm and the Hispano-Oerlikon 30 mm twin naval guns, assuming full responsibility for the entire weapon system package.

STATUS

Designed and developed as a private venture by Contraves A.G., Zurich, Switzerland, in collaboration with Contraves Italiana SpA, Rome, Italy. The first 10 systems went into service with different Navies in the years 1970 to 1972.



Sea Hunter-4 control console for engagement of air, surface, and shore targets

THE UNITED KINGDOM

1242.281
MRS3/GWS22 FIRE CONTROL SYSTEMS

DESCRIPTION:

Shipborne fire control system for the direction of gunfire against surface and aircraft targets, and the Seacat missile against aircraft targets. The MRS3 is designed for the control of RN guns of 3, 4.5 and 6 inch calibre. The GWS22 is designed to control the Seacat launcher and to provide guidance for the Seacat missile.

Each system is designed to work in conjunction with a ship's weapon direction system, the latter normally performing the target designation function. Radar or optical target acquisition and tracking methods are available. The radar provides auto-tracking facilities and guidance for Seacat missiles. Computation is performed by analogue methods.

DEVELOPMENT:

Design studies began in 1948 to devise a system to meet British Admiralty requirements.

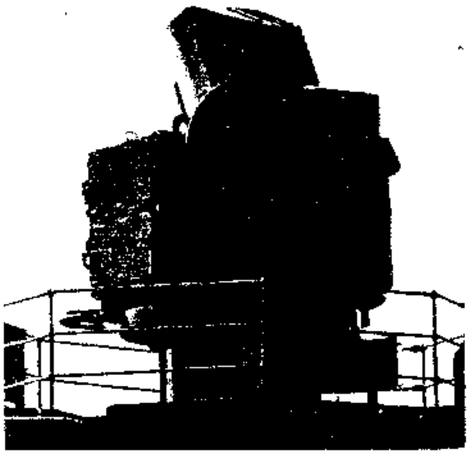
STATUS:

The MRS3 first entered service in 1958, followed by GWS22 in 1962, and now equips vessels of the 'Tiger', 'County', 'Rothesay', 'Tribal' and 'Leander' Classes of the Royal Navy, in addition to Commonwealth and other Navies. Over 100 have been supplied. In September 1973 it was revealed that Sperry had been awarded a multi-million pound contract for the up-dating and modernisation of RN MRS3 gunfire and GWS22 missile control systems. The modifications will up-date the director and tracking system for RN service for a number of years, and they include provision for a new Sperry designed gyro unit using gas bearings.

DESIGNED AND MANUFACTURED BY:

Sperry Gyroscope, Bracknell, Berks, England.

In accordance with British Admiralty policy, manufacture is decentralised and a number of other sources participated. These include Vickers Armstrong (Engineering) Ltd, GEC-AEI Electronics and Lawrence Scott who produce the surface predictor.



MRS3 fire control unit with radar and optical target acquisition and tracking facilities

1524.281
WSA-400 SERIES NAVAL WEAPON CONTROL SYSTEMS

DESCRIPTION

Derivatives of the RN Type 21 frigate Weapon Automation System 4, WSA-4 (**1496.281**) intended for other classes of vessel carry designations in the WSA-400 Series. There is considerable commonality of both hardware and software between WSA-4 and the WSA-400 Series versions, the principal differences being those necessary to accommodate varying combinations of sensor equipment and the weapon systems fitted for specific operational roles.

Three versions of the WSA-400 Series are to be fitted in the Vosper Thornycroft Type 10 frigates to be built for the Brazilian Navy, and which will form the 'Niteroi' Class. These ships will be completed in two types: one specialised anti-submarine type, whose armament will include Ikara missiles, and a general-purpose type to be fitted with Exocet surface-to-surface missiles. In addition, both types will carry Seacat air-to-surface missiles, 4.5 inch (114 mm) Mark 8 guns, anti-submarine weapons, and a torpedo armed helicopter.

Each type of vessel will be equipped with three digital systems based on Ferranti FM 1600B computers, and comprising one tactical and display system, and two fire control systems.

The first of these is a development of the Computer Assisted Action Information System (CAAIS), also being fitted to a number of RN ships, and in the case of the Brazilian vessels, designated CAAIS-400. This system will have six Decca CA 1600 two-man display consoles for the presentation of combined radar and computer generated data.

Both types of 'Niteroi' Class ships will have a WSA-401 as the Forward fire control system, principally for the control of the Mk 8 gun and also for a Bofors anti-submarine rocket launcher. The main sensor for this system will be the forward Selenia RTN-10X Orion tracker radar, with the ship's search radar providing target indication.

In the anti-submarine version of the Type 10 frigate, the After fire control system will be a WSA-402 which will have as its main weapon system the Ikara anti-submarine missile. The WSA-402 will have its own RTN-10X Orion fire control radar.

The general-purpose Type 10 after fire control system is a WSA-403 for the control of the second Mk 8 gun which is fitted in this class, and for Seacat missile control. The main sensor is an RTN-10X Orion fire control radar. All three Ferranti systems are interconnected to permit transfer of data between them in digital form to provide maximum operational flexibility and a high degree of freedom to transfer the functions of control positions, sensors and weapons to meet changing circumstances.

The systems for the Brazilian "Niteroi" Class frigates are similar to that being produced for the RN Type 21 ships. More details of "Niteroi" Class weapons and sensors are given in Entry No. **1665.281** at the beginning of this section.

DEVELOPMENT:

Tenders for the Type 10 frigates were invited in February 1970 and Ferranti prepared a total of twelve different system configurations. The systems evolved for the Vosper Thorneycroft frigate designs were selected, and these have subsequently been refined in collaboration with the Brazilian authorities.

STATUS

The Brazilian contract announced in September 1970 calls for six Type 10 frigates, four of which will be for anti-submarine duties. The first deliveries are expected to be made in the mid-1970s, and production of the WSA-400 Series equipment will match this schedule. There is a possibility that the 'Niteroi' Class may be extended to a total of ten vessels.

MANUFACTURERS:

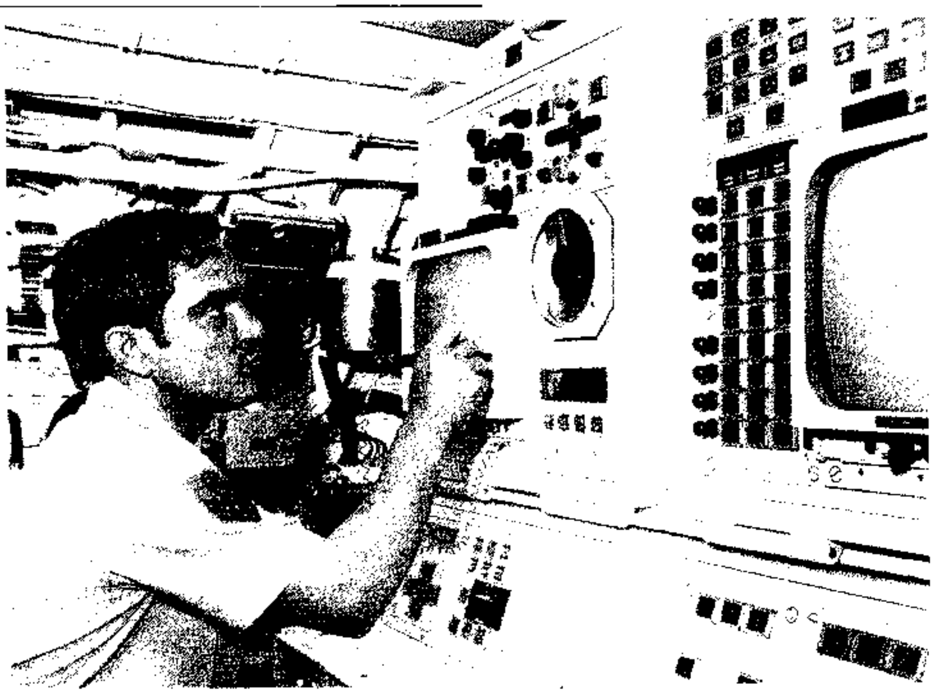
Ferranti Ltd, Digital Systems Division, Western Road, Bracknell, Berkshire, England.

Decca Radar Ltd, Decca House, 9 Albert Embankment, London SE1, England (Displays).

1233.481
TIOS – TACTICAL INFORMATION ORGANISATION SYSTEM

DESCRIPTION

TIOS is a computer-based tactical information system, developed initially by Vickers and ordered by the Brazilian Government for installation in its 'Oberon' Class submarines. It is capable of performing all the torpedo control functions of earlier



TIOS operating console installed aboard a modern submarine systems appropriate to vessels of this kind, and also provides additional facilities for the processing of tactical data, plus an extensive and flexible display system. Another major design feature is the use, in combination, of mostly extant equipment to yield a system only marginally more costly than its predecessors. It is suitable for retro-fit or new installation and is not limited to any particular class of submarine.

Capable of controlling all types of RN torpedoes TIOS, because of its modular construction, can be modified for the control of other torpedoes with minimal system changes. Wire guided, cable set, and spindle set types can be operated, specific types include the Mk 8 Mod 2/3/4, Mk 20, Mk 23 Mod 2/3, Mk 24 Mod 0, and Mk 37 Mod 0/1/2. Control of air-flight weapons, the Vickers SLAM (Submarine Launched Air Missile) system in particular, is under development. A further advantage over earlier equipment is the ability to control two guided torpedoes independently to permit simultaneous attacks.

The system displays tactical situations and provides full information on the operational state of the submarine. It may also be used for navigational purposes.

The console contains two 28 cm CRT displays, and five types of display information can be selected by the operator without affecting the computations being carried out. Display parameters can be changed manually by use of a light pen. A centralised tactical picture can thus be obtained. All tube ordering, weapon selection and system monitoring is performed at the console.

The digital computer employed is a Ferranti FM1600B, which has been standardised by the RN for fire control and other applications, and this stores all relevant information such as target positions, speeds, bearings, etc.

The interface between operator, computer and weapon (torpedoes, or SLAM) is the responsibility of Gresham Lion Electronics Ltd, and consists of a console providing facilities for CRT display of tactical data, manual or automatic guidance and computer input/output functions. Also on offer is an interface and computer programme for use with navigation systems such as Omega, to add to the inherent features of the system.

DEVELOPMENT:

The development of TIOS was a joint venture by Vickers, Ferranti and Gresham Lion. Further development of the fore-end equipment associated with TIOS has produced a compact fire control system that is well suited to submarines much smaller than the 'Oberon' Class. Factory acceptance of trials of the new equipment began in 1974.

STATUS:

The first system entered production in early 1970 and factory trials were completed in 1971. The first production system was installed during construction of a submarine for the Brazilian Navy in 1972 and underwent seagoing trials in February 1973. A permanent shore-based installation is in operation at Barrow-in-Furness for post-design development and training. Current developments for the shore facility include a programmable training aid to improve operator training by dynamic simulation of target manoeuvres.

MANUFACTURERS:

Vickers Ltd, Barrow Shipbuilding Works, PO Box 6, Barrow-in-Furness, England.

Ferranti Ltd, Digital Systems Dept, Western Road, Bracknell, Berks, RG12 1RA, England.

Gresham Lion Electronics Ltd, Twickenham Road, Hanworth, Middlesex, England.

1826.481
CICAS – COMPUTER INTEGRATED COMMAND AND ATTACK SYSTEM

DESCRIPTION:

The Computer Integrated Command and Attack System (CICAS) is the export version of a new system for submarine applications which is under development for the Royal Navy by Gresham Lion Electronics. Most information concerning this system is still classified, but it is known that CICAS and its RN counterpart are digital installations based on a Ferranti processor complex. It has been reported as being more advanced than TIOS, in which Gresham Lion is involved, and as using techniques not previously applied to warship systems to achieve close integration of the functions of Action Information Organisation and weapon control.

The feasibility study for RN CICAS was carried out in 1970 and the first production equipment had begun on site tests by early 1974. RN production orders have been placed and overseas interest is reported.

Modular techniques are employed and the system provides multi-target handling capability, and, in addition, control of a wide range of weapons that includes underwater-to-surface guided missiles being developed for the RN. The range of weapon control is variable by operator demand and can be changed at short notice. Elements of the system can, if required, duplicate the functions of other units without degradation of their own function. For example, attack displays may be used to present Action Information Organisation data and control facilities. In addition to the FM1600B computers employed for AIO and fire control data processing, other Ferranti equipment includes core storage modules, input/output devices and special-purpose interfaces. Ferranti engineers were also responsible for the software development. Display units for CICAS have been specially produced by Decca Radar.

MANUFACTURER:

Gresham Lion Electronics Ltd, Defence Division, Twickenham Road, Hanworth, Middlesex, England.

1827.481
TCS 9 TORPEDO CONTROL SYSTEM

DESCRIPTION:

This is a standard torpedo fire control system for certain Royal Navy submarines and it is also employed by a number of other navies. All details of the TCS 9 remain classified, however, apart from the information that it was preceded by TCS 6 and 7 equipments and TCS 9 itself has been the subject of more or less continuous development and modernisation. The Torpedo Guidance Control Unit Mk 2, which forms part of TCS 9 is produced by Gresham Lion Electronics, which company is now the design authority for the whole of the system as well as being responsible for repair and refurbishing on behalf of the RN.

1043.261
ADAWS Mk 1 – ACTION DATA AUTOMATION WEAPON SYSTEM FOR COUNTY CLASS GMDs

DESCRIPTION:

Shipborne automatic data-handling and display system, based on two Ferranti Poseidon digital computers which form the central processing complex.

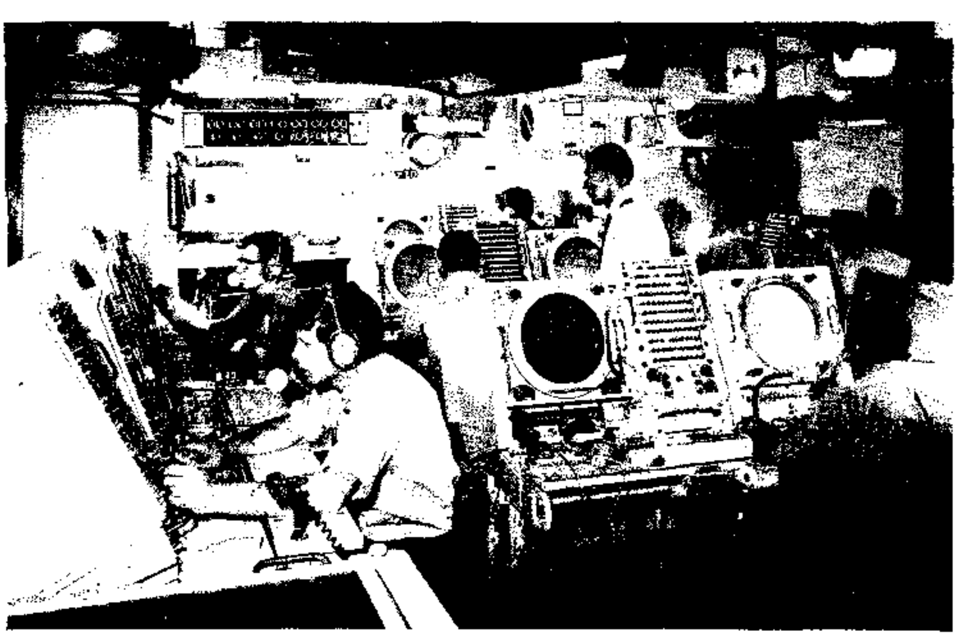
OPERATION:

The system provides for the automatic compilation of the air, surface and sub-surface tactical situation 'picture', using information from the ship's radars, sonars, passive direction finding equipment, and data link. The latter data source can be assumed to carry data from similar sensors deployed by co-operating craft of a force, such as ASW helicopters, and other surface vessels.

Automatic processing of surveillance radar and automatic operation of the height-finder radar is also incorporated. Target recommendations and target designation signals are provided for the ship's above-water weapons, such as Seaslug, Seacat and guns. These, however, retain their separate analogue fire control systems. Special functions are performed by the ADAWS system to enable optimal use to be made of the Seaslug II missile system. Orders are also calculated and displayed for fighter and helicopter action.

DEVELOPMENT:

Development work on the Poseidon computers began in 1959 based upon previous ADA system



The operations room of an ADAWS Mk 1 equipped guided missile destroyer

ies, first entering service in HMS *Eagle* in 63. The computers were designed and developed, the software written and ADAWS-1 developed by Ferranti working in collaboration with the

Admiralty Surface Weapons Establishment.

STATUS:
ADAWS Mk 1 entered service in 1965 on vessels of the 'County' class series of guided missile destroyers (Fife, Glamorgan, Antrim and Norfolk). A later version has now succeeded the Mk 1 system.

MANUFACTURERS:
Ferranti Ltd, Digital Systems Department, Western Road, Bracknell, Berks, RG12 1RA, England – all digital equipment.
Pye Ltd, Cambridge, Cambs, England – display consoles.

ADDITIONAL EQUIPMENT:
A shore trainer for the ADAWS Mk 1 was installed by Ferranti in 1969.

The "County" Class guided missile destroyer HMS Glamorgan

1044.261

ADAWS 2 ACTION DATA AUTOMATION WEAPONS SYSTEM

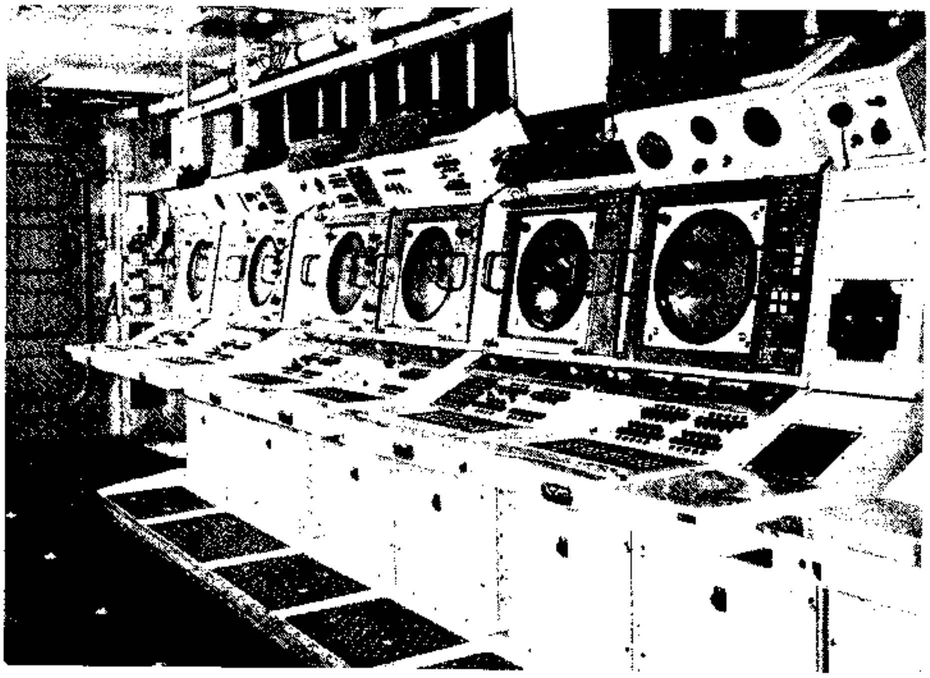
DESCRIPTION:
This is the first of a new series of action data automation systems developed for the Royal Navy and based upon Ferranti FM1600 series digital computers, and using later display equipment by Plessey to provide improved performance and facilities over those of the ADAWS Mk 1 which used Poseidon computers. Another important operational difference is that the later systems in addition to the action data automation functions, also provide fire control facilities for the various weapons carried by the vessel.

The ADAWS 2 has been designed for the Type 82 guided missile destroyer HMS *Bristol*, and accepts inputs from multiple sensors including radars, sonar, passive devices, and data link. The FM1600 micro-circuit computer suite performs the co-ordination, processing, distribution and display of tactical information derived from these sources. Fire control calculations and co-ordination are also performed by the computers for the armament of Sea Dart surface-to-air missiles, the Ikara ASW weapon, and conventional weapons fitted.

In comparison with the earlier ADA systems, still more comprehensive processing is performed on sensor data, and the Plessey Mk 8 digital autonomous displays provide improved facilities for the presentation of operational data. Integrated circuits are employed throughout the construction of these displays.

The ADAWS 2 display system comprises a number of labelled plan displays (LPD) and electronic data displays (totes) which operate in conjunction with a display central equipment. The display fit provides a comprehensive operations room outfit with a standardised type of display console incorporating a 305 mm CRT. This console is used for all purposes – picture compilation, tactical appreciation, and weapon control.

A new type of automated, three-man tactical display embodying a 560 mm CRT is a feature of these display systems, and this has been designed as a modern solid-state replacement for the traditional projection type plotting table. It provides access to all radar data and synthetic information available to the system, so that users can select the filtered data appropriate to the tactical situation. Comprehensive facilities are provided for readout of alpha/numeric data at the tactical displays and elsewhere in the operations room.



Plessey Mk 8 displays for ADAWS-2 on board HMS Bristol

DEVELOPMENT:
Development began in the mid-1960s, collaborating agencies being Ferranti, Plessey, Admiralty Surface Weapons Establishment, Admiralty Underwater Weapons Establishment.

STATUS:
The ADAWS 2 equipment for HMS *Bristol* was installed in 1970.

MANUFACTURERS:
Ferranti Ltd, Digital Systems Department, Western Road, Bracknell, Berks, RG12 1RA, England main contractors for digital equipment, software.
Plessey Radar Ltd, Addlestone, Surrey, England – displays, interface, and drive equipment.

1234.261

ADAWS 4 ACTION DATA AUTOMATION WEAPON SYSTEM

DESCRIPTION
This system is essentially a different version of the ADAWS 2, using the same hardware, but with variations to accommodate the requirements of the Type 42 guided missile destroyer class of vessels and the differences in armament compared with the Type 82 GMD with which the current ADAWS series originated. ADAWS 3 was designed for the CVA 01 carrier which was subsequently cancelled.

The ADAWS 4 is being produced in two slightly different versions for the RN Type 42 GMDs and the Type 42s on order for the Argentine Navy.

The central data processing complex consists of a suite of Ferranti FM1600 micro-circuit digital computers, with a Plessey Mk 8 digital display system for the presentation of tactical and other information. The computers provide a total of 128,000 words of core store, and they will gather data from all the ship's sensors, assemble and correlate this information and that from other vessels obtained via data link, and present it to the command teams on appropriate display consoles.

All information from 'own ship' and consorts in data link contact will be accessible at any console, and on a selective basis. For example, air situation or underwater situation. The computers also include programmes to assist in the evaluation of the relative threat posed by different targets, thus assisting the command in the selection of targets and assigning weapons. When action is joined, the computers also provide control of ship's weapons. In addition to providing all the aiming and fire control computations for the Type 42's Sea Dart missiles, the ADAWS 4 also includes fire control for the 4.5 inch automatic gun mounting, and the calculation of intercept instructions to be passed by radio to fighter aircraft or anti-submarine helicopters.

DEVELOPMENT:
Development of the ADAWS 4 is a continuation of the ADAWS 2 work, and began in 1967. Ferranti as prime contractor worked in collaboration with Plessey Radar as major subcontractor for the display system and with the British MoD

(Navy) and the Argentine naval authorities in respect of the Type 42 vessels for each of the two Navies.

STATUS:

Production of equipment for the first RN Type 42 had commenced in the summer of 1970, and orders have been received in respect of the two Type 42 GMDs for the Argentine Navy. Ferranti has announced that more than 50 of the FM1600 computers used in the ADAWS series have been ordered for these and other naval applications.

MANUFACTURERS:

Ferranti Ltd., Digital Equipment Division, Western Road, Bracknell, Berks, RG12 1RA, England.

Plessey Radar Ltd, Station Road, Addlestone, Surrey, England.

1235.261
ADAWS 5 ACTION DATA AUTOMATION WEAPON SYSTEM

DESCRIPTION:

This system is essentially a further version of the ADAWS 2 system (which see) that is fitted to the Type 82 guided missile destroyer HMS *Bristol*, and uses the same basic hardware and a large proportion of the software of that system, but configured to meet the requirements of vessels of the "Leander" class of frigates equipped with the Ikara ASW weapon system (which see).

From the information released it is not possible to amplify upon the system description as given for the other action data automation systems in this series, ADAWS 2 and 4, other than to say that the sensor, computer programming, and display arrangements for ADAWS 5 are optimised for the principal role of this class of vessel (ASW) and the Ikara anti-submarine weapon which is the main armament.

DEVELOPMENT:

Development has been carried out in conjunction with the other ADAWS programmes, by the same companies and government agencies, and originated in 1967.

STATUS:

In service.

MANUFACTURERS:

Ferranti Ltd., Digital Equipment Division, Western Road, Bracknell, Berks, RG12 1RA, England.

Plessey Radar Ltd, Station Road, Addlestone, Surrey, England.

1830.281
ADAWS 6 ACTION DATA AUTOMATION WEAPON SYSTEM

DESCRIPTION:

Although the designation ADAWS 6 has not been officially confirmed it can be stated with reasonable certainty that this is the correct title of the new system for the Royal Navy through-deck cruiser HMS *Invincible*. Ferranti and Plessey, who in partnership have produced most of the ADAWS for preceding RN ships, have been named as contractors for the computer complex and display systems for *Invincible*. Few details have been released concerning specific hardware or performance but it has been stated that two Ferranti FM1600 computers will be used and the Plessey contribution is valued at almost £1 million.

HMS *Invincible*, the largest ship to be built for the RN since World War II, is to have a more comprehensive automated AIO than any previous vessel, and its functions will include deployment and control of the ship's own weapons and aircraft as well as command and control of co-operating forces.

Invincible's probable armament includes the Sea Dart missile (two twin launchers), Sea King helicopters, and the later possibility of Exocet surface-to-surface missiles and Harrier V/STOL strike aircraft. Sensors will include a Type 965 long-range surveillance radar, IFF/SIF, Type 992Q search and target indication radar, two Type 909 radars for the Sea Dart system, Type 1006 navigation radar, data link, EW and probably sonar.

There is a significant area of commonality in both armament and sensors with other RN ships (Type 42 and Type 82) that have Ferranti/Plessey ADAWS, and as would be expected the new ADAWS for HMS *Invincible* will embody parts of the systems developed for these classes. In ADAWS 6 the two computers will function as a complementary pair, neither being dedicated to any particular task but both capable of performing all roles, sharing the data processing load as the situation demands. Additional software to meet the special requirements of the *Invincible*'s new operational role will be generated by a Ferranti team working at and in collaboration with the Admiralty Surface Weapons Establishment.

The Plessey display systems to be used represent a significant advance over those used in early ADA systems in that radar ranging, video processing, and processing of all target and synthetic data is carried out digitally. The display resolution and system accuracy necessary for air, surface and anti-submarine actions is achieved by the use of high-speed logic, which also ensures that maximum benefit is derived from the computerised data handling system.

STATUS:

In development.

MANUFACTURERS:

Ferranti Ltd., Digital Equipment Division, Western Road, Bracknell, Berks, England.

Plessey Radar Ltd, Station Road, Addlestone, Surrey, England.

1046.261
CAAIS – COMPUTER-ASSISTED ACTION INFORMATION SYSTEM

DESCRIPTION:

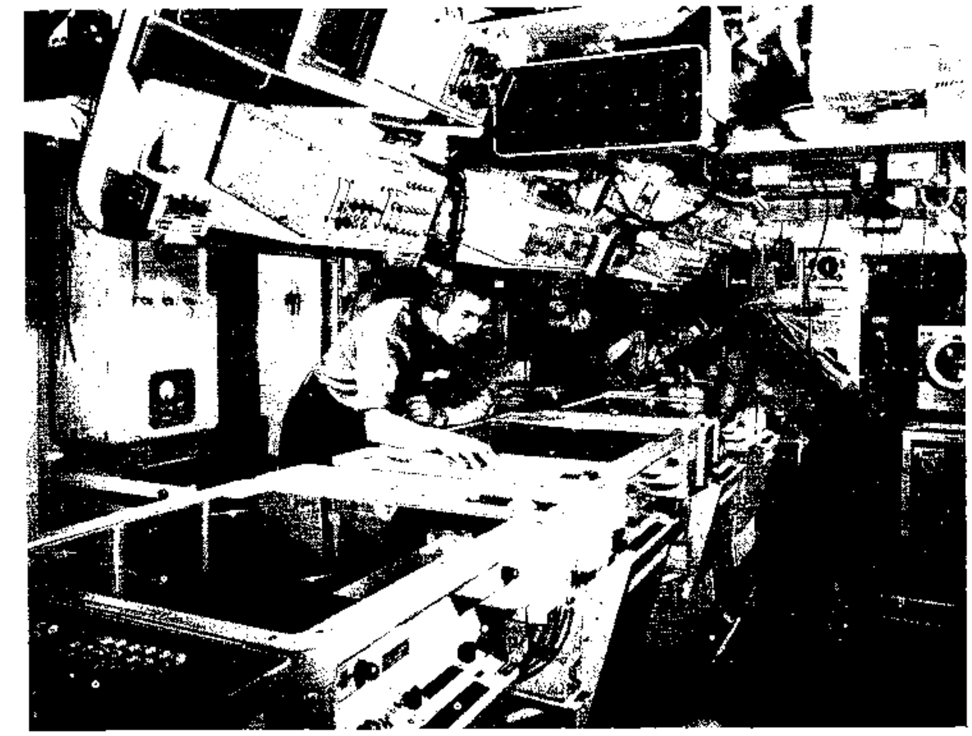
Shipborne operational data-handling and display system, based on the use of a digital computer (Ferranti FM1600B) but cheaper and less complicated than full action data automation systems.

OPERATION:

Optimal tactical appreciation and rapid deployment of naval units or weapons depends upon an accurate, up-to-date and clear presentation of the position, movement and identity of all friendly and enemy forces in the vicinity. Any one ship of a force may have vital information not obtainable by others; this must be passed to consorts and integrated with their own displays so that a common and unambiguous presentation of all information is available to the Command in every ship.

In 1966 MoD (N) recognised that solutions were possible using the techniques and principles previously evolved for the ADA systems. These were already fitted in larger ships of the Royal Navy, but a substantial reduction in cost and size would be essential if Computer Assisted Action Information Systems (CAAIS) were to be fitted in a useful number of anti-submarine frigates.

After deciding in principle that a system of viable cost, size and weight could be built largely from elements already available or under development in UK and in the light of operational experience already gained at sea, MoD (N) defined



Deccascan display consoles of the CAAIS installation on board the frigate HMS Torquay an operational requirement matched to the task. It permitted considerable reduction in complexity and cost by making full use of the man for assessment and decision while leaving the machine to collect, process and present tactical data and transfer it between ships.

In each ship of a force all available data on targets from own ship's sensors (including radar with auto tracking facilities, sonars passive direction-finding equipment) is injected together with a reference number – automatically or semi-automatically – into a computer which correlates it, stores, and calculates movement etc. Other input data includes navigational information from the ship's navigational equipment. Data thus stored is exchanged with consorts by digital data link so that each ship's store contains total and up-to-date information available to the whole force. This is presented – as required by individual users – by selection in alpha-numeric or symbolic form super-imposed on raw radar on a number of PPI displays. Data may be injected into store, altered or called up for presentation by operators using keyboards at the displays, which thus constitute the interface between man and machine. Data selected from the tactical displays can be transmitted for the direction of weapons.

Target designation is transmitted to weapon systems, and orders are displayed for helicopter anti-submarine attacks. Anti-submarine torpedoes may also be controlled.

A new approach to display and plotting techniques was also adopted for CAAIS, which led to the development of the Decca Radar Deccascan display system. This uses rotating coils for PPI deflection for the presentation of conventional radar data, and fixed coils for off-centring and presentation of symbolic and alpha-numeric 'labels'.

The Decca CA 1600 display employs a 16 inch (40 cm) CRT mounted with its face horizontal in a freestanding console. It is provided with a large parallax-free plotting surface. Two keyboard/tracker ball modules can be attached.

DEVELOPMENT:

Final development of the CAAIS was the responsibility of Ferranti as main contractor, and Decca Radar as principal sub-contractor. Development was in collaboration with the Admiralty Surface Weapons Establishment.

STATUS:

Two versions of the CAAIS were put into production in 1969 – DBA1 for general fitting or retro-fitting in ASW frigates of the Royal Navy, and DBA2 to be fitted in the Type 21 frigate. The Type 21 CAAIS installation will interface with the WSA-4 system installed to provide a two-tracker fire control system for the 4.5 inch Mk 8 gun and Seacat missiles. The first complete CAAIS to go to sea was installed on the training frigate HMS *Torquay* for sea trials in the latter part of 1972. CAAIS installations are in production or development for all Type 21 (Amazon class) and a number of Leander class frigates, and for HMS *Hermes* in her new configuration as a helicopter carrier.

MANUFACTURERS:

Ferranti Ltd. Digital Systems Department, Western Road, Bracknell, Berks, RG12 1RA, England – main contractor, development of digital equipment and software.

Decca Radar Ltd, Decca House, 9 Albert Embankment, London SE1, England – Deccascan displays.

1831.281

MINE COUNTER-MEASURE CAAIS

DESCRIPTION:

A contract worth approximately £750,000 was placed by the Ministry of Defence with the Ferranti Digital Systems Division in early 1974 to provide the first production FM1600B computer action-information system for the projected new class of Royal Navy mine counter-measure vessels (MCMV). Development of the necessary operational computer programs forms a major part of the work. This contract followed successful completion of a study project to assess the specific characteristics required of a computer information and control system for MCMVs.

The development of this special version of a computer-assisted action-information system (CAAIS) (see Entry **1046.261**) was entrusted to Ferranti by virtue of experience acquired by the Digital Systems Division in designing, installing and maintaining CAAIS systems for larger warships such as Amazon Type 21 frigates for the Royal Navy, HMS *Hermes*, and also the Mk 10 frigates now being built for the Brazilian Navy.

The new class of MCMVs have reinforced plastic hulls and one of the engineering tasks undertaken by Ferranti has been to reduce the magnetic signature of the computer equipment. At the heart of the system will be an FM1600B computer driving two Deccascan displays equipped with Ferranti manual input assemblies which enable operators to communicate with the computer by means of alpha-numeric keyboards and tracker balls.

The CAAIS system for MCMVs fulfils a triple role: it compiles and displays information with the speed and precision required for successful MCM operations; it makes the detailed calculations necessary for the accurate navigation and control of the ship; and, as in all CAAIS systems, it provides a comprehensive display of the tactical situation, such as would be required when the ship is on patrol duties.

The ability of the CAAIS system to automatically accept and process sensor information presents the Command with the ability to reduce errors and action-time operator fatigue, and generally to increase the MCMV's ability to meet its designated task.

MANUFACTURERS:

Ferranti Ltd, Digital Systems Division, Western Road, Bracknell, Berks RG12 1RA, England.

Decca Radar Ltd, Decca House, 9 Albert Embankment, London SE1, England.

1496.281

WSA-4 FIRE CONTROL SYSTEM

DESCRIPTION:

WSA-4, Weapon System Automation Mk 4 is the digital weapon control system designed for the new Type 21 ("Amazon" class) of RN Frigates. In these ships WSA-4 will interface with the Computer Assisted Action Information System (CAAIS– Entry No. **1046.261**) and, like that system is based on the Ferranti FM1600B digital computer. The system has been designed to fully utilise the capabilities of the Weapons and Sensors and minimise reaction times, whilst being capable of operation with a very small crew. Weapon direction and target designation is normally performed at a CAAIS display position. Targets selected at the display are indicated to the relevant tracker radars which are automatically controlled to search and acquire the target. Visual weapon direction facilities are also incorporated. Weapons controlled by the system are the Seacat missile and 4.5 inch (114 mm) gun used in conjunction with two Orion RTN-10X fire control radar equipments (see entry No. **1368.253**). The Orion radar heads are equipped with closed circuit TV cameras for Seacat operation.

The system includes facilities for operation in the event of breakdown or damage to the primary system. The Seacat can be aimed and fired in visual control from the Pedestal Sight while the gun can carry out surface engagements under the control of the Lookout Aiming Sight, with fire control corrections being applied at an Emergency Fire Control Box.

STATUS:

Trials of the first system in HMS *Amazon*, are at an advanced stage, and three further installations have been ordered for the following vessels in this class.

MANUFACTURERS:

Ferranti Ltd, Digital Systems Department, Western Road, Bracknell, Berks, RG12 1RA, England.

Decca Radar Ltd, Decca House, 9 Albert Embankment, London SE1, England.

1363.261

COMMODORE A I O SYSTEM

DESCRIPTION:

This is a flexible AIO system designed especially for small ships. It co-ordinates inputs of tactical data during operations and presents this in a readily assimilable form. It will solve all ship handling and tactical problems and output the directions to gun, missile and torpedo aiming systems while automatically keeping continuously updated tracks on up to 20 targets, with manually rate-aided tracking on more if required. If the system includes a data link Commodore will automatically format and compile messages for transmission to shore bases or co-operating forces. Incoming information is similarly accepted and processed for immediate display or action on board. The heart of the system is one of the Marconi-Elliott 900 series of digital computers.

All the operator controls and interfaces are flexible and logical for unambiguous input and output of data. The display facilities provide precise selection of part of the tactical picture area to the exclusion of all other information.

The interfacing facilities are designed for single logical control and consist of PPI, in relative, true motion or off-centred modes, for the presentation of an interlaced radar/symbol picture and a readout for track, supplementary information and solutions to tactical problems. Manual input to the system is by a rolling ball controller and keyboard, and there are also facilities for range scale and symbol category selection. One feature of the system is that all operating stations are completely independent.

OPERATION:

The Commodore will input from a radio link, radar, ship's log, heading gyro, stabilisation unit, visual, and the radar display. Information is then output to the radio link, the radar display, torpedoes, missile and gun stations. Individual system facilities may be selected from the following.

Radar:

Inputs accepted from up to 3 radars.

Auto track facility for tracking up to 20 targets.

Manual rate-aided tracking facilities as a backup and for additional targets.

Link:

Processing of data link information for exchange between co-operating units.

Search Radars:

Display of 8 bearing lines.

Display of search receiver fix and probability area.

Sonar:

Inputs accepted from up to 3 sonars.

4 sonar tracks each with 7 positions displayed in a 'ripple'.

3 datums each surrounded by 16 points representing a 'furthest on circle'

Log and Gyro:

Inputs accepted from log and gyro.

Capacity:

60 tracks (but max auto track 20 and max bearing 8)

Target Indication:
To 3 weapon systems.
Display Console:
PPI incorporating readout for display of target supplementary information, solutions to problems, and manual injection sequences.
Range scale selection.
Off centring and true motion available.
Category selection of symbols.
Radar selection.
Selection of radar or symbols or radar and symbols.
Rolling ball and manual injection keyboard.
Other Facilities:
Sonar contact association programme.
Helicopter control.
Solution of ship handling relative velocity problems.
Past positions of surface tracks stored for display on request.
Display of weapon danger zone.
MANUFACTURER:
Marconi Space and Defence Systems Ltd, Naval Division, Chobham Road, Frimley, Camberley, Surrey, England.

1828.261
MARCONI/SPERRY LIGHTWEIGHT GUNFIRE CONTROL SYSTEM

DESCRIPTION:
Sperry Gyroscope and Marconi Radar Systems have collaborated to create a cost effective Lightweight Gunfire Control System. Designed for any size of warship from fast patrol boats upwards, the system is capable of maintaining rapid and accurate control over small and medium calibre guns against air, surface and shore targets. The system is fully automatic, thus keeping manning requirements to a minimum – only one man, in an essentially supervisory role, is required to operate the system.
The main components of the system are:
(a) The Marconi 800 series autonomous tracking radar, ST802 (Entry **1508.253**).
(b) The Sperry Digital Predictor consisting of the Sperry 1412 Computer (Entry **1443.063**), associated interfaces and power unit.
(c) The Control Console, incorporating the display and control units for one man to supervise the radar, predictor and gun.
The total package is designed to be compact and lightweight, thus being suitable for installation in FPBs, Corvettes, Frigates, etc. The predictor uses a dedicated computer leading to operational simplicity and autonomous operation. The radar uses monopulse processing giving a significant advantage in that it is free from fade noise when compared with a conical scan radar. The system will control servo-operated guns with calibres from 20 mm upwards.
In order to make full use of the possible roles of naval guns the system offers three modes of operation:
(a) Anti-Aircraft (AA) for defence against high and low level air targets;
(b) Surface (SU) for use against surface vessels moving at speeds up to 60 knots;
(c) Naval Gunfire Support (NGS) including:
  (i) Direct Bombardment. This mode of operation is used for bombardment of a shore target visible from the ship;
  (ii) Indirect Bombardment. In this mode of operation the gun is trained on to a shore target using spotting corrections from a shore observer;
  (iii) Blind Bombardment. This is used to bombard a point defined by present range, bearing and height from map co-ordinates.
  (iv) 'Radar Assisted' Bombardment. This is used when a discrete radar echo ashore can be tracked. Offsets are then added using map co-ordinates to take account of the separation between the radar echo and the required target.
In SU and NGS modes, fuse computation is provided for use with star-shell and window. The system can also be used to give surveillance information by means of horizon search or sector scan.
DEVELOPMENT:
During 1973, aircraft tracking trials proved the ability of the system to acquire rapidly, and provide, smooth training and elevation signals to a typical AA gun. Firing trials using a medium calibre gun against surface and air targets, to prove the overall system, will take place in 1974.

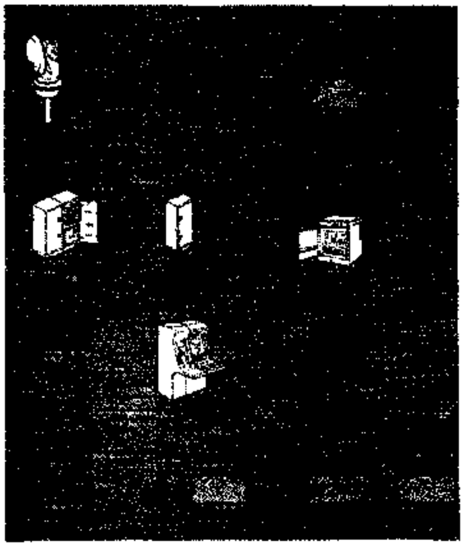


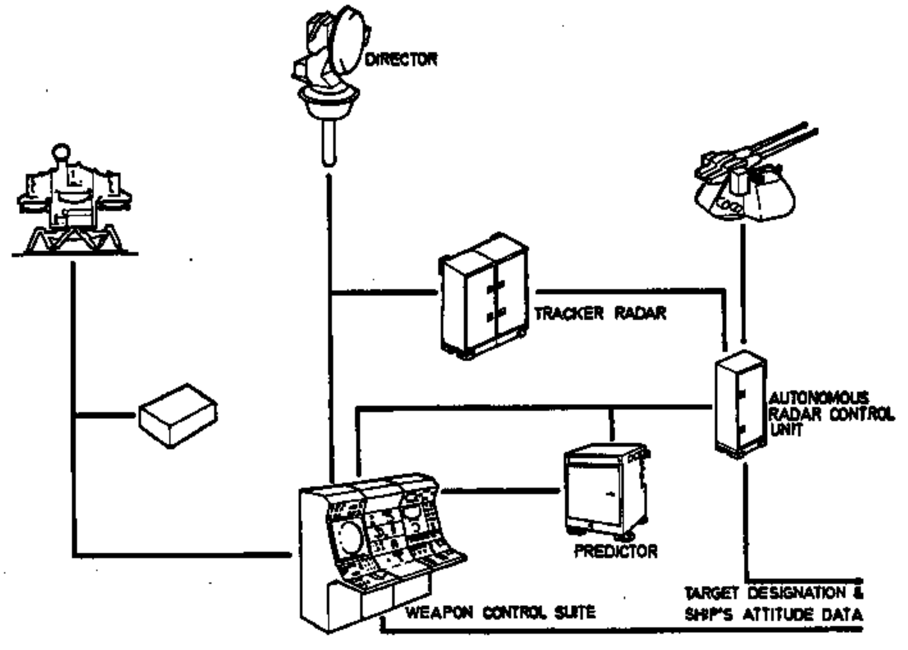
Diagram of Marconi/Sperry Lightweight GFCS

STATUS:
Proposals and submissions have been prepared. On the strength of the interest shown, small production quantities have been initiated by the two companies.
MANUFACTURERS:
Sperry Gyroscope, Downshire Way, Bracknell, Berkshire.
Marconi Radar Systems, New Parks, Leicester.

1829.281
MARCONI WEAPONS CONTROL SYSTEMS

DESCRIPTION:
The Marconi Company has followed the development of the 800 series radars with the development of integrated Naval Fire Control Systems for use with guns, surface-to-air and surface-to-surface missiles. There has been extensive co-operation with many UK companies, notably Short Brothers (Seacat missile) and Sperry UK Limited, (Digital Gunfire Predictor). The range of available systems is already extensive, and is being expanded to control different types of gun mounts and missile systems.
The Weapons Control Systems fall into three main categories:
1 Those based on surveillance radars – CS series;
2 Those based on tracking radars – CT series;
3 Those incorporating both surveillance and tracking radars – CST series

CS SERIES:
The Marconi Company manufactures a range of surveillance radars operating in the L, S and X-bands, and any of these with the appropriate Tactical Command System can form the basis of an effective anti-surface weapon control system as simple or as sophisticated as required. In its simplest form, the system provides target data to remote weapon systems. The addition of automatic track-while-scan facilities and a Sperry digital predictor allows control of a surface-to-surface missile system and guns against surface or shore targets. A limited anti-aircraft gunfire capability can be achieved by the incorporation of an optical sight for the provision of elevation data. These systems can constitute the complete fit for, say, a picket boat or may be used to update existing systems on larger vessels being retrofitted with surface-to-surface missiles.



CT Series system for gunfire control and dark-fire and blind-fire capabilities for the Seacat missile

CT SERIES:
These systems are based on fully-automatic light-weight tracker radar giving accurate space-stabilised target data for a variety of weapon

control systems. Packages already developed give a dark-fire and blind-fire capability to the Short Brothers Seacat missile system through the incorporation of a boresight television camera system, and accurate control of gunfire with the addition of a Sperry digital predictor. A system is available for the control of two different calibres (30 mm and 120 mm) and work continues to adapt the system to other calibres. The tracking radar is the Marconi ST802 (Entry **1508.253**), which provides automatic acquisition and tracking of targets. For acquisition the radar generates its own stabilised search patterns based on target range and azimuth data obtained via the Tactical Command System. It is an X-Band pulse doppler tracker with extensive ECCM facilities and is capable of continuous rotation in azimuth. It may be used to provide a stabilised horizon search which is particularly effective against low flying aircraft and sea skimming missiles.

The digital gunfire predictor provides accurate control of the light gun but, if required, a second gun mount may also be controlled. The tracking radar console includes a splash spotting display.

Defence against aircraft is provided by the Shorts lightweight Seacat control system. This has been developed jointly by Marconi and Shorts, and includes the ST802 tracker radar fitted with the Marconi V1000 TV system for automatic missile gathering. Two versions of the tracker are available providing ''dark fire'' and ''blind fire'' of the missile. In both versions the target is tracked by the radar, but for ''dark fire'' the TV is used to control the missile to the sight line. In the ''blind fire'' version the radar tracks both target and missile.

The packages are completely autonomous apart from the need for target indication and ship's attitude data; but also available is a version of the tracker (ST801) which can be controlled directly from the data handling centre of an existing action information system. In each system, the Tactical Command System incorporates the full range of status and control facilities at one location giving true autonomous operation.

CST SERIES:

This is a series of fully integrated systems comprising combinations of the various CS and CT systems. They are designed primarily for the modern Fast Patrol Boat and its enhanced fire power, but they also meet the needs of corvettes or larger warships. In the typical FPB system illustrated, any one of four surveillance radars may be fitted. They are all 200 kW X-Band radars, fully stabilised against ship's motion. The radars differ in size of antennae (1.25 metres for S810/811, 2.50 metres for S815/S816) and provision of digital MTI (S810 and S815). Air coverage is provided to 40 km.

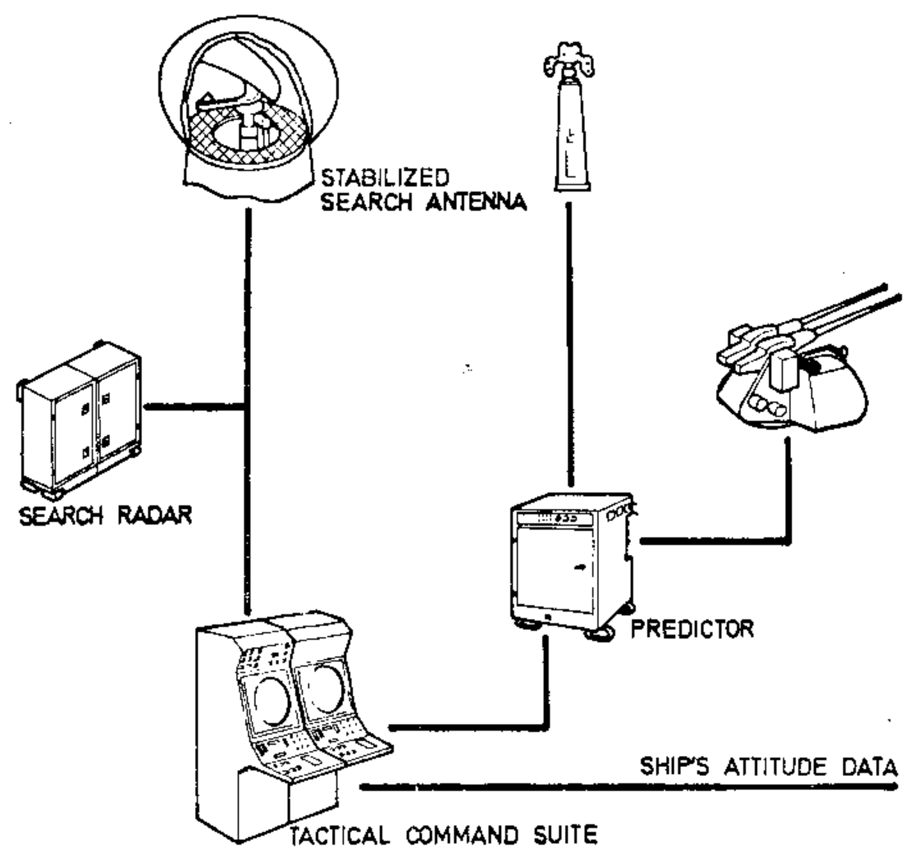
Target detection, tracking, threat evaluation and weapon assignment are carried out using the Tactical Command System which is tailored to meet the particular needs of the ship. Normally the ST802 tracking radar is used to provide accurate target indication data to the appropriate weapon systems, but for simultaneous engagement of air and surface targets, the surveillance radar is used for controlling gunfire against the surface target, and the tracker is used to control missile engagement of the air target.

Target tracking, gun and missile control facilities are identical to those provided with the CT series weapon systems. The tracker and surveillance radars utilise a large number of common components, thus keeping to a minimum the number of on-board or base spares required. Target indication data may also be transmitted to a surface-to-surface missile control system such as that for Exocet or Otomat.

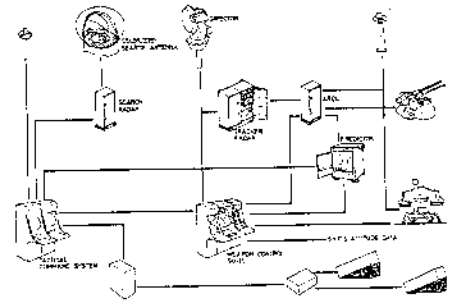
Additional sensors such as Electronics Warfare receivers and optical sights may be included in the system, to provide more comprehensive picture compilation and weapon control facilities. In particular Seacat can be controlled optically, as was the original version of the missile. A portable, on board radar simulator is available for operational training purposes.

MANUFACTURER:

Marconi Radar Systems Limited, New Parks, Leicester, England.



CS Series package providing radar control of a lightweight gun



CST Series fully integrated system for fire control of surface-to-air and surface to-surface missiles and a lightweight gun

THE UNITED STATES OF AMERICA

1666.261
GUN DIRECTOR MK 35 MOD 0

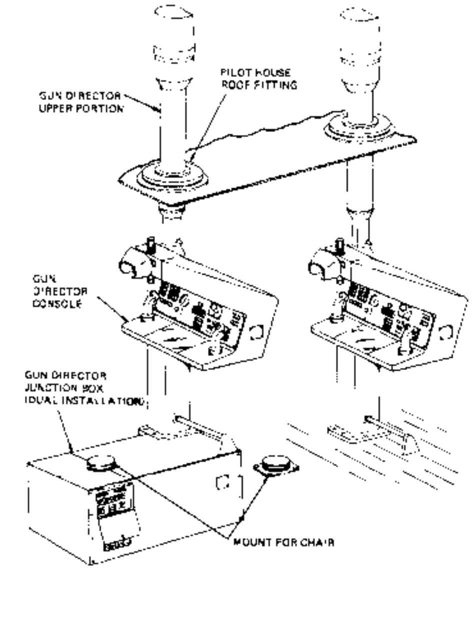
DESCRIPTION:

The Mk 35 Mod 0 Gun Director is a ship-board system for acquiring and tracking surface and air targets and engaging them with automatic gun fire. It incorporates a dual-power optical system, with day and night viewing capabilities, the line of sight being internally stabilised to the deck plane, to compensate for pitch and roll. The director combines inputs of radar (not part of system), computer, and optical scanning, under the control of the operator. Gun mounts, when under control of the director, are slaved to it.

The complete installation comprises two gun directors (No. 1 Forward, No. 2 Aft) with one junction box serving both directors. Each director head contains a head prism which can be rotated through 360 degrees (continuous) in azimuth and slewed in elevation between +80 degrees and −30 degrees. An image-intensifier tube can be interposed in the optical path to provide night vision capabilities. Controls and indicators are grouped on the two operator consoles associated with the No. 1 and No. 2 director heads. Provision is made for optical or radar ranging techniques.

MANUFACTURER:

Kollmorgen Corporation, Electro-Optical Division, Northampton, Massachusetts 01060, USA.



Shipboard installation of two Mk 35 Mod 0 gun directors

1832.261
GUN FIRE CONTROL SYSTEM MK 37

DESCRIPTION:
The GFCS Mk 37, although undeniably old and dating back to World War II years, is still in widespread use by many navies and was known to have remained in US Navy service until at least 1969. Because of a more or less continuous process of modification and improvement over a period of more than 20 years and at least 14 user nations, a detailed description of the equipment is virtually impossible. During this time various radars have been used with the Gun Director Mk 37 which provides stabilised optical and radar lines of sight to a computer (usually a Mk 1A) and, by tracking manually or with rate control, establishes and corrects target rates. Different users are likely to have changed the computer facilities to meet their own particular needs.
The main function of the system is the control of 5-inch/38 calibre guns against surface or air targets, but it has also been applied to the direction of 3-inch/50 calibre and 40 mm guns, as well as 6-inch and larger guns for barrage fire against air targets. The system has been installed aboard destroyers, light and heavy cruisers, battleships, aircraft carriers and some auxiliaries. It is also used as a battery control and a spotting station.

DEVELOPMENT:
Development was completed in time for the GFCS Mk 37 to see service in World War II. It has been the subject of various modification and updating programmes since production ceased in 1946.

STATUS:
A total of 1013 units were built, 413 by the US Naval Gun Factory and 600 by General Electric. Users, either current or within recent years, include: Argentina, Brazil, Chile, Colombia, Germany (Fed. Rep), Greece, Italy, Japan, Korea (S), Peru, Taiwan, Turkey, USA.

MANUFACTURER:
General Electric Company, Ordnance Systems, Electronic Systems Division, Pittsfield, Mass. 01201, USA.

2633.281
GUN FIRE CONTROL SYSTEM Mk 56

Gun Fire Control System (GFCS) Mk 56 is a shipboard, intermediate range anti-aircraft, gun fire control system designed for use against subsonic aircraft and surface targets.
Its primary functions are first to track aircraft targets and secondly to compute train, elevation, parallax, and fuse orders for shipboard guns. The system can also be used to control gun fire against surface targets and shore installations.
To accomplish its purpose, the system uses a radar sub-system for automatic tracking of either visible or obscured targets, an optical sub-system for tracking visible targets, an electromechanical sub-system for computing gun orders, and servomechanisms for operating the director power drives.
GFCS Mk 56 may be used against different types of targets under different operational modes. The computing sub-system is designed for optimum performance against the types of target most dangerous to own ship, which are incoming high speed torpedo planes, dive bombers, and medium altitude bombers. At slightly less effectiveness, the system can also be used against all types of surface vessels and shore installations.

SYSTEM FUNCTION:
The Mk 35 X-band radar is of conventional auto-follow design, the elevation and traverse error signals derived from the radar receiver when the target moves away from the radar line-of-sight being used to servo the radar antenna back on target. Inserted in the servo loop are the tracking control circuits which accept the error signal inputs and process them to produce, on the one hand, tracking signals for the antenna power drives and, on the other hand, elevation and traverse rate outputs to the fire control computer.
The tracking signals are passed to a gyro unit which modifies them so that the demands on the antenna power drives are modified to allow for the pitch and roll of the ship. The gyro and power drive units form part of the Gun Director, and from this sub-system are taken two sets of outputs to the computer, one set defining the target line of sight relative to the ship and the other set defining it relative to the gyro platform.
Other inputs to the computer are own ship's speed and course taken from the log and gyrocompass and target range from the radar. In addition values are set in for gun dead time and initial velocity and true wind speed and direction. From this information and the fixed displacements between the guns and the radar antenna the computer generates train elevation and fuse orders for the guns.

DEVELOPMENT HISTORY:
Development of the system was initiated by the US Navy at Massachusetts Institute of Technology in 1942 with industrial support furnished by the General Electric Company and the system went into service in the USA in 1947. More than 700 systems were delivered, and although production ceased in 1955 the system is still widely deployed, particularly in US forces but also in eleven other countries.

STATUS:
Obsolescent but navies known to have Mk 56 fittings in recent years are those of the USA, Argentina, Brazil, Chile, Taiwan, Colombia, German Federal Republic, Greece, Japan, Peru, Spain and Turkey.

MANUFACTURERS:
Complete System: General Electric Company, Ordnance Systems, Electronic Systems Division, Pittsfield, Massachusetts.
Computers: Librascope Inc; Reeves Instrument Co; Ford Instrument Co; Bosch-Avma Co.
Telescope: Kollmorgen Optical Co.
Radar: General Electric Co, Syracuse N.Y.
Wind Transmitter and Parallax Corrector: Reeves Instrument Co; Belock Co.

2634.281
GUN AND GUIDED MISSILE FIRE CONTROL SYSTEM Mk 74

Similar in general conception to the Gun Fire Control System Mk 56 (q.v.) the Gun and Guided Missile Fire Control System Mk 74 is a modern system that is both electronically and mechanically of far more advanced design. It is a shipboard system designed for the control of guns or guided missiles and with the capability of performing its target acquisition, tracking and control functions against targets flying at supersonic speeds.
Main elements of the system are the Gun and Guided Missile Director Mk 73, the Radar Set AN/SPG-51 and the Computer Mk 118. The radar is in two parts, the transmitter-receiver rotating with the director and antenna assembly and being connected to the remainder of the equipment through slip rings.

SYSTEM FUNCTION:
Weapon detection equipment (not part of the GMFCS Mk 74) designates targets to the radar, computer and director, and the radar and director synchronize to this signal. The computer then generates a search pattern which the director and radar follow until the target is acquired.
When the radar and director have acquired the target they track it under computer control. The range and angular error data derived by the radar are fed directly into the computer and the computer generates the rate signals that are used to control the angular motion of the director.
Once the radar and director are tracking smoothly the computer generates fire control data and transmits gun mount and/or missile launcher position orders to the appropriate stations. It also provides missile seeker angle data as appropriate.

STATUS AND MANUFACTURERS:
In current production as part of the Tartar weapon system.
Main contractor for Tartar: General Dynamics Corporation, Pomona Division, Pomona, California.
Gun and Guided Missile Director Mk 73: General Electric Company Ordnance Systems, Electronic Systems Division, Pittsfield, Massachusetts, USA.

2632.281
GUN AND GUIDED MISSILE DIRECTOR Mk 73

This equipment is a major component of the Gun and Guided Missile Fire Control System Mk 74, one application of which is to the Tartar surface-to-air guided weapon system. Gun and Guided Missile Director Mk 73 is an unmanned, amplidyne-controlled, direct-drive motor-driven 2-axis unit. It serves as a mount for the antenna and part of the electronics of another major component of the system – Radar Set AN/SPG-51. The radar line of sight can be rotated continuously in train and can be elevated from −30 degrees to +83 degrees relative to the deck plane.

DEVELOPMENT HISTORY:
In common with other Tartar sub-systems, development of the director began in 1956. The first prototype was completed in 1958 and the equipment went into service in 1960. Currently in production, 122 equipments have been delivered to date for use in US Navy and foreign ships. Four more sets were ordered in early 1974.

MANUFACTURER:
General Electric Company, Ordnance Systems, Electronic Systems Division, Pittsfield, Massachusetts, USA.

1241.281
GUN FIRE CONTROL SYSTEM Mk 86
DESCRIPTION:
This ship's fire control system uses three sub-systems, surface and air target radars, and a remote-controlled television system, for the direction of gun-fire against surface and aircraft targets. A general-purpose digital computer is employed for the rapid processing of target data, ballistics, and computation of range and training parameters for guns.
The radar for surface target engagement is the AN/SPQ-9, a track-while-scan system. The aerial is protected by a spherical radome of estimated diameter 300 cms. This is supported on a cylindrical pedestal about 300 cms high. The remote TV camera sub-system is mounted at the foot of the pedestal, and this probably also incorporates optical sighting elements. For use against air targets, a pulse-doppler and AN/SPQ-60 tracking radar is provided.
DEVELOPMENT:
Initial in-house studies were started by Lockheed in 1961, and the first prototype was completed in 1966.
STATUS:
Two prototypes had been delivered to the USN by March 1970. Production has started, and by March 1973 16 sets had been completed when a contract for a further 11 systems was awarded by the US Naval Ordnance Systems Command. This contract included an option to purchase a further seven systems, and this option was taken up in January 1974 to bring the total number ordered to 34. The Mk 86 GFCS is used in the US Navy's new fleet of helicopter assault ships (LHAs), Spruance class destroyers, and DLG(N)-36 and -38 nuclear-powered guided missile frigates.

MANUFACTURER:
Lockheed Electronics Company, Route 22, Plainfield, New Jersey 07060, USA.

1260.281
GUN FIRE CONTROL SYSTEM Mk 87
DESCRIPTION:
This is the US designation for the Signaal M22 system described in Entry No. **1259.261**. Licence manufacturing rights were acquired by Sperry Rand and procurement for the US Navy was authorised in 1964. A successful land-based evaluation was started in 1966, and a technical and operational evaluation was started aboard the USS *Antelope* in January 1968. Preliminary findings of these evaluations reveal the Mk 87 as far superior to the Mk 63 FCS now being fitted under the new ship construction programme. It was also stated to be cheaper over a 10-year life-span.
However, the only vessels in the approved new construction programme in May 1969, when the Mk 87 was reviewed by the Committee on Armed Services in the House of Representatives, for which the system was suitable were 20 tank landing ships and 10 motor gun boats. Secretary of Defense, Melvin R. Laird, stated that to fit the Mk 87 to these craft would delay their completion and therefore the decision to fit the Mk 63 should stand. Seven other vessels in future building programmes are planned to have the Mk 87, but its procurement in Fiscal Year 1970 was not required.

1835.281
FIRE CONTROL SYSTEM Mk 92
DESCRIPTION:
The Mk 92 FCS is under development for fitting in two new classes of USN ships, the Patrol Frigate and Patrol Hydrofoil, Missile, (PF and PHM). The latter is also known as the NATO Hydrofoil, since the overall programme of development and construction is being carried out in collaboration with W. Germany and Italy, who both plan to have essentially the same craft but differing in some aspects of weapon and sensor fits. One such variation is in respect of the fire control system: the Italian Navy will employ an Argo FCS, while the USN and German Bundesmarine will have virtually the same system, namely the Hollandse Signaalapparaten M28 which has been given the American designation Mk 92, and which will be produced under licence in the USA by Sperry Gyroscope. Details of the M20 Series of HSA fire control systems will be found in Entry No. **1359.291**, a few pages earlier in this section.
The Mk 92 is very similar to the M25 and M27 systems built by HSA for the Belgian, German and Netherlands navies, the former providing for control of air and surface engagements by guns and missiles, while the M27 additionally has provision for torpedo control. The Mk 92 will be used for air and surface actions using guns and missiles, and there are a number of other changes from the basic M25/M27 configuration to suit USN requirements. In compliance with the differing sensor arrangements and armament in the two classes of USN vessels to be fitted with the Mk 92 this system will be produced in different versions, and the Mk 92 Mod 2 for the Patrol Frigate. An Mod 0 version has been built for the initial test, evaluation, and proving procedures starting in 1974.
PATROL HYDROFOIL, MISSILE:
The USN variant of the PHM will have as its armament eight Harpoon anti-ship missiles (**2641.221**), and an Oto-Melara 76 mm dual-purpose gun. In addition to the co-mounted search and tracking radars which are a feature of the M20 Series fire control system, other sensors will include an X-band navigation radar, inertial navigation system, and an Electronic Warfare suite. Current plans call for a total USN force of 30 of these ships by 1977/8.
PATROL FRIGATE:
The new class of Patrol Frigate (PF) for the US Navy will have as its principal operational roles Anti-Submarine Warfare, Anti-Air Warfare including both anti-aircraft and anti-missile capability, and anti-ship missions. These ships will have a dual-purpose launcher able to launch either Harpoon surface-to-surface or Standard surface-to-air missiles. Other armament will include a US-built Oto-Melara 76 mm dual purpose gun (Mk 75).
The Mk 92 Mod 2 FCS for this class of vessel will operate within a more elaborate environment than the PHM's Mod 1 version. In addition to its own search and tracking radars (with integral IFF), other sensor equipment will include an AN/SPS-49 search radar, AN/SPS-55 X-band navigation radar, and an AN/SPG-60 STIR (Standard Target Illuminating Radar). The Mk 92 system's radar will be provided with an additional CW illuminating radar transmitter of US origin, and in the Mod 2 version the original Dutch digital computer will be replaced by a Univac UYK-7 machine. The complete Mk 92 Mod 2 is to be integrated with the ship's digital rapid reaction command and control system, which is one reason for the change of computer which eases the interfacing problems.
In the period 1974 to 1979 the USN plans to procure a total fleet of 50 PF ships, the current programme being for construction of the first seven vessels. Shore and sea trials of the Mk 92 will be carried out in advance and concurrently with building of the lead PF ship. Sea trials will be carried out aboard the USS Talbot (DEG-4).

MANUFACTURER:
Sperry Gyroscope, USA.

1307.231
SAMID – SHIP ANTI-MISSILE INTEGRATED DEFENCE
DESCRIPTION:
This programme is to a large extent the American response to the Egyptian sinking of the Israeli destroyer Eilath in October 1967 with a Soviet-designed Styx anti-shipping missile, and to other factors giving the US Navy concern regarding weapons of this type. These factors include, according to Congressional statements, continuing increases in the number and types of anti-shipping missiles available to the USSR forces; the variety of available launch platforms (ships of most sizes, aircraft, submarines and shore sites); and Soviet exports of anti-shipping missiles. Although struck from the Congressional record, it is believed that it was also stated that the USN had a limited capability to counter such weapons, apart from the capability to destroy the launch platforms.
Only very broad indications have been given of the means adopted to counter the threat of anti-shipping missiles under the SAMID programme. Improved passive electronic warfare sensors and active deception measures are among those known to be involved, and the use of chaff dispensing rockets to confuse the incoming missiles' radar homing is a further provision.
Relatively simple modifications have been evolved for several search radars to improve their clutter performance, and the man/machine interface.
Fire control radars were given the best available modifications (i.e. those that could be applied without extensive design or new research effort) to improve detection, acquisition and tracking capabilities against anti-shipping missiles. Another measure was a major effort to achieve far greater integration of the ship's active and passive sensors with all other elements of the ship. This was accomplished by the introduction of data transfer units, and has the effect of considerably reducing the reaction time to anti-shipping missile threats. It also permitted a better utilisation of the counter-measures and defensive weapons available.
On-board training facilities were also improved by the provision of an ECM signal generator. Type 15E27 and an AN/SPH-1 radar video recorder which enabled simulated attacks to be generated.
STATUS:
Active development continues, and the system will be installed initially in US Navy guided missile destroyers (DDG), "Belknap" class frigates (DLG), and "Gearing" class destroyers (DD). Evaluation is in progress in USS Towers (DDG).

1493.261
US NAVAL TACTICAL DATA SYSTEM
DESCRIPTION:

NTDS, Naval Tactical Data System is the designation given to the combinations of digital computers, displays of various types, and data links which are installed on US Navy ships for the on-line collection, processing, storage, and presentation of information from sensors such as sonar, radar, optical, and aircraft or ship consorts, via data link. NTDS also is engineered to interface with ATDS (Airborne Tactical Data System) and MTDS (Marine Tactical Data System). All three systems have the prime function of providing for automated organisation and display of information for command and control teams for such purposes as threat detection and assessment, and weapon-target allocation.

Although designed to a common concept, NTDS exists in a number of versions, varying in size and equipment complement according to the age of installation and the size of vessel fitted. The overall system has also been subject to a continuous process of updating since its introduction into service in the late 1950s. By 1969, for instance, three generations of display devices had been employed. The basic digital computer for the system, the AN/USQ-20, was preceded in some installations by other types, and newer NTDS will employ the Univac AN/UYK-7 (Entry No. **1467.063**).

STATUS:

By 1969, 30 USN ships had been fitted, in aircraft carriers, guided missile frigates and cruisers, and installations are now approaching 50 in number. Versions of NTDS are planned for most new construction attack vessels, the most significant being the 30 DD-963 destroyers to be built by Litton.

1834.281
AEGIS COMMAND AND CONTROL SYSTEM
DESCRIPTION:

Aegis represents the latest development in the evolution of AAW (Anti-Air Warfare) combat systems. The AN/SPY-1 introduces a fully automatic radar to perform search and tracking, and the use of a midcourse-commanded missile increases the firepower of the ship. The introduction of these innovations into the fleet with the attendant high target-handling capability brings a requirement for considerable expansion of automation in C and C and requires that command be exercised by negation.

The aspects of Aegis as an anti-aircraft and anti-missile weapon system are described more fully in Entry No. **2507.231**, in an earlier section of this volume, this entry being more directly concerned with the C and C features of the system.

Originally, Aegis was designed for installation in a 10,000-ton DLGN-38 class ship. The paragraphs that follow briefly describe this ship s combat system and the role of C and C within it.

The combat system of the DLGN-38 ship is shown in simplified form in Fig. 1. The Aegis part of the system consists of Radar Set, AN/SPY-1; Weapon Direction System (WDS), Mk 12; Fire Control System Mk 99 (consisting of a Tracking Illuminator, Mk 91 and Slaved Illuminator, Mk 90) the Guided Missile Launchers, Mk 26; the midcourse-command-version of the standard missile, SM-2; and finally the Aegis portion of the C and C system, Mk 130.

In addition to AAW, this ship also performs surface warfare and anti-submarine warfare missions. These missions, as well as Aegis, are supported by the additional sensors shown in Fig. 1 and by the gun and underwater-battery fire-control systems; the latter shares one of the launchers with Aegis. The C and C system integrates the Aegis and non-Aegis elements into a total combat system, and interfaces these elements with command personnel in CIC.

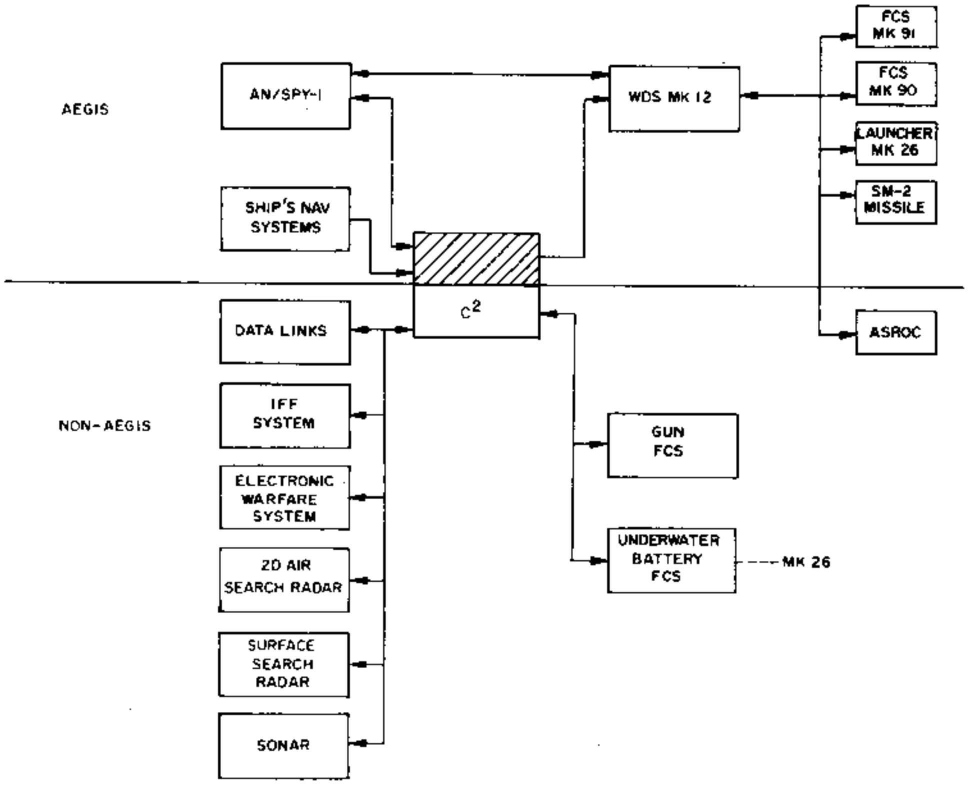


Figure 1. DLGN-38 Combat System

The baseline design of the C and C segment in the Aegis combat ship was based on the use of standard digital computers (AN/UYK-7) and associated peripherals, and an updated general purpose display system, Display Group AN/UYA-4. Auxiliary equipment in the system includes switching equipment, a digital clock, a magnetic disc and a multiplexer to allow non-C and C computers to assess the disc.

The operation of the Aegis weapon system is shown in Fig. 2. It begins with a search-and-detect operation by the phased-array radar. A detected target is placed into track by the radar and passed to the command-and-control system for evaluation. Once a target is determined to be a threat by the C-and-C system, orders are furnished to the weapon-direction system to develop a fire-control solution. Missiles are loaded on the launcher by commands furnished by the weapon-direction system. The phased-array radar furnishes target track data to the fire control system which designates the launcher firing position through the weapon-direction system.

After launch, the missile is guided by the phased-array radar until the homing phase of the flight at which time the fire-control system illuminator is slaved to target coordinates supplied by the radar, thereby furnishing the illumination on which the missile can home. Following intercept, the illuminator is available for the next threat. In the meantime, the multifunction phased-array radar, coupled with the multicomputer control system, continuously searches for new targets and simultaneously tracks targets already detected or engaged. The result is virtually instantaneous response to any new single or multiple threat that evolves.

The overall system control of Aegis is exercised through the console operators. These operators insert 'doctrine', select targets for various actions, and establish modes of operation. The UYA-4 consoles are usually co-located in a Combat Information Center (CIC) for ease of operator communications.

The ATC (Aegis Tactical Coordinator) is the lead operator. The main functions of the ATC are to supervise the overall conduct and operation of the CIC; insert tactical doctrine, threshold values, and own ship position data; and evaluate the computed threat potential of targets and assign weapons to the MSS/EC when required.

The MSS/EC (Missile System Supervisor/Engagement Controller) combines positions normally separately manned. He provides operator control of the weapon system. His main functions are to assign launcher and illuminator and mode of operation, monitor launcher and illuminator status, monitor engageability of selected targets, control firing and re-firing, monitor missile status, and monitor air engagements.

The SS (Sensor Supervisor) interacts with the Detector Tracker (see below) and provides a degree of track management. His main functions are to delete targets from the C and C system if the track load becomes too great, perform manual tracking using radar video displayed on the PPI, and enable use of SPY-1's burnthrough mode.

The DT (Detector Tracker) reports to the sensor supervisor in the organi ational structure. He has a direct counterpart in the NTDS system and does manual tracking in support of the SS.

MANUFACTURER:
RCA Government and Commercial Systems, Moorestown, NJ, USA. (Prime Contractor).

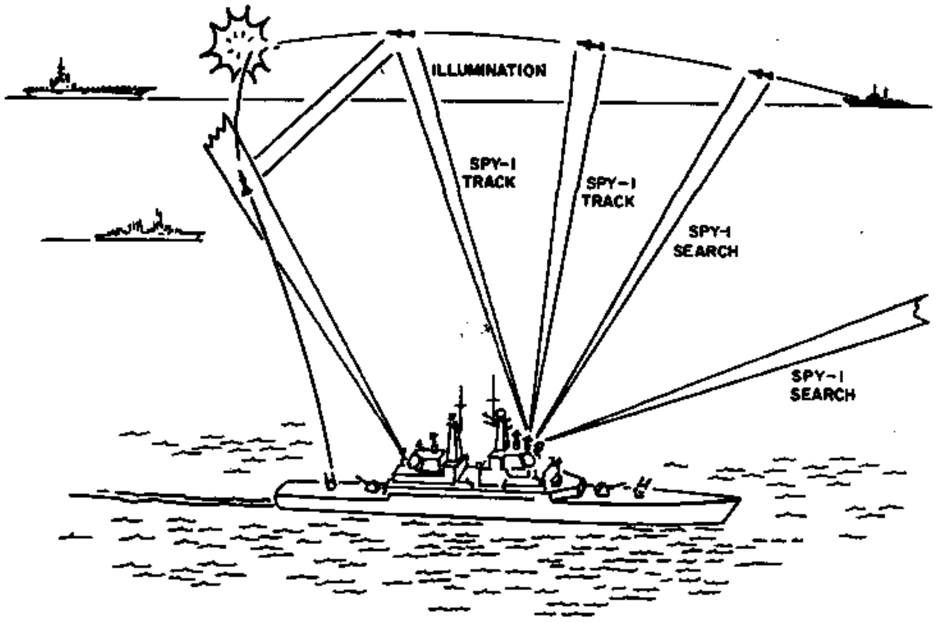


Figure 2. Weapon system operation

COUNTERMEASURES

1333.081
ELECTRONIC WARFARE SYSTEMS

Because, in general, the efficiency of a nation's electronic warfare (EW) systems and equipment is enhanced by denying possible opponents information on its operation, performance and the level of technology attained in this area, it is not possible to either apply the same treatment to this subject as that applied in Jane's Weapon Systems to other aspects of military equipment or to suggest that what can be described is representative of the latest state of the art.

Nevertheless EW is too important to be disregarded, and the following notes and entries have been compiled to enable readers to place in perspective what information is available and any other data which they may individually acquire.

EW Objectives:

Military electronic systems are mostly employed either to obtain information concerning an enemy, or to assist in the use of such information in support of one's own actions against that enemy. Examples are radar to detect and track targets, and radio command links to guide missiles to the targets. In this simple case the attacker would use ECM to (1) try to avoid detection, (2) prevent tracking, and (3) to interfere with the defender's missile guidance. The defender would employ ECCM techniques to counteract the attacker's attempts. He also would employ ECM to oppose those attacker's electronic systems that are necessary for performance of the attack.

Elint:

There is a whole range of EW equipment dedicated to the gathering and collation of as much data as possible within practically the entire electro-magnetic spectrum. This area of EW is usually referred to as Elint (Electronic Intelligence) or electronic reconnaissance. Companion disciplines, which can employ similar techniques but which have different objectives, are Comint (Communications Intelligence) and Sigint (Signals Intelligence). It is not proposed to elaborate upon these activities in this section but their principal function is the interception and monitoring of enemy, and possibly friendly or neutral, communications traffic of all kinds. Though this may on occasion yield direct information of military or political value, there are important secondary forms of data that can be derived from Comint and Sigint operations. These may range from indications of possible intentions which can be deduced from changes in the levels of signals activity in differing geographical locations, to tactical intelligence obtained by recording the locations of identified signal sources.

While overlapping communications monitoring to some extent, Elint is mainly concerned with the collection and analysis of electronic radiation from sources other than communications systems. Elint is performed on a regular basis in times of peace, prior to specific missions under actual war conditions, and during an attack.

Operations in the first of these categories have the basic objective of securing the maximum possible data on the complete electronic environment; on the grand scale, globally; at lower levels, within those areas of interest to any one nation. Depending upon the resources available and the military requirements, special ships, aircraft, and fixed and mobile land Elint facilities are employed, often operating to comprehensive reconnaissance schedules.

This branch of Elint may be termed 'strategic', and in the next three paragraphs the principal categories of information sought and the purposes to which it is applied are briefly discussed.

Ideally, all types of radars (land, sea, or airborne, for surveillance, fire control navigation etc) will be detected, located, and identified by their 'radar signatures' in all their operating modes (eg search, tracking etc), and their transmissions recorded. These recordings, which will contain the radar characteristics such as PRF (pulse repetition frequency) pulse width, transmitter frequency, modulation, etc, which constitute the 'signature' of a radar which enables it to be identified without being seen. Other electronic reconnaissance targets which are given similar attention are, navigation systems, command and telemetry links, and data links.

The information thus obtained is applied in several ways. Firstly, there is the straightforward intelligence function where the recorded signals are analysed for the purpose of establishing the likely function and mode of operation of each individual electronic equipment. This information may also permit an assessment of the equipment's and/or its associated system's performance. This in turn may make possible some evaluation of the state of the art attained by the nation surveyed.

Secondly, the types, numbers, and locations of electronic systems detected will enable an evaluation of the other nations' strength and intentions to be made. Regular monitoring may reveal potential changes in strategy.

Elint and its subsequent analysis will also fulfil a number of 'tactical' functions. Most direct in application is the use of the knowledge of opposing equipment in the development of appropriate ECM and ECCM equipment and procedures. At the tactical level, in war, special Elint missions may be mounted for the purpose of gaining data for use in planning a specific attack. Typical objectives might be the discovery of the number, types and locations of defensive search radars, missiles etc, and the level of activity in the target area, this data to be used in planning the best mode of attack and the ECM and ECCM tactics to be employed.

An extension of this which is typified by the latest American programmes is to employ computers and other sophisticated equipment to provide a very precise correlation between the location of emitters, defined by a variety of geographical reference frames, so that this information can be used for the guidance of air-to-surface weapons of various kinds for "defence suppression" purposes. DME (Distance Measuring Equipment) is one of the principal navigation reference systems under development for this purpose. Additional information will be found on projects such as PELSS (Precision Emitter Location and Strike System), ALSS (Airborne Location and Strike System), and the other reconnaissance aspects which come within the Pave Strike programme; and weapons, such as Maverick and laser-guided munitions, are described in the Air-to-Surface Missiles, and Reconnaissance Systems pages of Section One of this book.

ECM Objectives:

In broad terms, ECM are employed against an opponent's electronic systems with the objectives of denying him the information they provide, and frustrating the operation of opponent's electronic systems which threaten the realisation of the attacker's intentions. The paragraphs which follow contain examples of specific applications of the techniques which are available to achieve this overall objective.

The crew of a bomber aircraft in the course of an attack on a fixed target will be concerned to achieve the following objectives in turn as the attack develops: to avoid detection by enemy surveillance radar for as long as possible; to prevent tracking by radar after detection; to hide, if possible, the probable identity of the target; to prevent acquisition and tracking by artillery and surface-to-air missile radars. The ECM means available for fulfilling these aims consist of jamming systems which are intended to (a) deny the opposing radar any target information, (b) confuse the radar, or (c) constructively deceive it. The various means are further sub-divided into 'active' and 'passive' techniques.

Considering first, active jamming intended to completely neutralise the opposing radar, two main techniques are used, 'spot' or 'barrage' jamming. The former will normally be applied when the parameters of the radar to be jammed are known, and consists of the transmission of continuous noise on the frequency of the victim radar. Here it is necessary to briefly anticipate the description of ECCM which follows, and mention the techniques of rapidly varying the operating frequency of a radar to frustrate spot jamming. Several modes are possible, known variously as 'frequency agile', and 'frequency wild', or 'swept frequency' radars. These developments have in turn led to jammers capable of following the changes in frequency of the victim radar, and 'swept spot' jammers in which the jammer frequency is swept across a band of frequencies covering those of the victim radar.

The other main type of noise jammer is the 'barrage' or broad-band jammer, the output of which is simultaneously radiated across a whole band of the radar spectrum. This method can be more effective against frequency agile radars or in an environment where exact radar transmitting frequencies are not known, but it requires appreciably greater jammer output power to achieve comparable results to a spot jammer on a given victim radar channel. Where a spot jammer might prove effective with an output of 100 watts, a broad-band jammer could require an output of 10 kW.

The next category of active jamming is that known as deception jamming. Here the aim is not to swamp the victim radar with so much noise that the target return cannot be extracted, but to deliberately falsify the indications. This technique may also be used to confuse, by providing sufficient false, but realistic, data to the victim radar as to make extraction of the valid target data impossible. It will immediately be apparent to the reader that active jammers of this type are considerably more sophisticated than the straightforward noise jammers.

The main reason for their greater complexity is that the jammer's performance characteristics need to be more closely matched to those of each type of radar it is desired to counter. There is a need for far more detailed knowledge of the victim radar's performance parameters and modes of operation, both in advance and in the course of actual military missions. The latter requirement has to be met by on-board equipment designed to monitor and analyse the transmissions of the victim radar, while Elint will have furnished the advance data which is needed for the design of the ECM system.

Deception techniques are mostly directed toward either of the two principal elements of target data produced by a radar— range and bearing. In simple terms, the ECM system detects and analyses the illuminating radar's pulses, and having determined PRF etc, transmits on the victim radar's frequency reply pulses of greater amplitude than the normal reflected signal. This series of pulses, being stronger than the genuine target echoes, is then tracked by the radar's range-gate circuits instead of the genuine target echoes. By systematically altering the delay of the ECM-generated pulses, the victim radar produces erroneous range data indicative of a false track for the target. ECM sets of this type are usually referred to as 'range-gate' stealers or 'track-breakers'.

False bearing information is generated by the ECM system transmitting a strong pulse at a point in time when the victim radar's antenna is not pointing at the target. The false echoes, being stronger than the genuine returns, are seen by the radar as the actual target, in much the same way as the 'range-gate' stealer creates a false set of range data. To be effective the ECM system must be provided with means of establishing the victim radar's characteristics, and in particular its scanning pattern and rate.

Combination of the two foregoing techniques can be effected to yield an ECM system capable of generating a number of false targets, the spread and number of which it is hoped will make it impossible to identify the genuine target.

Other active counter measures include the use of decoy devices which can range from simple drones programmed to fly away from the attacking force along the most deceptive flight path, to more complicated devices which incorporate ECM equipment to simulate the electromagnetic signature of an actual attacking aircraft. They may also include their own ECM systems. The benefits to the attacker of such methods accrue from the deception and confusion they create and the overloading of the defensive system that they are capable of inflicting.

The most widely known and used form of passive ECM is that known as 'chaff'. In essence this consists of the dispensing of quantities of radar reflecting material, such as tin-foil, which has been cut to lengths approximately one half wave length at the band of radar frequencies which are of interest. This characteristic ensures a strong radar response, and the spread of large quantities of chaff produces effects which may be used either to conceal the true target or confuse the defending radar.

Although an aircraft attack against a land target has been used as an example, the fundamental ECM techniques described in that situation are also applied (with detail variations) to the majority of the remaining military situations in which opposing electronic systems confront each other.

So far in this discussion, ECM has been considered from the attacker's point of view, but ECM techniques are available, and are used, by the defender also. He too has much to gain by depriving his opponent of as much information as possible, and to this end passive methods of target detection are preferred to active methods (radar) where possible. For instance, the attacker will not know when he has been detected, or the locations of defensive radars if these are inactive. Passive detection systems, which rely upon the information that can be obtained from any electromagnetic radiations emanating from the attacker are widely used. Examples of typical equipments are described in later paragraphs.

Specific sources of radiation from the target which may provide a subject for this form of ECM are the attacker's radars (navigation, search etc), or conventional radio transmissions. The information that can be obtained by the defender by its use includes: warning of the target's presence, its bearing from the ECM detector, and such data as analysis of the recorded target signals yields.

ECCM:

Having set out the broad objectives of ECM, the objectives of ECCM can be simply summarised as those of rendering ineffective ECM, or if this is not possible, either reducing its effects or trying to turn ECM procedures against their users. One other general observation can be made at this stage. ECCM is mostly concerned with *techniques*, which are embodied in the design of electronic systems (eg a surveillance radar), whereas ECM usually requires a separate item of *equipment* which operates in its own right and not as an adjunct to another system.

As has previously been seen, the ultimate objective of most ECM systems is to either deny the opposition the information he seeks, to surround this with so much false data that the true information cannot be extracted, or to supply so much false data that the information handling capacity of the victim system is swamped. In terms of communication theory, all these aims represent varying degrees of degradation of the victim system's signal-to-noise ratio, to the detriment of its signal detection performance.

In the design of electronic systems, such as a radar, certain general basic principles apply when seeking to obtain the optimum desired signal detection probability. High transmitter power, good antenna gain, a narrow system bandwidth, and those means which drive an enemy to the use of a broader jamming bandwidth are all important.

All but the last of these desired qualities will be design objectives, quite apart from ECM considerations, if only to counteract the effects of natural noise. The last, however, represents a major ECCM activity.

Before going on to describe some of these techniques, it will be useful to consider some of the other design objectives in the context of their relationship with certain forms of ECM. Good directional properties in the antenna, and the minimising of side-lobes will reduce the amount of noise entering the system from directions other than that in which the antenna is pointing. This in turn will eliminate or reduce the efforts of jamming which is intended to produce false bearing information. However, any increase in antenna receiver gain obviously increases both signal and jamming equally when directed at the target.

Measures which can be adopted to force the enemy to spread his jamming over a broader bandwidth are based mostly on the various techniques for changing the operating frequency of the radar. These include rapid switching between a number of discrete frequencies, sweeping the frequency and random variations in frequency.

In meeting the challenge of more sophisticated jamming, i.e. that which attempts to obscure the genuine signal by false data having characteristics akin to genuine signals, instead of mere noise, more complex ECCM methods are required.

A fundamental concept upon which a number of such ECCM techniques are based is that of imposing on the transmitted signal some form of coding that will provide a means of positively identifying the returns. Such techniques may also have the additional benefit of making it more difficult for opposing ECM to generate spurious returns which accurately simulate genuine ones. The amplitude, phase and frequency of the transmitted signal may each be modulated according to a variety of coding methods, and the system receiver equipped with appropriate decoding circuitry to permit recognition of return signals. Other receiver techniques which are of use include coherent detectors and cross- and auto-correlation systems.

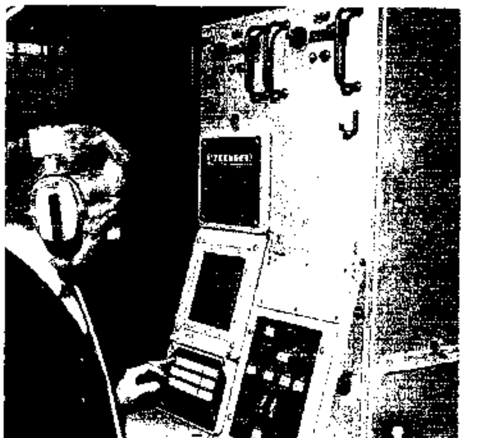
Each of the several different classes of radars (pulse, CW or Continuous Wave, pulse-doppler, etc) and the various modes of operation have inherent resistance to some forms of ECM, and also lend themselves to one or more specific ECCM techniques. Readers who wish to explore this wide subject more fully are referred to the numerous excellent texts on radar technology.

1378.091
ELINT EQUIPMENT

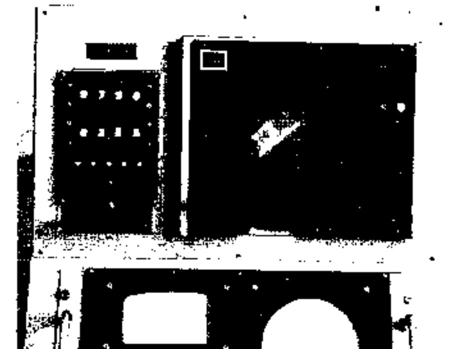
The prime requirements of Elint (Electronic Intelligence) equipment fall into three broad functional categories: detection, monitoring, and analysis. Although operational requirements and other factors will lead to equipment which is designed to take care of one or other specific aspect of Elint, certain desirable general design criteria can be stated. For detection and monitoring, receivers ideally will have the highest possible total bandwidth coverage, coupled with a narrow detection bandwidth for the examination of selected bands of interest in the spectrum. This latter requirement immediately forces a compromise between it and the need to provide sufficient detection bandwidth to ensure the acceptance of enough of the signal bandwidth to permit analysis. Good receiver sensitivity is a further requirement. Another characteristic of importance is that known as 'dwell time'. This may be paraphrased as the time a given receiver needs to look at a signal of interest before it is ready to go on to deal with another signal at a different frequency. This is conditioned by the performance of the logic circuitry used, the scanning methods employed, and recording limitations. The aim is to achieve the lowest attainable dwell time.

Three types of receivers for Elint use can be mentioned. Simplest is the 'wide-open' or video receiver which achieves a broad band response by the use of broadly tuned circuits. Such receivers frequently incorporate little or no logic circuitry, and as there is no frequency conversion, received signals are rapidly and relatively faithfully available for recording. Limitations of the type are lack of sensitivity and poor frequency resolution.

These deficiencies are mitigated in the second type of receiver in which banks of parallel filters,



Operator's console of the SUSIF, Surface Ship Intercept Equipment made by the MEL Equipt. Co. Ltd. The rectangular display presents the complete electromagnetic environment in terms of frequency band and direction of arrival of intercepted signals. More details of this equipment are given in Section Three



A compact EW installation of Decca RDL Series equipment (Entry No **1341.253***) in which the basic direction finder display (upper right) is complemented by additional units for frequency analysis functions*

each bank having progressively narrower pass bands, are linked by IF (Intermediate Frequency) stages in which signals passed through the preceding filter bank are converted down to frequencies lying within the collective pass band of the next bank of filters. As an example, the first stage may consist of three filters capable of passing signals 9-10 GHz, 10-11 GHz and 11-12 GHz, respectively. Therefore if an unknown frequency between 9 and 12 GHz is fed in, it can be determined in which third of this band its frequency lies by recording which of the three filters produces an output. If this output is then 'down converted' and applied to a second bank of filters which have a combined pass band of 1,000 MHz and individual pass bands of 200 MHz, the frequency of the signal can now be established to the nearest 200 MHz. Further converters and filter stages can be added to increase the resolution of the system. Logic circuitry is provided to establish those filters through which a given signal passes, this information being used to provide an indicator readout or printed record. This technique offers advantages of higher sensitivity and frequency resolution compared with the 'wide-open' receiver, but at the price of somewhat increased dwell-time. The latter effect arises since a signal passing through a sequence of filters inhibits those filters (and segments of the spectrum they monitor) until the measurement is completed. Newer technology, such as the use of digital computers to control Elint receivers, offers ways of increasing the speed of operation thereby mitigating the effects of higher dwell time.

The third basic type of Elint, or 'ferret' receiver, is that in which a sharply tuned circuit is manually or automatically swept across the frequency band of interest. Typically, this type of equipment consists of a superhet receiver with provision of accurate, ganged tuning of RF, mixer, and oscillator stages, generally under mechanical or electronic control. Means are also provided for recognition of signals of interest and interruption of the frequency scanning process while these signals are recorded or analysed. Compared with the two previous types of receiver, sensitivity is higher, but data rate is lower. Data rate can be increased by raising the scanning rate, but to the detriment of sensitivity and frequency resolution.

Emitter characteristics of interest for Elint purposes include, carrier frequency, PRF, pulse-width, antenna scan rate, antenna scan pattern, antenna side-lobe pattern, modulation (FM, AM, digital etc), and radars of all types, command links, etc, are the principal objects of attention.

Signal analysis systems and equipment vary considerably in the levels of sophistication employed and in the facilities provided. Some, such as the EMI Electronics Ltd SARIE (Semi-Automatic Radar Identification Equipment), are intended for use with existing direction finding receivers and interfacing with other ships' systems.

SARIE automatically analyses the video-data derived by the receiver from the intercepted radar transmission into a number of parameters, including pulse repetition frequency and pulse width. These parameters, together with certain manually determined data, are then electronically compared with a 'library' of known radar data. The result of the analysis and any identification arising from the comparison are presented on the Alpha-Numeric Display. Facilities can be provided for interfacing the output with a standard ship's teleprinter or Action Computing Centre. Compact, modular design is suitable for installation in new or existing ships, aircraft or other military vehicles with the minimum of modifications.

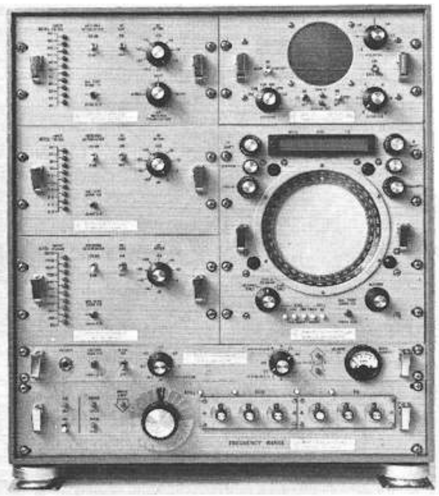
1379.091
EW DIRECTION FINDERS

In Entry No. **1378.091**, the detection and analysis of enemy electromagnetic radiations was discussed. If this information is to be fully utilised, the geographical locations of the sources must be established. This generally entails the use of direction-finding equipment, which exists in many forms to comply with differing operational requirements. Equipment of this kind is known by several names, most common being 'passive radar', 'RDF-Radio Direction Finding', or 'Intercept systems'. Direction finding techniques also play an important part in ECM and ECCM systems, in addition to their role in Elint operations.

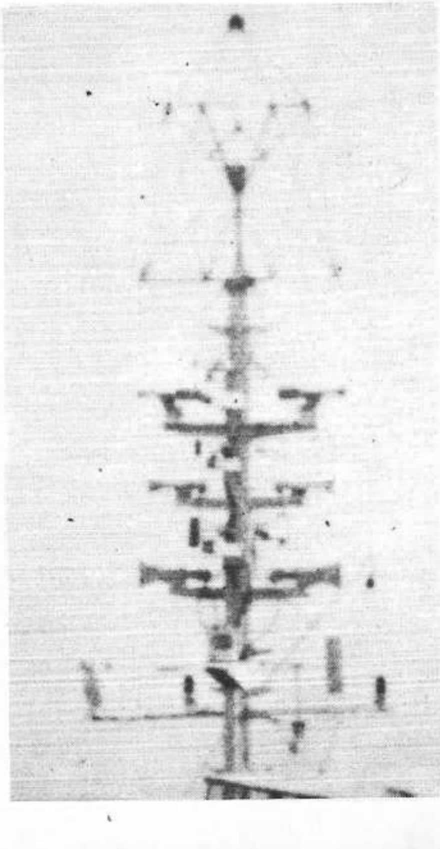
As might be expected from the diversity of direction finding applications implicit in the above, this results in a large number of types of equipment, designed to fulfil specific functions. Land-based systems, for example, will include those for detecting and locating potentially hostile emitters approaching or operating near friendly territory. These emitters may be carried by ships, aircraft or land forces. Other land-based direction

The antenna housing for the Decca RDL Series direction finding system can be seen clamped to the mast of the Vosper Thornycroft Tenacity missile boat. The fire control radar group is the Contraves Sea Hunter system

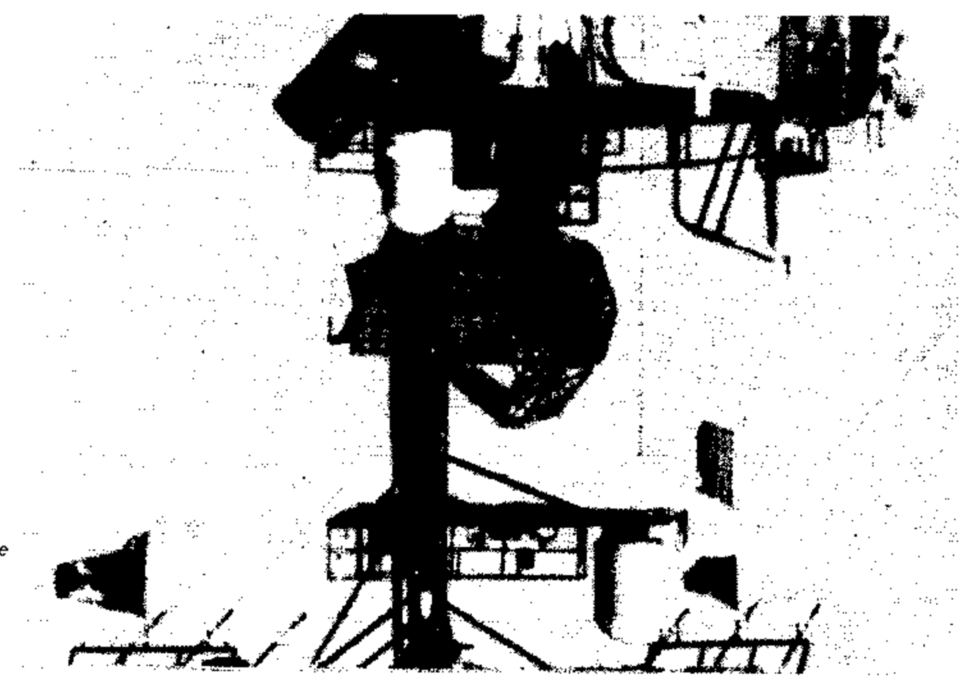
Direction finding antenna unit of the Canadian Model 100 shipborne DF system produced by General Precision Industries Ltd, Montreal. This system has a frequency coverage extending from VLF to VHF, the latter band using the lower array of 16 monopole elements. These can be arranged as crossed-Adcock and parallel dipole in both the horizontal and vertical planes of polarisation. The upper part of the array consists of a pair of multi-turn switched loops for LF and HF direction finding. The balanced dipoles are for sense



The operating position of the Model 100 three-channel direction finding receiver, which provides a wide range of surveillance and analysis features also. A similar, land-mobile version is produced as the Model 109



This mast-top array of antennas on a Royal Navy ship includes a Racal AE.701 HF DF crossed loop aerial, several sets of orthogonally arranged microwave horns (with the lower frequencies at the bottom) and various others



The three domed housings seen here on the USS Sample *appear to be the same as those shown in the nearby photograph of USS* Hepburn, *and are thought to contain 'spinning' antenna direction finder/ intercept equipments. Radar antenna is SPS-40, with X-band fire control radar at bottom left of picture*

finders may be concerned with surveillance of the electromagnetic environment in 'hostile' territory, as part of the overall Elint programme.

Naval forces require EW direction finders to give warning of opposing ships and aircraft, and in aircraft similar systems are used to locate a potential threat (air search radar, missile tracking radar etc), or a potential target.

Both directional and omni-directional antennas are employed, but the latter are more common, one reason being the unavoidable operational circumstance that the direction of arrival of a signal is not known in advance. Antennae are dealt with in more detail in entry No. **1380.091**.

Directional antennas of one form or another, designed to produce radiation patterns appropriate to overflying or 'sideways-looking' aerial reconnaissance applications, may be used on aircraft, drones, or satellites in support of Elint operations. Location of radiation sources is usually effected by the subsequent correlation of the recorded signals with navigational data, time, and the known characteristics of the antenna. Multiple observation of the emitter, and the use of triangulation plotting techniques, or variants of it, are typical of this method of location.

A type of EW direction finder which most justifies the use of the term 'passive radar' is that in which a directional antenna, rotated at high speed, is connected to a receiver. Such systems are generally employed for the passive detection of hostile radar transmissions, and provide bearing information of the source relative to the receiver. Thus, to some extent, the system operates as a radar without its transmitter. Broad-band provisions are made according to requirements to enable one system to cater for the detection of as many radar bands as possible. These provisions apply to both the antennae and the receiver. A high scanner rotation rate is necessary to increase the probability of reception of the hostile radar illumination. Representative relative rotation speeds are, up to 2-3,000 RPM for the passive radar, and 10-30 RPM for surface search radars. An example of this type of EW direction finder is given in Entry No. **1381.053**. Land, sea, and airborne equipment using this technique are in use.

Fixed antennas of several types also are used for direction finding, mostly relying upon monopulse techniques. To derive directional data by these methods entails more complex signal processing arrangements, and consequently systems of this sort are more usually employed in non-airborne roles, though their use in aircraft is by no means excluded. Ships' EW systems frequently include one or more systems in this category.

Two methods described by Sparagna, Oeh, Huber, and Bullock of GTE Sylvania, Inc (*Microwave Journal*, May 1971), illustrate techniques possible with antenna arrays of two or more conical log spiral elements, and broad-band spirals.

In a three-channel phase and amplitude comparison monopulse system, RF signals are received by each of four such elements and then combined in a beam-forming network to produce azimuth and elevation sum and difference signals simultaneously. The sum of the four element radiation patterns is characterised by a single beam with its maximum on the axis of the array. The difference produces a split beam with its null coincident with the axis of the array, and lobes in anti-phase on each side. Since the phase relationship between sum and difference patterns is in opposition to one side of the axis and in phase on the other side, the sense of signals arriving from left or right of the axis can be determined by phase comparison.

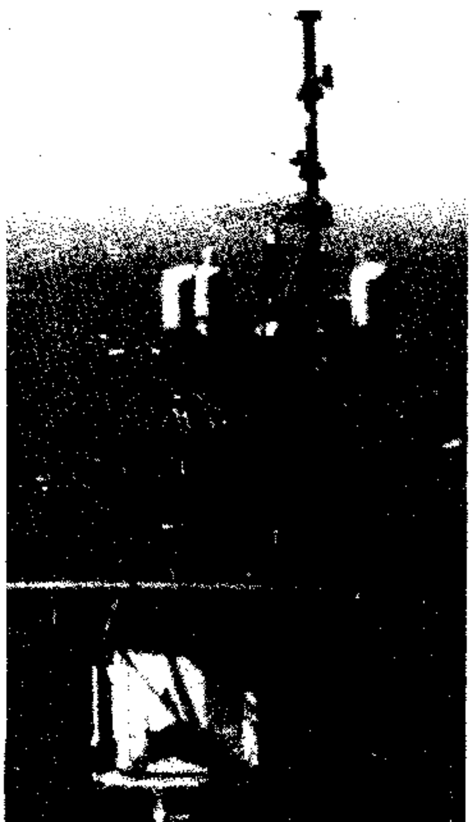
Precise bearing data is obtained by comparison of the amplitudes of the signals amplified in the sum and difference log IF strips, the output voltage difference being proportional to the ratio of the signal strengths received by the sum and difference patterns. The magnitude of this ratio is equated to the angle of arrival of the signal off the array axis.

A typical field of view for an array of this sort is in the region of 30 degrees, and RMS bearing accuracies of 2-3 degrees are quoted.

The other method described is phase comparison monopulse interferometry, in which the differential phase between two antennas is compared to determine the direction of arrival of an incident RF wave front. This defines the angle of arrival in one plane, and another, similar, channel is needed to determine the second co-ordinate angle. While it is essentially true that accuracy of such a system increases as the baseline between antenna elements is increased, this gives rise to ambiguity.

For multi-octave phase interferometry, measurement of frequency is critical in order to resolve phase and angle ambiguities. The multiple wavelength base-line interferometer referred to as the phase/phase technique can be used over several octaves. The antenna separation to wavelength ratio is selected for the interferometer baselines to provide a ratio that permits unambiguous angle determination once the frequency of the signal is measured. Broad-band planar log periodic spiral elements arranged to provide the interferometer baselines over the desired frequency range of the system are used.

Lobe comparison systems, of greater or lesser complexity than those described above, are employed with suitable antennae to fulfil a variety of other operational functions in addition to that of Elint. In aircraft, for instance, Radar Homing And Warning (RHAW) systems which alert the crew to the fact that their aircraft is being illuminated by radar, generally provide an indication of the direction of the threat.



This picture of the upperworks of the USN escort, USS Hepburn, *shows a variety of EW antennas. The three dome-topped housings probably protect 'spinning' aerial DF and intercept equipments for various parts of the RF spectrum, and other aerials can be discerned arranged around the drum-shaped section of the mast. Near the bottom of the picture is another small assembly of eight horn antennas in a group which also may be for microwave direction finding*

1380.091
EW ANTENNAE

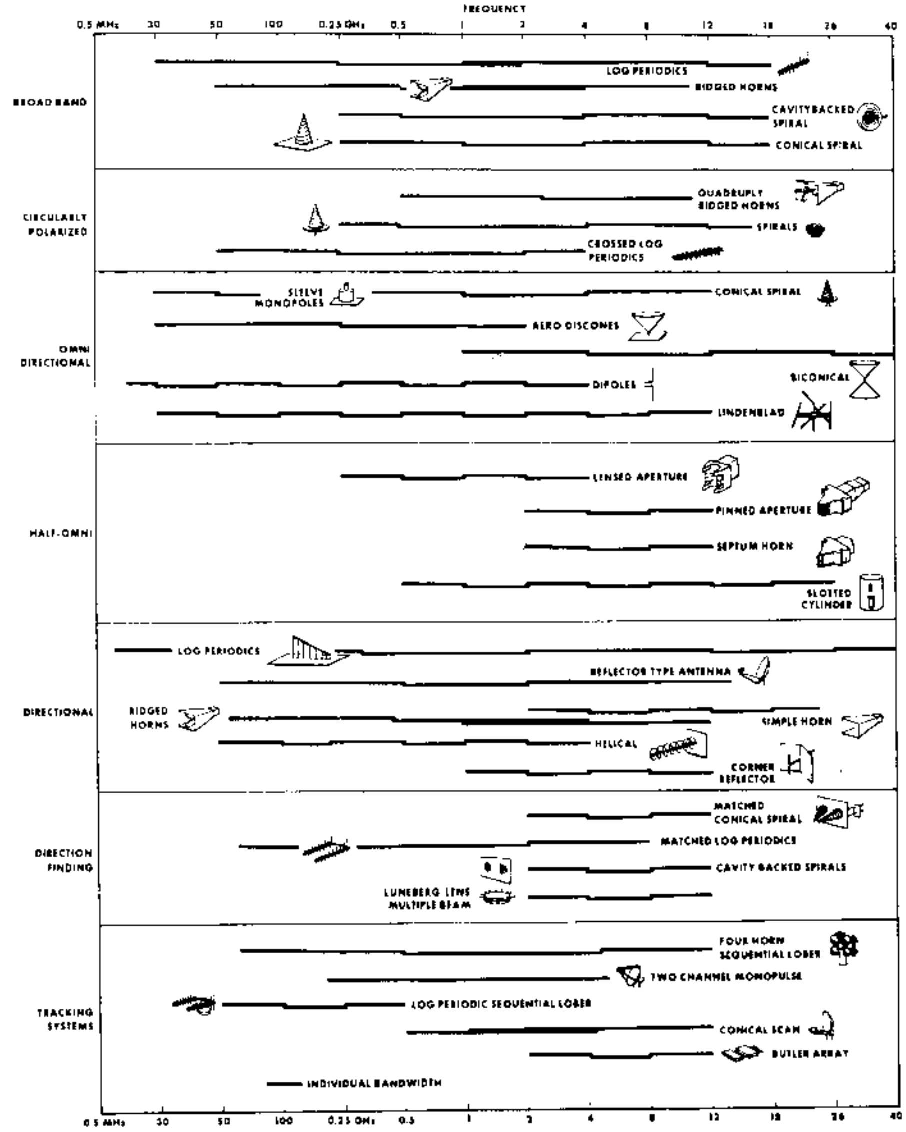
Antennae for EW applications are as widely varied as the numerous functions of EW itself and the differing constraints imposed by the requirements of operation from mobile platforms of all types, and fixed bases. Much of antenna design still remains nearer to art than science, which leads to a situation where secrecy concerning new developments is likely to be rewarded by greater dividends than in other areas of military technology which have been more rigidly formulated. For these reasons the following paragraphs contain descriptive notes of examples of those types normally found in EW systems only. Practically all other types find application in one or other area of the overall EW activity, but are treated fully in many textbooks.

As the previous paragraphs on other aspects of EW have indicated, normally conflicting design objectives such as broad-band operation, high gain/sensitivity, good signal-to-noise performance, etc have to be faced. These and similar problems are encountered in EW antenna design.

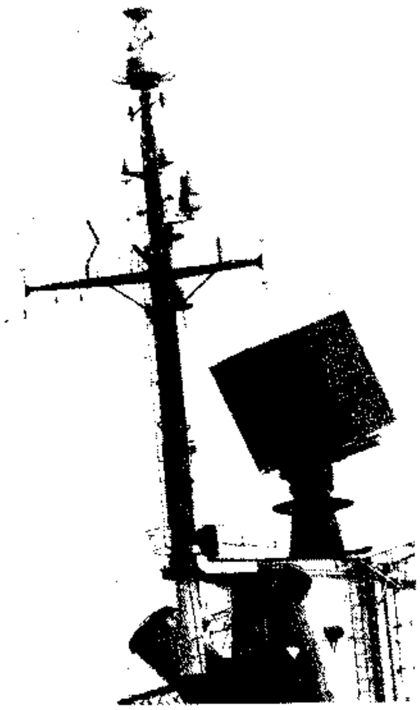
Pairs of bent dipoles, arranged to form a turnstile array, provide hemi-spherical coverage and circular polarisation. This is a type of antenna commonly met on naval vessels for monitoring purposes, and can often be identified as a symmetrical installation of four tapered 'thimble'-shaped radomes on a flat base-plate.

Log-periodic antennae of various types are widely used, and this form of antenna is valuable for both its broad-band and directional characteristics.

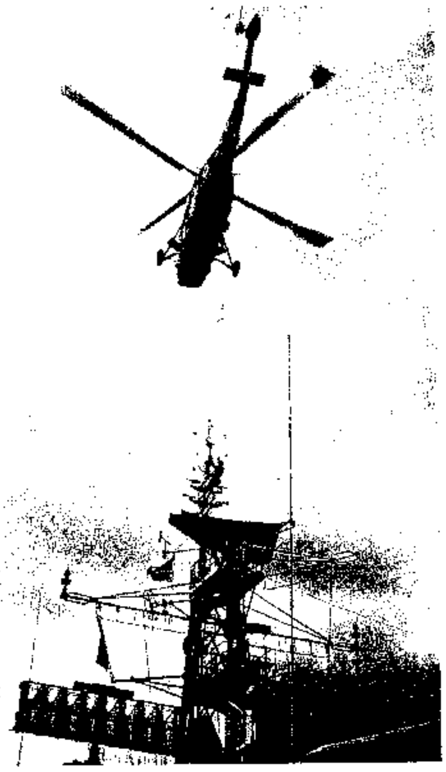
The spiral in its several forms is a particularly useful EW antenna type and has applications on ships and in aircraft. Two or four-arm equi-angular cavity-backed spirals are widely used for the broad band, circularly polarised and good directional properties they exhibit. They are particularly suited to aircraft installation because of their small size and flush mounting possibilities. Spiral elements are frequently used in precision broad-band direction finding systems such as amplitude monopulse, two-channel phase and



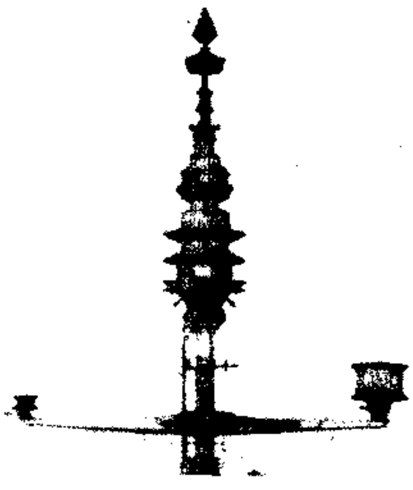
Typical antenna frequency characteristics (Sylvania Electronic Systems)



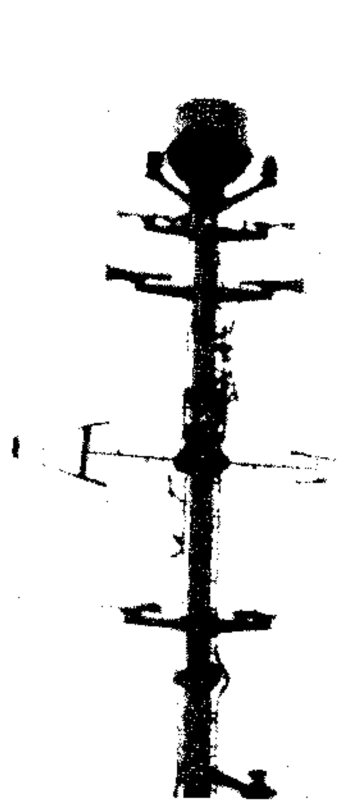
Mast of the Italian ship Vittorio Veneto *carries a varied array of EW antennas. Three-dimensional radar antenna (right) is SPS-52.* (Photo: D. Starck)



This RN picture shows a helicopter lifting into position an HF direction finding antenna on HMS Leopard. *Below this are a number of horn antennae for the reception of microwave signals*




Two views of EW antennas on mast of HMS Fife show later addition of what is probably microwave absorbent material to prevent interference with Type 992Q search radar (lower right)



Electronic warfare aerials on the mast of a Royal Netherlands Navy ship. Microwave horns can be seen, with an array of four log-periodics

amplitude monopulse, and double-base interferometer arrays.

A related type of antenna is the Archimedes spiral, and this form, allied to a serpentine effect introduced into the spiral, in the Raven AM-139 is stated to permit either smaller physical dimensions for a given performance, or an electrically larger antenna for the same physical dimensions.

Phased arrays of equi-angular spirals are employed to form simultaneous multiple beam DF systems. One array produced by Sylvania Electronic Systems consists of five 'venetian blind' slats each of which carries 16 spiral elements and is capable of being rotated (with the other slats) to increase the gain of the beams off the broadside position.

Matched conical spirals with beam-forming networks can be used to form arrays for monopulse and other direction finding methods, as previously described. Such arrays are more frequently encountered on naval vessels and can often be distinguished by relatively large 'thimble' protective radomes on the superstructure.

In the field of antennae for active ECM purposes, the use of phased arrays to provide beam agility is a subject which is currently receiving considerable attention, but upon which little information is available. So-called multiple beam antenna systems are similarly under energetic development in this context. Stripline techniques, which eliminate the heavy and complex waveguide arrangements previously required, are significant in the development of the latter.

1492.091
ACTIVE ELECTRONIC COUNTER MEASURES

INTRODUCTION:

Within this broad category of Electronic Warfare are contained those systems and equipment which seek to deny an enemy the proper use of his electronic systems by the use of radiation(s) on one's own part. Two main classes of equipment are employed. These are described by their general mode of operation, and are 'noise jammers' and 'deception jammers', respectively. The terms are self explanatory. The former has the objective of injecting sufficient noise into the opposing system (radar, command link, etc) to render it inoperative, while the second is designed to give protection by more subtle means which usually are intended to deceive. This is often achieved by the generation of enough false targets to make it impossible to establish the genuine one, or to produce a single, strong false target for an opposing radar to lock on to while the real target goes untracked.

NOISE JAMMERS:

The principal criterion in the design of noise jammers is the realising of maximum noise-power density at the opposing receiver(s). A jammer transmitter capable of an output of 100 watts and a bandwidth of 10 MHz radiating on one X-band radar frequency would produce a noise-power density of 10 W/MHz. The same output spread over a bandwidth of 1,000 MHz would yield a noise-power density of 0.1 W/MHz.

The former type of jamming corresponds to what is known as spot jamming, and the latter to broad band barrage jamming. Among the ECCM available against the former are the various methods of varying the operating frequency of the subject radar. To meet this, and additional to the broad-band barrage technique, jammers can be made to sweep a band of frequencies, the rate of sweep being optimised to produce the greatest coincidence with the subject radar's frequency usage, or to monitor and follow changes in the subject radar operating frequency. There are thus a number of compromise options available in the design and tactical use of noise jammers.

If sufficient space and prime power can be provided to permit a reasonable noise-power density to be achieved, broad-band barrage jamming is generally preferable, especially in regard to such ECCM as frequency agility which modern microwave devices are making increasingly attractive.

An ALQ-87 ECM pod beneath an F-111A aircraft

A type of ECM system extensively employed by the American air forces in Vietnam is based on the use of pods specially equipped to fulfil one or more ECM roles. The ALQ-71 barrage jamming pod contains sub-systems for noise jamming in the L-, S-, and C-bands of the radar spectrum. The pod weighs about 150 kg, is 3 m long, and 25.4 cm in diameter.

Separate units contain pairs of jammers for each of the three radar bands. The noise signals are radiated by blade antennae, six in all, on the underside of the pod. These provide both horzontally and vertically polarised signals. At least 700 of these ALQ-71 systems have been produced for use on F-4, F105D/F, F-101, T-23, B-57 and RB-66 aircraft, and they are used to give protection against air surveillance radars and surface-to-air missile battery radars.

Another pod system, the ALQ-72, operates in the X-band and is designed to counter airborne intercept radars. Noise signals are radiated from a rear facing horn projecting beneath the pod which weighs 91kg and is 2.5 m long. Over 300 have been produced and it is used on the same aircraft types as the ALQ-71.

Noise jammers used on the B-52 include the ALT-13/28 carcinotron noise jammer, the ALT-16/31 travelling wave tube barrage jammer, and the ALT-15/32. US Navy jammers include the ALQ-31, ALQ-55, ALQ-76, ALQ-78, and ALQ-91, for airborne use, and SLQ-12A, SLQ-17, SLQ-19, and SLQ-21 equipment for shipboard applications.

DECEPTION JAMMERS:

Most deception jammers have the objective of replacing genuine radar target data with information which is false in respect of range or bearing, or both parameters. The basic essentials for this to be achieved are a means of generating a replica of the subject radar's signals at a higher power level, and arrangements for systematically controlling the transmission of the false signal in time, relative to the subject radar's parameters. Those of the latter which are of principal concern are PRF and antenna scanning rate. Thus, it is implicit that the jammer also incorporates certain facilities for the analysis of radar signals reaching the aircraft.

Considering first the generation of false target information in respect of range, a pulse on the correct frequency and of the current waveform, if transmitted 12 micro-seconds after receiving the radar's pulse, will produce an effect at the subject of a target one nautical mile further from the radar than the actual range. If the subject radar's PRF can be accurately and successfully predicted, it is possible to anticipate reception of the pulse at the target and for the jammer to transmit the false reply early, thus producing a false, shorter range indication. This suggests one ECCM, variation of the radar PRF.

To produce false targets at other than the genuine bearing from the subject radar, the antenna scanning rate is determined, and pulses are transmitted by the jammer on a systematic basis when the radar beam is not directed at the real target. Factors determining the efficiency of this type of jamming are the radar antenna sidelobe and gain characteristics, and the power available from the jammer. Range, of course, influences the relative effects of these parameters.

The above remarks apply essentially to the jamming of non-coherent radars. In the case of coherent systems, the jammer must be able to maintain the correct phase and frequency stability relationships with the subject radar for the false reply to be accepted by the radar receiver. Deception jamming is made more difficult by the adoption of pulse-compression, matched filter, and pulse coding techniques. One method of coping with such ECCM is to employ a jammer-repeater, in which instead of attempting to generate a replica of the radar's transmission, the received signals are delayed by a controlled length of time before re-transmission.

Principally, these jamming measures are employed to frustrate surveillance and search radars. For tracking radars different jamming techniques are required.

At its simplest the track-breaker technique involves overlaying the genuine target echo with a false one (when the tracker radar has locked on), increasing the power of the false echo, and then varying the false echo so that as the radar remains locked on to the stronger echo, false target data is generated.

Tracking systems using conical scanning can be jammed by sensing the scan rotation rate, and modulating the false echo at the same frequency. This has the effect of causing the tracking antenna servo system to point the scan in an incorrect direction. The extent and direction of this deflection are dependent on the amplitude of the modulation and its phase relationship with scan rotation.

A more recent concept in the active jamming field, mainly directed towards creating confusion and/or saturation in the opposing radar environment, is that of expendable jammers. This idea has been the subject of substantial research and considerable debate in the USA, and the outcome is not yet clear. Specific proposals which have been made include the 'seeding' of planned areas of operation by numerous jamming transmitters supported by parachutes, and possibly switching them all on simultaneously by command link. Other functions, such as tuning, might also be performed by similar means from a control aircraft.

1497.091
PASSIVE ELECTRONIC COUNTER MEASURES

DESCRIPTION:

Within this category of electronic warfare are those means of combating opposing radars which do not rely upon the use of transmissions. It includes chaff, decoys, radar absorbent materials, and more latterly, the incorporation of certain design features in targets such as aircraft that have no other purpose than to reduce the effective radar cross-section.

Of these, chaff is the oldest, still the most widely employed, and most varied in form and application. Chaff consists of lightweight metallic dipoles of dimensions corresponding to those of dipoles at or around the radar frequencies it is desired to jam. By resonating at these frequencies, when deployed in great numbers, clouds or corridors of chaff produce a very large radar back-scatter cross section. This property is exploited tactically in many ways to counter specific threats, and results in a considerable range of equipment for the deployment of chaff.

Physically chaff is generally of either thin metal foil or a metallised glass or plastic. The latter materials are newer, although metal foil or wire may be used in some instances. Advantages of the more recent substitutes are better dispersion after ejection, lighter weight, and better packing density.

The use of metallised glass fibres, which are of about one mil diameter, permits roughly twice the number of individual dipoles to be packed in a given volume as occupied by aluminium foil. The former material is also more convenient for the longer dipoles which are necessary for countering radars operating in the lower frequency bands, S- and L-bands, for example. Bundles or balls of fibres cut to varying lengths to cover several frequency bands are employed, and these are contained in small cardboard packets which fly open after being ejected from the chaff dispenser. The slipstream then causes each ball to rapidly break up into individual strands over a wide area.

A typical chaff dispensing system used by US forces is the ALE-32 which is capable of ejecting both chaff packets and infra-red flares, the latter as decoys of infra-red homing missiles. One installation of the ALE-32 is in a pod-mounted system in which two ALE-32 dispensers and their magazines (3 per dispenser) are located in a back-to-back configuration. Up to six of these pods could be carried by USN EA-6A ECM aircraft but two is the normal complement. A variety of release programming options is available to the aircraft crew.

Another dispensing technique employed consists of a rocket which is projected ahead of an attacking aircraft to provide protection by creating a chaff cloud between it and the defending radar(s). An example of this is the ADR-8A carried by USAF B-52 bombers, which is fired from the ALE-25 rocket pod.

The ejection system as used in the ALE-32 is electro-mechanical, and other examples of this type are the ALE-24 and ALE-27. The latter is a repackaged version of the former, and both are installed in different models of the B-52. In the B-52 G and H, the ALE-24 consists of four 5-channel ejectors located in each wing of the aircraft, each ejector being capable of releasing 10 packets of chaff per second. In B-52 C to F models, the ALE-27 installation comprises four ejectors on each side of the rear fuselage.

Alternative ejection methods include pneumatic and pyrotechnic. The ALE-28, used in the F-111, is of the former type and uses compressed nitrogen to expel chaff packages from dispensers housed in the rear of the fuselage. Each dispenser has two independent magazines under the control of a remote timing and control unit in the cockpit. The ALE-29A has two separate dispensers, each having 30 launcher tubes for individual packets of chaff. These are ejected by electrically fired impulse cartridges. Firing can be programmed to permit bursts, or salvoes, of packets of varying sizes to be fired at various intervals on an automatic basis. The ALE-29A was initially developed for carrier-borne aircraft.

The uses of chaff for the defence of naval forces, especially from radar homing missile threats, are a subject of considerable study. In this context there is a potential advantage over the aircraft uses of chaff in that the far smaller ratio of target speed to chaff cloud speed in the surface ship case renders discrimination between the two on this basis far more difficult. Depending upon tactical requirements and the resources available, chaff could be dispensed from aircraft or helicopters, but in addition to these methods, ways of making surface vessels self-sufficient in this respect are under examination. One technique, which has been used on the USS *New Jersey* is an adaptation of the Zuni rocket, which is used to carry a chaff payload some kilometres from the ship before dispersing the chaff by explosive means. There is also a requirement for shorter range rockets or mortars which would be capable of rapid and accurate response to meet the threat of low-altitude anti-ship missiles.

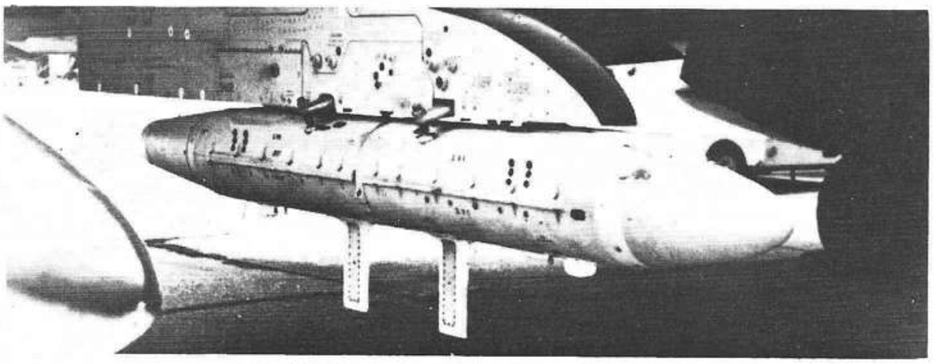
A variety of devices based on similar principles to those of chaff technology have been developed by USA as 'penetration aids' for ballistic missiles, with the objective of confusing detection and tracking radar systems. Some are identical or similar to those used in conventional airborne

This photograph taken from an RN Phantom of a Soviet Badger bomber shows what is probably a passive tail warning blister above the gunner's position applications, such as metallised glass fibres, while others are specifically for outer atmosphere use.

An example of this class, and which is probably intendedfor more sophisticated usage, is a dielectric rod on which are wound bands of radar reflecting material in a form which suggests the intention of creating the radar signature of a much larger body (warhead, for example). Their construction indicates the possibility that they are projected from either the missile booster or the warhead on a systematic basis to create a number of realistic tracks from which it is difficult or impossible to discern the genuine warhead.

In the overall anti-radar activity, work on radar energy absorbing materials has been in progress for a long period and is continuing. Although such materials have proved valuable in such applications as linings for radar anechoic test chambers and other scientific or engineering applications, widespread use in the operational military environment appears still to lie in the future. While an appreciable body of knowledge has been acquired in respect of particle size and distribution necessary in radar absorbent materials, combining these requirements with the mechanical properties required in aircraft, for example, remains a difficult problem. Still more sophisticated, electrical, means of absorbing incident radar energy are being explored, but details are too scarce to permit a useful account in the present volume.

EA-6B aircraft of USN Tactical Electronics Squadron 129 (VAQ-129), showing ALQ-99 ECM pods and fin-top housing for ECM receivers. Each pod contains two jamming transmitters and a receiver; the fin housing contains six antennas and a receiver. Antenna for ALQ-100 deception jammer projects from left wing



ALQ-87 ECM pod beneath wing of F-4 aircraft

1643.091
AMERICAN ELECTRONIC WARFARE PROJECTS

GENERAL:

Each of the US Services has Elint responsibilities, and in addition there are similar facilities operated by other US Government agencies. The USAF, USN, and US Army each carry out airborne Elint operations, and all three operate ground based installations for data gathering and analysis. Ferret satellites are another source of Elint, and the USN has an effective force of electronic intelligence ships, which though numerically smaller than the Soviet equivalent, is highly active and effective. Throughout the world the USA maintains numerous "special communications" installations, both large and small, supported by comprehensive communications networks for the exchange and transmittal of either 'raw' or analysed information to users. Drones and remotely piloted vehicles are increasingly being employed for EW operations in each of the main operational categories—Elint, active counter-measures, and passive counter-measures. The most recent project being the Compass Cope programme.

The scale and efficacy of these varied EW activities can only be surmised from occasional items of authentic information that reach the public domain at infrequent intervals. American trade and technical journals have been able to publish more information concerning the performance of certain Soviet airborne radars than they are able to provide on the physical construction or appearance of these equipments. The almost inescapable conclusion is that these journals have been given some of the fruits of Elint operations, since few journalists, of any nationality, are likely to have either the equipment or the opportunities to gather data such as operating frequencies, pulse-length, PRF, scan patterns etc of Soviet military aircraft radars.

Occasional indications of this type give some slight insight to the importance of Electronic Warfare in the overall military environment. The following list of known US EW projects, and the EW equipment lists in Section Four of this edition are included to assist the reader in his own researches.

AGTELIS:

This is a US Army design project for an automatic ground transportable emitter location and direction finding system. The contractor is Bunker-Ramo, and a contract valued at about $8.5 million was announced in June 1974.

Big Look:

This is a US Navy system for bulk gathering of electronic intelligence data using EC-121M aircraft. These aircraft have been operating in most parts of the world for many years. They will be replaced progressively with EP-3E Orion Elint aircraft.

Big Team:

USAF designation for ten special purpose RC-135C aircraft used by Strategic Air Command in late 1960s.

Black Crow:

USAF code name for a system of detecting vehicles in South East Asia battle areas by means of the RF energy emitted by their ignition systems. All AC-130 gunship aircraft in that theatre were equipped with the Black Crow sensor, which has since been considered as the basis of systems for gathering more sophisticated intelligence by the same method. (See RINT).

Cefirm Leader:

This is a US Army programme providing for battlefield airborne direction finding and jamming of enemy communications systems. It was formerly called project Crazy Dog, and was initiated in the late 1960s. The aircraft employed is the Beech RU-21 and equipment contractors include McDonnell Douglas Electronics Company.

Cefirm Lion:

A similar project to Cefirm Leader (qv), but with different frequency coverage.

Cefirm Scavenger:

This is a US Army project study to provide Beech RU-21 aircraft with the means of communications code breaking.

Cefly Lancer:

This US Army programme was revealed in early 1972. It was planned to use a modified Beech RU-21 aircraft to gather enemy signals information and relay this data to a ground station. It has been reported that the aircraft will be 'minimally manned', which is understood to mean that in normal operation the route will be followed under pre-programmed automatic control, but with provision for manual over-ride and return to base in the event of an emergency.

Charger Blue:

A US Navy programme under which the frequency coverage of USN aircraft ECM equipment is being extended to cater for the use of new frequencies by Soviet radar and missile systems. Equipment employed includes the ALR-45 and ALR-50 receivers and analysis sets, and the ALQ-126 deception jammer.

Combat Angel:

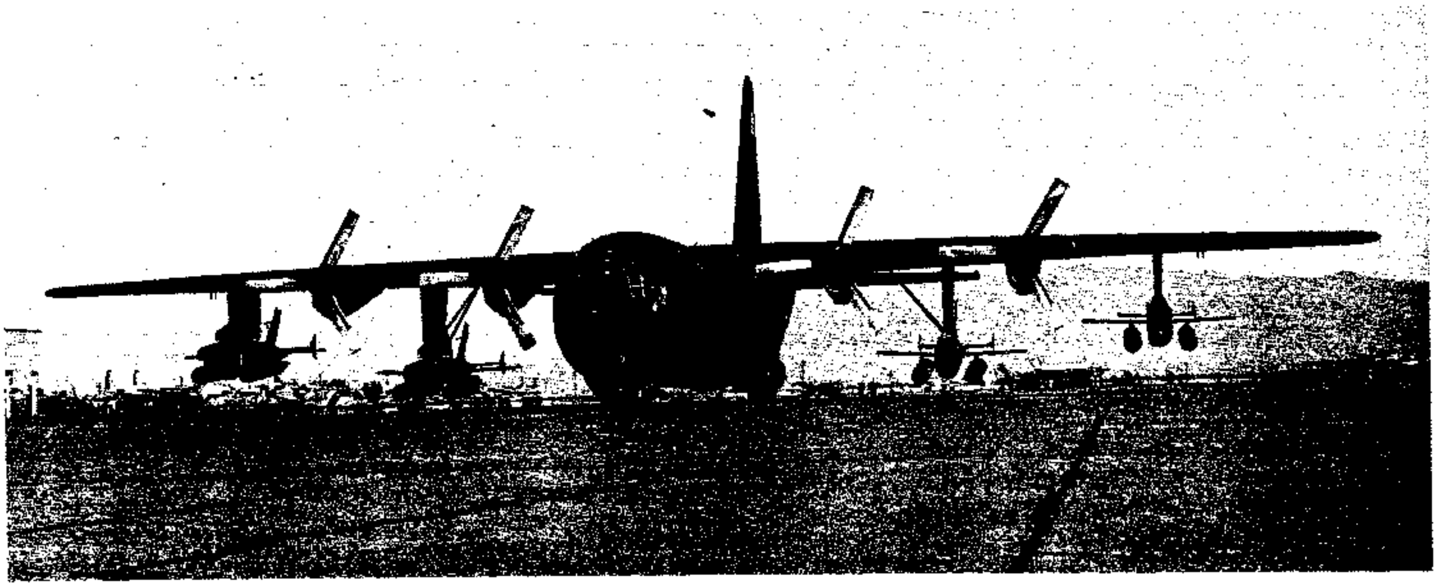
USAF project to use Teledyne Ryan Aeronautical Model 147 drones to precede a bomber force to disperse chaff as a counter-measure to ground air defence radars. Each drone carries two underwing pods containing ALE-2 chaff dispensers, and a later development is the replacement of the older dispenser by the ALE-38 which can carry between 110 and 160 kg of rolled chaff. Employed in South East Asia. The drones are air-launched from special C-130 aircraft and are recovered in mid-air by helicopter or aircraft. Drone flight path is normally pre-programmed. In the latter half of 1973 it was announced that 57 Combat Angel drones operated by Tactical Air Command were to be modified for use as temporary replacements for EB-66 electronic warfare aircraft due for retirement. The normally air-launched drones were adapted for rocket assisted ground launching. Other modifications include the installation of internal jammers.

Combat Dawn:

USAF signal collection system using a Teledyne Ryan Aeronautical 147TF drone. Used in South East Asia and possibly further afield in the Far East.

Combat Look:

A USAF programme by which four RC-130A



DC-130A aircraft loaded with four Model 147 drones, each carrying two ALE-2 chaff dispenser pods

aircraft were modified and provided with equipment for radar mapping duties in South East Asia. Probably operational from late 1967.

Combat Scent:
USAF programme involving the equipping of a number of special-purpose RC-135U aircraft for Strategic Air Command. Programme believed to have been initiated in 1970-71, and probably now operational.

Compass Cope:
A USAF project under which Boeing and Teledyne Ryan are developing competitive long-endurance, high-altitude drones for multiple reconnaissance and Elint operations.

Compass Dart:
USAF programme for electronic direction finding.

Compass Dawn:
USAF programme for electronic direction finding.

Compass Dwell:
A USAF project under which Martin Marietta is developing a piston-engined drone for Elint and photo-recce missions.

Compass Ghost:
A USAF research and development programme of investigation into electro-optical countermeasures for tactical aircraft.

Compass Matrix:
Project to achieve more flexible and efficient use of the jamming capabilities of the ALQ-119 pods carried by USAF F-4 fighter bombers through the use of a computer to control the energy management of the jammer outputs.

Compass Quick:
An equipment and system improvement programme for USAF C-135 Elint aircraft.

Compass Strike:
USAF system of direction-finding using TOA (Time of Arrival) technique for location of hostile radars by computer-equipped F-4 aircraft.

Constant Angels:
A USAF project to carry low-cost, expendable ECM drones beneath the wings of strike aircraft for launch when in the combat area to provide deception and active jamming of defence radars. Studies were planned to start in the latter half of 1972.

Coronet Organ:
USAF study programme for improved methods of employing existing ECM systems. it includes use of Combat Angel drones, flying either pre-programmed or remote controlled flight paths, and specially equipped jamming aircraft.

DTPEWS:
Design To Price Electronic Warfare Suites. Under this programme a family of EW equipment ranging from threat warning systems to passive surveillance equipment and deception electronic counter-measures, of modular design, will be developed to permit EW suites appropriate to various classes of USN ship to be assembled with maximum commonality and minimum cost. The activity is a follow-on to Shortstop. A total of 293 new and existing ships are planned to be fitted. All will have a threat warning capability; a wide area surveillance capability in 175 ships; and an ECM capability in about 60 ships.

EF-IIIA:
Electronic Warfare version of F-111A. One of eleven projects in the Pave Strike programme for enhanced strike capability and defence suppression for the USAF.

ERASE:
Electronic Radiation Source Eliminator. This is a US Navy research and development programme devoted to advanced anti-radiation missile technology.

EP-3E Aircraft:
A number of Lockheed Orion anti-submarine aircraft (seven P-3A and two P-3B) are being modified for electronic surveillance duties, in which role they carry the designation EP-3E. These will be deployed on a world-wide basis to replace EC-121M aircraft. Changes in the Orion aircraft include use of Allison T-56-A-14 engines, as in the P-3C; strengthened wings and landing gear; and a modified fuselage. Take-off weight has been increased to 64,400 kg. Three large radomes, two ventral and one dorsal, give the EP-3E a characteristic appearance; the lower two presumably house scanners for passive search and direction finding, and it is possible that the forward unit also has an active radar capability. The upper radome will house special broad band-receiver antenna arrays. There are also numerous fixed antennas for Sigint data collection.

EV-1:
In May 1974 the US Army announced plans to modify a number of OV-1 reconnaissance aircraft to equip them for Elint duties. The new designation is EV-1. There is a possibility of Israel evaluating the EV-1 and acquiring a number of these aircraft.

Le Faire Vite:
This colloquially named project is a US Army programme for the provision of a sophisticated and extensive Elint facility in Europe to accept and process what radio and radar data can be gathered from adjoining Warsaw Pact countries. Collection methods are likely to involve both airborne and ground-based systems. The only information concerning the location of Le Faire Vite is that it will be based in West Germany. Harris Radiation Systems was awarded a $9.5 million contract in January 1972.

MEWS:
Microwave Electronic Warfare System. A US Navy development programme under which Texas Instruments is producing a phased array jamming equipment for USN aircraft.

PELSS:
PELSS—Precision Emitter Location and Strike System—is an $86 million programme with the objective of devising a method of locating opposing radar emitters by means of TOA (Time-of-Arrival) techniques. One of the eleven major projects of the Pave Strike programme.

Quick Fix:
This is a US Army programme to provide a helicopter-borne communications intelligence collection capability. The major contractor is the United Technology Laboratory and the project had reached the test phase by early 1972.

Quick Look 1:
This code name refers to a US Army Elint system that employs Mohawk OV-1C aircraft equipped with the APQ-142 electronic intelligence receiving system flying missions parallel to the European NATO/Warsaw Pact boundary line for the gathering of radar activity data. The equipment is thought to cover a band extending from the UHF region up to J-band, and to be capable of providing emitter locating facilities. It is housed in two large pods carried on outboard wing station mounts. The APQ-142 is produced by United Technology Laboratory.

Quick Look 2:
Quick Look 2 is the designation of a US Army study for an improved version of Quick Look 1, and which will be carried by the OV-1D aircraft. The Litton ASN-86 inertial navigator fitted to this aircraft provides potential for improved emitter location accuracies, and other improvements would include provisions for on-board analysis or ground relay of intercepted radar signals. The contractor is HRB Singer.

RINT:
RINT—Radiation Intelligence is the term given to methods being examined for the gathering of intelligence data by detection and analysis of spurious RF radiation from enemy systems and equipment. Potential sources include: motor transport, power generation and supply equipment, radar when working into a dummy load, electro-mechanical communications equipment, power lines etc. The US DoD, USAF and a number of manufacturers are engaged in studies of this technique.

Rivet Ace:
This is the sixth and latest in a series of ECM updating programmes for USAF Strategic Air Command B-52 bomber aircraft. Equipment involved includes the ALQ-117 combined noise and deception jammer: ALQ-122 'smart noise equipment', developed by Motorola under the Quick Reaction Contract (QRC) 496; ALQ-127 active tail warning radar; and QRC-515 improved ALT-28 jammer.

Rivet Card:
A USAF programme of the late 1960s under which six special purpose RC-135M aircraft were outfitted for Strategic Air Command.

Rivet Quick:
A USAF programme under which a number of special purpose RC-135M aircraft were equipped

for Strategic Air Command in 1968.

Rivet Top:
Under this USAF project of the late 1960s a number of EC-121 aircraft were equipped with an automatic data relay system for the transmission of ground sensor data back to a ground analysis station. Deployed in South East Asia.

See Saw:
US Navy airborne electronic warfare project.

Senior Book:
A USAF programme for gathering Elint data using U-2 high-altitude reconnaissance aircraft.

Shortstop:
US Navy ship-borne EW system, AN/SLQ-27. Two systems had been produced by ITT and had entered evaluation trials by early 1972. System combines a multi-band antenna array, several receivers, a threat evaluation sub-system, and counter-measure equipment. Equipment includes a Sylvania antenna, the SLQ-17 deception repeater jammer, and WLR-8 spectrum scanner and analysis receiver. Shortstop was developed for use on carriers, missile frigates and destroyers. The project was cancelled because of unacceptable costs, and the successor programme is the Design To Price Electronic Warfare Programme.

TAREWS:
Tactical Air Reconnaissance and Electronic Warfare Support. USAF photographic/Elint/ECM drone study project.

TASES:
Tactical Airborne Signal Exploitation System. This is a US Navy project with the aim of providing a successor system for the carrier-borne EA-3B, land-based 'Big Look' EC-121 aircraft, and later the interim EP-3E (qv) Elint aircraft. The system will be carried on an aircraft yet to be chosen and will be used for long-range Elint missions to provide detection, location, signal collection, and automatic analysis of emitters. In February 1973 it was reported that the two principal candidate aircraft are the S-3A Viking and the EA-6B. TASES-equipped aircraft would detect radar signals of unknown ships at long range, determine their direction, perform some signal classification and relay real-time data back to surface ships.

TEDS:
Tactical Electronic Decoy System for simulating strike aircraft to draw the fire of enemy surface-to-air missiles. The USAF originally proposed that the decoys would carry jamming equipment and target augmentation devices, and have adequate performance to simulate high-performance aircraft, but subsequent to the 1973 Middle East conflict, reconsideration suggested a less complex and cheaper type of vehicle.

TEREC:
Tactical Electronic Reconnaissance. Extended spectrum, high accuracy Elint system under development for USAF F-4C.

TEWS:
Tactical Electronic Warfare System. Internal EW suite for F-15 aircraft, and comprising Loral ALR-56 radar warning receiver, Hallicrafters

Teledyne Ryan Model 147 drone with ALE-2 chaff dispenser pods

ALQ-135(V) counter measures set, and Magnavox ALQ-128 warning receiver.

Tree Cat:
US Navy phased array jammer equipment under development by Maxson Electronics.

Tree Moth:
US Navy noise jammer released by parachute from an aircraft or drone and capable of radiating 1 kW of noise in the S-band during a descent time of about 10 minutes. USN tests of the system, which was developed by Bowmar/TIC, were carried out in the last quarter of 1973.

Wild Weasel:
The Wild Weasel code name is applied to USAF ECM-equipped aircraft and their operations against opposing air defence and missile guidance radars, in support of strike and bomber aircraft. A small number of the specially equipped Wild Weasel aircraft accompany the larger force of strike aircraft with the objective of providing protection for the latter by co-ordinated jamming operations of all kinds (deception, spot, barrage etc) to reduce the effectiveness of anti-aircraft defences. Wild Weasel operations were carried out in South East Asia since 1966 at least, and the overall designation covers a variety of aircraft, equipment, and operational techniques.

Initially, the primary platform was the F-105F Thunderchief aircraft, carrying an Electronic Warfare Officer to operate the ECM systems, one of these aircraft accompanying other fighter-bombers on strike missions. A number of RB-66 tactical bombers were also employed. More recently, in the USAF attacks on North Vietnam in April, 1972, EB-66 and F-105G Wild Weasel aircraft were used to jam 'Cake' series height-finding radars and Fan Song B guidance and control radars. Hardware included in Wild Weasel installations includes AN/APR-25, -26, -35, -36, -37, and -38 ECM sets. A number of F-4D aircraft are to be fitted with an advanced Wild Weasel installation.

466L:
The USAF 466L programme is a world-wide network for the collection, processing, distribution and transmission of electronic intelligence data to a variety of user organisations, including the US Forces. Data gathered is understood to include communications traffic, satellite transmissions, navigation signals, and certain radar transmissions. Site locations that have been named include Turkey, Pakistan (Bada Beir), Clark Air Force Base (Philippines), Japan, Alaska, and Australia. The Pakistan site was dismantled several years ago, and there is some doubt that the Australian installation is associated with 466L.

Few details of equipment have been obtained, but the ITT FLR-12 passive receiver antenna system and the Sylvania FLR-9 are used.

438L:
Under the 438L designation the USAF set up an intelligence data handling system (AIDS— Auto Intelligence Data System) for the high speed processing of information gathered on a world-wide basis. The system was subsequently transferred from the USAF to the Defence Intelligence Agency thereby making the 438L nomenclature redundant. It has not been confirmed that this system deals with actual electronic signals intercepted from foreign transmitting equipment, and it is possible that its function is to process written and other forms of intelligence data.

1644.091
SOVIET ELECTRONIC WARFARE

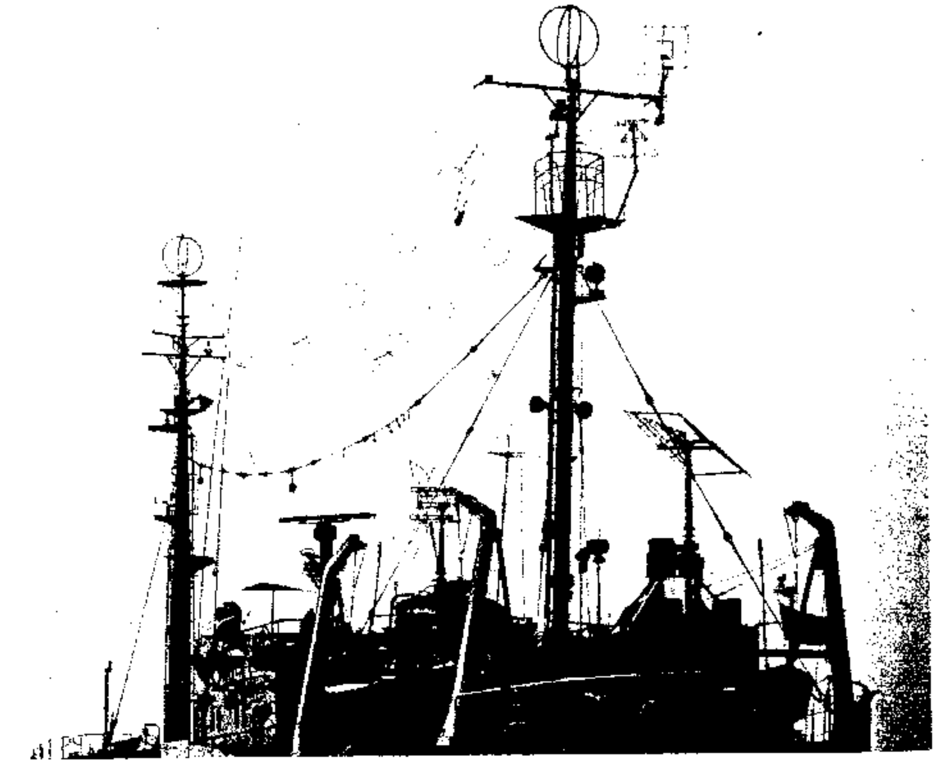
General:
Evidence of Soviet EW activities, in detail at least, is even more scanty than that of comparable American operations, but what there is points clearly to a full appreciation and considerable skill in the use of EW techniques. The specially equipped Russian 'trawlers' which can usually be found in the neighbourhood of foreign forces whenever anything of interest is happening, are a well-known example of Soviet Elint at work. There is a fleet of over 50 Soviet surveillance ships. Almost equally widely recognised are the naval vessels that accompany NATO forces on their exercises, and the Soviet aircraft that probe land defence systems and shadow shipping.

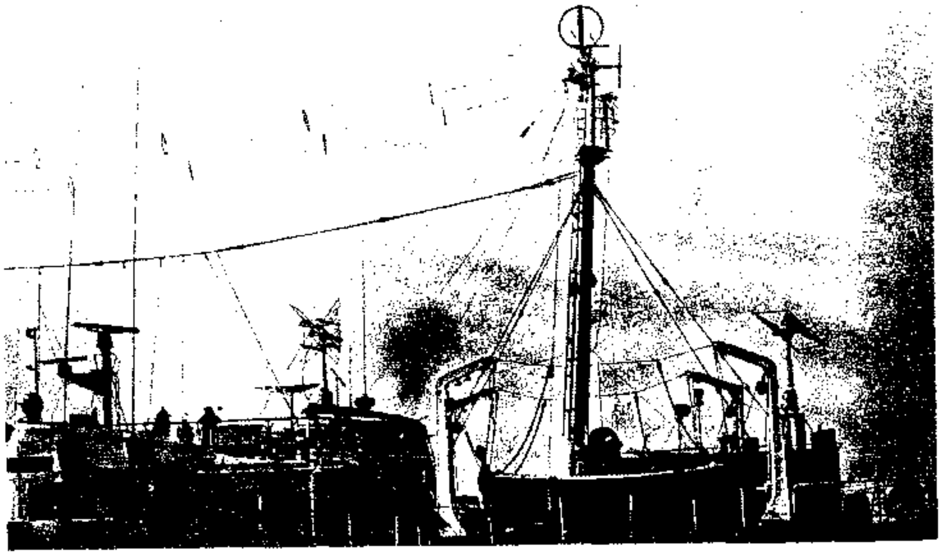
Other significant indications are such difficult to conceal objects as EW antenna arrays on ships of the Soviet fleet, which items of hardware handsomely outnumber their counterparts on Western vessels. The large number of Cosmos series satellites includes so many which are not photographic reconnaissance vehicles, scientific, or other identifiable missions, that a considerable ferret satellite population is a fairly safe assumption.

Most of the other evidence of Soviet EW activity is only directly obtainable by military authorities in the West, and how much of this becomes public is a matter of accident or design on the part of those who reveal morsels of what has been discovered.

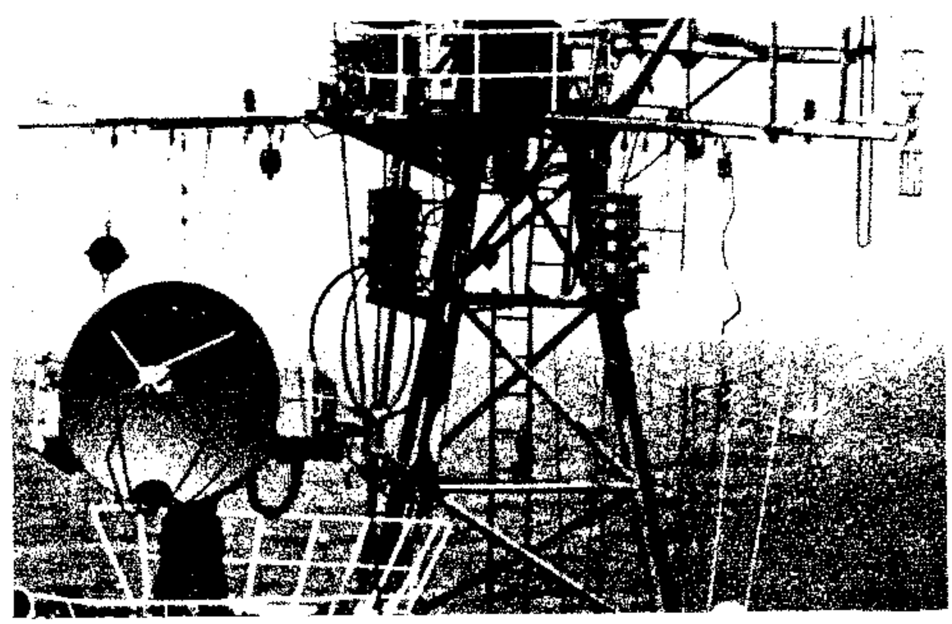
Sources of this nature have yielded such uncorroborated, but reasonable, facts as: sophisticated use of chaff to obscure air transport movements at the time of the large-scale movement of forces into Czechoslovakia in 1968; passive tracking of US Navy ships in the Mediterranean by night and without using active radar; the use of spot and barrage noise jammers capable of 1 kW in aircraft; use of deception repeater jammers in bomber aircraft; the incorporation of elaborate ECCM in missile guidance and other radars, and the use of ground-based jammers to frustrate radiation homing air-to-surface weapons. The existence of a land-based radio direction finding network, designated 'Krug', has also been reported, and this is said to be used for the location of surface ships at ranges of about 10,000 km and for the direction of maritime reconnaissance aircraft. In November 1972, General Sir Walter Walker, when addressing the Military Committee of the North Atlantic Assembly in Bonn, said the Soviet EW capability had shown a "startling increase" in the two previous years, and went on to warn that on the NATO northern flank the Soviet forces "can neutralise our ship-to-ship tactical networks, our early warning radars, our weapon control systems, and our battlefield communications."

The inadequacy of this information makes it impossible to attempt any quantitative or qualita tive analysis of Soviet EW capabilities, but in general similar sums of money to those spent by the USA can be expected to be devoted to EW by the Soviet Union, and the same relationship between the technologies of the two major powers as obtains in other areas of military equipment, probably applies also.





The two photographs of a Soviet Elint monitoring ship, taken in the Baltic recently, reveal the elaborate arrays of antennae fitted. Several types of direction finding loops, four directional broad-band log-periodic arrays, and many others can be identified



The two cylindrical shaped antenna arrays on the lattice mast of this Soviet Navy Petya Class escort are probably microwave detection and direction finding systems. Radar to left is Owl/Hawk Screech fire control radar for guns

SECTION TWO – PLATFORMS

ARMOURED FIGHTING VEHICLES

AUSTRIA

2015.102
AUSTRIAN MEDIUM TANKS

DESCRIPTION

Main tank forces of the Austrian Army comprise some 150 M-47 (**5046.102**) and 120 M-60 (**5024.102**) medium tanks. There are also some 40 M-41 light tanks.

It has been reported that an experimental substitution of an M60 A1 engine in an M47 tank has been made. It is understood that if this proves to be satisfactory after evaluation some or all of the M-47 tank force will be so modified. The modification involves both raising and modifying the rear deck of the tank.

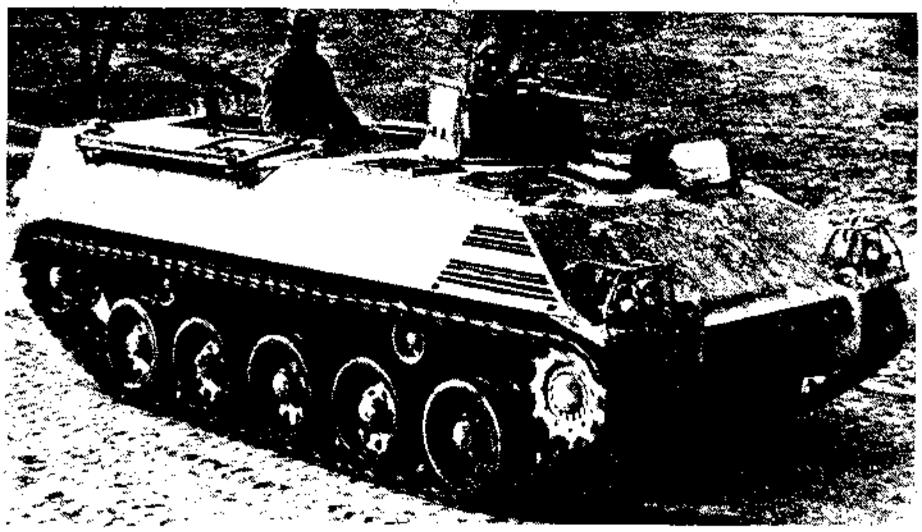
5075.102
SAURER SCHUTZENPANZER SPz-G 4K3F

DESCRIPTION:

One of a family of armoured personnel carriers developed by Osterreichische Saurer-Werke, the SPz-G1 4K3F is currently the standard carrier in use by the Austrian forces.

The chassis of this vehicle has also been used, in modified form, in the Panzerjäger 'K' SP anti-tank gun (**5032.102**). In its unmodified form it has a front-sprocket drive from a Saurer 200 b.h.p. diesel engine (or from a Saurer 4F 220 b.h.p. engine, in which case the vehicle designation is 4K4F) and a hull designed to accommodate a driver and 9 infantrymen. Provision is made for mounting a 12.7 mm machine gun or a 20 mm turret-mounted cannon: the vehicle has also been fitted experimentally with twin 80 mm rocket launchers.

Variants of the basic design include artillery control vehicles (SPz-Fü A1 and SPz-Fü A4), AA control vehicle (SPz-FüFla), mortar carriers (SPz-GrW1 and SPz-GrW2), radio vehicles (SPz-Fü 1 and SPz-Fü 2), teleprinter vehicle (SPz-FS) and ambulance (SPz-San).



Saurer Schützenpanzer—APC version with machine gun

CHARACTERISTICS:

Crew: 10 (driver plus 9 infantrymen).
Weight: 12.5 tonnes (laden)
Size: Height 1.65 m (excluding MG etc). Length 5.4 m Width 2.5 m.
Road Speed & Range: 60 km/h/350 km.
Armament: Provision for 12.7 mm MG or 20 mm cannon
Engine: Saurer 200 b.h.p. (3F) or 250 b.h.p. (4F).
Agility: Ground pressure 0.5 kg/sq cm. Max step 0.8 m. Max trench 2.1 m. Max gradient 80%. Ground clearance 0.42 m.
Water-crossing: Unprepared wading to 1.0 m.

DEVELOPMENT:

Sequential development by Saurer. Development of the earliest version (3K3H) started in 1956.

STATUS:

In service only with the Austrian Army, where more than 400 of various versions are in use.

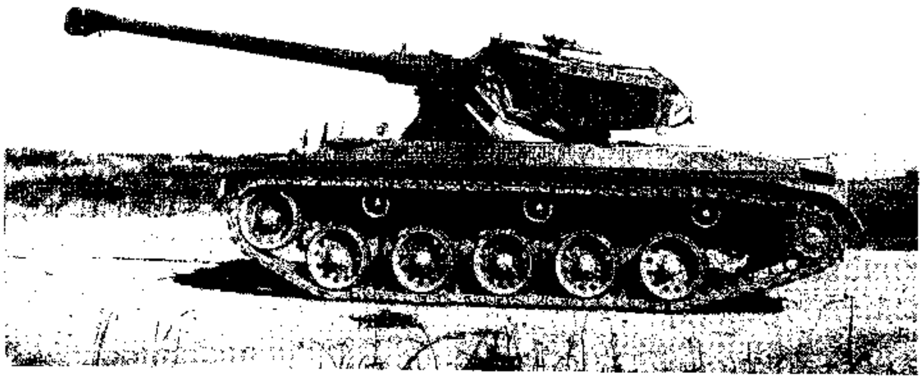
MANUFACTURERS:

Osterreichische Saurer-Werke AG, Vienna, Austria. (taken over by Steyr-Daimler Puch in 1970)

5032.102
SELF-PROPELLED ANTI-TANK GUN PANZERJAGER 'K'

Development of this weapon was initiated in 1965 to provide the Austrian Army with an anti-tank weapon independent of those mounted on their M47 and M60 tanks. The development involved mounting the French FL-12 turret (**2148.103**) and 105 mm gun on the chassis of the Saurer 4K Armoured Personnel Carrier.

The gun used is the French D 1504 (**2147.103**) which fires a spin-stabilised hollow charge shell with a range of 2,000 m and a muzzle velocity of 800 m/sec. The FL-12 turret used on this vehicle and on one version of the French AMX 13 tank (**5020.102**) is of the 'oscillating' type, permitting the use of a semi-automatic loading mechanism with two ammunition magazines, each holding six rounds, in the rear turret overhang. This system enables the crew to be reduced to three, and permits a high rate of fire for the first twelve rounds after which the magazines must be replenished. The modifications to the chassis have been quite extensive, these have included moving the engine and transmission to the rear, the drive sprocket now being at the rear, the suspension has been modified and there are now three return rollers, the armoured personnel carrier having only two.



Panzerjager 'K' with 105 mm gun in 'oscillating' turret

CHARACTERISTICS:

Crew: 3 (Commander, gunner, driver)
Weight: 17 tonnes (laden)
Size: Length 7.78 m (gun forward), 5.58 m (hull only) Height 2.355 m Width 2.50 m.
Road Speed: 65 km/h **Range**: 530 km.
Main Armament: French 105 mm QF gun.
Method of ranging: Commander's estimate. A laser rangefinder is under development. An infra-red/white light searchlight can be fitted.
Max anti-tank range of main armament: 2,500 m.
Ammunition type: Spin-stabilised HEAT, HE and smoke. 26 rounds carried
Secondary armament: Coaxial 7.62 mm MG.
Turret rotation: 360° powered traverse.
Gun elevation limits: $-6°$ to $+13°$
Engine: Steyr Model 6FA 6 cylinder diesel developing 300 hp at 2300 rpm.
Transmission: Mechanical manual gearbox type ZF 655, with five forward and one reverse gears. Single plate clutch.
Agility: Ground pressure 0.75 kg/sq cm. Max step .8 m. Max trench 2.40 m. Max gradient 70%. Ground clearance .40 m. Power-to-weight ratio 17.8 bhp per tonne.
Water crossing ability: Unprepared wading to 1.0 m.

STATUS:

Five prototypes have been built and these have undergone extensive trials. An early production order is expected.

MANUFACTURERS:

Steyr Daimler-Puch (who took over Osterreichische Saurer-Werke AG in 1970)

BELGIUM

FN 4 RM62 in mortar version with 60 mm mortar and twin 7.62 machine guns

5058.102
FN4 RM62 LIGHT ARMOURED CAR

DESCRIPTION:

The FN 4 RM62 has been produced for the Belgian gendarmerie in two versions; first, in a gun version, equipped with a 90 mm gun; second, in a mortar version, carrying a 60 mm mortar and twin 7.62 mm FN machine guns. An army troop carrier version to carry 9 men (including the driver) has also been built as a prototype only.

CHARACTERISTICS (both versions unless stated):

Crew: 3 (Commander/loader, gunner, driver)
Weight: Gun version 8.8 t. Mortar version 8.0 t.
Size: Height 2.52 m. Length (hull) 4.5 m. Width 2.26 m.
Road Speed/Range: 110 km/h/550 km
Main Armament: 90 mm CATI gun or 60 mm mortar
Method of Ranging: Commander's estimate
Rounds carried: For gun 40 rounds mixed HEAT and anti-personnel. For mortar 46 rounds
Secondary armament: Gun version: 1 co-axial one roof mounted AA 7.62 mm MG. Mortar version: Twin 7.62 mm MG's that can be elevated independent of mortar
Turret rotation: 360°, electrically assisted hand traverse at two speeds, fast or slow
Engine: FN 652 6 cylinder petrol engine of 4.74 litres. 130 bhp at 3,500 rpm
Transmission: Single plate dry clutch, synchromesh gearbox with 4 forward and 1 reverse gears

STATUS:

Production was completed in 1971. A total of 62 were delivered to the Belgian Gendarmerie.

MANUFACTURER:

Fabrique Nationale Herstal S.A. (FN), Herstal, Belgium

FN 4 RM62 in gun version with 90 mm gun

BRAZIL

2028.102
BRAZILIAN ARMOURED VEHICLES

DESCRIPTION:

In recent years Brazil has developed a number of AFVs, the first of these being the Cutia-Vete T1 A1 (**5100.102**). The two more recent vehicles are the EE-9 Cascavel armoured car (**5101.102**) and the EE-11 Urutu armoured personnel carrier (**5102.102**). Both the EE-9 and EE-11 have good export potential.

5100.102
CUTIA-VETE T1 A1

DESCRIPTION:

Design of this vehicle commenced in 1966 and by 1972 about 100 had been built. The Cutia-Vete T1 A1 is probably used as a reconnaissance vehicle or personnel carrier.

CHARACTERISTICS:

Crew: 4
Weight: 2.72 tonnes (laden)
Size: Length 3.66 m. Height 1.0 m. Width 1.83 m.
Road speed/Range: 80 km/hr/370 km
Armament: 1 7.62 mm MG
Engine: Four cylinder petrol

STATUS:

In service with the Brazilian Army

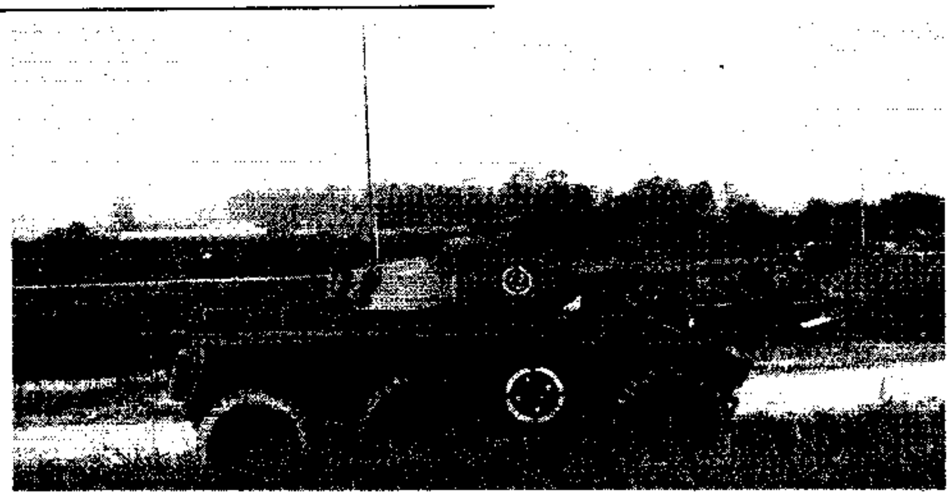
5101.102
EE-9 CASCAVAL ARMOURED CAR

DESCRIPTION:

Design of the EE-9 started in July 1970 and the first prototype was completed in November 1970: it uses many components of the EE-11 Urutu armoured personnel carrier (5102.102). It was developed by Engesa with the assistance of the University of Sao Paulo and the Brazilian Army. The prototype was armed with a 37 mm gun but production vehicles will be fitted with 90 mm gun as fitted to the French AML 90.

CHARACTERISTICS:

Crew: 3 (Commander, gunner, driver)
Weight: 10.75 tonnes (laden)



EE-9 Cascavel Armoured Car with 90 mm Gun

Size: Length 5.998 m (gun forward). 5.18 m (hull only). Height 2.33 m. Width 2.44 m
Road Speed / Range: 100 km/hr/800 km
Main Armament: French 90 mm gun (Model D.921)
Max anti-tank range of main armament: 1500 m
Ammunition types: HE (m/v 650 m/s) and Hollow Charge (m/v 760 m/s) Total of 20 rounds carried
Secondary armament: Coaxial 7.62 mm MG
Engine: Mercedes Benz (Brazil) 6 cylinder, in-line diesel developing 172 hp at 2,800 rpm.
Transmission: Clark gearbox with five forward and one reverse gears. Single plate clutch
Agility: Max step: .6 m. Max gradient 60%
Ground clearance .35 m.
Water crossing ability: Unprepared wading to 1.0 m

STATUS:
Production of a small batch is under way for the Brazilian Army

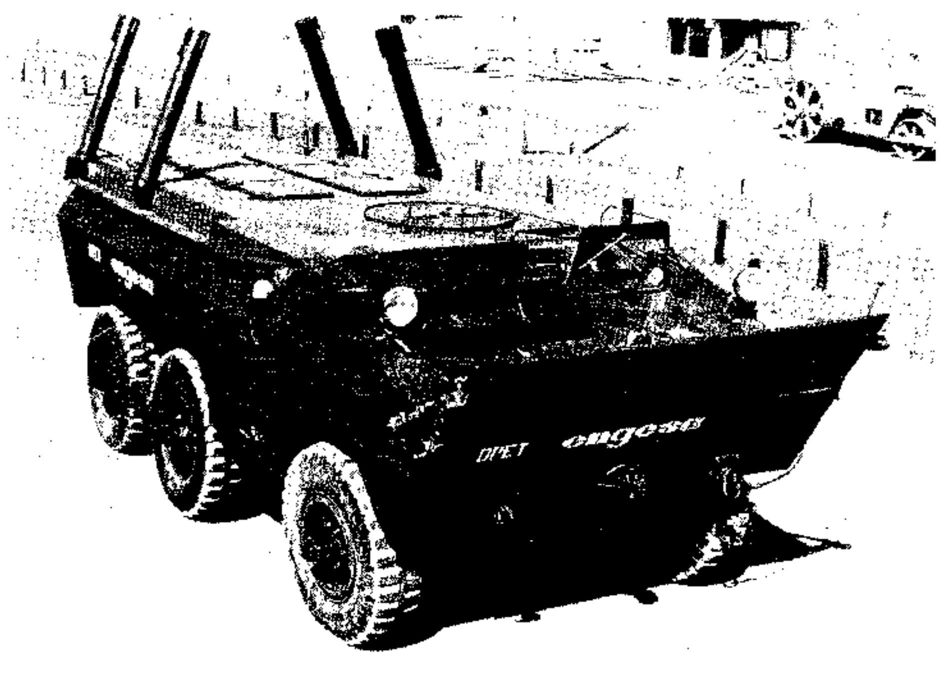
MANUFACTURER:
Engesa, Sao Paulo, Brazil

5102.102
EE-11 URUTU ARMOURED PERSONNEL CARRIER

DESCRIPTION:
The EE-11 Urutu has been designed by Engesa: the first prototype was completed in July 1970 and in 1972 Engesa received a production order for the vehicle.

The hull of the EE-11 is of all-welded construction. The driver is on the left with the engine to his right. There are doors in each side of the hull, a single door is provided at the rear and there are hatches in the roof. Firing ports are provided on either side of the hull and at the rear. A wide range of armament installations can be provided including a single 7.62 mm or 12.7 mm MG on a ring mount, turret mounted 7.62 mm or 12.7 mm MGs, turret mounted 20 mm cannon, or a turret mounted 76 mm or 90 mm gun. Various types of engine can be installed, according to customer requirements. The basic model is fully amphibious for crossing inland waters and optional equipment is available to enable it to operate in heavy seas.

CHARACTERISTICS:
Crew: 15 (driver plus 14 men)
Weight: 10.50 tonnes (laden)
Size: Length 5.76 m. Height 2.0 m (without armament). Width 2.44 m
Road Speed / Range: 95 km/h/700 km
Main Armament: See above
Engine: Mercedes Benz (Brazil) 6 cylinder, in-line diesel developing 172 hp at 2800 rpm
Transmission: Gearbox has five forward and one reverse gear. Two speed transfer case
Agility: Max step: .6 m. Max gradient 60%.



EE-11 Urutu Armoured Personnel Carrier

Ground clearance .35 m
Water crossing ability: The basic model is amphibious being propelled in the water by its wheels. If required it can be fitted with two propellers and two rudders, this model can operate in heavy seas.

STATUS:
The basic model is in production for the Brazilian Army and the Brazilian Marines have ordered some fitted with propellers.

MANUFACTURER:
Engesa, Sao Paulo, Brazil

CHINA (PEOPLE'S REPUBLIC)

5042.102
T59 MAIN BATTLE TANK

DESCRIPTION
Very few details of the Chinese tank manufacturing programme are available. It is known that there are two large tank factories in the neighbourhood of Mukden, and it is believed that the bulk of the current production is based on the T59 tank, which is a modified version of the T54 Soviet tank (**5049.102**), 3,000 of which were supplied to China in the 1950s and early 1960s. Production of T59 is believed to have started in 1963.

The major differences from the T54 appear to be the lack of a gun stabiliser and of infra-red equipment, and the omission of power traverse. Both the gunner and loader have hand traverse mechanisms, but this must mean a very poor rate of engagement and difficulty of engagement on anything but a flat fire position. This information is not recent, however, and it may well be that tanks in current production are superior to the early models. Some of the early production tanks were supplied to Pakistan in 1966 and much of the available information has come from that source.


Chinese built T59 Tank on a parade in Pakistan

5103.102
T-60 LIGHT TANK

DESCRIPTION:
The T-60 Light Tank is a development of the Soviet PT-76 Light Tank (**5038.102**), some of which were supplied to China by the Soviet Union in the late 1950s.

It has six road wheels with the driving sprocket at the rear and the idler at the front. The turret, which is similar in shape to that fitted to the T-59 (**5042.102**), is fitted with an 85 mm gun and a co-axial 7.62 mm machine gun. A 7.62 mm anti-aircraft machine gun can be fitted to the turret roof. The T-60 is fully amphibious, being propelled in the water by waterjets.

STATUS:
In service with China, North Vietnam, Pakistan and Tanzania

5104.102
T-62 TANK

DESCRIPTION:
This is said to look like a miniature T-59 and to be armed with an 85 mm gun and a co-axial 7.62 mm machine gun. Loaded weight is about 21 tonnes. Five large road wheels are fitted

STATUS:
In service with Albania, China and Sudan.

5105.102
T-63 TANK

DESCRIPTION:
The only information available on the T-63 is that it is armed with an 85 mm gun and has five small road wheels and four return rollers.

5106.102
TYPE 55 ARMOURED PERSONNEL CARRIER
DESCRIPTION:
This is the Soviet BTR-40 (**5037.102**) built in China. As far as it is known the Chinese model has characteristics similar to those of the Soviet vehicle.

5107.102
TYPE 56 ARMOURED PERSONNEL CARRIER
DESCRIPTION:
This is the Soviet BTR-152 (**5035.102**) built in China. As far as it is known the Chinese model has characteristics similar to those of the Soviet vehicle.

5108.102
M-1967 (or M-1970) ARMOURED PERSONNEL CARRIER
DESCRIPTION:
This is a Chinese designed and built armoured personnel carrier and was first seen in 1967. Its running gear is similar to that fitted to the T-60 (**5103.102**) light tank and may well be based on this vehicle. It has a loaded weight of 10 tonnes and can carry ten men including the driver. Armament consists of a 12.7 mm machine gun.
STATUS:
In service with China and Tanzania.

CZECHOSLOVAKIA

5074.102
OT-64 (SKOT) ARMOURED PERSONNEL CARRIER
DESCRIPTION:
The OT-64 (or SKOT) is based on the Tatra 813 truck. Development started in 1959 and by 1964 the vehicle was in service. The vehicle has a hull of all-welded construction, doors are provided each side of the hull, at the rear are twin doors and there are hatches in the roof. Firing ports are provided in the sides and rear of the vehicle.

The OT-64 is fully amphibious, being propelled in the water by two propellers at the rear. All eight wheels are powered, the front four being used for steering.

CHARACTERISTICS:
Crew: 2 (Commander and driver) plus 18 infantrymen
Weight: 14.8 tonnes (laden)
Size: Length 7.44 m. Width 2.55 m. Height 2.70 m (with turret)
Road Speed / Range: 95 km / hr / 700 km
Armament: See derivatives
Turret Rotation: 360° by hand
Engine: Tatra Model T-928-14 8 cylinder diesel developing 180 hp at 2,000 rpm
Transmission: 8×8 drive. Gearbox has five forward and one reverse gears
Agility: Max step 0.5 m. Max trench 2 m. Max gradient 60%. Ground clearance 0.4 m
Water crossing ability: Fully amphibious, water speed 8.9 km / hr

DERIVATIVES:
Model 1 with or without a single 7.62 mm machine gun.
Model 2 with 7.62 or 12.7 mm machine gun with a curved shield.
Model 3 (Also known as the SKOT-2A). This has a similar turret to that fitted to the BTR-60PB (**5034.102**) and BTR-40P-2 (**5036.102**) vehicles. The turret is armed with 14.5 mm and 7.62 mm machine guns.
Model 4 (Also known as the SKOT-2AP). This has a very high turret with the same armament as the Model 3.
Model 5 with two Sagger anti-tank missiles mounted towards the rear of the vehicle.

OT64B with 12.7 mm MG in turret. This amphibious vehicle can carry up to 20 infantry men

STATUS:
In service with Czechoslovakia, Egypt, Hungary, India, Libya, Morocco, Poland, Sudan, Syria, Uganda

5109.102
OT-62
ARMOURED PERSONNEL CARRIER
DESCRIPTION:
The OT-62 (or TOPAS) is the Czechoslovakian built version of the Soviet BTR-50PK (**5035.102**) armoured personnel carrier. The Czech built version is a better vehicle than the Soviet model and has a higher road speed and a higher radius of action. An NBC system is fitted.

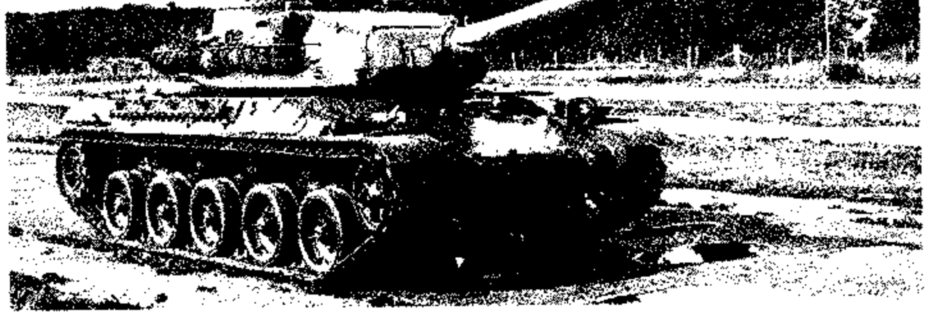
CHARACTERISTICS:
Crew: 2 (Commander and driver) plus 18 infantrymen
Weight: 15 tonnes (laden)
Size: Length 7.08 m. Width 3.14 m. Height 2.35 m (with turret)
Road Speed / Range: 62 km / hr / 450 km
Armament: See derivatives
Engine: PV-6,6 cylinder in line diesel, 132 hp at 1200 rpm
Agility: Max step 1.1 m. Max trench 2.8 m. Max gradient 70% Ground clearance .36 m. Ground pressure 153 kg cm^2
Water crossing ability: Fully amphibious, water speed being 11 km / hr, propelled in the water by waterjets

DERIVATIVES:
Model 1 has two projecting bays, no armament normally fitted.
Model 2 is similar to Model 1 except right bay has a turret fitted with a 7.62 mm MG and a T-21 recoilless rifle.
Model 3 this has a large turret fitted with one 7.62 mm and one 14.5 mm machine guns. Model 3 has a crew of 3 plus 12 infantrymen.
STATUS:
In service with Czechoslovakia, Egypt, Hungary, India, Poland

FRANCE

5018.102
MAIN BATTLE TANK
AMX 30
DESCRIPTION:
The design of AMX 30 stems from the same joint specification agreed by the Defence Ministries of France and West Germany in 1957, as does the Leopard tank. As with Leopard, the priorities in the design were: Firepower, Mobility, and Protection. The trials of the first two prototypes were conducted in 1962, and although these mounted a 105 mm gun, the total weight was kept to 32 tonnes. Later the weight increased in development to 35 tonnes, but even so AMX 30 remains the lightest main battle tank mounting a 105 mm gun.

The semi-automatic gun is electrically fired and can achieve a rate of 8 rounds per minute. Side-mounted on the gunshield this weapon is composed of a 56-calibre barrel, without muzzle brake or smoke evacuator, and a recoil and counter-



AMX30 Tank

recoil mechanism. Recoil length and stress are 380 mm and 25 tons respectively.

Designed primarily as an anti-tank weapon the gun will normally fire either an anti-tank shell with a non-rotating hollow charge (MV – 1,000 m/s) or an anti-personnel high-explosive shell (MV – 700 m/s). It will accept other NATO standard ammunition, however, with the exception of APDS which the French authorities regard as outmoded. The anti-tank shell is effective up to at least 3,000 metres and will perforate up to 360 mm of armour at normal incidence and up to 160 mm at 70 degrees from normal. The HE shell can be used up to 3,500 metres with a flat trajectory and has a maximum range of 11,000 metres with a 20 degree elevation angle. Fifty rounds of 105 mm ammunition can be carried by the tank, of which twenty-two can be in the turret.

For fire control there is an X12 coincidence range-finder for the tank commander and an X8 sighting telescope for the gunner. Normal gunlaying is hydraulic with an emergency manual standby. Gun traverse is unlimited and elevation limits are $-8°$ and $+20°$.

Secondary armament can be either a co-axial 12.7 mm machine-gun paired with the main gun or a co-axial 20 mm gun. In addition there is a 7.62 mm NATO machine gun for close defence.

The mobility of the tank is good, with a high power to weight ratio of 20 bhp/t, the limitation of cross-country performance being set by the suspension system rather than the power available at the sprocket.

The undercarriage is of Vickers type, comprising a rear sprocket wheel, five rubber-tyre double bogie-wheels, five supporting rollers that support only the inner half of the track, a crank-mounted pulley mechanism to stretch the tracks and a centrally-guided track consisting of track shoes on which V-shaped rubber soles are bolted. The suspension is of the torsion-bar type with resilient stops and with hydraulic dampers for the two outer bogie-wheels.

A great deal of care has been given to the optical and sighting arrangements, which are as comprehensive for both daylight and night use as on any main battle tank. The AMX 30 is likely to prove an economical and reliable tank in service.

Ballistic protection is achieved as much by the design of the armour as by its thickness, oblique angles being presented to probable impact wherever possible. The body is made of laminated armour plates and of fully welded cast iron parts. The turret consists of a carapace made of armour steel cast in one piece. For a tank of this type, however, mobility, effective observation and inconspicuous silhouette are as important to protection as its ability to withstand direct attack. In keeping with modern requirements NBC protection has been designed with especial care: absence of unnecessary leaks, an air filtration system and a slight internal overpressure being the main features of this part of the design.

CHARACTERISTICS:

Crew: 4 (Commander, loader, gunner, driver)

Weight: 36 tonnes (laden)

Size: Length, with gun reversed 9.48 m. Length of chassis 6.60 m. Width 3.10 m. Height to top of turret 2.29 m. Height overall 2.86 m

Road Speed/Range: 65 kmh/5-600 km

Main Armament: 105 mm QF gun

Method of ranging: Optical coincidence range-finder

Rounds carried: 50 rounds. Mixed HEAT and HE

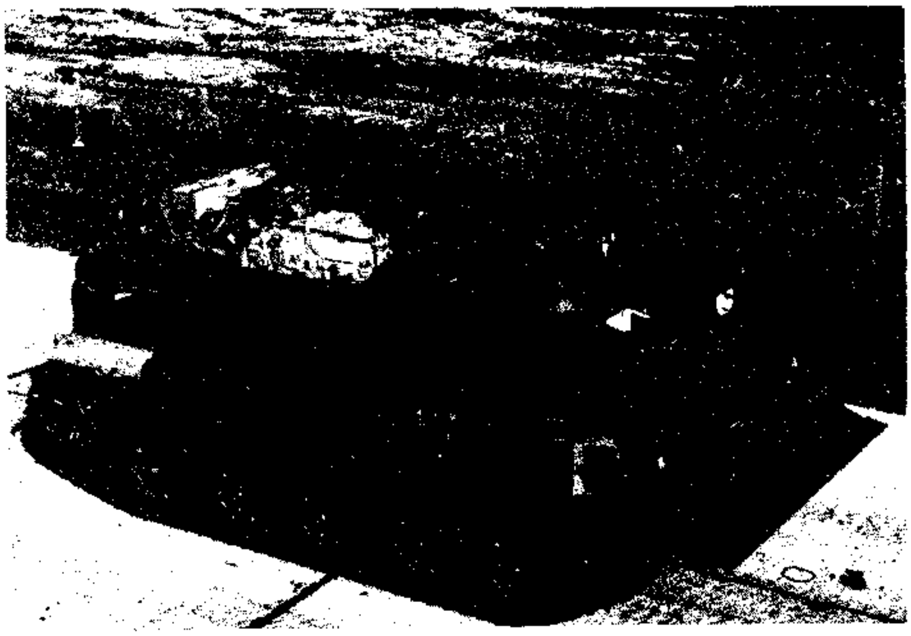
Max Anti-tank range of main armament: 3,000 metres

Secondary Armament: Coaxial 12.7 mm MG (likely to be replaced by 20 mm cannon in some production tanks). One 7.62 mm MG on Commander's cupola

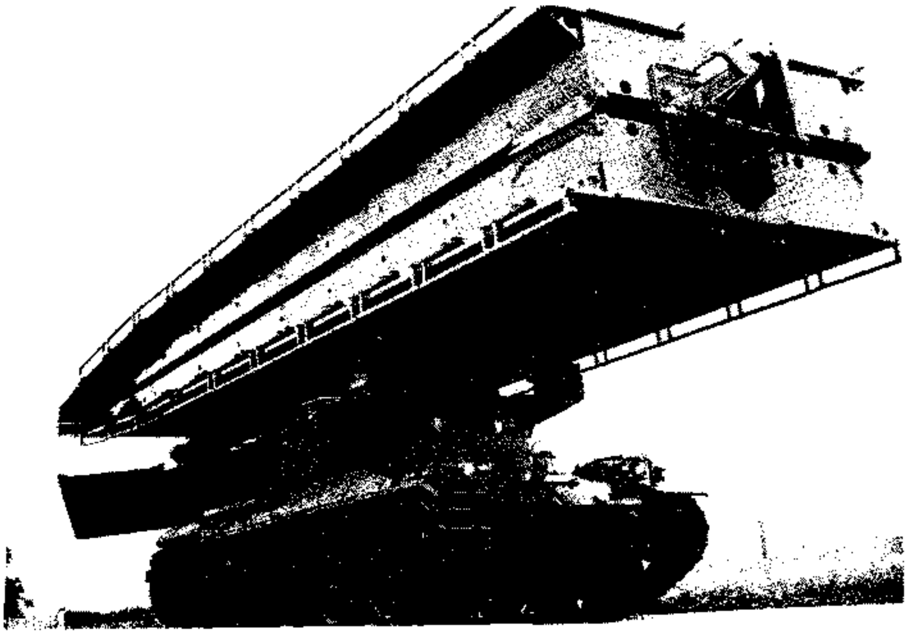
Turret Rotation: 360° in 12 secs

Engine: Hispano Suiza HS 110 flat-12 cylinder multifuel supercharged diesel. 720 bhp at 2,600 rpm

Transmission: Mechanically operated gearbox giving 5 forward, one reverse gear. Centrifugal automatic clutch, electrically controlled by the gear lever.



AMX-30 Armoured recovery vehicle



AMX-30 Bridgelaying tank

Agility: Ground pressure 0.77 kg/cm². Max step 0.9 m. Max trench 2.9 m. Max gradient 60% (1 in 1.7). Ground clearance 0.45 m. Power-to-weight ratio 22 bhp/tonne

Water crossing ability: Unprepared wading depth 2.2 m. (i.e. to top of turret). A snorkel adaptation enables wading to 4 m to be conducted

NBC Protection: The air supply for the crew can be passed through a three-stage filter unit in the turret when the tank is closed down

Night Vision Equipment: Searchlight for white light or IR mounted above the gun. IR sights for commander and gunner can be fitted.

AMX-30 DERIVATIVES:

Bridgelayer

The bridgelayer version has a hinged span 22 m long which can be used to bridge a 20 m gap: it takes 10 minutes to lay and remove the bridge. The bridge is composed of one span in two hinged elements with removable widening panels and wheel guides. Without widening panels the width of the bridge is 3.1 m, but this may be increased to 3.93 m by the use of widening panels.

The bridge can be laid from slopes up or down to 30° and with a tilt of 15°. The span can be laid or removed from either end. It has a crew of three men (commander, operator and driver). Main dimensions of the bridgelayer in road trim are – length 11.5 m, width 3.8 m, height 4 m. Weight with the bridge is 40 tonnes and without the bridge 32 tonnes.

Recovery Vehicle

This has a crew of four men (commander, driver/radio operator and two mechanics). Equipment fitted includes an hydraulically operated spade at the front of the vehicle; the main winch has a capacity of 35 tonnes and the auxiliary winch a capacity of 4 tonnes, cable lengths being 90 m and 120 m respectively. The hydraulically operated crane can lift between 4 and 15 tonnes and can be rotated through 240°. Loaded weight with a spare power unit is 40 tonnes and it has a maximum road speed of 60 km/hr. Overall dimensions are – length 7.18 m, width 3.14 m and height 2.65 m.

AMX-30-S 401 A Anti-Aircraft vehicle with twin 30mm cannon – see entry 2138.131 and 5539.103

AMX-30 Javelot Anti-Aircraft System – see entry 2110.131

AMX-30 155mm GCT – see entry 5574.103

AMX-30 Roland Anti-Aircraft System – see entry 2218.131

AMX-30 with Pluton missile – see entry 2130.111

AMX-30S

This is now in production. It differs from the basic AMX-30 in that it has been designed to operate in very high temperatures. The modifications to the basic vehicle include: slightly lowered gear box ratios, the engine develops 620 hp at 2400 rpm, sand shields have been fitted. The road speed is now 60 km/hr. A light intensifying passive driving periscope can be fitted and a laser rangefinder is under development.

AMX-30 STATUS:

In production. On order for, or in service with, the following countries – Chile, France, Greece, Iraq, Libya, Peru, Saudi-Arabia, Spain, Venezuela.

MANUFACTURERS:

Groupement Industriel des Armements Terrestres, 10, place Georges Clémeneeau, 92211 Saint Cloud, France.

5020.102 LIGHT TANK AMX 13

DESCRIPTION:

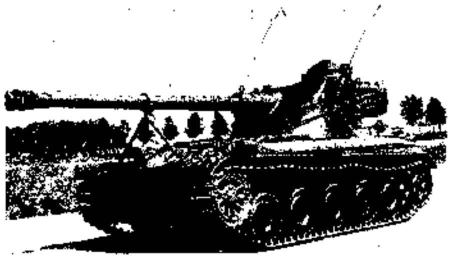
One of the most successful tanks produced since the Second World War, the AMX 13, has a history extending back to a requirement issued in 1946. It has been in production for some twenty years – during which time it has undergone numerous modifications to meet changing requirements and take advantage of technological improvements – and is still manufactured in very large numbers.

Original main armament was a 75 mm gun; but later versions mounted a 90 mm gun, in which form the tank is currently in service with the French Army, and a 105 mm gun, which is the version currently in production. The 105 mm gun fires the same anti-tank shell as is fired by the AMX-30 tank gun (**5542.103**) but with a muzzle velocity of 800 m/s: this shell will perforate up to 360 mm of armour at normal incidence. The gun will also fire a high-explosive anti-personnel shell with a muzzle velocity of 700 m/s. The gun is fired electrically.

By far the most notable feature of the AMX-13 tank is the use of an oscillating turret (see **2149.103**) which makes it possible to incorporate an automatic loading device for the main gun while still achieving a low profile for the turret. This automatic loading system permits a high rate of fire while requiring only two men in the turret.

In order to keep weight down the AMX-13 is not heavily armoured and relies extensively on its mobility and on its low silhouette for protection on the battlefield. It is indeed the lightest tank to mount a 105 mm gun.

From the basic tank a family of 23 armoured vehicles has been developed over the years; and, apart from those supplied to the French Army, some 4,000 of various members of the complete family have been exported to Algeria, Argentina (has also assembled AMX-13s, the first one being completed in 1969), Austria, Cambodia, Chile, Dominican Republic, Ecuador, Egypt, France, India, Indonesia, Israel (few, if any, remain in service), Ivory Coast, Jordan, Kenya, Lebanon, Morocco, Netherlands, Nepal, Peru, Saudi Arabia, Singapore, South Vietnam, Switzerland, Tunisia, Venezuela.



AMX13 with 105 mm gun

AMX-13 with 90 mm gun (ECP Armées)

CHARACTERISTICS:

Crew: 3 (Commander, gunner, driver)

Weight: 15 t in combat order

Size: Length 4.88 m (chassis only); 6.36 m (including 90 mm gun); 6.50 m (including 105 mm gun). Width 2.50 m. Height 2.30 m

Road Speed: 64 km/h

Main Armament: 105 mm gun (MV 800 m/s) or 90 mm gun (MV 950 m/s) or 75 mm gun (MV 1,000 m/s)

Secondary Armament: Coaxial 7.5 mm or 7.62 mm MG.

Method of Ranging: Optical rangefinder linked to sight and laser rangefinder.

Main Armament Rounds Carried: 32 rounds of 105 mm or 34 of 90 mm. 12 rounds in the automatic loader magazines

Night Equipment: IR searchlight and IR sights

Turret Rotation: 360°; power-assisted traverse mechanism

Engine: SOFAM Type 8GXb, 8 flat in-line cylinders – petrol spark ignition 250 bhp

Agility: Ground pressure 0.76 kg/cm². Max step 0.65 m. Max trench 1.6 m. Max gradient 60% (31°). Ground clearance 0.37 m. Power-to-weight ratio 16 bhp/ton.

DERIVATIVES:

As noted above, the AMX-13 family of derivatives numbers 23. Some of the more important are:

- 155 mm SP Howitzer
- 105 mm SP Howitzer
- Anti-aircraft tank (various calibres)
- Mortar vehicle (81 or 120 mm)
- Armoured personnel carrier
- Bridge-layer
- Dozer
- Recovery vehicle
- Ammunition carrier
- Ambulance

STATUS:

With 75 mm gun: still in service outside France.

With 90 mm gun: in service as standard equipment of French mechanised infantry brigades and elsewhere.

With 105 mm gun: in service in several countries outside France.

MANUFACTURER:

Creusot-Loire (Groupes Marine Schneider), 15, rue Pasquier, 75383-Paris, France.

5009.102 AMX 10P ARMOURED PERSONNEL CARRIER

DESCRIPTION:

This amphibious armoured personnel carrier is the first tracked APC developed in France which has not been adapted from a tank design. Its high, straight sides make it amphibious, and water-jet propulsion is used to give it an impressive water-crossing performance. It is powerfully armed with a 20 mm cannon which is operated from below armour, so that no member of the crew need be exposed. Prototypes of this vehicle have been under trial since 1969 and production for the French armed forces began in 1973.

CHARACTERISTICS:

Crew: 11 (Driver, gunner plus section of 9 infantrymen)

Weight: 13.8t in combat order, 11.3 t in travel order

Size: Length 5.85 m. Width 2.78 m. Height to top of turret 2.54 m (hull only 1.87 m)

Road Speed: 65 km/h

Cross-country Speed: 30-40 km/h

Water Speed: 6.5 km/h (by tracks)

Road Range: 600 km

Combat Range (NATO war mission): 24 hours

Engine: Hispano Suiza watercooled, multi-fuel 280 bhp at 3,000 rev/min

AMX 10 Amphibious Armoured Personnel Carrier

AMX 10P on rough ground

Armament of the AMX10P, 20 mm cannon and 7.62 coaxial MG operated from inside the vehicle

Interior of the AMX10PC Command Post Vehicle

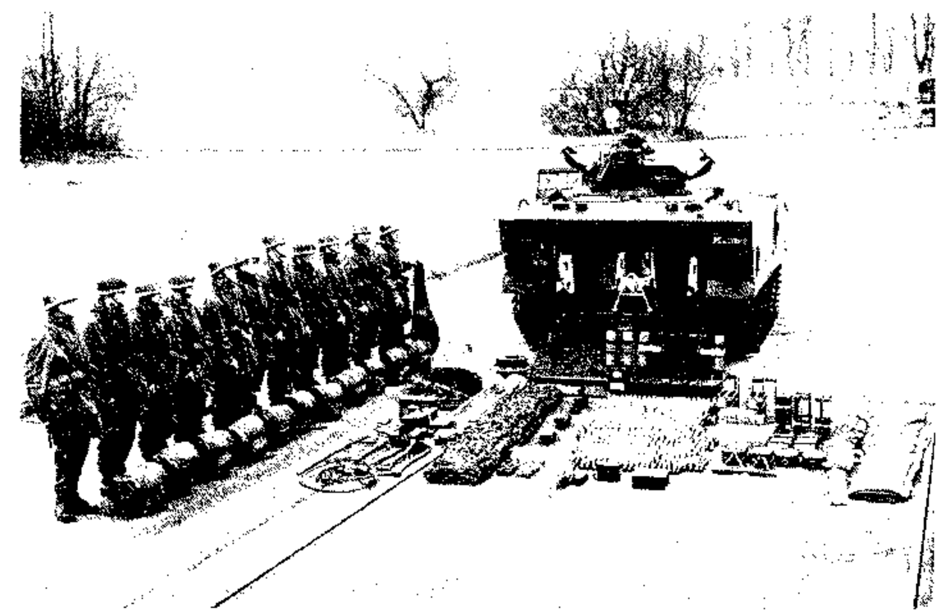
Transmission: 4 forward, 1 reverse pre-selected gears with hydraulic torque converter
Agility: Ground pressure 0.53 kg/cm². Max step 0.7 m. Max trench 1.6 m. Max gradient 60%. Power to weight ratio 20 bhp/ton
Armament: 20 mm cannon. 350 ready rounds + 450. 7.62 mm MG 900 ready rounds + 1,100. Both operated from inside the turret
Sights: Gunner, × 2 and × 6. Commander × 1 and × 6. Optional night observation and firing equipment

VARIANTS:
The French authorities are taking the AMX10P vehicle as the starting point for a substantial AMX10 family of AFVs

The first of these are the AMX-10TM, which tows the Hotchkiss-Brandt 120 mm mortar and has a crew of six, and the AMX-10PC command vehicle. Under development is the AMX-10D recovery vehicle, AMX-10M anti-tank vehicle with ACRA (**2071.111**) or HOT (**2212.111**) missiles and the AMX-10C with turret- or hull-mounted 105 mm gun.

Also under development is a wheeled family of vehicles, the first of which, the AMX-10R, was shown in 1971; in 1973 the AMX-10RC (**5110.102**) was shown.

MANUFACTURER
GIAT (Groupement Industriel des Armements Terrestres) 10, place Georges Clémenceau, 92211 Saint-Cloud, France.



This picture of the AMX10P with its large rear door lowered well illustrates the carrying capacity of the vehicle. In addition to the eleven men with their kit, weapons and food and the tools and accessories for the vehicle, the picture shows 800 rounds of 20 mm ammunition and 2,000 7.62 mm rounds

5110.102
AMX-10RC
RECONNAISSANCE VEHICLE

DESCRIPTION:
The AMX-10RC is a member of the AMX-10R family of vehicles at present under development; it was shown for the first time at Satory, in June 1973. All of these vehicles use components of the AMX-10P family (**5009.102**).

The vehicle is fully amphibious, being fitted with waterjets. Its oleo-pneumatic suspension can be adjusted to suit the tactical situation. A full range of passive night driving and night fighting aids are fitted. A comprehensive fire control system is also fitted, including a laser rangefinder.

CHARACTERISTICS:
Crew: 4 (Commander, gunner, loader/radio operator, driver)
Weight: 15 tonnes (laden)
Size: Length 6.243 m (hull). Width 2.78. Height 2.565 m (overall)
Road Speed/Range: 85 km/hr/800 km
Main Armaments: 105 mm gun, elevation −8° to +20°
Method of Ranging: Optical and laser rangefinder
Ammunition: no low-charge finned shell with a m/v of 1000 m/s, maximum m/v being 1500 m/s. Effective range 1650 m
Secondary Armament: co-axial 7.62 mm machine gun
Turret Rotation: 360° hydraulic traverse with manual for use in an emergency
Engine: Hispano-Suiza HS 115-2, V-8 water-cooled, 276 hp at 3000 rpm

AMX-10RC Reconnaissance Vehicle (Christopher F. Foss)

Transmission: 4 forward and 1 reverse pre-selected gears with hydraulic torque converter
Agility: Max step 0.7m. Max trench 1.6 m. Gradient 60%. Ground clearance 0.30 m
Water crossing ability: Fully amphibious
NBC Protection: An NBC system is fitted

STATUS:
Trials with the French Army.

MANUFACTURER:
GIAT (Groupement Industriel des Armements Terrestres) 10 place Georges Clémenceau, 92211 Saint-Cloud, France

5010.102
ARMOURED PERSONNEL CARRIER
AMX-VTP M-56

DESCRIPTION:
Developed during 1955 and 1956 on the basis of a lengthened AMX 13 tank chassis, this APC is still the standard equipment for mechanised infantry in the French Army. A maximum of 12 infantrymen can be carried, ten of them sitting back to back down the middle of the vehicle. Large hatches which open up the sides and top enable the infantry section to use their weapons from the vehicle on occasions. A turret left forward can be equipped with either a 7.62 mm or 12.5 mm MG. The crew can dismount either through two rear doors or through their top hatches. In addition to the French Army, the Dutch, Italian and Belgian armies are equipped with this vehicle. It is likely to be replaced by AMX-10 as this comes into service.

CHARACTERISTICS:
Crew: 13 (Commander, driver plus eleven infantrymen)
Weight: 14 tons (laden)
Size: Height 2.40 m. Length 5.70 m. Width 2.70 m.
Road Speed/Range: 60 kph/370 km
Armament: Turret mounted MG in two versions, either a 7.62 mm or 12.5 mm MG
Turret rotation: 360°
Engine: SOFAM 8, 8 flat in-line cylinders. Petrol spark ignition 270 bhp
Agility: Ground pressure: 0.7 kg/sq cm. Max step 0.65 m. Max trench 1.60 m. Max gradient 60% (31°). Ground clearance 0.48 m. Power to weight ratio 17.8 bhp/ton
Derivatives: The principal derivatives of this basic design are:
Command vehicle, ambulance, dozer vehicle, battery command vehicle, 81 mm and 120 mm

AMX VTP M56 Armoured Carrier armed with 12.7 mm MG mortar vehicles, pioneer vehicle, cargo carrier, artillery support vehicle, missile vehicle with two launchers either side for ENTAC (**2081.111**) anti tank missiles. The Netherlands have fitted a TOW (**2830.111**) system to one of their vehicles for trial purposes.

MANUFACTURER:
Creusot-Loire (Groupes Marine Schneider) 15, rue Pasquier, 75-Paris-08, France.

5021.102
ARMOURED CAR
AML 245

DESCRIPTION.

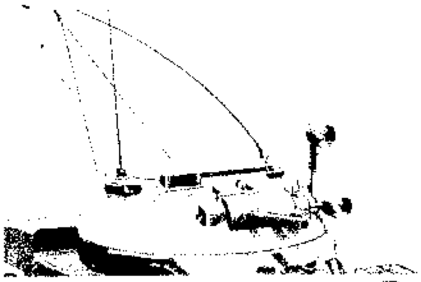
The requirement for a light armoured car for the French Army arose during the Algerian War in the 1950s. A specification was written for a vehicle of similar mobility, but greater firepower, than the Ferret Scout Cars that were then in French Army service. At the same time it was to be lighter and more easily serviced than the 8-wheeled EBR Armoured car. The result was the Auto-mitrailleuse Légère or AML (Panhard Model 245). Prototypes were built in 1960 and production followed with commendable speed, so that the first French Army Units were equipped in 1961. Since then some 4,000 vehicles have been produced in 6 different armament configurations and sales have been made to 27 nations. A large number have also been built under licence in South Africa. The roles of the AML are armed reconnaissance, frontier protection, convoy escort and internal security. Its reliability, silence, and speed make it especially valuable in these roles. Special features include the use of Hutchinson puncture proof tyres, enabling the vehicle to run even when the tyres have been damaged by gunfire or by mine, the long range of 600 kms, and the simplicity and ease of maintenance of the vehicle.

Latest in this series of fighting vehicles is a version mounting the new 60 mm Hotchkiss-Brandt vehicle-mounted mortar (**2151.103**). Another recent addition to the range is the AML HS 30, the "HS 30" referring to the 30 mm Hispano Suiza

AML 245 Turret Types

HE 60-7 Turret

Armament	One 60 mm breech loaded mortar, which can fire direct up to 350 m and indirect to 1,800 m. Also twin 7.62 mm MGs.
Ammunition	53 mortar shells, 3,800 rds MG
Laden Weight of Vehicle	4.8 t

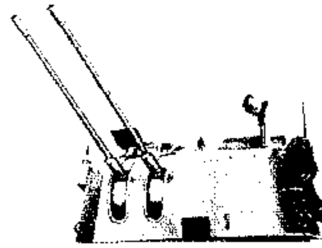


H90 F1-7 Turret

Armament	D921 90 mm gun, firing HE and HEAT ammunition up to 1,500 m range. Also one coaxial 7.62 mm MG.
Ammunition	20 90 mm shells (MV of HE is 650 m/s and of HEAT is 760 m/s). 2,000 rds MG
Laden Weight of Vehicle	5.5 t

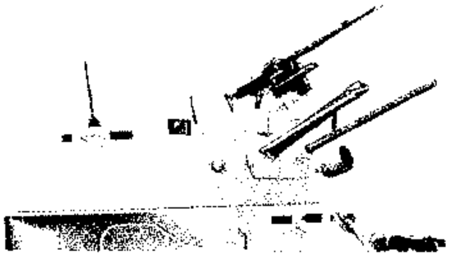
S 530 Turret

Armament	Two AME 621 20 mm anti-aircraft guns. Automatic loading from two magazines of 300 rds.
Traverse speed	80 degrees/s
Elevation speed	40 degrees/s
Firing rate	740 rds/min per barrel
Laden Weight of Vehicle	5.5 t



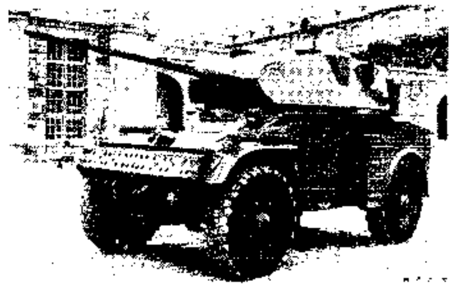
HE 60-20 Turret

Armament	One 60 mm breech-loaded mortar, which can fire direct up to 350 m or indirect up to 1,800 m. Also one automatic 20 mm gun firing HE or AP shells at 750 rds/min with MV of 720 m/sec. A 7.62 mm MG is mounted on the roof.
Ammunition	39 mortar shells, 300 20 mm shells.
Laden Weight of Vehicle	4.9 t



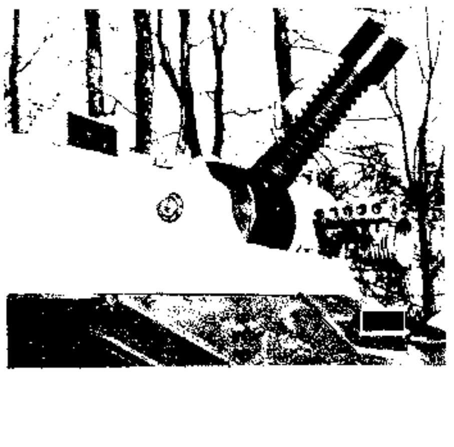
HS 30 Turret

Armament	One HS 30 mm gun (831 SL) for ground and anti-aircraft fire, electrically or manually fired. Also one AA 52 machine gun mounted alongside the 30 mm gun and a second mounted on the turret roof.
Ammunition	200 30 mm rounds (155 on belt) 2,200 rounds MG.
Turret weight	1.9 t in fighting order



HB Vehicle Mortar Turret

Armament	One 60 mm Hotchkiss Brandt Vehicle Mortar type 60 MC A1, breech-loading or muzzle loading (for high angle fire). Twin 7.62 mm Mgs.
Ammunition	53 mortar shells, 3,800 rounds MG (M35-47 or M61 shell and HB "canister" shell)



gun which is the vehicle's main armament. A two-man turret carries this gun and MG and the vehicle is designed to engage both ground and airborne targets – the main gun can be elevated to 75° or depressed to —8° and the practical engagement range is 2,600 metres.

CHARACTERISTICS (common to all turret types):

Crew: 3 (Commander / loader, gunner, driver)

Weight: Varies between 4.8 t and 5.5 t depending on turret type

Size: Height 2.1 m. Length (hull 3.79 m). Width 2.0 m.

Road Speed / Range: 100 km / h / 600 km

Method of Ranging: Commander's estimation

Turret Rotation: 360°, manually operated traverse on all except S530 turrets, 15 secs per revolution

Engine: Panhard 4HD 4 cylinder horizontally opposed air cooled petrol engine. 1,997 cc. 90 bhp at 4,700 rpm. Compression ratio 7 : 1

Transmission: Manually operated gearbox with six forward and one reverse gear. Electrically operated centrifugal clutch eliminating need for a clutch pedal

Agility: Ground pressure about 0.98 kg/cm varying slightly with different turrets. Maximum step 0.3 m. Maximum trench 0.78 m with one set of ditch plates, can be increased to 3.1 m using ditch plates from four cars. Maximum gradient 60% (1 in 1.6). Ground clearance 0.33 m. Power to weight ratio varies from 16 to 19 bhp / t depending on turret type.

Water crossing: By fording, without preparation to depth of 1.1 m

Variant: The VTT-AML APC, separately described, uses 95% similar components.

Amphibious AML

A major feature of Panhard's recent work on the AML has been the enlargement of its capabilities by making it amphibious. This has been done by boxing the existing armoured hull of the vehicle with thin sheet-metal coffers filled with expanded polyurethane. This material has the advantages of being self-extinguishing when ignited, of being non-absorbent and therefore buoyant and of providing a detonating point for a hollow charge projectile before it reaches the armour plate. The added materials increase the all-up weight by only about 10% and the vehicle is then amphibious.

STATUS:

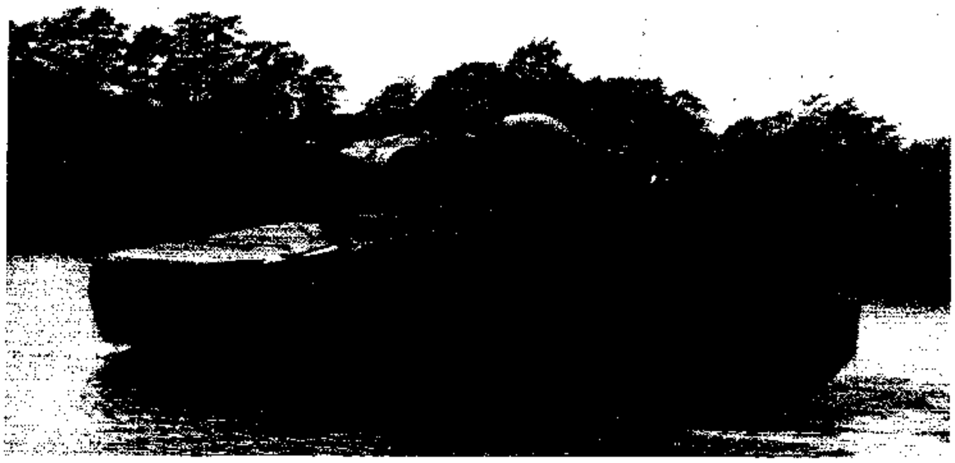
In production. The AML is in service with the following countries – Algeria, Burundi, Cambodia, Congo, Ecuador, Eire, Ethiopia, France, Iraq, Israel, Ivory Coast, Kenya, Libya, Mauritania, Morocco, Malaysia, Nigeria, Portugal, Rhodesia (from South Africa), Rwanda, Saudi Arabia, Senegal, South Africa, Spain and Tunisia.

MANUFACTURER:

Société de Constructions Méchaniques Panhard et Levassor, 18 Avenue d'Ivry, Paris 13e, France.

The Panhard AML 245 Armoured Car in the H90 version mounting a 90 mm gun. This vehicle is shown fitted with an infra-red searchlight and infra-red filtered headlamps

AML 245 Type H90-7 with 90 mm gun in amphibious configuration

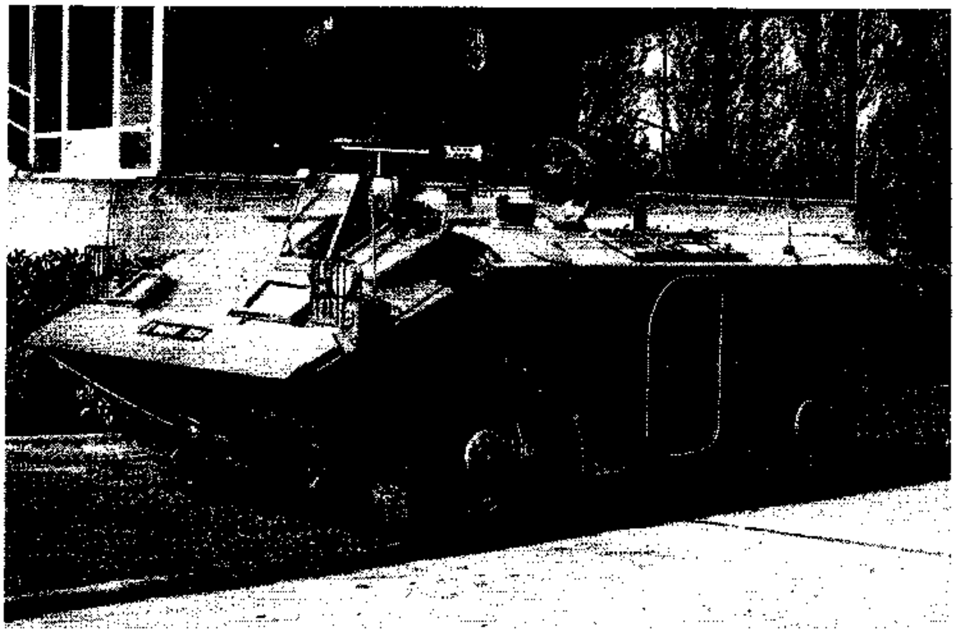


AML HS30 – amphibious version

2158.102
NEW PANHARD WHEELED VEHICLES

DESCRIPTION:

Panhard has built prototypes of a new range of wheeled armoured vehicles. These are known as the M4 (4 × 4), M6 (6 × 6) and M8 (8 x 8). They all have hulls of all welded construction and are fully amphibious being propelled in the water by two propellers at the rear of the vehicle, water speed being 6/7 km/hr. They have doors in the sides and rear of each vehicle and firing ports are provided. Hydropneumatic suspension is fitted, allowing the height of the vehicle to be adjusted. They all use a number of similar components such as suspension units and gearboxes, thus keeping logistics and costs to a minimum. The conventional clutch has been replaced by an hydraulic converter that ensures a smooth transmission: the gear box has two ranges. An NBC system is fitted.



Panhard M4 vehicle

CHARACTERISTICS

	M-4	M6	M-8
Crew:	10	10	12
Weight (laden):	10.9 t	11.8 t	13 t
Length:	5.305 m	5.855 m	6.70 m
Width:	2.50 m	2.50 m	2.50 m
Height (low):	2.53 m	2.53 m	2.53 m
Height (road):	2.67 m	2.67 m	2.67 m
Height (cross country):	2.79 m	2.79 m	2.79 m
Road speed:	90 km/hr	90 km/hr	90 km/hr
Road range:	1000 km	1000 km	1000 km
Max step:	.60 m	.91 m	.80 m
Max trench:	1.1 m	1.9 m	2.2 m
Max gradient:	60%	60%	60%
Fording:	Amphibious	Amphibious	Amphibious

DERIVATIVES:

M-4 – This can be fitted with a wide selection of turrets up to and including a 90 mm gun. It can be powered by a Caterpillar 1150 developing 200 hp/3000 rpm or a Berliet V800 developing 165 hp/3000 rpm or a Baudouin DF 6S developing 185 hp/3000 rpm. A Voith 502-3 automatic gearbox is fitted.

M-6 – This can be fitted with a wide selection of turrets up to and including a 90 mm gun. It is powered by a Caterpillar 1150 developing 200 hp/3000 rpm or a Caterpillar 1160 developing 225 hp/2800 rpm or a Baudouin DF 6S developing 185 hp/3000 rpm. It has a Voith 502-2 automatic gearbox.

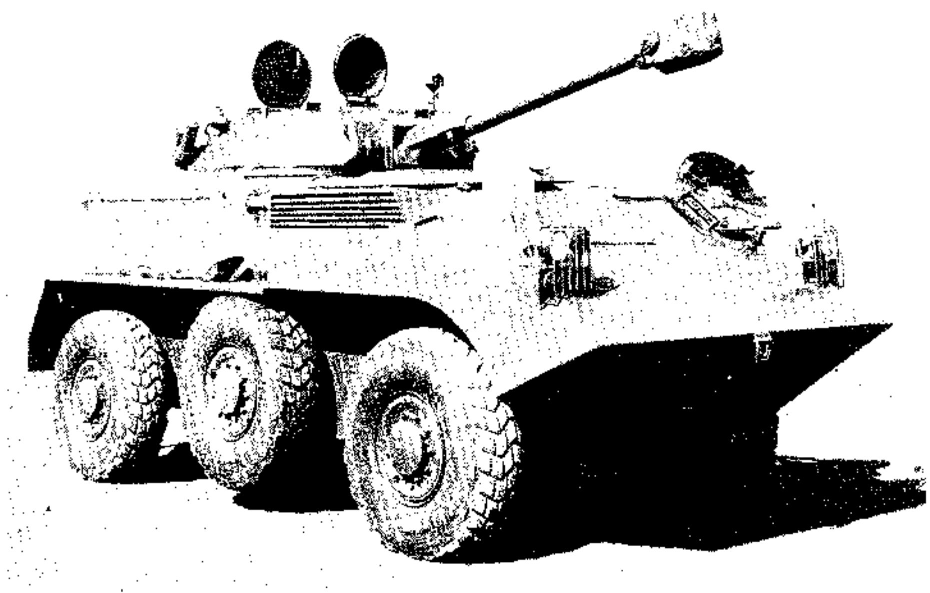
M-8 – This can be fitted with a wide selection of turrets up to and including a 105 mm gun (ie the same as that fitted to the AMX-10RC 6 × 6 vehicle **5110.102**). It is powered by a Caterpillar 1160 engine developing 225 hp at 2800 rpm and a Voith 502-3 automatic gearbox is fitted.

STATUS:

The Panhard M-4 and M-6 are being tested by the French Army and are in competition with the Saviem VAB (**5111.102**).

MANUFACTURER:

Société de Constructions Mécaniques, Panhard et Levassor, 18, Avenue d'Ivry, Paris 13e, France.



Panhard M6 vehicle

Panhard M8 vehicle

5022.102
M3/VTT
ARMOURED PERSONNEL CARRIER

DESCRIPTION

This comparatively recent vehicle has been developed from the AML 245 Armoured Car, and has 95% compatibility in mechanical components with the earlier vehicle. It is designed especially for use in counter-insurgency and internal security situations, where large numbers of armed men have to be conveyed swiftly, silently and safely to a trouble spot. It is likely to be especially valuable in this respect in city riots and other similar situations and the vehicle has indeed already been adopted officially by the French police. In addition to the crew of two, it will carry ten fully armed infantrymen. To permit exit through the back of the vehicle, the engine position has been

The M3 / VTT armoured personnel carrier

moved forward from its position at the rear of the AML 245 Armoured Car to just behind the driver on this vehicle. The box-like structure of the body, mostly fabricated from 10 mm armour plate, allows the vehicle to be fully amphibious.

A variety of different armaments can be carried, either with a fully rotating cupola or with a roof mounted weapon. Several variants to the basic design for special functions are now in development. The vehicle is now in full production and has already been sold to several countries.

CHARACTERISTICS:

Crew: 12 (Commander, driver plus 10 armed men) as APC

Weight: 5.8 t

Size: Height over CAFL turret 2.24 m. Length 4.45 m. Width 2.4 m

Road Speed / Range: 100 km / h / 600 km

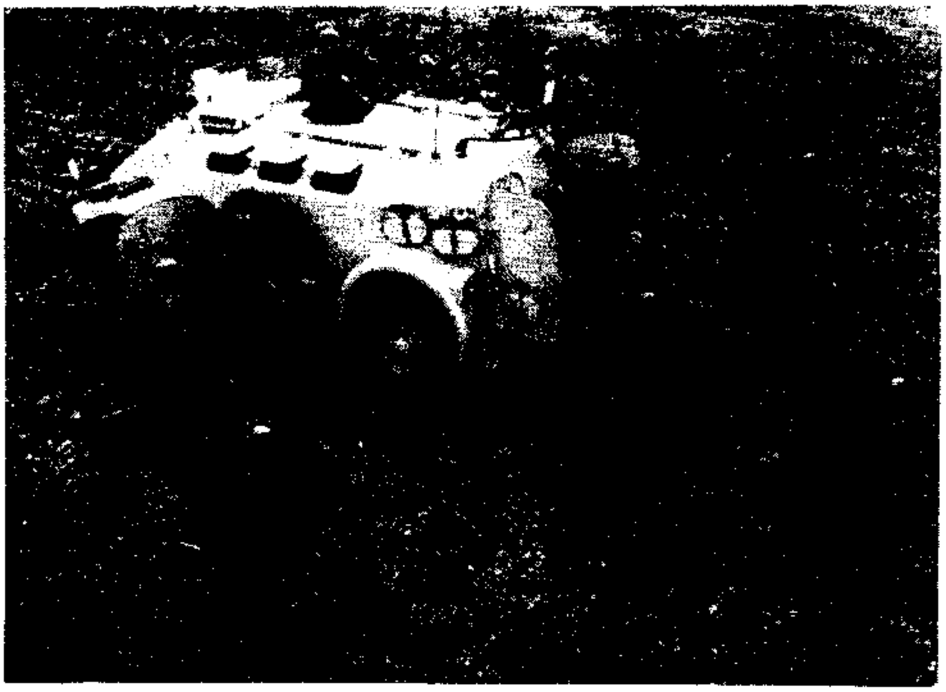
Armament: Various

Access: Two side doors and two rear doors

Engine and Transmission: As for AML 245

Agility: As for AML 245 except that power to weight ratio is 16.5 bhp / t

Water crossing ability: Inherently amphibious; propulsion by wheel spin



The personnel-carrying capacity of the M3-VTT is well illustrated here

VARIANTS:

The basic M3 can also be used as an ammunition / load carrier, mortar carrier, radio / command vehicle, workshop vehicle or an ambulance. Shown at Satory in 1973 was the M3 VDA Anti-Aircraft vehicle armed with twin 20 mm cannon (**2164.131**).

STATUS:

In production. In service with Abu-Dhabi, Congo, Eire, France, Iraq, Kenya, Lebanon, Malaysia, Saudi-Arabia.

MANUFACTURER:

Société de Constructions Mécaniques, Panhard et Levassor, 18, Avenue d'Ivry, Paris 13e, France.

5059.102
BERLIET VXB ARMOURED PERSONNEL CARRIER

DESCRIPTION:

The BL12 prototype amphibious armoured personnel carrier developed by the Berliet company between 1965 and 1968 was evaluated by the French Army in 1969. As a result of this trial, a modified version of the same vehicle, known as VXB, has now been designed. The VXB incorporates the considerable experience that the Berliet company have gained in the development of trucks and heavy wheeled vehicles for military and civil use. It is a robust, reliable and easily maintained vehicle with good cross-country performance.

CHARACTERISTICS:

Crew: 12 (Commander, driver and 10 infantrymen)

Weight: 15.5 t

Size: Height (to top of turret) 2.0 m. Length 5.92 m. Width 2.5 m

Road Speed / Range: 85 km / h / 750 km

Armament: See under Variants

Engine: Berliet V800 Diesel. 8-cylinder V type, 6.92 litres. 160 bhp at 3,000 rpm

Transmission: Berliet synchromeshed and air-assisted gearbox giving six forward and one reverse ratios

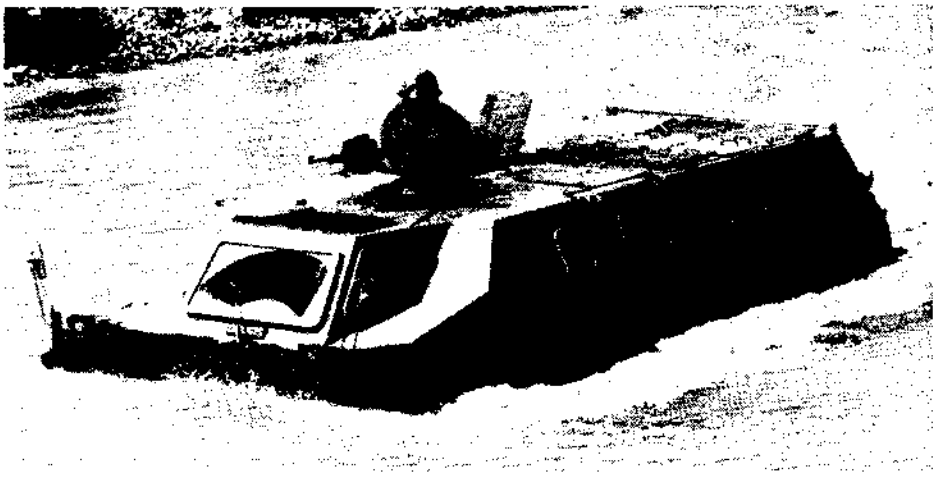
Agility: Maximum gradient 60%. Ground clearance 0.48 m. Power to weight ratio 14.2 bhp / t

Water crossing ability: Full amphibian, propulsion by wheel spin at 4 km / h

Exit for crew: The engine is at the rear of the vehicle. Exit is by two large doors at the centre of each side

Self-recovery: A 4.5 t winch is fitted at the front

The Berliet VXB Amphibious Armoured Personnel Carrier



Berliet VXB swimming

as a standard feature, particularly designed to assist in negotiating steep river banks.
VARIANTS:
A wide range of possible uses of the VXB has been proposed and prototype models embodying many of these proposals have been constructed. The vehicle can be used as a personnel carrier, as a carrier of a smaller number of troops with a substantial volume of stores, as an ambulance and as a cargo carrier.
Allied with these internal arrangements is a range of possible armament configurations extending from the provision of one or more MGs in single mountings on the hull to fully rotating one-man turrets armed with MGs or 20 mm cannon.
STATUS:
In service with the French Gendarmerie.
MANUFACTURER:
Automobiles M. Berliet, Département des Affaires Militaires, 160 Boulevard de Verdun, 92-Courbevoie, France.

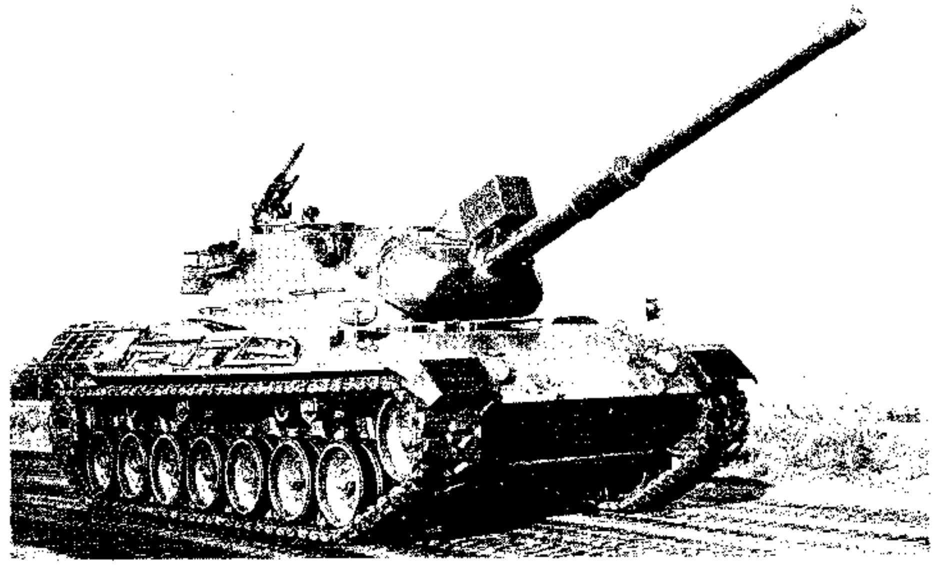
5111.102
SAVIEM VAB
FRONT ARMOURED VEHICLE
DESCRIPTION:
The Saviem VAB (Vehicule de l'Avant Blindé) has been developed under a programme laid down by the French Army and is in competition with the Panhard M-4 and M-6 vehicles (**2158.102**).
There are two models in the range, a 4 × 4 and a 6 × 6, both of which have the same over-all dimensions and use the same components. They have hulls of all-welded construction and are fitted with an NBC system. The vehicles are fully amphibious and can be fitted with a winch. A wide range of roles is envisaged including a troop carrier (12 men), missile vehicle, mortar carrier, cargo vehicle (up to 2 t of cargo), command post, ambulance, radio vehicle and recovery vehicle. Various types of armament can be fitted including 20 mm cannon.
CHARACTERISTICS:
Crew: 2 (commander and driver)
Size: Length 5.855 m, Width 2.48 m, Height 2.06 m
Road Speed / Range: 90 km / hr / 1000 km
Engine: 6 cylinder diesel, 245 hp
Transmission: Either mechanical with 6 gears or hydraulic with 5 gears and a converter
Agility: Max gradient 70%. Ground clearance .40 m
Water crossing ability: Fully amphibious
STATUS:
Under test by the French Army
MANUFACTURER:
Saviem, 8 quai Léon Blum, 92152 Suresnes, France.

GERMANY (FEDERAL REPUBLIC)

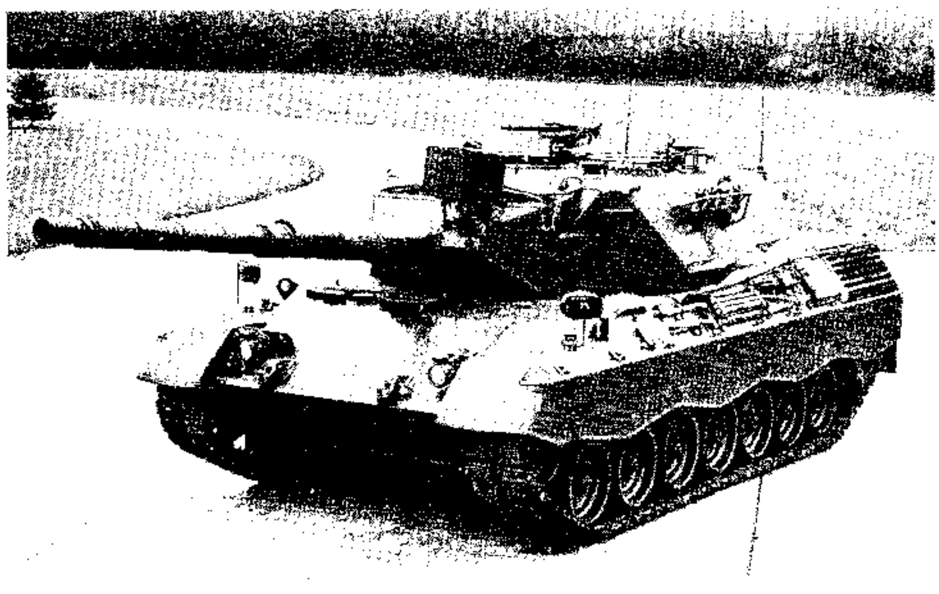
5015.102
MAIN BATTLE TANK
LEOPARD
DESCRIPTION:
Leopard is the first main battle tank to be manufactured in Germany since 1945, and it has been an extraordinarily successful achievement. The specification drawn up jointly by the Defence Ministries of France and Germany in 1957 listed the priorities for the design in order as: Firepower, Mobility, Protection. The intention of this joint agreement was to devise a NATO standard tank in the 30 t class. In the event a joint design could not be achieved, and the French initiated the design which eventually emerged as AMX 30, whilst the Germans designed Leopard.
The firm of Krauss-Maffei were chosen as overall contractors for series production of Leopard Tanks and Gepard AA Tanks (**2370.131**). The ARV, CEV and Bridgelayer versions were prepared by MaK Maschinenbau GmbH of Kiel. The testing of a 155 mm GCT on a Leopard chassis has started.
The first Leopard left the production line on 9th September, 1965, the first ARV, exactly a year later, on 9th September, 1966, and the first Bridgelayer (know known as Biber) in November 1973. Up to November, 1973, 3141 Leopards had been built: Germany (2187), Belgium (334), Netherlands (342), Italy (200) and Norway (78). 600 tanks are being built under licence by Oto-Melara in Italy (**2005.102**). there is also an additional order for 250 tanks for the German Army.
670 Leopard variants have been built by MaK of Kiel distributed as follows:

	ARV	CEV	BRIDGELAYER
Germany	444	36	6
Belgium	36	6	
Netherlands	41	14	–
Italy	69	12	–
Norway	6	–	–

The production of 105 Bridgelayers for Germany and 14 for the Netherlands is anticipated.
In mid-1976 the series production by Krauss-Maffei of 420 Gepards (Anti-Aircraft Vehicle) for the German Army and 95 for the Netherlands will begin. Belgium is interested in purchasing 55 and Italy 130.
The features that have contributed to the success of Leopard, can be summarised as:
1. Exceptional mobility, especially on hard going, achieved by a power to weight ratio of 21 bhp/t.
2. A powerful, accurate and quick firing gun (the 105 mm L/A3) which accepts the standard NATO ammunition stockpiled in huge quantities.
3. The reliability and long life of components due to good design and intensive environmental testing.
4. The ease of maintenance, and ease of crew training due to the absence of electronic luxuries.

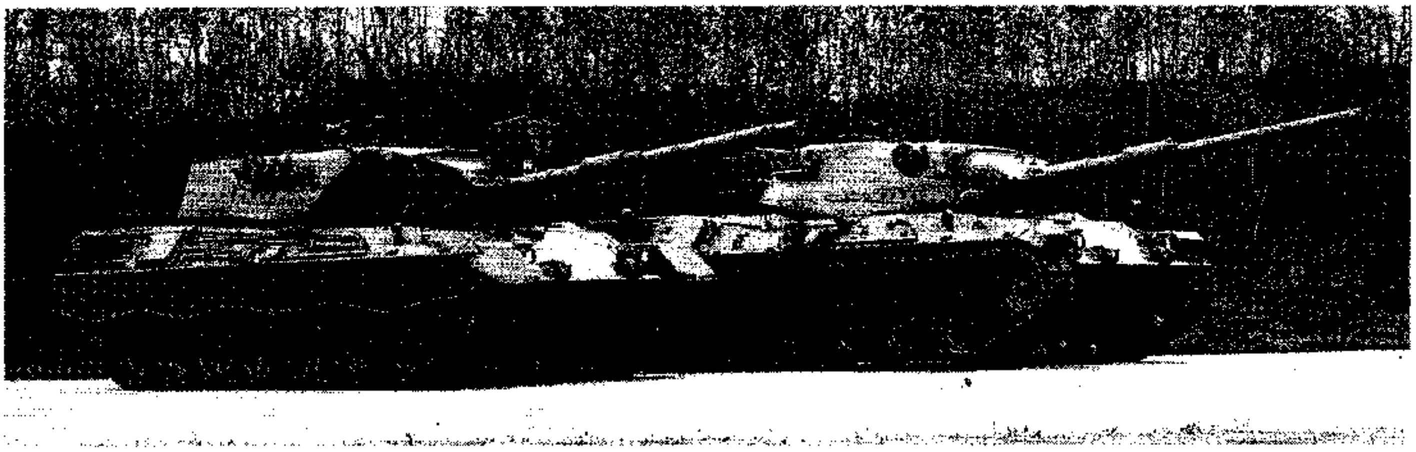


The Leopard Tank as originally delivered

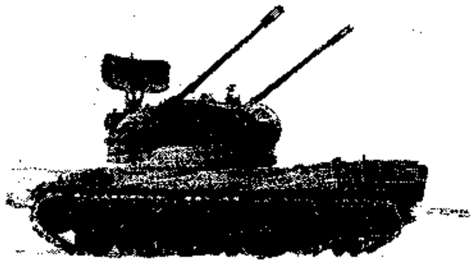


Leopard A3 MBT with new turret

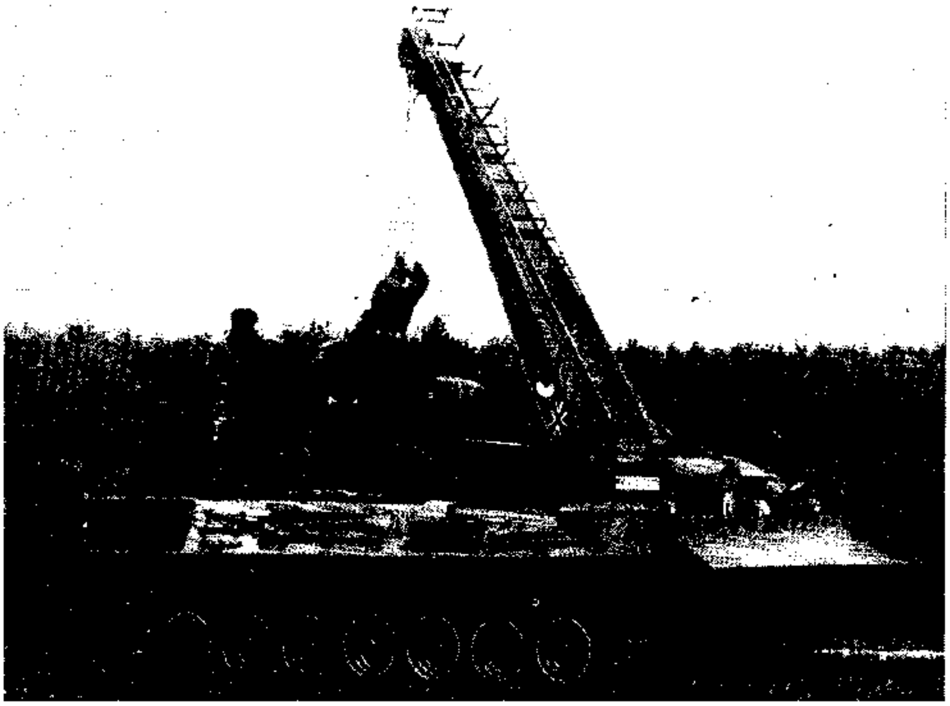
CHARACTERISTICS:
Crew: 4 (Commander, loader, gunner, driver)
Weight: 42.2 tonnes (laden)
Size: Height 2.62 m, Length (hull) 6.94 m, Width 3.25 m



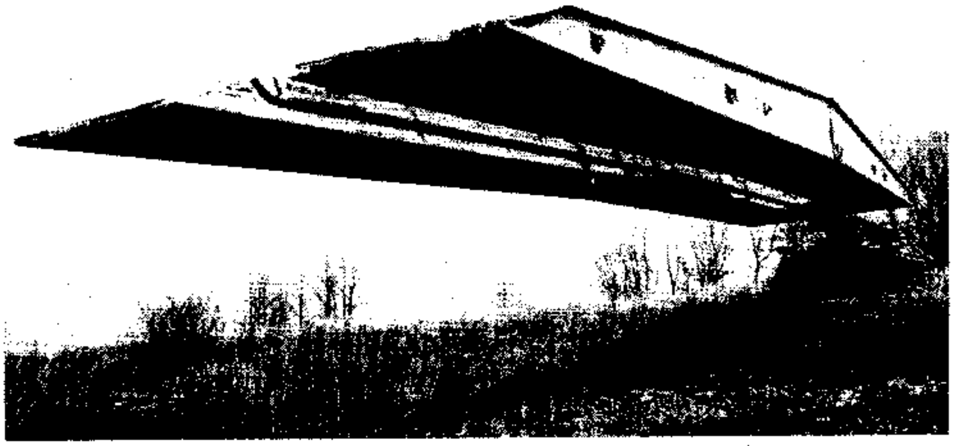
Leopard A3 (left) *and A2* (right)



Flakpanzer Gepard – German version of the AA vehicle



Leopard Armoured Recovery Vehicle



Leopard Bridgelayer BIBER

Road Speed / Range: 65 km/h/600 km
Armament: British 105 mm QF gun (L7A3)
Method of Ranging: The gunner has a rangefinder capable of being used either stereoscopically or coincidentally
105 mm Rounds Carried: 60 mixed loads of ADPS, HESH, HEAT and smoke
Max anti-tank range of main armament: APDS – 2,500 m. HEAT – 2,500 m. HESH – 5,500 m
Secondary Armament: One coaxial 7.62 mm MG. One roof mounted 7.62 mm MG for operation by Commander. 5,500 rounds carried
Turret Rotation: 360°, by Cadillac Gage electro hydraulic power traverse, in 12 secs
Engine: Daimler-Benz 90° V-10, 4 stroke, liquid cooled, supercharged, multifuel, compression ignition. 830 bhp at 2,200 rpm
Transmission: Four speed gearbox with hydraulic torque converter and electro-hydraulic gear selection
Steering: By tiller bar giving infinitely variable turn radii
Agility: Ground pressure – 0.86 kg/cm². Max step – 1.15 m. Max trench – 3.00 m. Max gradient – 33°. Ground clearance – 0.45 m. Power-to-weight ratio – 21 bhp/t
Water crossing ability: Unprepared wading to 1.2 m. Prepared wading to 2.25 m (turret top). Snorkel equipment permits deep water wading to 4.5 m
NBC Protection: Pressurised air conditioning and filtration system fitted
Night Vision Equipment: A white light/IR searchlight can be fitted on the gun mantlet. Gunner and driver positions can be fitted with IR viewers, and sights
Variants: The 1845 Leopards delivered to the German Army between 1965 and 1971 have now been designated Leopard **A1** after retrofitting of Cadillac-Gage main armament stabilisation system, thermal sleeve for the main armament, replaceable track pads, suspension skirts and deep wading equipment. 232 vehicles have additionally been designated Leopard **A2**s with improved ballistically protected turrets and image-intensifying night vision equipment **(1727.153)**

The 110 Leopard **A3**'s have a turret welded from rolled steel (spaced armour). From 1974, 250 vehicles, designated Leopard **A4**, with the same turret as the A3 and an integrated fire control system will be delivered to the German Army. The fire control system consists of a stabilised panoramic telescope on the commander's cupola, a computer-controlled rangefinder coupled with the stabilised main armament and a ballistic computer.

Leopard Derivatives

Armoured Recovery Vehicle – This is fitted with a crane that can be traversed through 270°, a spare engine can be carried on the rear deck and a dozer blade is mounted at the front, this can be used for dozing operations or for supporting the vehicle when the crane is being used. Performance data is similar to the basic Leopard, additional data is as follows:
Road Range: 800 km
Capacity of crane: 20 t (cable length 100 m)
Max pull of winch: single pull: 35 t (90 m of cable, double pull: 70 t

Width: 3.25 m
Fording depth: with schnorkel 4 m
Armament: 7.62 mm MG in bow of vehicle, 7.62 mm AA MG on roof

Combat Engineer Vehicle: This was developed from the ARV and has the following additional features – the dozer blade is fitted with ripping teeth for tearing up roadways etc, earth boring equipment is fitted and there is stowage space for sapper equipment.

Flakpanzer 1 (Gepard) – This is based on a Swiss development concept (**2370.131**). The Flakpanzer 1 is built by Krauss-Maffei as general contractor on a Leopard chassis with twin 35 mm cannon and two different radars, Siemens for the German Army and HSA for the Netherlands Army (**2302.153**). For these the chassis is equipped with an auxiliary power supply consisting of a 90 hp diesel engine and a 60 kw generator. Mobility is the same as the Leopard.

Self-Propelled 155 mm GCT Leopard: This has been carried out by Krauss-Maffei in collaboration with the French GIAT. The Leopard chassis has been fitted with the 155 mm turret normally mounted on the AMX-30 chassis. The turret is completely unmodified and is interchangeable between the AMX-30 and the Leopard chassis. The Leopard chassis maintains an auxiliary power supply from a 9 KW generator driven by a 20 hp multi-fuel engine. For details of the 155 mm GCT see **5574.103**.

Bridgelayer – In contrast to the normal method used to date, ie raising the bridge to unfold it and then place it in position, the Leopard bridgelayer bridge sections are slid flat one after the other and thus show as low a silhouette as possible. Performance is similar to the standard Leopard and additional data is – Range road 800 km. Length of bridge 22 m. Width of bridge 4 m. Weight of bridge 9.8 t. Capacity 50 t.

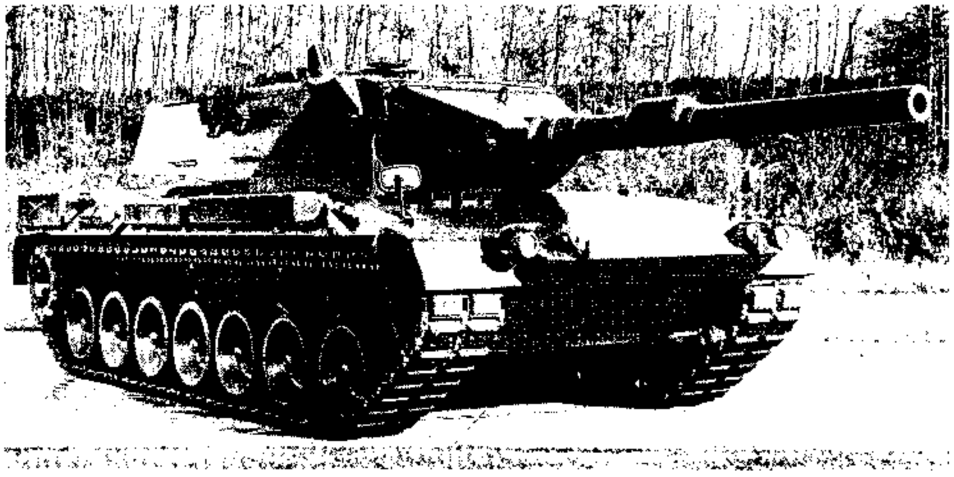
MANUFACTURER:
The main contractor is Krauss-Maffei AG, D-8000 München 50.

5114.102
LEOPARD 2 MAIN BATTLE TANK

DESCRIPTION:
The Leopard 2 has been developed by Krauss-Maffei as a replacement for the large number of M-48 tanks at present used by the German Army. A total of 17 prototypes have been built, and these are undergoing extensive trials by the manufacturers and the German Army, and one Leopard 2 has been ordered by the United States Army for early delivery; this will be used in comparative trials with American tanks.

Leopard 2 has a number of new and interesting features which will doubtless set the trend for future MBTs. It is powered by a 12 cylinder engine which develops 1500 hp and gives it a power-to-weight ratio of 30 bhp/ton which is far in advance of any MBT at present in service. It is armed with a 105 mm or a 120 mm smooth-bore gun. The suspension has been improved and is of the tube over bar type. the Leopard 2 has a better road and cross country performance than current MBTs. It is also the first post-war tank to have a turret and hull incorporating spaced armour (Leopard A3's have a turret with spaced armour), and this armour together with the heavier automotive components such as engine and transmission, have pushed the weight of the tank up to just over 50 t. Previously, when a tank had better armour the performance and mobility declined; in designing the Leopard 2 the Germans have reversed this trend, the end result being a superior vehicle.

CHARACTERISTICS:
Crew: 4 (Commander, gunner, loader and driver)
Weight: 50.5 t
Size: Length (hull) 7.73 m. Length (overall) 9.78 m (105 mm gun). Width 3.54 m (with track skirts). Height 2.45 m.
Road speed: 68 km/hr



Leopard 2 MBT with 120 mm gun

Armament: 105 mm or 120 mm smooth bore weapon developed by Rheinmetall.
Method of ranging: Optical-base rangefinder and laser rangefinder
Secondary armament: 7.62 mm co-axial MG, 7.62 mm anti-aircraft MG on loader's hatch. 2 × 4 smoke launchers either side of turret.
Turret rotation: 360° by Cadillac Gage electro-hydraulic power traverse. A stabilisation system is fitted enables the vehicle to fire on the move.
Engine: MTU 90", V-12, 4 stroke, liquid cooled, multi-fuel, compression ignition developing 1500 HP at 2,600 rpm
Transmission: HSWL-354/3 Hydromechanical with 4 forward and 2 reverse gears.
Agility: Ground pressure 0.83 kg/cm². Max step 1.15 m. Max trench 3.1 m. Ground clearance 0.50 m. Power-to-weight ratio 30 bhp/t
Water crossing ability: Unprepared wading 1.1 m. Prepared wading to 2.25 m (turret top). Schnorkel equipment permits deep water fording to a depth of 5.5 m
NBC Protection: Pressurised air condition and filtration system fitted
Night vision equipment: Passive IR night fighting and night driving equipment is fitted.

STATUS
Under test. Could enter production and service in 1976/77.

MANUFACTURER:
Krauss-Maffei AG, D 8000, München 50, Germany.

5115.102
SPÄHPANZER 2

DESCRIPTION:
The Spähpanzer 2 is an 8 × 8 armoured reconnaissance vehicle that has been developed to replace the Hotchkiss SPZ 11-2 vehicles at present used in this role. It is a very mobile vehicle and it is fully amphibious, it continues the long line of German 8 × 8 armoured vehicles. Its only drawback is that, for a reconnaissance vehicle, it is rather large and its armament is weak compared with that mounted in other recent reconnaissance vehicles.

The design dates from the mid 1960's and prototypes were completed by two main contenders (one being a consortium of companies, the other being Mercedes-Benz), a few years ago. It was announced late in 1973 that contracts had been awarded for two batches, one of 200 and one of 208 vehicles. At the present time it is not known which company will be building the production vehicles although the companies involved in their design included Mercedes-Benz, MAN, Rheinstahl, Büssing, Klockner-Humboldt-Deutz and Krupp. Deliveries are expected to commence late in 1975. The Spähpanzer (or Radspänpanzer as it is also known) uses a number of components of the new range of tactical trucks for the German

Prototype of the 8 × 8 Spähpanzer 2 vehicle

Army, ie, similar gearboxes, axles and engines. Under development is the 4 × 4 Spähpanzer which will also be fully amphibious.

CHARACTERISTICS:

Crew: 4 (commander, gunner and 2 drivers – 1 front and 1 rear)

Weight: 19 t (loaded)

Size: Length 7.34 m Width 2.98 m Height 2.50 m

Road Speed / Range: 100 km / hr / 800 km

Main armament: 20 mm Rh 202 cannon (**5600.103**)

Secondary armament: 7.62 mm anti-aircraft machine gun

Engine: Mercedes Benz Model OM 403 VA, 10 cylinder multi fuel, 390 HP

Transmission: Model ZF 4 PW 95 H 1, 4 forward and 1 reverse gears

Agility: Max step 0.6 m. Max trench 1.9 m. Max gradient 60%. Ground clearance 0.405 m

Water crossing ability: Fully amphibious, propelled in the water by two propellers at 11 km/hr

STATUS:

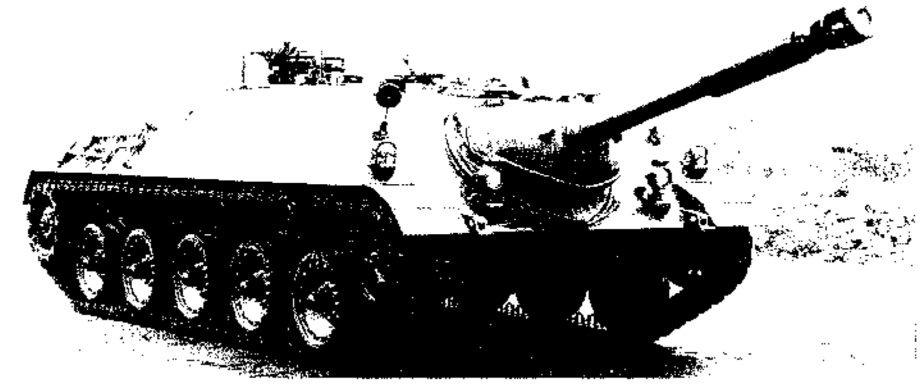
Entering production

5019.102
SELF-PROPELLED ANTI-TANK GUN
KANONE JPZ 4-5

DESCRIPTION

The Germans made extensive use of self-propelled anti-tank guns during the 2nd World War and the JPZ 4-5 is a continuation of this line of vehicle. Development of the vehicle started in the late 1950s and three series of prototypes were built and tested. After extensive trials a total of 750 vehicles were built by Rheinstahl-Hanomag and Rheinstahl-Henschel between 1965 and 1967. It uses the same chassis as the Rakete M-1966 (**5014.102**) and this common chassis was used as a basis for the development of the Marder MICV (**5013.102**) which is now in production.

In 1972 the Belgian Army placed an order for 80 vehicles: these will be assembled in Belgium. These Belgian vehicles differ from the German vehicles in that they have an improved transmission and suspension system which is based on that fitted to the Marder, and an improved and more up to date fire control system has been installed.



Kanone JPZ 4.5 self propelled anti-tank gun

CHARACTERISTICS:

Crew: 4 (Commander, gunner, loader, driver)

Weight: 26 t (laden)

Size: Height – 2.08 m. Length (hull) – 6.23 m. Width – 2.98 m

Road Speed / Range: 70 km / h / 400 km

Main Armament: 90 mm high velocity gun Bord K L/40.8 (Rheinmetall)

Rounds Carried: 51. Mixed HEP and HEAT (US pattern)

Max Useful Range: 2,000 m

Gun Traverse Limits: +15° in azimuth, +15°, −8° in elevation

Method of Ranging: By commander's estimate, with fine lay by hand-operated gunner's control

Secondary Armament: Two 7.62 mm machine guns, one coaxial with main armament, the other pintle-mounted on commander's cupola

Engine: Daimler Benz 837 Aa V-8 four-stroke diesel 500 bhp at 2,000 rpm

Transmission: Renk HSWL 123, hydraulically operated gearbox with 3 gears. A two-position transfer box selects backward or forward movement

Agility: Ground pressure – 0.75 kg/cm². Max step – 0.75 m. Max trench – 2.0 m. Ground clearance – 0.45 m. Power-to-weight ratio – 19.5 bhp/t

Night Vision Equipment: An IR target search light and driver's IR viewer can be fitted

NBC System: Yes

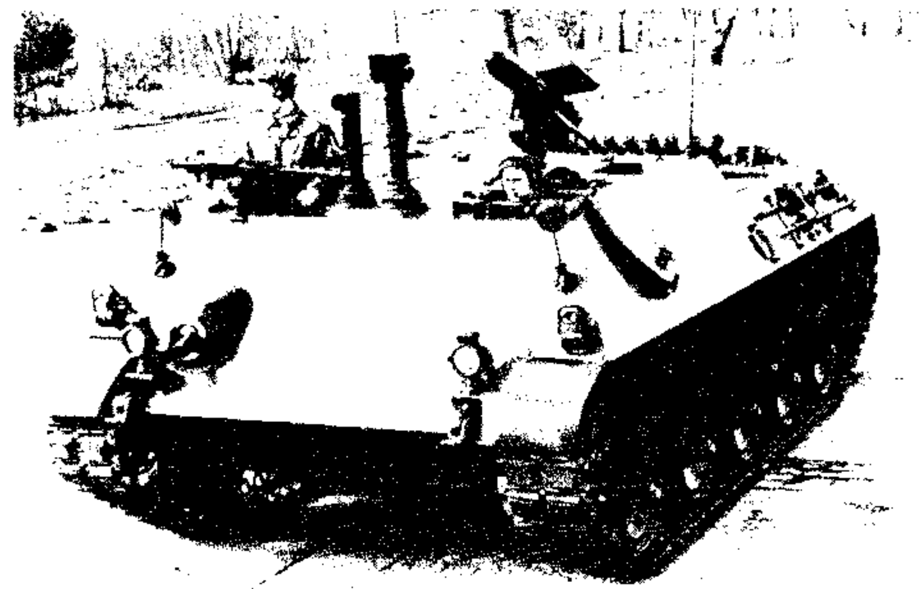
MANUFACTURER

Rheinstahl AG Sonderfertigung, 35 Kassel Henschelstrasse 2, Germany

5014.102
GUIDED WEAPON LAUNCHER
RAKETE M-1966

DESCRIPTION:

Developed in 1959 / 60 as a supplement to the JPZ 3-3 Guided Weapon Launcher based on the HS 30 chassis, it has been in service since 1963. It uses the same chassis and has a similar performance to the SP gun Kanone. It carries two SS-11 anti-tank missiles in the ready-to-fire position on launchers above the hull roof, with a further 12 carried under armour. After the first missile is fired an automatic reloading sequence begins, and a rate of fire of one missile per minute can be maintained. This vehicle increases the tank-killing range of the equipment of the Panzer Grenadier Battalions from the 2,000 m of the Kanone SP gun to the 3,200 m of the SS-11 missile.



Rakete Guided Weapon Launcher showing one of the two launcher arms extended

CHARACTERISTICS:

Crew: 4 (commander, GW controller, loader, driver)

Weight: 23 t (laden)

Size: Height – 1.98 m. Length – 6.43 m. Width – 2.98 m

Road Speed / Range: 70 km / h / 350 km

Armament: Two launchers for SS-11 guided weapons mounted above the hull roof. Two 7.62 mm machine guns, one firing through front hull plate, the other mounted in front of the commander's hatch

Rounds Carried: 14 SS-11 missiles

Traverse: Each launcher has a traverse of 90°; together they cover a total arc of 180°

Maximum Anti-tank Range: 3,200 m

Engine: Daimler Benz 837 Aa V 8 four stroke diesel 500 bhp

Derivatives: The JPZ 4-5 (**5019.102**) has the same hull as the Rakete. Trials have been carried out with a Rakete fitted with the HOT ATGW (**2212.111**)

MANUFACTURER

Rheinstahl AG Sonderfertigung, 35 Kassel Henschelstrasse 2, Germany.

Transmission: Renk HSWL 123, hydraulically operated gearbox with three gears. A two position transfer box selects backwards or forwards movement

Agility: Ground pressure 0.63 kg/cm². Max step – 0.75 m. Max trench – 2.0 m. Ground clearance 0.45 m. Power-to-weight ratio – 21.5 bhp/t

Night Vision Equipment: IR headlights and driver's IR viewer can be fitted

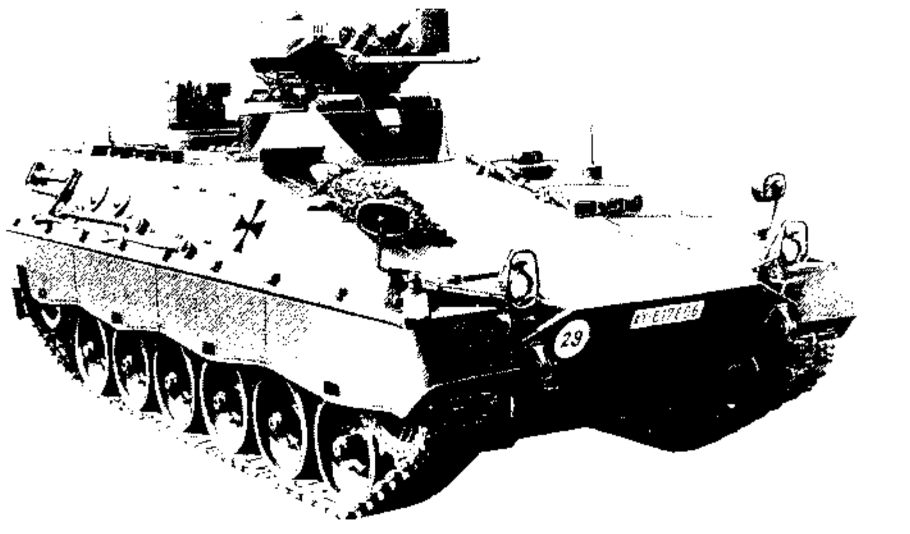
5013.102
MECHANISED INFANTRY COMBAT VEHICLE MARDER-SCHUTZENPANZER NEU M-1966

DESCRIPTION:

Designed to complement the Leopard tank in performance and mobility, the development of this vehicle was initiated at the same time as that of the Rakete GW Launcher, and the Kanone SP Gun in 1959, and many of the components are identical. Marder provides the German Army with a fast, large, hard-hitting and adequately protected MICV, which it has lacked up till now. A feature is its firepower; with a 20 mm cannon plus 7.62 mm MG mounted in a 2-man turret at the front and another 7.62 mm MG mounted in a rear cupola, and with firing ports along the side for the crew weapons, it is much more than an infantry transport vehicle. Special attention has been given to crew facilities to allow for long periods of close-down action, by heating, ventilation, noise and vibration reduction and so on.

The crew are disposed as follows. The driver is forward left, with the engine on his right. Behind him sits one infantryman. In the centre of the vehicle is the two man turret, containing the commander on the right, the gunner on the left. Six infantrymen sit back to back down the middle of the vehicle, able to use their weapons through firing ports in the roof and side. The rear gunner faces backwards and is the first man out through the rear doors, which open outwards and downwards to form a ramp.

The seats fold down to form beds, and hammocks can be slung, to allow the majority of the crew to sleep inside the vehicle at the same time. A novel feature of the vehicle is the use of a conventional steering wheel, and a truck-type gear-shift, making the task of training conscript drivers easier. Much thought has been given to make the vehicle reliable and easy to maintain. It is noteworthy that Marder is not an amphibian, since this would impose severe penalties on the design in other ways. Provision is however made for deep wading. Trials are under way of a Marder fitted with flotation bags at the sides and front of the vehicle. It is clear that this vehicle is expensive compared to other less well equipped and armed APCs. It does nevertheless represent a considerable advance on the existing APC equipment of the German Army. It is likely to be produced in very considerable numbers both for the German Army and for those other Armies that have already bought Leopard.



Marder Armoured Personnel Carrier

CHARACTERISTICS:

Crew: 10 (Commander who also commands the section when dismounted), driver, gunner for front turret, gunner for rear turret (who dismounts), six infantrymen. Exit is by rear door

Weight: 28.2 t (laden)

Size: Height – 2.95 m. Length – 6.79 m. Width – 3.25 m

Road Speed/Range: 70 km/hr/520 km

Armament: Externally mounted 20 mm cannon (Rh 202) in front turret with coaxial 7.62 mm MG. Rear cupola mounts another 7.62 mm MG. Firing ports are available for crew to use whilst closed down

Fire Control: 20 mm cannon can be aimed and fired by either of crew in the two-man turret

Rounds Carried: 1,250 of 20 mm. 5,000 of 7.62 mm

Turret Rotation: 360° (front turret only)

Engine: MTU MB 833 6-cylinder turbocharged diesel, developing 600 bhp at 2,200 rpm

Transmission: Four speed gearbox with torque converter

Steering: Hydrostatic system of double plate brakes operating onto the output shafts of the transmission unit

Agility: Ground pressure – 0.8 kg/cm². Max step – 1.0 m. Max trench – 2.5 m. Max gradient – 60% (1 in 1.7). Ground clearance – 0.43 m. Power-to-weight ratio – 21.3 bhp/t

NBC Protection: The crew compartment can be pressurised

Night Vision Equipment: An IR target searchlight can be fitted on the front turret. Commander, gunner and driver have IR viewing devices

Additional Equipment: A snorkel device to permit wading across rivers to a depth of 2 m is available

Derivatives: The 'Roland' anti-aircraft missile system is mounted on the Marder chassis in one version (**2218.131**). A mortar version with a 120 mm mortar has been developed but not placed in production. Trials are taking place with a fully stabilised turret

STATUS:

In production. Production is scheduled to end late in 1974 by which time 1926 vehicles will have been built.

MANUFACTURER:

Rheinstahl AG Sonderfertigung, 35 Kassel Henschelstrasse 2, Germany.

5008.102
ARMOURED PERSONNEL CARRIER SPZ 12-3 (HS-30)

DESCRIPTION:

The SPZ 12-3 has been the standard equipment of the German Army Panzer Grenadier Battalions since 1960, but is now being replaced by the Marder APC. The specification was drawn up in the late 1950's, at a time when the German Army was expanding rapidly and was in urgent need of an APC. To cut development time, the design was based on the chassis of an anti-aircraft gun system developed as a private venture by Hispano Suiza of Geneva, hence the designation HS 30. But Hispano Suiza did not have the manufacturing facilities to cope with volume production. It was therefore arranged that most of the order would be manufactured by the Leyland Company in England, the remainder being manufactured by the Hanomag and Henschel companies in Germany.

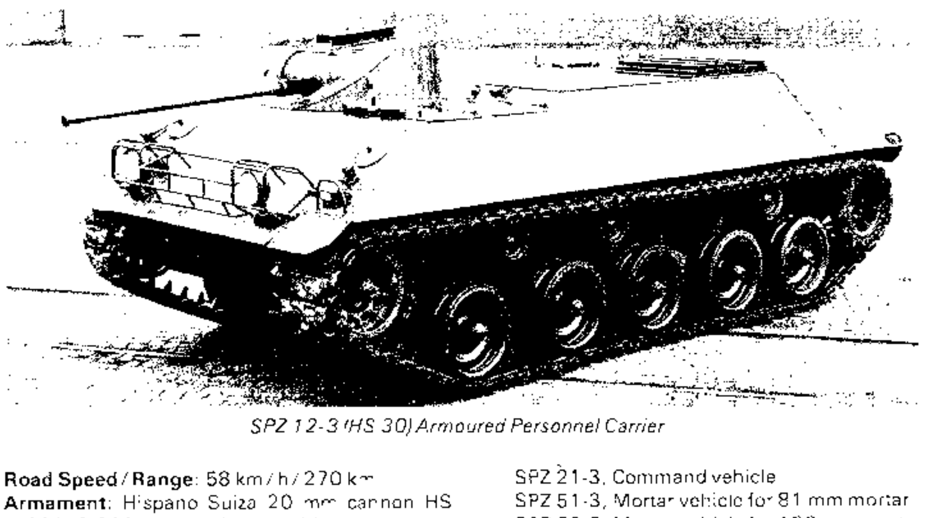
Deliveries started in 1960 and were completed (except for some variants) by 1965.

CHARACTERISTICS:

Crew: Driver plus seven infantrymen

Weight: 14.6 t (laden)

Size: Height – 1.85 m (including turret). Length – 5.56 m. Width – 2.55 m



SPZ 12-3 (HS 30) Armoured Personnel Carrier

Road Speed/Range: 58 km/h/270 km

Armament: Hispano Suiza 20 mm cannon HS 820. 2,000 rounds of ammunition

Turret rotation: 360°

Engine: Rolls-Royce 8 cylinder, petrol, spark ignition. 229 bhp

Ground pressure: 0.75 kg/sq cm

Power to weight ratio: 16 bhp/t

Derivatives:

JPZ 3-3 ATGW vehicle (SS 11)

SPZ 21-3, Command vehicle

SPZ 51-3, Mortar vehicle for 81 mm mortar

SPZ 52-3, Mortar vehicle for 120 mm mortar

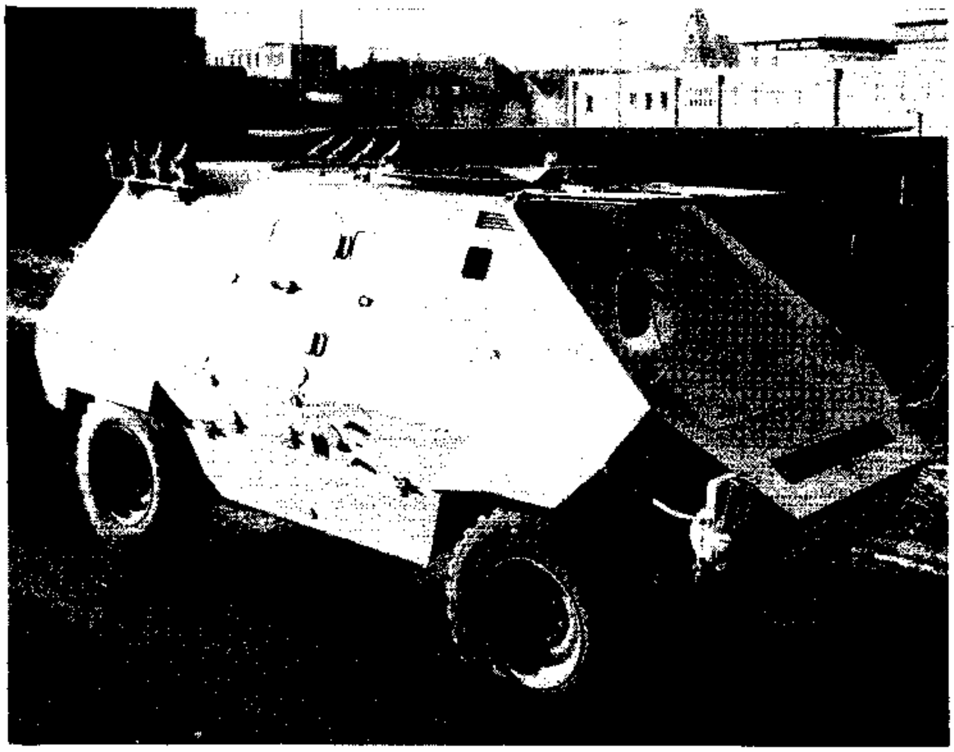
SPZ 81-3, Artillery fire control vehicle

It can also be fitted with the 106 mm recoilless rifle M-40 (**5584.103**) or TOW (**2830.111**) missile system

MANUFACTURERS IN GERMANY:

Rheinstahl AG Sonderfertigung, 35 Kassel Henschelstrasse 2, Germany.

5116.102
UR 416 ARMOURED PERSONNEL CARRIER
DESCRIPTION:
The UR 416 has been developed since 1965 and its primary role is border patrol and internal security work. The vehicle consists of a Unimog chassis on which has been fitted an armoured body. Doors are provided in the sides and rear, there are numerous firing and vision ports around the hull, and there are roof hatches. Various types of armament can be fitted according to the role required. Basic models include – ambulance, command or radio vehicle, maintenance vehicle, police vehicle with various items of equipment including obstacle clearing blade, missile vehicle with TOW or Cobra anti-tank missiles, and reconnaissance vehicles with various combinations of turret mounted 7.62 mm MG, 20 mm cannon and 90 mm recoilless rifle.
CHARACTERISTICS:
Crew: 8 (commander, driver and 6 men)
Weight: 6.3 t (loaded)
Size: Length 4.99 m. Width 2.26 m. Height 2.18 m (hull top)
Road Speed/Range: 80 km/hr/700 km
Armament: depends on role of vehicle
Turret rotation: 360°
Engine: DB-OM 352 4-cylinder diesel, 110 hp at 2,800 rpm
Transmission: Single plate dry clutch, 6 forward and 2 reverse gears, 2 speed transfer case can be fitted if required
Agility: Max step 0.55 m. Ground clearance 0.44 m. Gradient 70%
Water crossing ability: Fords to a depth of 0.55 m
NBC System: Nil

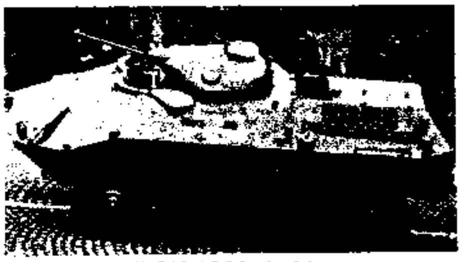


UR 416 with no armament fitted

STATUS:
In service with numerous countries in Europe, Africa, Asia and South America.
MANUFACTURER:
Rheinstahl AG Sonderfertigung, D-3500 Kassel, Germany.

HUNGARY

2189.102
FUG M-1963 (OT-65) SCOUT CAR
DESCRIPTION:
The FUG M-1963 (or OT-65 as it is also called) is the Hungarian equivalent of the Russian BTR-40P (**5037.102**). The Hungarian vehicle does however differ in a number of ways, the engine is at the rear of the vehicle and it is propelled in the water by two hydrojets. Like the Soviet vehicle it has four small wheels under the centre of the hull which can be lowered to give increased cross country performance or to assist the vehicle crossing ditches. The tyre pressures can be adjusted as required.
CHARACTERISTICS:
Crew: 5
Weight: 6.1 t
Size: Length 5.79 m. Width 2.36 m. Height 1.90 m (without armament)
Armament: one 7.62 mm machine gun
Engine: Csepel 4-cylinder in-line water cooled diesel, 100 hp at 2,300 rpm
Agility: Max step 0.47 m. Max trench 1.3 m. Gradient 60%. Ground clearance 0.305 m
Water crossing ability: Inherent amphibian. Propelled by hydrojets at 9 km/hr
Night vision equipment: Can be fitted
NBC system: Yes
DERIVATIVES:
The FUG M-1966 (also called the OT-66) is based on the FUG M-1963. The M-1966 has no belly whells and a modified glacis plate. Its turret mounts a 23 mm cannon and a 7.62 mm machine gun, and it retains the amphibious characteristics of the FUG M-1963.



FUGM-1966/OT66

STATUS:
In service with Czechoslovakia, Hungary and Poland.

INDIA

5041.102
VIJAYANTA (Victorious)
MAIN BATTLE TANK
DESCRIPTION:
The tank known as Vijayanta (Victorious) and manufactured in India was originally designed by Vickers Engineering in England. The design deliberately emphasized the use of well-proven components and ease of training and servicing and therefore lent itself readily to adoption by any country seeking to embark on the development of an armoured force. An initial quantity was sold to India in 1966 after which the Indian Government set up a factory for manufacture under licence in Madras. Over 400 have now been built in India. Details of the tank can be found below in entry number **5057.102**.
MANUFACTURER:
Avadi Company, 29 Mount Road, Madras, India.

INTERNATIONAL

5126.102
FMBT-80
DESCRIPTION:
The United Kingdom and Germany are carrying out a joint study for a tank for the 1980s called FUTURE MAIN BATTLE TANK 80. At the present time various companies and government establishments are carrying out work on this project. Late in 1973 the British Army carried out trials with some Swedish S tanks to see if this sort of tank could fulfil the required role. It has been reported that a 110 mm gun is being developed for this tank, Rheinmetall (Germany) being mentioned as being connected with the development (**2197.103**). No other information has become available at the time of writing.

ISRAEL

2009.102
ISRAELI ARMOURED FIGHTING VEHICLES
Over the years Israel has acquired, some as gifts, some as purchases and others as booty, a wide variety of armoured fighting and troop carrying vehicles. Many of these remain in service in their original form· others have been modified – sometimes quite drastically – in order to improve their combat characteristics or to maximise the number of operational AFVs available.
Somewhere in the region of a quarter of the country's total tank strength is made up of Russian-built vehicles – mainly T-55 (**5049.102**) but with a few JS III (**2882.102**) – captured from Egyptian forces. Of the remainder about half are of American origin and the other half is made up mainly of British Centurions (**5004.102**).
The entries which follow relate to a complete new development (**5062.102**) and to some modifications which have been put on a production basis in a form that has been standardised enough for the results to be regarded as new tank types.

5061.102
M4 'SHERMAN' MEDIUM TANK

DESCRIPTION:

A quantity of some 200 ex-US Sherman M4 tanks were procured by Israel in the 1950 s and were then modernised in Israel by the addition of medium velocity tank guns from France, and new Cummins diesel engines. Some of the turrets were re-equipped with the French 75 mm gun (this version being known as the Super Sherman), but the majority were converted to the French 105 mm gun (this version being known as the Isherman), firing HEAT and HE ammunition. These tanks were used extensively in the 1967 war, but their comparatively thin armour left them rather vulnerable to the 100 mm guns of the Egyptian T54/55, and casualties were heavy. Nevertheless there are believed to be still some 150 of these tanks in service with the Israeli Army. Other Sherman chassis are used to mount 160 mm mortars and 155 mm guns.

CHARACTERISTICS: M4 (105 mm)

Crew: 5 (Commander, gunner, loader, driver, co-driver). The co-driver is often omitted from the crew
Weight: 39.6 t
Size: Height 2.92 m. Length (hull) 5.93 m. Width 2.98 m
Road Speed/range: 45 km/h/240 km
Main Armament: French 1508d 105 mm gun
Method of ranging: Commander's estimate
Rounds Carried: Total of 55 mixed HE, HEAT, phosphor
Secondary Armament: Coaxial 0.3 inch Browning MG and hull mounted 0.3 inch Browning MG. Commander's externally mounted 0.5 inch MG
Turret rotation: 360°, hydraulically operated power transverse
Engine: Cummins diesel of 460 bhp
Agility: Ground pressure 0.89 kg/cm². Maximum step 0.86 m. Maximum trench 2.29 m. Maximum gradient 31°. Ground clearance 0.43 m. Power to weight ratio 11.6 bhp/t
Water crossing ability: Wading to 0.9 m

2010.102
PATTON TANK (ISRAEL)

DESCRIPTION:

One of several modifications carried out on imported or captured tanks of American, British, French or Russian origin, this alteration to the American M-48 Patton (**5056.102**) has been made by the Israeli Ordnance Corps on a scale sufficient for the resultant tank to be regarded as a separate mark.

Full details of the modification are not known, but notable features are the replacement of the M-48's 90 mm M-41 gun (**2832.103**) by the Centurion gun (**2451.103**) and the incorporation of a diesel engine in those tanks which were still fitted with petrol engines. The gun modification reduces the number of rounds carried by about 10%.

STATUS:

In service.

MANUFACTURERS:

Modification by Israeli Ordnance Corps

5122.102
ISRAELI CENTURION

DESCRIPTION:

The Israeli Army has used the standard Centurion MBT (**5004.102**) for many years and has been full of praise for the vehicle. In 1973 details were released of the Israeli Modified Centurion. It has a Continental 750 hp diesel and a General Electric hydraulic gearbox. This gives the vehicle a maximum speed of 43 km/hr, a great increase in range and a far more reliable power pack. It has also been reported that a Hughes laser rangefinder will be incorporated into the Centurion and other Israeli AFVs.

5123.102
ISRAELI T54/T55 (TI-67)

DESCRIPTION:

In the 1967 campaign the Israelis captured hundreds of Russian-made T-54 and T-55 tanks. By 1972 many of these had been modified to Israeli requirements and were either in service with the Israeli Army or held in reserve. They have the Israeli designation of TI-67. The modifications include replacing the Soviet machine guns with American machine guns, replacing the 100 mm gun by the British-designed 105 mm gun which is built in Israel, the fitting of a new electrical system as well as an air-conditioning system, and improving the fire control system. Some reports state that the tank has been fitted with a new engine, others that the Soviet engine has been retained and the cooling system modified. From most reports it would seem that the tank is not liked by its Israeli crews. In the October, 1973 campaign Israel captured some additional T-54 and T-55 tanks. In addition, large numbers of T-62s were captured from the Syrians.

5062.102
SABRA (OR TSABAR) MAIN BATTLE TANK

DESCRIPTION:

Sabra (or Tsabar – opinions differ) is the first tank designed and constructed in Israel. Built by the Israeli Army Ordnance Corps, it is said to be in the 40-ton class, mounting either the British 105 mm L7A2 gun which served the Israel armoured forces so well in the 1967 war or more probably the more recent Vickers L7A3 (**2452.103**). Other parts which are believed to have been purchased from outside Israel are an American Continental 1,000 bhp diesel engine and the hull and turret castings. It is said that the appearance of the turret is similar to that of the Russian T-55 (**5049.102**).

STATUS:

Believed to have entered service late 1972

MANUFACTURER

Israeli Army Ordnance Corps

ITALY

2005.102
MAIN BATTLE TANK LEOPARD (ITALIAN)

DESCRIPTION:

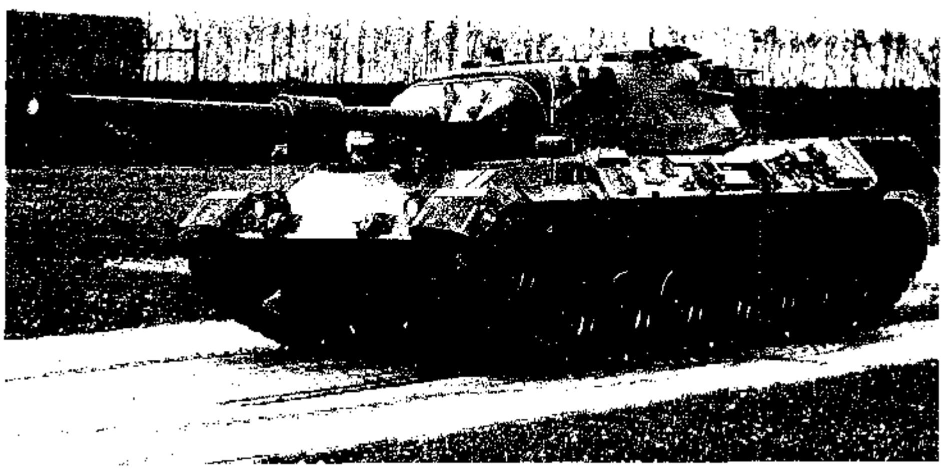
A quantity (understood to be 600) of Leopard tanks, destined for use by the Italian Army, will be produced under licence in Italy by OTO Melara with the co-operation of Fiat and Lancia in Turin.

So far as is known the tanks will not differ to any significant extent from the Leopard tanks made by Krauss Maffei in Germany (**5015.102**). OTO Melara will be making the hull, turret and gun, Fiat the engine suspension and tracks and Lancia the transmission.

Deliveries to the Italian Army were scheduled to start in the first half of 1974. 200 German-produced Leopards have already been delivered to Italy.

MANUFACTURER

Prime contractor – OTO Melara, via Valdilocchi 15, 19100-La Spezia, Italy



Leopard tank

5052.102
MAIN BATTLE TANK
M60 A1 (ITALIAN)
DESCRIPTION:

Manufactured in Italy under licence from Chrysler in the USA, 200 M60 A1 tanks are now in service with the Italian Army. As far as is known these tanks are identical in performance and appearance to the version manufactured in USA (**5024.102**).

MANUFACTURERS:

Prime contractor for the manufacture under licence was OTO-Melara, via Valdilocchi 15, 19100-La Spezia, Italy. Associated with them in this as with various other projects of this nature was the Special Vehicles Division of Fiat.

M60 AI Tanks manufactured in Italy

2006.102
MODIFIED M-47 TANK (ITALIAN)
DESCRIPTION:

The Italian Army's AFV strength includes 800 M-47 (Patton) tanks. Although no doubt it is intended that the new Leopard tanks made in Germany (**5015.102**) and under licence in Italy (**2005.102**) will replace these and the Italian-built M60 A1 tanks (**5052.102**) in front-line service, there are grounds for believing that the M-47 tanks may still have a useful role to play.

Accordingly, OTO-Melara have proposed, developed and successfully tested a modification to the M-47 which could extend the useful life of those still in service. The modification involves replacing the standard 90 mm gun by the British-designed 105 mm gun (**2452.103**) and incorporating a new diesel engine and new transmission to give a 60% increase in cruising range.

STATUS:

A prototype has been built and tested.

MANUFACTURER:

OTO-Melara, via Valdilocchi 15, 19100-La Spezia, Italy.

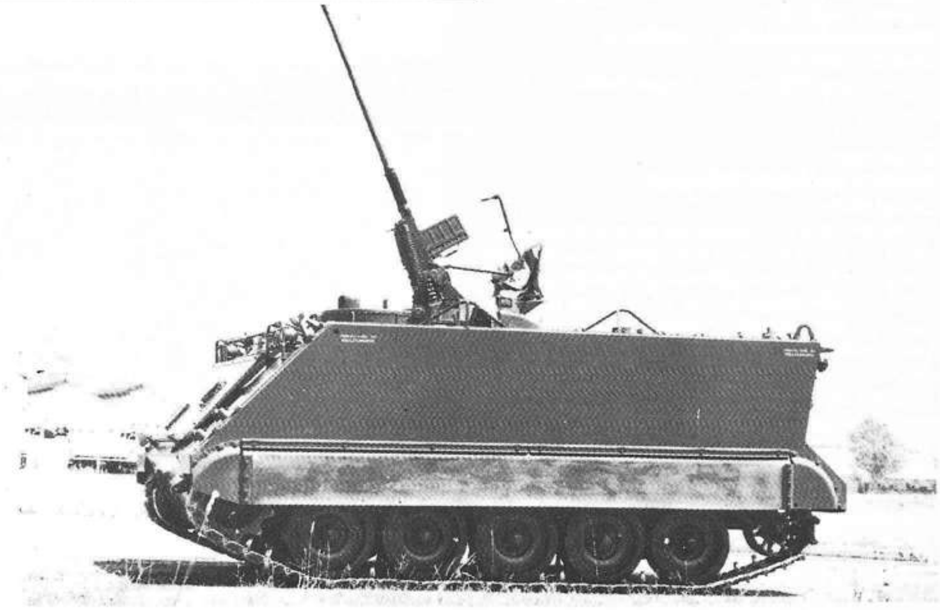
5072.102
M113 AND VARIANTS (ITALIAN)
DESCRIPTION:

In addition to manufacturing the M60 A1 main battle tank, OTO-Melara has a licence to manufacture and service the M113 Armoured Personnel Carrier and its variants from the FMC Corporation of USA. Thousands of M113s have been manufactured in Italy since 1963, in cooperation with Fiat and Lancia of Turin. Some 3,000 in various versions have been made for the Italian Army, others have been supplied to Turkey and Libya and the vehicles are still in production for several customers.

OTO-Melara have also had the contract to repair and re-build the M113 series of vehicles for all armies in Europe. The vehicles are generally identical to those of US manufacture. A variant of the M113 mounting the HS 820 20 mm cannon in a fully rotating and protected turret was developed in cooperation with Hispano Suiza of Geneva, Switzerland.

MANUFACTURER:

Main Contractor – OTO-Melara, via Valdilocchi 15, 19100-La Spezia, Italy.



M113 APC manufactured by Oto Melara, mounting the HS 820 20 mm cannon in a fully rotating and protected one-man turret

5118.102
INFANTRY ARMOURED FIGHTING VEHICLE (M-113 A1 FAMILY)
DESCRIPTION:

The Infantry Armoured Fighting Vehicle is the result of a development programme carried out by the Automotive Technical Service of the Italian Army to increase the combat effectiveness of the current M-113 A1 (**5072.102**) at present in use. It consists of the basic M-113 A1 with revised rear hull: there are a total of five firing ports above each of which is a glass block for viewing purposes. The vehicle is armed with a 20 mm or 25 mm cannon installed in a one-man turret; in addition there is a rotating hatch on the rear deck. Additional armour has been fitted – welded directly to the existing armour. The automotive components are the same as those of the basic M-113 A1.

CHARACTERISTICS:

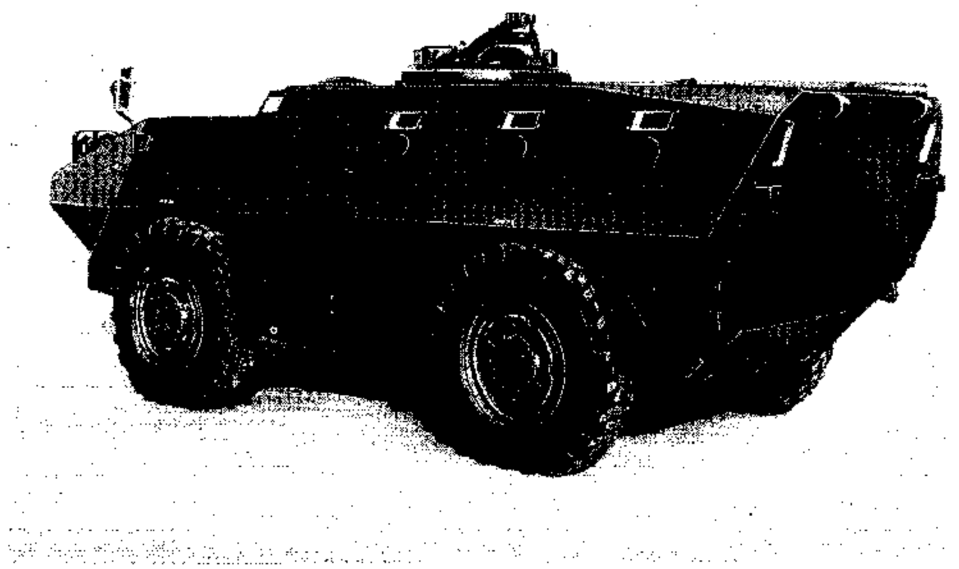
Crew: 9 (driver, gunner and 7 infantry including the vehicle commander)
Weight: 11.56 t
Size: Length 5.27 m. Height 2.55 m. Width 2.69 m
Road Speed/Range: 64.4 km/hr/550 km

OTO-Melara AIFV

Armament: 20 mm or 25 mm cannon
Agility: Ground pressure 0.56 kg/cm². Max step 0.61 m. Max trench 1.68 m Max gradient 60%. Max side slope 30%. Ground clearance 0.41 m Power-to-weight ratio 18.9 hp/t

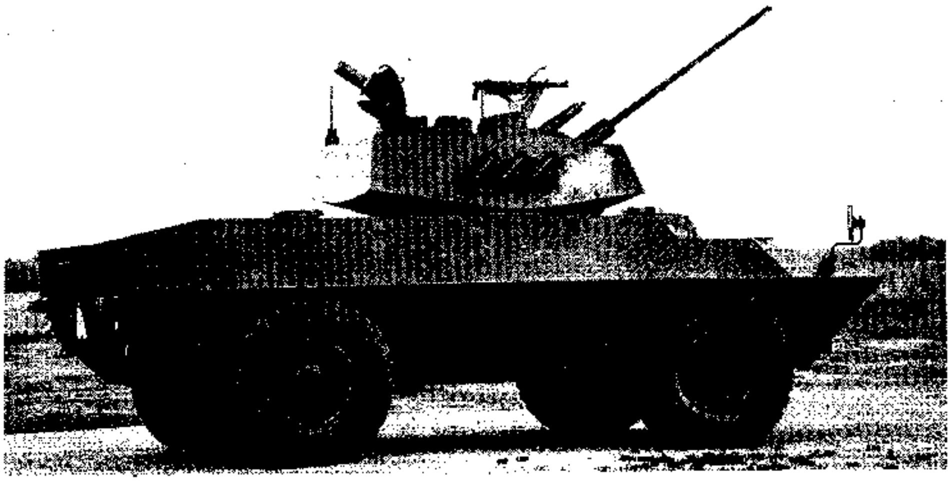
STATUS:
According to OTO-Melara this vehicle has completed its trials and is now in production. The vehicle is probably an improvement over the current M-113 but not to the extent of the new FMC AIFV (**5120.104**), the latter having improved armour and improved automotive characteristics.
MANUFACTURER:
OTO-Melara, via Valdilocchi 15, 19100-La Spezia, Italy.

5121.102
TYPE 6614 ARMOURED PERSONNEL CARRIER
DESCRIPTION:
This has been built as a prototype by Fiat and has been evaluated by the Italian Police authorities. The Type 6614 is a 4 × 4 vehicle and is fully amphibious, being propelled in the water by its wheels. It is designed primarily for the police/internal security role and for this reason it has numerous firing ports and vision blocks, at the rear is a large ramp allowing the crew to dismount from the vehicle in a very short time; in addition there are doors either side of the hull. A hatch is provided in the roof and this can be fitted with various types of armament including light machine guns.
CHARACTERISTICS:
Crew: 7
Weight: 5.9 t
Size: Length 5.16 m. Width 2.25 m. Height 1.71 m (w/o armament)
Road speed: 100 km/hr
Engine: Fiat 6 cylinder petrol, 122 hp at 5,000 rpm
Agility: Max step 0.5 m. Gradient 60%. Ground clearance 0.37 m
Water crossing ability: Amphibious
MANUFACTURER:
Fiat, Corso Marconi 10, Torino, Italy.



Type 6614 Armoured Personnel Carrier without armament

5119.102
TYPE 6616 ARMOURED CAR
DESCRIPTION:
The 6616 4 × 4 armoured car has been developed by Fiat (hull) and OTO-Melara (armament system). It is fully amphibious and air-droppable, and has been designed for a variety of roles including reconnaissance, border patrol and convoy escort duties. It has a hull of all-welded construction with the engine mounted at the rear. It is powered by a turbocharged diesel coupled with a five speed synchromesh transmission and a two speed transfer case. The wheels are fitted with runflat type tyres and have independent suspension on all wheels. Other features include power assisted steering, mechanically lockable front differential and limited slip rear differential.
The vehicle is armed with a 20 mm cannon and a co-axial 7.62 mm machine gun: on its roof is a breech-loaded smoke grenade launcher: there are six fixed smoke grenade launchers on the turret. If required the turret could be fitted with a TOW or Milan missile launcher or a 40 mm grenade launcher.
Turret rotation and weapon elevation/depression is electric/servo operated with manual operation available in an emergency.
CHARACTERISTICS:
Crew: 3 (commander, driver and gunner)
Weight: 7.4 t



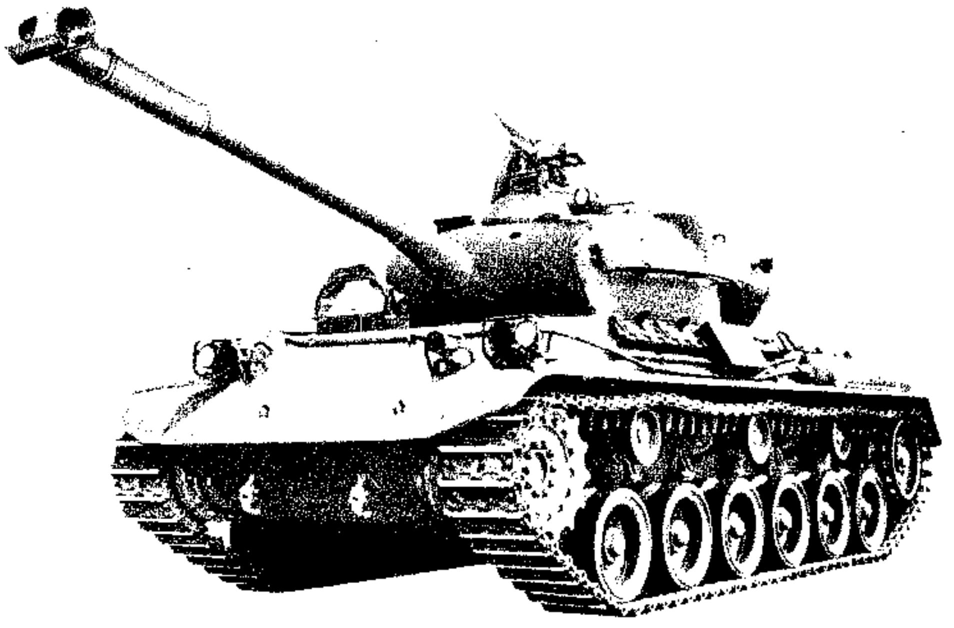
Type 6616 Armoured Car with turret-mounted 20 mm cannon

Size: Length 5.235 m. Width 2.50 m. Height 1.98 m
Road Speed/Range: 95 km/hr/750 km
Engine: Fiat 8062.22, 6-cylinder, 5.184 litres, supercharged diesel developing 147 hp at 3,200 rpm
Agility: Max step 0.45 m. Max gradient 60%. Minimum turning radius 6.5 m. Ground clearance 0.37 m
Water crossing ability: Amphibious
Self-recovery: 3 t winch
MANUFACTURERS:
Fiat, Corso Marconi, 10-Torini, Italy.
OTO-Melara, via Valdilocchi 15, La Spezia, Italy.

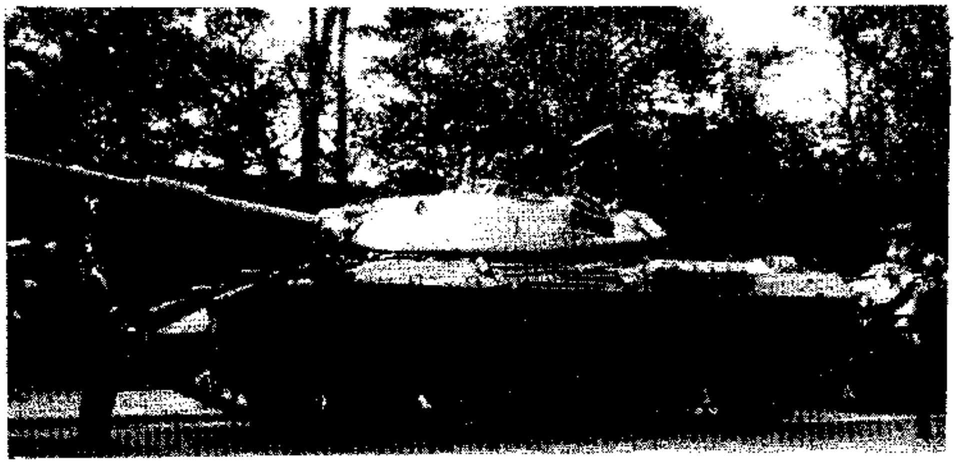
JAPAN

5027.102
MAIN BATTLE TANK
TYPE 61
DESCRIPTION:
When the Japanese Self Defence Forces were created in the early 1950s, all the armoured vehicles were obtained from the USA. However, as these vehicles became worn out the decision was taken to develop a range of armoured vehicles specifically designed for the requirements of the Japanese forces.
The Type 61 Main Battle Tank was one result of this decision. Its design was based more on the US M48 Tank, than on the pre-1945 Japanese Type 97 and Type 1 Medium tanks. In modifying the M48 design, advantage could be taken of the smaller stature of the average Japanese crew member compared with that of the average American – indeed it is believed that when the Japanese were using American-designed tanks their tank crews found them inconvenient in many ways. This allied to the need to match the tank to the narrow-gauge railways and light bridges found in Japan resulted in a smaller, lighter vehicle than the M48, but with equivalent firepower and mobility.
Two prototypes of this modified design were ready for testing in 1957, and after further design work two more prototypes were produced in 1960. Production followed in 1962, since when several hundred tanks have been manufactured. Notable features include a powerful V12 air-cooled diesel engine, giving this tank good mobility, a Japanese-made 90 mm gun fitted with muzzle brake and fume extractor and a simple but robust transmission system taking the drive to the front sprocket. The protection of the tank has been sacrificed to the need to keep size and weight down, and is clearly inadequate against modern anti-tank weapons.
The design of this tank is now more than ten years old and it is beginning to look out-of-date by comparison with current European and US tanks. For this reason the development of the new main battle tank ST-B (**5073.102**) is being expedited to replace Type 61 in the mid-1970s.
CHARACTERISTICS:
Crew: ½ (Commander, gunner, loader, driver)

Weight: 35 t (laden)
Size: Height (to turret top) – 2.49 m. Length (hull) – 6.30 m. Width 2 95 m
Road Speed: 45 km/h
Main Armament: 90 mm gun
Method of ranging: One metre base coincidence rangefinder
Ammunition: An APC round is used. Quantity carried not known
Secondary Armament: One .50 in MG mounted on the roof, operated by Commander. One .30 in MG coaxial
Turret rotation: 360° by power or hand traverse
Engine: Mitsubishi 12 HM 21WT V-12 air-cooled diesel. 600 bhp at 2,100 rpm
Transmission: Pneumatically assisted clutch syncromesh gearbox with 5 forward, one reverse gear. Drive taken to front sprocket
Agility: Ground pressure 0.95 kg/sq cm. Ground clearance 0.4 m. Power-to-weight ratio 17 bhp/t
Water crossing ability: No special arrangements
NBC Protection: None
Night vision equipment: IR driving lights and IR searchlights have been fitted to some tanks
Derivatives:
Type 67 Armoured Vehicle Launched Bridge
Type 70 Armoured Recovery Vehicle
Type 67 Armoured Engineering Vehicle
MANUFACTURER:
Mitsubishi Heavy Industries Ltd, Tokyo Machinery Works, 10, 2-chome, Marunouchi, Chiyoda-Ku, Tokyo, Japan.


Type 61 Main Battle Tank

5073.102
ST-B MAIN BATTLE TANK
DESCRIPTION:
The STB is the replacement for the Type 61 tank at present used by the JSDF. Development of the STB commenced in 1962 and the first prototypes were completed in 1968/69. Early models were fitted with a semi-automatic loading system for the 105 mm gun which is the British L7A3 (**2452.103**) built in Japan under licence by the Japan Steel Works.
In designing the STB the Japanese have managed to combine many of the best features of foreign tanks at present in service. The tank is fitted with a hydro-pneumatic suspension system allowing the height of the vehicle to be adjusted to suit the tactical situation, the 105 mm gun is fitted with a gun stabilisation system, and a laser rangefinder has been incorporated in the fire control system. A full range of night vision devices is fitted as also is a NBC system. If required a dozer blade can be fitted to the front of the vehicle.


ST-B Main Battle Tank (S. Yamada)

CHARACTERISTICS:
Crew: 4 (commander, gunner, loader and driver)
Weight: 38 t (laden)
Size: Length 6.6 m (hull). Width 3.18 m. Height 2.25 m (normal)
Road Speed/Range: 53 km/hr/600 km
Main armament: 105 mm gun fully stabilised
Method of ranging: Nippon Electric laser rangefinder and a Mitsubishi Electric ballistic computer
Turret rotation: 360°
Engine: Mitsubishi 10 ZF Type 21 WT 10 cylinder diesel, air cooled, developing 720 hp at 2,200 rpm
Transmission: Mitsubishi with 6 forward and 1 reverse gears. Clutch is mechanical, oil cooled
Agility: Ground pressure 0.7 kg/cm^2. Max trench 2.7 m. Max gradient 70%. Ground clearance 0.4 m (normal). Max step 1 m. Power-to-weight ratio 19.7 bhp/t
Suspension: Hydropneumatic
NBC Protection: An NBC system is fitted
Night vision equipment: IR driving and fighting lights are fitted
Deep wading: a schnorkel can be fitted
MANUFACTURER:
Mitsubishi Heavy Industries Limited, Tokyo Machinery Works, 10 2-chome, Marunouchi, Chiyoda-Ku, Tokyo, Japan.

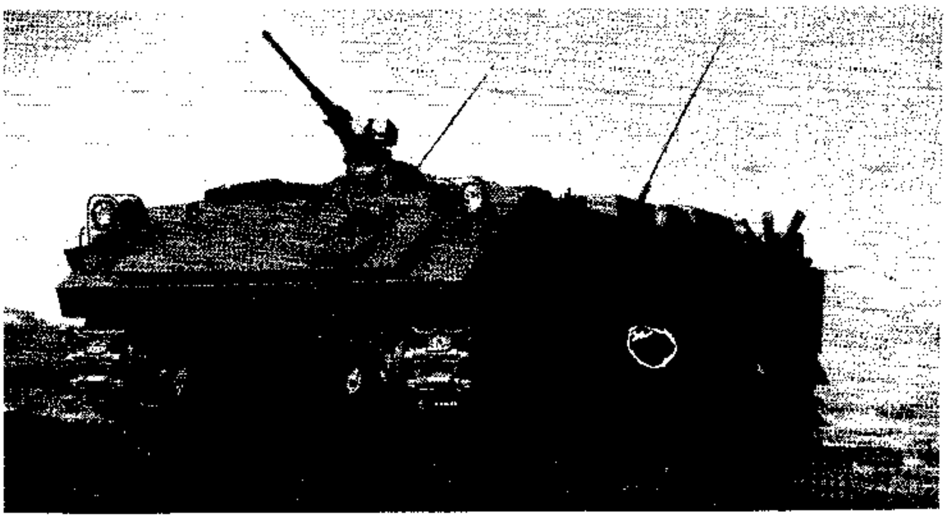
5124.102
TYPE 73 ARMOURED PERSONNEL CARRIER
DESCRIPTION:
The Type 73 Armoured Personnel Carrier (or MICV) has been designed to replace the Type 60 (**5026.102**) Armoured Personnel Carrier currently used by the JSDF. Whilst under development it was known as the Type 70. The Type 73 has a number of interesting features including a hull of aluminium armour, an NBC system and infra-red driving and fighting equipment. It is fully amphibious, being propelled in the water by its tracks: before entering the water a small trim vane is erected at the front.
Trials were carried out with two models. The first of these (SUB 1) was armed with a bow-mounted 7.62 mm MG, the roof cupola was provided with a simple mounting for a 12.7 mm MG and six smoke dischargers were mounted at the rear of the vehicle. The second model (SUB 11) also has the bow machine-gun but has a turret mounted 12.7 mm MG with three smoke dischargers either side: this model also has an IR searchlight to the left of the turret. A number of trials vehicles were fitted with rather simple firing ports either side of the hull.
CHARACTERISTICS:
Crew: 2 plus 10 infantrymen
Weight: 14 t (laden)
Size: Length 5.6 m. Width 2.8 m. Height 1.7 m (without armament)
Road Speed: 60 km/hr
Armament: 1 × 12.7 mm MG (roof) and 1 × 7.62 mm MG in bow
Engine: Mitsubishi Model V4, 2 cycle, air cooled diesel, supercharged developing 300 hp at 2,200 rpm
Agility: Max step 0.7 m. Max trench 2 m. Gradient 60%

Water crossing ability: Fully amphibious
DERIVATIVES:

None annonced so far, but some, (e.g. mortar carriers) are, without doubt, under development.

STATUS:
In production.

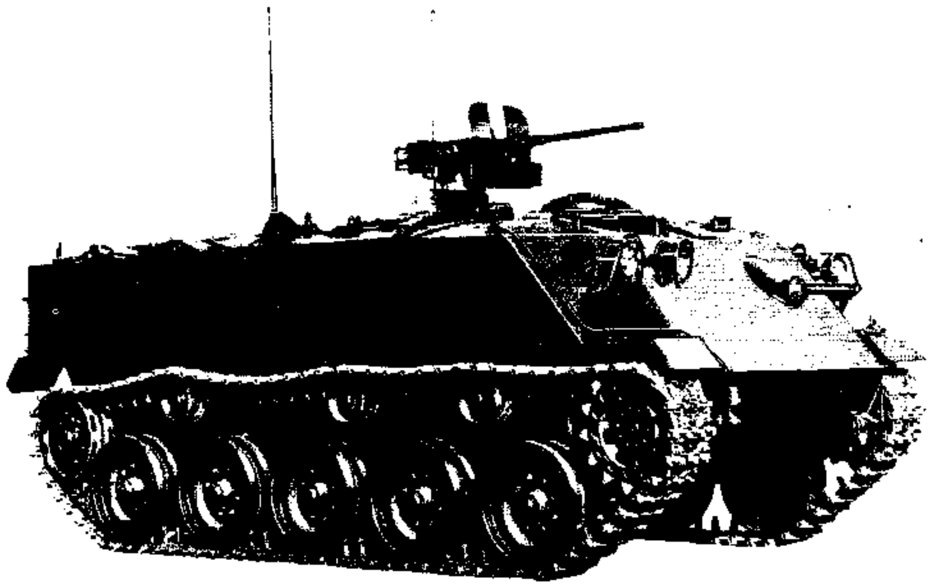
MANUFACTURER:
Mitsubishi Heavy Industries Limited, Tokyo.



Type 73 Armoured Personnel Carrier

5026.102
ARMOURED PERSONNEL CARRIER
TYPE 60

DESCRIPTION:
Two competitive prototypes to a Japanese Army specification for an Armoured Personnel Carrier were tested in 1958. One was designed by Mitsubishi, the other by Komatsu. The Mitsubishi prototype was successful but production was shared between the two companies. The Type 60 can be compared with the US M113 APC in weight and performance, but only carries a crew of 2 plus 8 infantrymen and so is smaller. In consequence it is unable to swim, and no provision has been made for a flotation screen. The commander is located at the centre front with a 0.5 in MG mounted alongside his cupola. The driver is to the right front of the commander, with a gunner on his left who fires the hull-mounted 0.30 in MG. The engine is at left centre, with the drive taken to the front sprockets. The crew members enter and leave the vehicle through two rear doors. This is an unusual lay-out, with the obvious disadvantage of the engine compartment intruding into the crew space. The vehicle has been made robust and reliable with no frills in the design. It is certainly an economical vehicle in initial and running costs.



Type 60 Armoured Personnel Carrier

CHARACTERISTICS:
Crew: 2 plus 8 infantrymen
Weight: 12 t (laden)
Size: Height 1.7 m. Length 4.85 m. Width 2.4 m
Road Speed / Range: 45 km/hr/230 km
Armament: 12.7 mm MG on pintle mounting alongside commander. 7.62 mm MG hull mounted with restricted arc of fire
Engine: Mitsubishi 8 HA-21 V-8 air cooled diesel. 220 bhp at 2,400 rpm
Transmission: Torque converter. Three forward and one reverse gear
Agility: Ground pressure 0.57 kg/sq cm. Ground clearance 0.4 m. Power-to-weight ratio 18 bhp/t
River crossing ability: Wading only
Derivatives: Two mortar carriers have been developed, one for 81 mm mortar, another for 4.2 inch mortar. Each carries a crew of 5

MANUFACTURER:
Mitsubishi Heavy Industries Ltd., Tokyo Machinery Works, 10, 2-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan.

THE NETHERLANDS

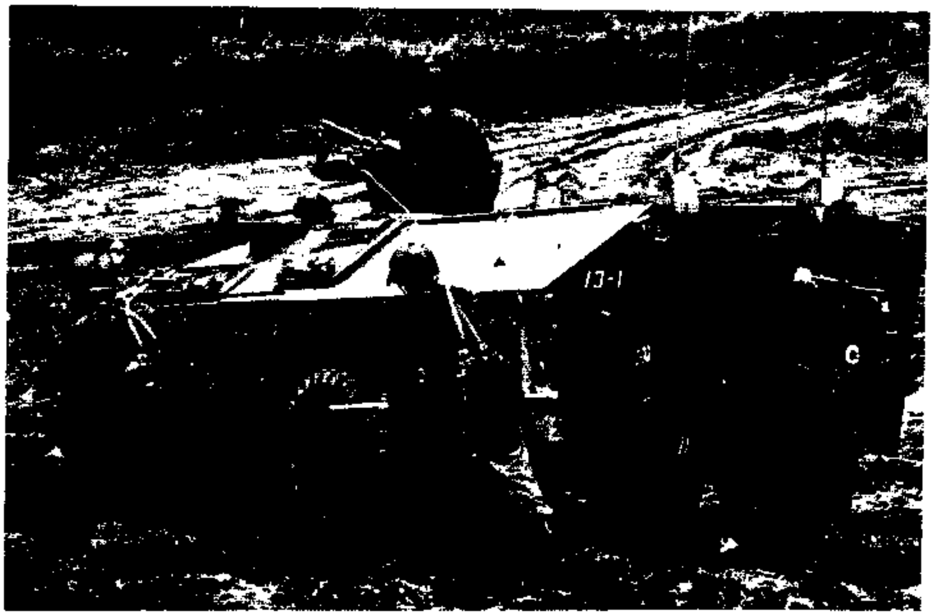
5011.102
ARMOURED PERSONNEL CARRIER
DAF YP 408

DESCRIPTION:
Developed between 1956 and 1958, using many of the components of the standard Dutch Army 3-ton truck DAF-YA 328, production of 750 vehicles for the Royal Netherlands Army was completed in 1968. It is an interesting attempt to use the reliability and economy of a truck design in an APC role. The drive from the 165 bhp diesel engine goes to six of the eight wheels, and the front four wheels steer. Cross-country performance is good, and the silence and economy of wheels makes this vehicle an attractive solution to the APC requirement. There are six variants: the details below apply to the basic group vehicle PW1-5(GR).

CHARACTERISTICS:
Crew: 12 (Driver, gunner/co-driver, 10 infantrymen)
Weight: 12 t (laden)
Size: Height 1.8 m. Length 6.23 m. Width 2.4 m
Road Speed / Range: 80 km/h/500 km

DAF YP408 Armoured Personnel Carrier

Armament: 0.50 Browning in a DAF mounting. The hatch plates are raised to the vertical position to provide some protection to the gunner
Turret Rotation: The gunner can traverse 360° by handwheel or by shoulder action
Engine: DAF DS 575, 6-line cylinders, 5.75 litres, supercharged diesel. 165 bhp at 2,400 rpm
Transmission: Drive is taken to the first, third and fourth pairs of wheels, by means of an H drive, to eliminate wheel slip. Synchromesh gearbox gives 5 forward, one reverse ratios
Agility: Max step 0.7 m. Max trench (if taken diagonally) 2.9 m. Max gradient 60%. Power-to-weight ratio 13.7 bhp/t
Water Crossing Ability: By wading, without preparation to 1.2 m
Night Vision Equipment: IR searchlight can be mounted alongside the MG. IR filters can be placed over headlamps. IR sight available for gunner. IR periscopic viewer available for the driver
Exit Doors: Two doors open at the back. Crew can also leave through hatches in the roof
Variants: PW1-S(PC) – Platoon commander's vehicle. Crew of 9. More radio equipment. Carries a portable Carl Gustav 84 mm anti-tank weapon.
PWCO – Company and Battalion Commanders Vehicle. Crew of 6. Equipped as a Command Post. Equipped with heater independent of main engine, and a pent house tent.



Troops disembarking from DAF-YP408 APC

PW-GWT – Ambulance – to carry 2 stretcher cases and four sitting patients.
PW-V – Freight carrier. Cew of 2. Can carry up to 1,500 kg of freight.
PW-MT – Mortar Tractor. Crew of 7. Developed principally to tow the 120 mm Brandt-Raye mortar. Carries 50 mortar shells.
MANUFACTURER:
Van Doorne's Bedrijfswagenfabriek BV, Geldropseweg 303, Eindhoven, Holland.

SWEDEN

5003.102
STRV 103 (S TANK) MAIN BATTLE TANK
DESCRIPTION:

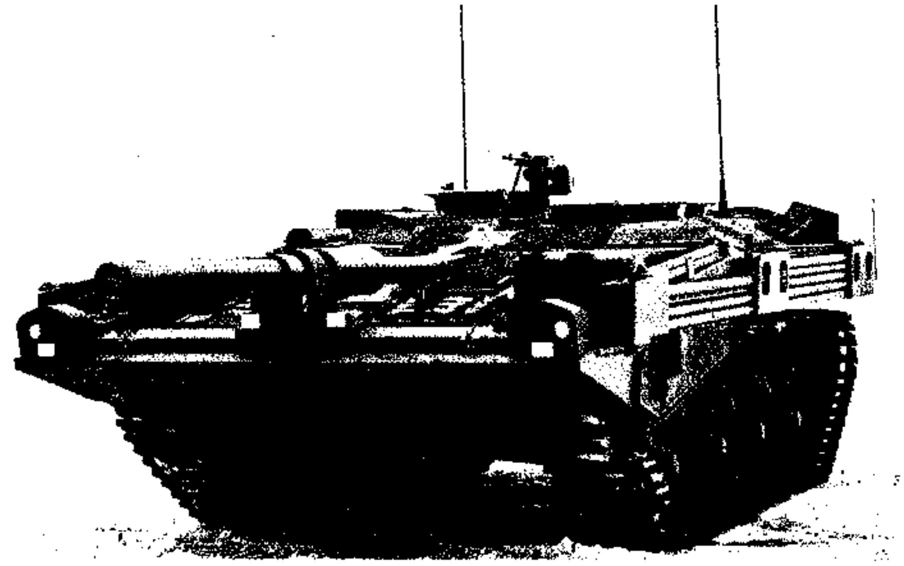
This is a highly unorthodox tank, which has incorporated more novel features into one design than any other post-1945 Armoured Fighting Vehicle. Yet this unorthodoxy has been introduced after very careful study of the requirement for AFV's in the 1970s and has not been incorporated as a technological gimmick. Paramount in the design has been the requirement to retain simplicity with reliability, and each new development incorporated has been compensated by a simplification in design elsewhere. For instance, although the fixed gun has meant complexity in the suspension arrangements for providing elevation and the steering arrangements for traverse, it has permitted automatic loading, no turret, a three man crew, duplicated gun and driving controls, and a considerable reduction in height and volume of the vehicle. The principle novel features can be listed as:

gun fixed to hull;
hydro-pneumatic suspension;
an advanced and unique steering system;
linked gas turbine and diesel engines;
duplicated gun and driving controls;
equal facility for forward or reverse driving.

Other, more minor, features of great interest to the specialist abound. There is evidence throughout this design of an unprejudiced and thoughtful examination of the established practices in tank design.

The development was initiated by a proposal put forward by the Chief Engineer of the Vehicle Division of Swedish Army Ordnance in 1956. This was followed by feasibility studies in 1958, resulting in the manufacture of two prototypes. Trials began with 10 pre-production vehicles in 1963, and full production started in 1966. The tank is now in service with the Swedish Army.

CHARACTERISTICS:
Crew: 3 (Commander/gunner, gunner/driver, rear driver/radio operator). The commander can also drive the vehicle from his position permitting one man operation of the tank in emergency. The rear driver faces backward.
Weight: 39.0 t
Size: Length (hull) 8.4 m. Length (including gun) 9.8 m. Width 3.6 m. Height 2.14 m
Road Speed/Range: 50 km/hr/390 km



STRV 103 (S tank) Main Battle Tank

Main Armament: British 105 mm gun L7A1 (**2451.105**) but with barrel 11 calibres longer than the British weapon (see **2343.103**)
Method of ranging: The original ranging machine gun method has been discarded and an optical system installed. Under development is a laser rangefinder
Rounds carried: 50 rounds mixed APDS, HE or smoke, carried in a magazine accessible through rear doors. The whole magazine can be re-loaded in 10 minutes
Rate of Fire: 10 rds/min with automatic loader. Type of round can be selected by commander or gunner. Empty cartridges are ejected through rear trap door
Method of elevation: By raising or lowering the tank suspension at back and front, the gun can be elevated between +12 deg and −10 deg. Controlled by handlebar grips by commander or gunner
Method of traverse: By slewing the tank on its tracks. Controlled by tiller boxes in commander's and gunner's positions. The process is accurate and sensitive
Secondary Armament: Two Belgian FN 7.62 mm coaxial MGs in a pod on left track guard. Sighted and laid with main armament. Can only be re-loaded by leaving vehicle. One commander's 7.62 MG for AA defence mounted to left of commander's cupola
Engines: 1 Rolls Royce K60 multifuel compression ignition 6 cylinder opposed piston. 6.57 litres 240 bhp at 3,650 rpm. 2. Boeing 553 gas turbine. 490 bhp at 38,000 rpm
Both engines are located at the front of the vehicle and are geared to a common output. Either will move the tank separately, but both are required to slew the tank for traversing the gun. Because of its better cold-start performance, the gas turbine can be used to start the diesel
Transmission: Torque converter, coupled to a gearbox with two forward and two reverse gears. Steering by a regenerative double-differential system, with an hydrostatic steering drive
Ability: Ground pressure 0.94 kg/sq cm. Max trench 2.3 m. Max gradient 30 deg (1 in 1.75).

Ground clearance 0.5 m. Power-to-weight ratio 18.7 bhp/t

Water crossing ability: Wading to a depth of 1.5 m without preparation. A swimming screen is permanently attached to each vehicle, and can be erected by the crew in 15 mins. Propulsion in water by tracks at 6 km/h

NBC Protection: No special arrangements

Night vision equipment: Driver has IR driving lights. At the present time no searchlight is fitted although trials have been carried out by fitting two Lyran illuminating shell systems to the top of the vehicle (as fitted to the British Striker **5040.102**)

Derivatives: All S tanks are fitted with a dozer blade at the front of the vehicle. First production models, the Strv. 103As did not have a flotation screen and had a less powerful engine. All Strv. 103As have now been modified to Strv. 103B standards with improved powerpack and flotation screen. Production of the S Tank was completed in June 1971. In late 1973 the British Army carried out trials with a number of S Tanks in Germany to discover if a turretless tank could meet British Army requirements for the FMBT

MANUFACTURER:

AB Bofors, S-690 20 Bofors, Sweden.

5063.102

Ikv 91 LIGHT TANK

DESCRIPTION:

The Ikv 91 is a member of the Hägglunds family of light armoured vehicles. Designed on contract for the Swedish Materiel Administration of the Armed Forces, it is a light tank intended primarily for use in an anti-tank role in terrain of most kinds and especially in marshy land and over water obstacles.

A 90 mm low-pressure gun mounted in a fully rotating power-traverse turret is designed primarily to fire HEAT rounds but can also fire HE. Comprehensive sighting and vision equipment and a fire control system including an optical rangefinder and a computer give the tank a good chance of a first-round hit on a moving target.

Mobility and fire-power have been given priority over armour; the tank's high power-to-weight ratio and low ground pressure give it good cross-country performance and it is amphibious without special preparation.

The chassis of the tank forms a fully closed unit. A bulkhead divides the driver's compartment and the central fighting compartment from the compartment for the engine and transmission.

Armour protection has been concentrated above the level of the track assembly where the probability of a hit is high. The glacis plate is given maximum possible slope. Hull sides are of double-plate type and the space between these armour plates is used for stowing of accessories and part of the diesel fuel. This combination provides good protection against HEAT.

Ikv 91 is powered by a commercial 6-cylinder turbo-charged Volvo diesel engine. This gives Ikv 91 a power/weight ratio of more than 20 bhp/ton while at the same time offering easy maintenance and good fuel economy.

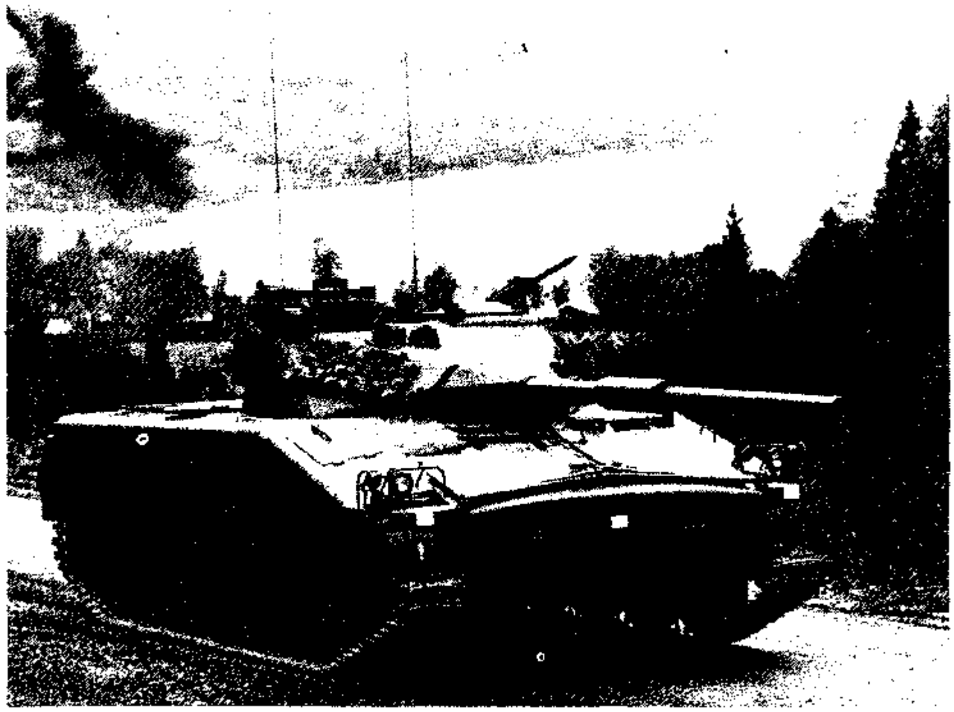
To keep length of ground contact as short as possible the big engine is mounted diagonally in the engine compartment driving the sprockets through a 58° bevel gear. The production vehicles will use an Allison HT 740 automatic gearbox which has been successfully tested as a replacement for the stick-shift gearbox used in the prototypes and Hägglunds' earlier vehicles.

The steering system is of the clutch-brake type designed to permit continuous slip-steering. The steering brakes are of the iron-to-iron disc brake type. A hydrostatic steering system is offered as an option.

Suspension of the road wheels is accomplished by individual torsion bars with shock absorbers at the front and rear road wheels on either side, giving a very smooth cross-country performance.

Track tension is operated by a hydraulic system which gives many advantages. Correct track tension under all conditions means optimal traction. Heavy strikes on idlers give no breakdown: on Ikv 91 the hydraulic system automatically readjusts track tension after a heavy strike.

For ventilation and heating of the crew compartments there are separate fans with heat exchangers in the driver's compartment and in the fighting compartment. An electric fan mounted at the air intake sucks the air through a dust-filtration system and blows it through a CBR-filter, creating a slight over-pressure in the crew compartment. Thus the crew are protected from fall-out and radio-active dust, chemical and biological agents when Ikv 91 is passing contaminated areas. The CBR-filter can be removed when dust-cleaning alone is sufficient.



Ikv91 Light Tank

ARMAMENT:

The 90 mm gun is of low-pressure type, mainly to keep the combat weight down in favour of mobility. This design with the 840 m/sec HEAT shell offers good accuracy on actual ranges of combat for the Ikv 91. Other advantages are the minimised flash and smoke and also dust screen from the ground.

90 mm ammunition types available at present are:

a fin-stabilised HEAT shell capable of penetrating the glacis platge of any battle tank;

a fin-stabilised HE shell with impact fuse.

Sixteen rounds of 90 mm ammunition are stowed in the turret and are easily available to the loader. A further 43 rounds are stowed in the chassis before and aft of the turret.

At present the gun is not stabilised in either traverse or elevation. The gun control system, however, has been designed to make it possible to achieve a fully stabilised system.

Other features of the turret are a coaxial 7.62 mm MG; smoke dischargers on the turret sides; the commander's cupola with power traverse and a 10-power binocular; the loader's cupola with 360° manual traverse and a second MG; the electrohydraulic gun control system and the ballistic computer.

Ikv91 swimming

INTEGRATED FIRE CONTROL SYSTEM:

The gun control system and ballistic computer of Ikv 91 are developed and produced by AGA Aerotronics as subcontractors to Hägglunds.

The ballistic computer operates with three different ballistics for HEAT, HE and the machine-gun ammunition.

It computes super elevation and in case of moving targets also lead angles both in traverse and elevation. Range information is usually fed to the computer from the rangefinder but it can also be fed from a manual input at the gunner's station. The computer also makes corrections for non-standard muzzle velocity, powder temperature, air conditions, cross wind and trunnion cant. Corrections are also made for jump in traverse and elevation.

The gunner's sight is a 10-power monocular with servos that deflect the line of sight in traverse and elevation according to the actual ballistic solution of the computer. When firing at moving targets the line of sight remains on the target all the time, even while lead angles and super elevation are changing due to target motions.

This is accomplished by an automatic contrarotation of the gun in opposition to the line of sight motion.

The gunner's sight can also be locked in zero-position permitting the gunner to use his reticule the ordinary way, eg. in case of power failure.

The optical rangefinder on the prototypes will be replaced on the production vehicles by a laser rangefinder, combined with the gunner's sight and binocular in the much-lowered commander's cupola.

The Bofors-produced Nd-laser is operated by the gunner and feeds range automatically to the computer.

STATUS:

Three prototypes were delivered to the Swedish

Army for evaluation between October 1970 and January 1971.

A production order for the Swedish Army was awarded to Hägglunds in March 1972 and the first production vehicles are being delivered in late 1974.

CHARACTERISTICS:

Crew: 4

Combat Weight: 15.5 metric tons

Size: Length 6.41 m (hull). Width 3.0 m. Height 2.355 m (overall)

Nominal ground pressure: 0.45 kp cm² (6.4 p.s.i.)

Performance:

Max speed road: 64 km/h

Max speed, water: 7 km/h

Range on road: 550 km

Trench crossing: 2.8 m

Maximum gradient: 30°

Angle of tilt: 30°

Power weight ratio: 22 bhp/ton

Engine:

Make: Volvo-Penta

Power at 2,200 rpm (SMMT): 330 hp

Water propulsion: Tracks

Armament:

Gun: AB Bofors

Calibre: 90 mm

Length of bore: 54 calibres

Max elevation: 15°

Max depression: −10° (0° in the rear arc)

Machine guns: 1 coaxial, 1 on loader's cupola

Calibre: 7.62 mm

Smoke dischargers: 6 barrels on each side of turret

Ammunition:

90 mm HEAT/HE: 59 rounds carried

7.62 mm MG: 4,500 rounds carried

Integrated Fire Control System: AGA Aerotronics

Gunner's Sight: Jungner Instrument AB

Magnification: × 10

Field of View: 6°

Rangefinder: AB Bofors, Nd-laser

Commander's Cupola:

Power Drive: Electrical

Binocular: Jungner Instrument AB

Magnification: × 10

Field of View: 6°

MANUFACTURER:

A. B. Hägglund and Söner, Armoured Vehicles Division, S-89101 Örnsköldsvik, Sweden.

5023.102
ARMOURED PERSONNEL CARRIER
Pbv 302

DESCRIPTION:

Pbv 302 is an APC developed by Hägglunds and in service with the Swedish Army where it has replaced the intermediate Pbv 301. It was developed on Government contract between 1961 and 1966. It has been designed to operate with the S-tank, complementing it in performance. With its power-to-weight ratio of 20 bhp/ton and its 8-ratio gearbox it has excellent cross-country performance. It carries a crew of two plus a section of ten infantrymen, and these can all use their personal weapons through the hydraulically operated top hatches. The armour is of a double-skinned variety, which is believed to give better protection weight-for-weight than homogeneous steel armour plate.

With its 20 mm cannon, and inherent swimming capability in addition to its other attributes, it is apparent that this vehicle has had a great deal of thought devoted to its design, and that it is one of the more effective APCs produced in any army in the last ten years.

CHARACTERISTICS:

Crew: Two (driver and gunner) plus a section of ten infantrymen

Weight: 13½ tons (laden)

Size: Height 2.5 m. Length 5.35 m. Width 2.86 m

Road speed/Range: 65 km/h/300 km

Armament: 20 mm automatic gun, belt or magazine feed. Rate of fire 500 rds/min

Ammunition carried: 505 rounds

Ammunition types: 20 mm HE quick fuse tracer shell, and armour piercing tracer projectile

Turret rotation: 360°, by handwheel, in approximately 12 secs

Sighting method: Periscopic sight, with a ring sight for use against aerial targets

Engine: Volvo-Penta supercharged 6 cylinder flat diesel, located under the commander, driver, and gunner's positions in the centre of the vehicle. Capacity 9.6 litres. 280 bhp at 2,200 rpm

Transmission: Mechanical, manual gearbox with double dry plate clutch. Steering by clutch and brake with driver's tiller bars (an unusual arrangement in a modern AFV). 8 forward gears, two in reverse

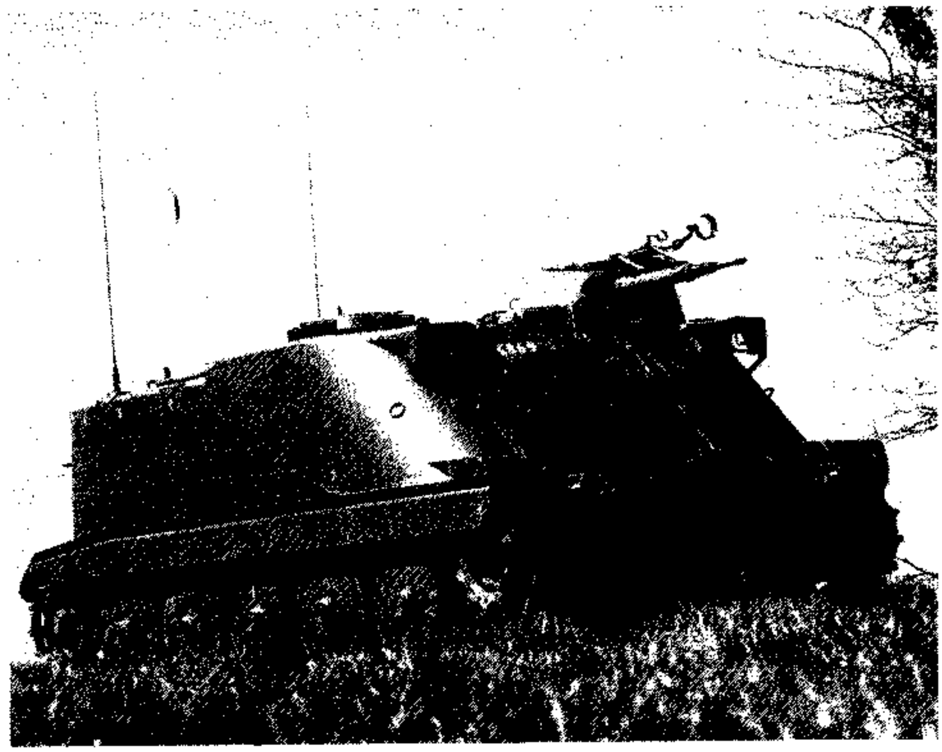
Agility: Ground pressure 0.6 kg/cm². Max step 0.6 m. Max trench 1.50 m. Ground clearance 0.4 m. Power-to-weight ratio 20 bhp/ton

Water crossing ability: Inherent swimming capability. Front wash plate is lowered as vehicle enters the water. Propulsion by tracks. Speed 8 km/h

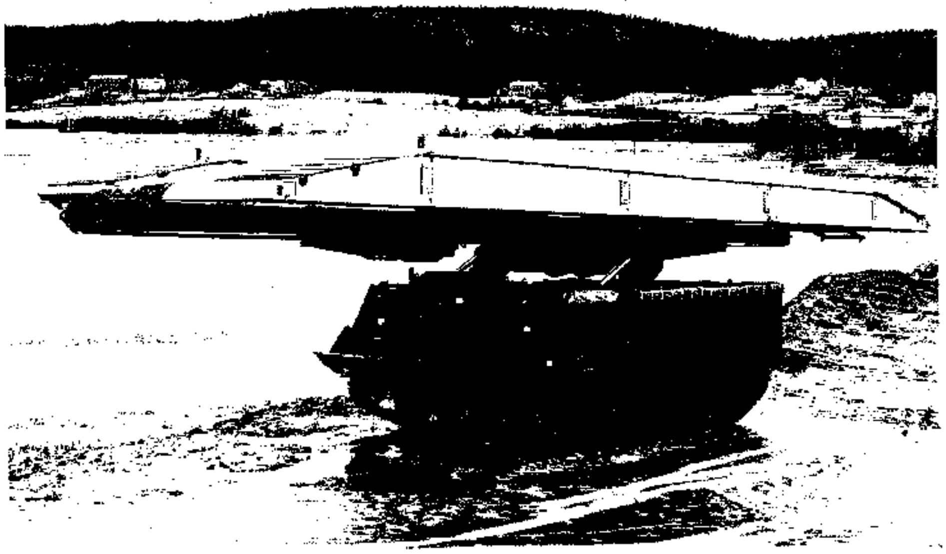
Exit: Exit for the section is by two large doors in the back opening on vertical hinges with a central pillar. Exit can also be made through the top hatches

DERIVATIVES:

Alternative 'fits' of the same vehicle include Armoured Command Vehicle, Armoured Observation Post Vehicle, Armoured Fire Direction Post Vehicle.



Pbv 302, Armoured Personnel Carrier



The Brobv 941 amphibious bridgelayer, based on the Pbv 302 chassis, and capable of laying a bridge of classification 50t across a 15 m gap in 5 minutes

Product Improved Pbv 302

Hägglund and Söner have suggested that the basic Pbv 302 could be improved by the following: (a) Replacing the 20 mm cannon with the 25 mm Oerlikon gun (**5586.103**); (b) Fitting an automatic Allison HT 740 gearbox; (c) Fitting the hydrostatic steering system that has been fitted to the Bgbv 82 and Brobv 941 vehicles; (d) replacing the engine with the Volvo THD 100C – this develops 310 hp against 280 hp of the current engine; (e) Sloping the sides of the vehicle and fitting firing ports and vision blocks. This would enable the crew to fire their weapons from within the vehicle. Trials with the Allison automatic gearbox have already been carried out.

Two heavier vehicles, based partly on the same chassis, are an amphibious recovery vehicle Bgbv 82, weighting 26 t, with hydraulic winch, hydraulic hoist and dozer blade, and an amphibious bridgelayer Brobv 941, weighting 28 t, able to lay a 15 m aluminium bridge, of 50 t classification.

The Ikv 91, 15 t amphibious light tank is partly based on the same chassis (**5063.102**).

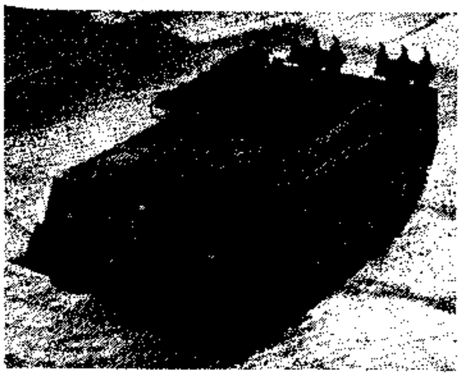
STATUS:

Delivery of Pbv 302 to the Swedish Army was completed on 30th December 1971. In addition to the basic carriers a small number of Slpbv 3021 armoured command vehicles, Epbv 3022 armoured observation post vehicles and Bplpbv 3023 armoured fire direction post vehicles have also been supplied.

The first production armoured recovery vehicle entered service with Swedish armoured units in the spring of 1972. Production of the bridgelayer started later in 1972.

MANUFACTURER:

AB Hägglund and Söner, S-89101 Ornsköldsvik, Sweden.



Bgvb amphibious recovery vehicle

SWITZERLAND

5031.102
MAIN BATTLE TANK PZ 61

DESCRIPTION:

Until 1958 the Swiss Army had always bought in foreign tanks, and is still equipped with some AMX13s bought in 1951, and Centurions, Mk 3, Mk 5 and Mk 7, bought between 1955 and 1960. However the decision was taken in 1951 to build in Switzerland a tank that was suited to both the military and the geographical situation of the country. The first run of 10 prototypes known as Pz 58 were manufactured in 1958, and were armed with the 90 mm gun. But by 1961 it was decided to manufacture a tank based on the Pz 58 chassis, but using the British 105 mm gun. This tank is known as Pz 61, and 150 were manufactured between 1964 and 1966.

Apart from the gun (British, but manufactured under licence in Switzerland), and the power plant (German) the design and manufacture are wholly Swiss. The tank is unusual in having a cast steel hull, and has an interesting suspension system employing Belleville washers in place of more conventional springs. Light alloys have been used in the construction wherever possible so as to permit the heavy armouring of critical areas. In addition to the protection provided against atomic blast by the armour a positive pressure is maintained inside the tank to keep out radioactive particles. The tank has an excellent cross-country performance and is a formidable defensive vehicle, which is said to be reliable and popular in service.

CHARACTERISTICS:

Crew: 4 (commander, gunner, loader, driver)
Weight: 38 tons
Size: Length (hull) 6.78 m. Height 2.73 m. Width 3.05 m
Road Speed/Range: 50 km/h/300 km
Main Armament: British 105 mm L7A2 gun (**2452.103**)
Method of ranging: 155 cm base coincidence rangefinder
Rounds carried: APDS and HESH
Secondary Armament: Coaxial 20 mm Oerlikon cannon plus one 7.5 mm MG mounted on loader's hatch for AA defence

Pz 61 Main Battle Tank

Turret rotation: 360°, power traverse
Engine: Daimler Benz MB 837, V8 Diesel, 29.8 litres water cooled, 630 bhp at 2,200 rpm
Transmission: Hydraulic multi-plate clutch. Gearbox has six forward, two reverse gears electrically selected
Agility: Ground pressure 0.85 kg/sq cm. Max step 0.75 m. Max trench 2.60 m. Max gradient 70% (1 in 5.5). Power-to-weight ratio 17 bhp/ton
Water crossing ability: Unprepared wading to depth of 1.12 m

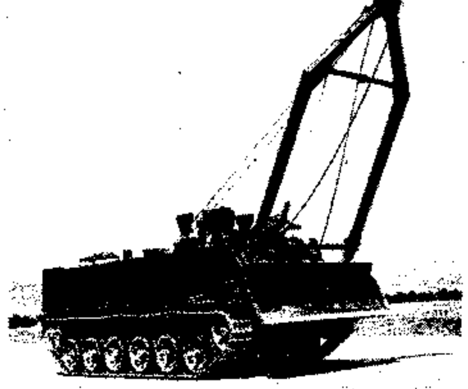
DERIVATIVES:

A prototype bridgelayer was constructed on a Pz 61 chassis, but this has now been superseded by one mounted on the later Pz 68 chassis.

An armoured recovery vehicle version is in Swiss Army service.

MANUFACTURER:

Eidgenössische Konstruktionwerkstätte, Thun, Switzerland.



Entpannungspanzer (Ent. Pz) 65 armoured recovery vehicle on Pz 61 chassis

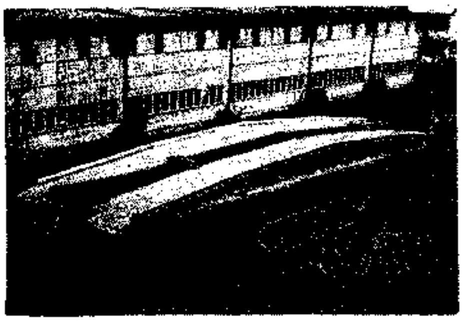
5076.102
MAIN BATTLE TANK PZ 68

DESCRIPTION:

An improved version of the Pz 61 (**5031.102**) the Pz 68 was introduced in 1968. The main differences between it and the Pz 61 are increased maximum speed and operating range, tracks fitted with rubber blocks and important changes in the armament system which include stabilising the 105 mm gun in both elevation and azimuth and replacing the 20 mm coaxial cannon by a 7.5 mm machine gun.

CHARACTERISTICS:

Crew: 4 (commander, gunner, loader, driver)
Weight: 39 tons
Size: Length (hull) 6.8 m. Height 2.72 m. Width 3.1 m
Road speed: 55 km sh
Range: 350 km
Main Armament: 105 mm 51 calibre stabilised gun
Method of ranging: 155 cm base coincidence rangefinder
Elevation/Depression: +21°/−10°
Turret rotation: Almost 360°, power traverse
Secondary Armament: Two 7.5 mm MG, one coaxial, the other on loader's hatch
Engine: Daimler-Benz Type 837 V-8 diesel, 660 bhp at 2,200 rev/min
Transmission: Hydraulic multi-plate clutch. Gearbox has six forward and six reverse gears
Agility: Ground pressure 0.85 kg/cm². Max step 0.75 m. Max trench 2.60 m. Max gradient 70% (1 in 5.5). Power-to-weight ratio 17.4



Brü. Pz 68 Bridgelayer on Pz 68 chassis

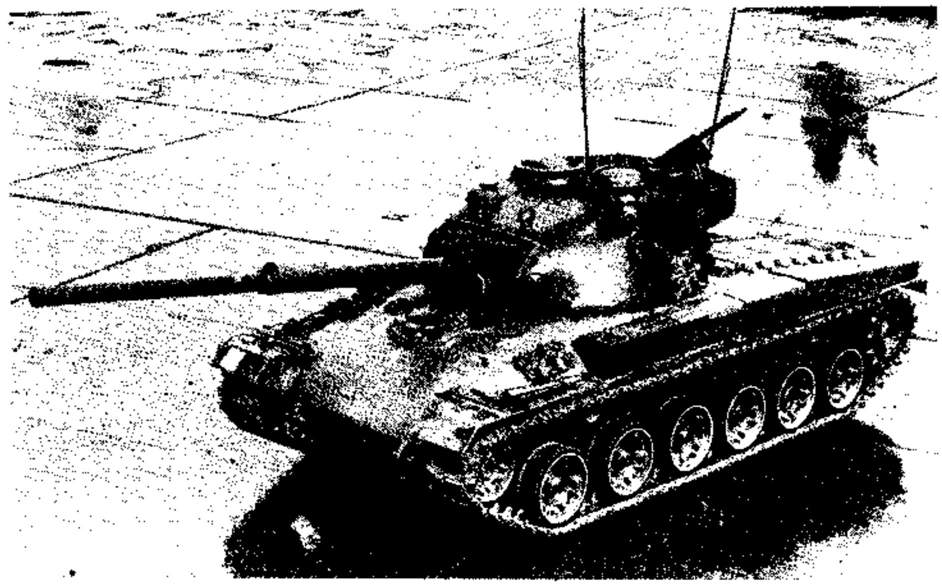
bhp/ton
Water crossing ability: Unprepared wading to 1.12 m

DERIVATIVE:

A bridgelayer with an 18 metre span capable of carrying 50 tons (60 in an emergency) is in service. Known as the Brü Pz 68 it has the same mobility as the Pz 68 and weighs 45 tons. In 1972 a prototype was shown of the Panzer-Kanone 68. This consists of a Pz 68 chassis with a turret mounting a 155 mm howitzer. This has a range of at least 30 km. It is also reported that an anti-aircraft vehicle based on the Pz 68 is under development, it is not known if this will be armed with guns or missiles.

MANUFACTURER:

Eidgenössische Konstruktionwerkstätte, Thun, Switzerland.



Pz 68 Main Battle Tank

5077.102
PUMA AMPHIBIOUS ARMOURED PERSONNEL CARRIER

One of a family of armoured amphibious wheeled vehicles designed by Mowag, the Puma is the middle one in size and payload. Weighing about 16 tons including a payload of some 4 tons it is a 6 × 6 vehicle that can be armed with a variety of weapons and can carry up to ten armed men in addition to the driver. The suspension and wheel drive mechanism gives the vehicle good cross-country performances and a useful waterborne performance is achieved by propellers driven from the rear axles.

NBC protection is provided for the crew who have access by overhead hatches and rear doors. The rear doors also contain special firing ports for use with 9 mm submachine guns.

CHARACTERISTICS:

Crew: 11 (driver plus 10)
Weight: 16 tons
Size: Length 6.75 m. Width 2.6 m. Height 2.08 m to top of hull (about 3 m to top of weapon mounting)
Road speed: 80 km/h
Cross-country speed: About 42 km/h
Water speed: 12 km/h
Road range: 500 km
Armament: Alternatives: turret-mounted 20, 30 or 40 mm cannon: trunnion-mounted 20 mm cannon; twin 80 mm rocket launchers; mortar. With all but the turret mounted cannon a remotely operated 7.62 mm MG mounting can be incorporated as secondary armament
Engine: Mowag M8DV V-8 diesel. 365 bhp at 2,000 rev/min

MANUFACTURER:

Mowag Motorwagenfabrik AG, Kreuzlingen, Switzerland.

Mowag Puma with 20 mm turret-mounted cannon

5045.102
TORNADO MECHANISED INFANTRY COMBAT VEHICLE

DESCRIPTION:

Developed as a private venture in response to a Swiss Army specification, the Tornado is a tracked armoured personnel carrier that is designed primarily for mounted combat or reconaissance use, enabling its crew to fight while enjoying a measure of NBC and armour protection.

According to the type of turret fitted the vehicle carries one or two men in the turret and has firing positions for six other infantrymen. Two basic turret types are available, one with a trunnion-mounted weapon and the other an enclosed turret with an internally-mounted weapon. The main armament is either a 20 mm or a 25 mm automatic gun; for secondary armament two remote control units for 7.62 mm machine guns are mounted at the rear. The four gun-ports in the hull are designed for use with 9 mm sub-machineguns and can be used effectively up to ranges of 100 metres or so.

To minimise internal space – and hence operational versatility – the engine, gearbox, steering gear and cooling system are made as a single subassembly and elastically mounted in the hull, power being taken directly from the differential gear to the driving sprockets. The power train can readily be removed from the vehicle for field maintenance and is separated from the crew area by an NBC partition. The NBC protection system produces a slight over pressure inside the hull.

Main access to the crew compartment is from the rear, but emergency escape hatches are also provided in the floor of the hull.

CHARACTERISTICS:

Crew: 9-10 (commander, driver and 7-8 infantrymen)
Weight: (Laden) about 21 tons
Dimensions: Length 6.1 m. Width 3.1 m. Height 1.8 m

Mowag Tornado with one-man turret and trunnion-mounted 25 mm gun

Armament: 20 or 25 mm cannon, trunnion or turret mounted plus two 7.62 mm MGs
Road speed: 65 km/h
Range: 500 km
Engine: Mowag M8DV TLK V-8 water-cooled CI 430 bhp at 2,000 rev/min
Transmission: Either Allison CLBT 5860 torque converter or Mowag M 150-6S synchromesh
Agility: Ground pressure 0.62 kg/cm². Max step 0.9 m. Max trench 2 m. Ground clearance 0.4 m. Power-to-weight ratio about 20 bhp/ton
Water crossing ability: Unprepared wading to 1.2 m. Prepared to 1.7 m
MANUFACTURER
Mowag Motorwagenfabrik AG, Kreuzlingen, Switzerland

THE UNITED KINGDOM

5004.102
CENTURION MAIN BATTLE TANK

DESCRIPTION:

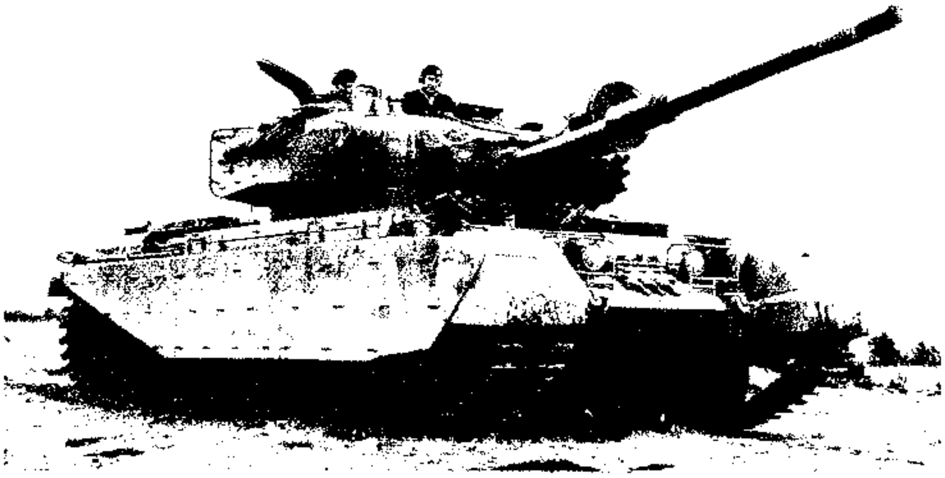
Centurions were the standard British Army tanks for over 20 years. First brought into service in 1945, they have seen service in Korea, Suez, the India/Pakistan war, the Israel/Arab wars of 1967 and 1973 and with the Australians in Vietnam. As they have been replaced in British Army service by Chieftain, they have found a ready market, particularly in the Middle East.

Export sales of this tank from UK have amounted to a total of some 3,000 tanks. Some of the major customers have been Egypt (30), Switzerland (320), Israel (400), Lebanon (40), Denmark (100), Jordan (40), Australia (200), Sweden (80), South Africa (100), Iraq (55), India (220), Netherlands (600) and Canada (60). They are currently in service in Australia, Canada, Denmark, Iraq, India, Israel, Jordan, Kuwait, Lebanon, Netherlands, South Africa, Sweden and Switzerland. The original design has gone through 13 Marks, up-gunning, up-armouring, improving fire control and introducing night vision aids in stages. The principal Marks still in service are:

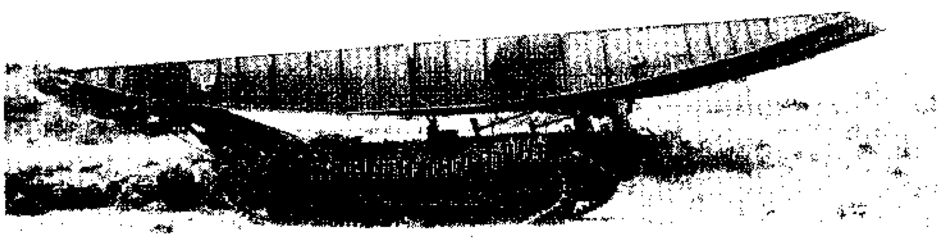
- Mk. 3 – 20 pdr gun.
- Mk. 5 – 20 pdr gun. Mk. 5/1 up-armoured, Mk. 5/2 105 mm gun.
- Mk. 6 – 105 mm gun, up-armoured and additional fuel. Mk. 6/1 IR equipment. Mk 6/2 ranging MG.
- Mk 7 – 20 pdr gun, hull re-designed to improve fuel capacity and stowage of ammunition. Mk. 7/1 up-armoured, Mk. 7/2 has 105 mm gun.
- Mk. 8 – 20 pdr gun with fume extractor. Mk 8/1 is up-armoured and Mk. 8/2 has 105 mm gun.
- Mk. 9 – is Mk 7 with 105 mm gun and up-armoured. Mk. 9/1 has IR equipment. Mk 9/2 has ranging MG.
- Mk. 10 – is Mk. 8 with 105 mm gun, up-armoured. Mk. 10/1 has IR equipment. Mk 10/2 has ranging MG.
- Mk. 11 – Mk 6 with Infra Red (IR) and RMG.
- Mk. 12 – Mk 9 with IR and RMG.
- Mk. 13 – Mk 10 with IR and RMG.

Numerous variants of these marks exist in the form of specialised versions for a variety of tasks. Centurion has proved to be among the most versatile and successful tank designs ever developed.

CHARACTERISTICS (Mk. 13):
Crew: 4 (commander, loader, gunner, driver)
Weight: 52 tons (laden)
Size: Height 2.97 m. Length (hull) 7.8 m. Width 3.39 m
Road Speed/Range: 34 km/h/190 km
Armament: 105 mm L7A/2 51 calibre with fume extractor **(2451.103)**
Method of ranging: Coaxial .50 in Ranging Machine. Gun firing in bursts of 3 rounds at 4 set ranges between 600 m and 1,800 m
Elevation: + 20°. Depression: −10°
Rounds carried: 64 mixed APDS and HESH
Turret rotation: 360 degrees in 26 secs
Engine: Rolls-Royce Meteor petrol engine. V-12, 650 bhp at 2,550 rpm



Centurion Mk 13 with 105 mm L7O2 standard NATO gun. The infra red searchlight and filtered headlamps are clearly visible



Centurion Bridgelayer (Christopher F. Foss)

Transmission: Non-synchromesh Merritt Brown gearbox giving 5 forward, 2 reverse ratios
Agility: Ground pressure – 0.94 kg/sq cm. Max step – 0.9 m. Max trench – 3.4 m. Max gradient – 35 degrees. Ground clearance – 0.4 m Power-to-weight ratio – 12.7 bhp/ton
Night vision equipment: Philips IR equipment including 1 kW searchlight, driver's viewer and gunner's sight can be fitted
Additional equipment variants: Snorkelling equipment has been fitted experimentally. The principal variants based on the Centurion chassis are: Dozer tank; Armoured Recovery vehicle; Bridgelayer (15.8 m bridge); Artillery observation tank, Engineer vehicle (in various forms); Beach Armoured Recovery Vehicle (will wade up to 3.35 m depth). A large number of other locally adapted variants exist.

PRODUCT IMPROVED CENTURION

Vickers are the Design Patentees of the Centurion and built about 1,000 of them. They are currently offering a retro-fit package to bring the Centurion up to modern tank standards. Vickers can carry out this programme or it can be carried out in the customer's own workshops. The modifications include a modern diesel power-pack comprising a GM V-12 engine, TN 12 gearbox as fitted to Chieftain, modernised gun control equipment, laser range-finder, new commander's cupola, modern ventilation system and passive night vision equipment. Vickers have already received an order to retro-fit Centurions for at least one overseas customer.

MANUFACTURER:

The majority of the Centurions produced were manufactured in Royal Ordnance Factories.

5006.102
CHIEFTAIN MAIN BATTLE TANK

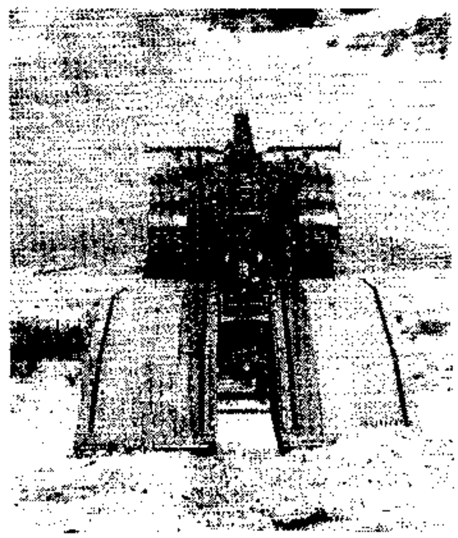
DESCRIPTION:

Design of the Chieftain MBT commenced in the 1950s and the first prototype was completed in 1959. In 1963 the Chieftain was accepted for production and two production lines were set up at the ROF Leeds and Vickers Limited, Elswick. The first model was the Mk. 1 which was used for training purposes and was followed by the Mk 2 in 1966. The Mk 2 has a 650 bhp engine. The Mk 3 entered service in 1969 and has an improved auxiliary generator, new cupola and improved main engine. Mk 3/G (prototype), Mk. 3/2 and Mk. 3/S have improved turret air breathing. Mk 3/3 has an improved engine, new air cleaner system, extended range (2,500 m) ranging machine gun and a Barr and Stroud LF2 laser rangefinder. Mk. 4 was for trials purposes only. The Mk. 5 is a development of the Mk. 3/3 and has an improved engine and more ammunition capacity. The Mk. 6 will be the Mk. 2 modified to Mk. 5 standard and the Mk. 7 will be the Mk. 3 and Mk. 3/3 brought up to Mk. 5 standards. Mk. 1s that are used for training will also be modified in due course with a new engine but not the improved FCS. GEC-Marconi Electronics are developing an Integrated Fire Control System for the Chieftain and this will include the Barr and Stroud LF-2 laser rangefinder. Some 800 of these tanks have been produced for the British Army.

The design features an exceptionally accurate and hard hitting 120 mm gun mounted on a chassis and turret affording better protection than any other in service. Nevertheless a reasonable weight has been achieved by the use of separated ammunition, employing a fully combustible bagged charge, and by lowering the turret ring through the expedient of a reclined driving position. Great care has been taken to give a good ballistic shape to the turret and hull, and the absence of a gun mantlet undoubtedly also improves the protection of the turret. It is believed that the armour thickness over the frontal arc is about 150 mm at a sloping angle of 60°, which is far superior to that of any other Western tank. The gun is fully stabilised in elevation and azimuth to permit accurate firing on the move.

The Barr & Stroud laser range finder type LF2 for the Chieftain tank. Ranges can be taken from 500 to 10,000 metres with + 10 metre accuracy for more than 90% of shots

CHARACTERISTICS:
(Mk. 5 except where stated)
Crew: 4 (commander, loader, gunner, driver)
Weight: 52.3 tons (laden) (Mk. 3) 53.8 t (Mk. 5)
Size: Height 2.75 m. Length (hull) 7.6 m. Width 3.5 m
Road speed: 40 km/h (Mk 3) 48 km/h (Mk 5)
Road range: 500 km
Main armament: 120 mm BL high velocity gun L11A2 (**2453.103**)
Method of ranging: Laser rangefinder
Rounds carried: 53 mixed HESH, APDS and smoke
Max useful range of main armament: 3,000 m APDS. 8,000 m HESH
Turret rotation: 360 degrees in 18 secs
Secondary armament: One coaxial 7.62 mm Browning MG and one 7.62 mm Browning MG mounted on commander's cupola for AA defence. One 12.7 mm ranging MG
Main engine: Leyland L60 No. 4 Mk. 7A 6 cylinder vertically opposed piston, turbocharged, multifuel 2 stroke, compression ignition. 840 bhp at 2,100 rpm. (Mk3 had 650 bhp engines)
Auxiliary engine: H30 3 cylinder, 1 litre developing 3.5 kW
Transmission: TN 12 gearbox with a Wilson epicyclic gear train and a Merritt Brown differential steering system. Electro-hydraulic gear selection
Agility: Ground pressure 0.92 kg/sq cm. Maximum step 0.9 m. Maximum trench 3.1 m. Maximum gradient 35 deg. Ground clearance 0.5 m. Power-to-weight ratio 15 bhp per ton
NBC protection: Pressurised air conditioning and filtration system
Night vision equipment: 2 kW convertible white – IR searchlight. IR filtered headlamps. IR sights for commander and gunner. IR viewer for driver. IR warning device
Additional equipment:
Snorkelling equipment for wading up to 5 m depth.
A dozer blade can be fitted to any tank.
Derivatives:
Armoured Recovery Vehicle FV 4204. This is scheduled to enter service in 1974/5 and is based on a Mk. 3 Chieftain hull. It is fitted with two winches each of the double capstan type, to give sustained pulls to the front of the vehicle of 30 tonnes and 3 tonnes respectively. An hydraulically-operated earth anchor blade is mounted on the front of the vehicle: this can also be used for simple dozing and enables the vehicle to exert a pull of 90 tonnes. The vehicle is armed with a 7.62 mm machine gun and smoke dischargers: other equipment fitted includes crew heater units and a NBC system. Basic data: – length 8,256 m, width 3,518 m (over blade), height 2.746 m, laden weight 52 tonnes, road speed 41.5 km/hr, range road 322 km and power-to-weight ratio 14.1 bhp/ton.



Chieftain Bridgelayer in operation
(Christopher F. Foss)

Chieftain Main Battle Tank with 120 mm gun. The thermal jacket on the gun prevents differential heating or cooling on opposite sides of the barrel, from affecting the accuracy of the gun

Armoured Vehicle Launched Bridge FV 4205. This is now in service with the British Army and on order for Iran. It has a crew of three men. The bridge is launched hydraulically without exposing the crew. The bridge normally carried is the No. 8 Tank Bridge, this is a class 60 scissors type 24.4 m long with a maximum span of 22.9 m; under development is the Tank Bridge No. 9 which is 13.4 m long. Basic data of the FV 4205 complete with bridge, length 13.73 m, width 4.16 m, height 3.92 m, weight 53 tonnes.

STATUS:

Chieftain MBT production has been completed for the British Army and is continuing for the Iranian Army. Chieftain ARV and AVLBs are in production for both the British and Iranian Armies.

MANUFACTURER:

Two production lines are in existence, one at Vickers Ltd, Armament Division, Elswick Works, Newcastle upon Tyne NE99 1CP, the other at Royal Ordnance Factory, Leeds.

Enquiries should be addressed to:

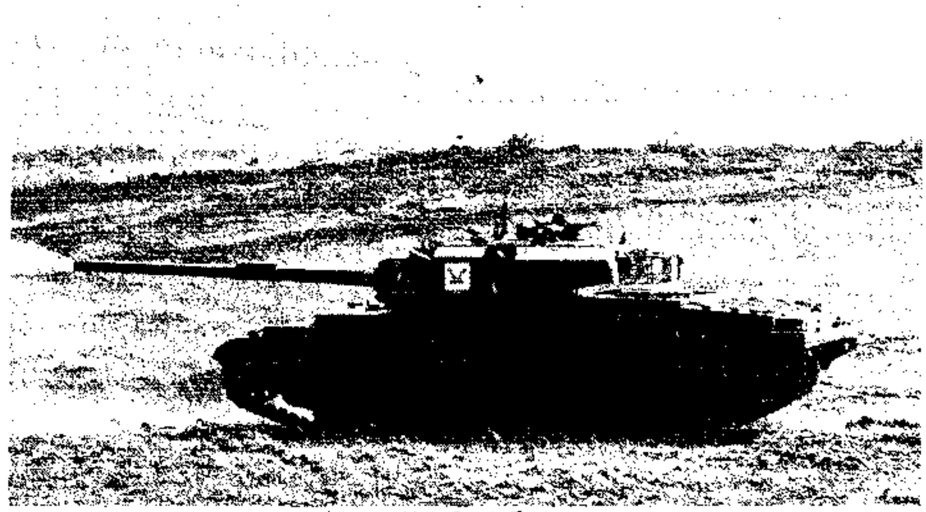
Ministry of Defence, Military Adviser (Overseas Equipment), St. Christopher House, Southwark Street, London SE1, England.

5057.102 VICKERS MAIN BATTLE TANK

DESCRIPTION:

The Vickers Main Battle Tank (Mark 1) was developed between 1958 and 1963 by Vickers Armament Division to meet the requirements of those countries needing a cheaper and lighter tank than Chieftain. The armament is that of the later marks of Centurion (105 mm gun), but with an improved transistorised gun control equipment. Engine and transmission are the same as in Chieftain. Weight was kept to 36.9 t by modifying the armour protection compared with Chieftain. Consequently this tank has the high power to weight ratio of 16.3 bhp/t, giving it a speed and cross-country mobility comparable with other battle tanks of this weight. Particular emphasis in the design has been placed on using components already proven in service and also on simplicity of training and servicing.

It is therefore particularly well adapted to the needs of countries that wish to build up an armoured force. A quantity were sold to India in 1966 and based on this initial order the Indian Government established a factory in Avadi, Madras, to manufacture tanks identical to the Vickers production under licence. In 1968 a quantity (believed to be 50) were sold to Kuwait and delivery was completed in early 1972.



Vickers Main Battle Tank

Vickers Main Battle tank Mark 3

The Mark 3 version has increased performance resulting from an increase in power and new final drive ratio giving greater acceleration and maximum speed. The turret has been completely redesigned, having a cast armour front welded to armour plate. The new design gives an improved ballistic shape, also greater crew comfort. A new cupola is fitted which gives improved vision using 'Chieftain' type sight and episcopes. The quantity of main ammunition carried has been increased to 50.

CHARACTERISTICS

The details below apply to Mark 3. The details for Mark 1 where they differ are in parentheses.

Crew: 4 (commander, gunner, loader, driver)

Weight: 38.1 (36.9) tons (laden)

Size: Height 2.48 m (2.44 m). Length 7.56 m. Width 3.16 m

Road Speed/Range: 53 (48) km/h/480 km

Main armament: British QF 105 mm high velocity gun (**2452.103**)

Method of ranging: Coaxial .50 ranging machine gun

Rounds carried: 50 (44) mixed APDS, HESH or Smoke

Max useful range of main ammunition: 1,800 m APDS, 5,500 m HESH

Turret rotation: 360° in 13 sec

Secondary armament: One coaxial 7.62 mm GPMG and provision for a second 7.62 mm GPMG on the commander's cupola

Main engine: Leyland L60 six-cylinder opposed piston, two stroke multi-fuel, compression ignition, 700 (600) bhp at 2,670 rpm. A power-pack based on the General Motors 12V-71T diesel engine is available as an alternative.

Transmission: TN12 gearbox with a Wilson epicyclic gear train and a Merritt Brown differential steering system. Electro-hydraulic gear selection

Agility: Ground pressure 0.79 (0.82) kg/sq cm. Max step 0.9 m. Max trench 2.5 m. Max gradient 30°. Ground clearance 0.4 m. Power-to-weight ratio 19.2 (16.3) bhp/ton

Water crossing ability: Unprepared wading to 1.1 m. Deep wading with preparation to 2.23 m. Optional screen can be fitted to provide amphibious capability with speed of 6.4 km/h. Erection time 15 minutes

Additional Equipment:

1. Auxiliary Engine – H30 3 cylinder 1 litre, developing 3.5 kW. (This is not required with the alternative main engine since this includes an additional alternator)
2. Night Vision Equipment – a white light/IR searchlight can be fitted to the mantlet. IR viewers are fitted to driver's and gunner's position.
3. NBC protection – pressurised air conditioning and filtration system.
4. Vehicle Heater – a heater can be incorporated in the ventilation system.

Derivatives: A recovery vehicle and bridgelayer based on the Mark 1 chassis can be offered.

MANUFACTURER:

Vickers Ltd, Armament Division, Elswick Works, Newcastle-upon-Tyne NE99 1CP, England

5040.102 SCORPION LIGHT TANK

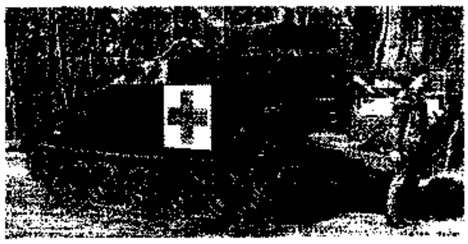
DESCRIPTION.

Scorpion is one of a range of Combat Vehicle designs specified by the British Army for world-wide deployment in the 1970s. It is intended to provide the armoured reconnaissance element in the British Army of the Rhine, whilst also employed in other parts of the world where ground conditions favour tracks as opposed to wheels for armoured support, patrol and escort duties. It has a hard-hitting gun, adequate protection and exceptional mobility.

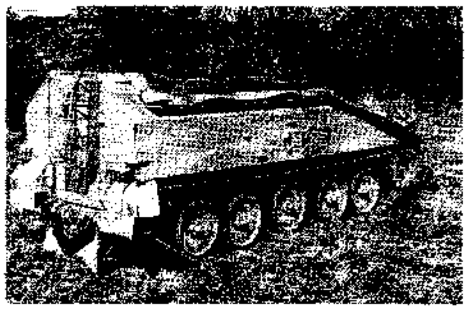
Its light weight, especially its exceptionally low ground pressure, combined with a power to weight ratio of over 26 bhp/t give it a performance in mud and bog which is not surpassed by any other light tank.

It has an inbuilt flotation screen for water crossing. Particular attention has been given to reducing the external noise for reconnaissance purposes. It has been designed from the outset for ease of maintenance and simplicity of crew duties, and should prove to be a consistently reliable vehicle. Scorpion is now in production and several thousand are on order for the British and Belgian

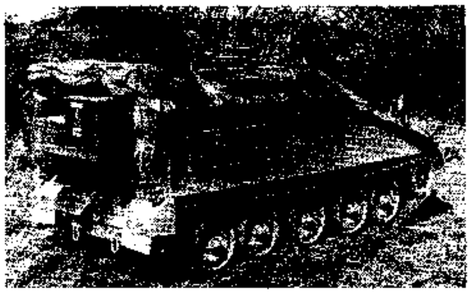
Scorpion in desert livery



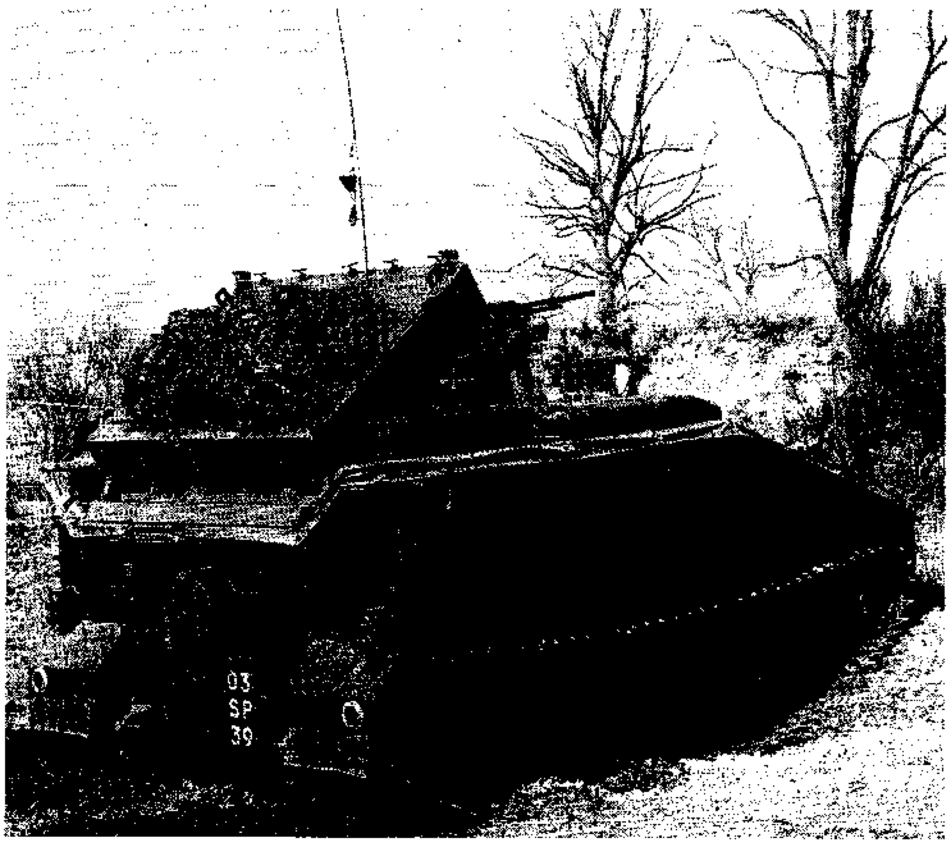
CVR(T) Ambulance : Samaritan



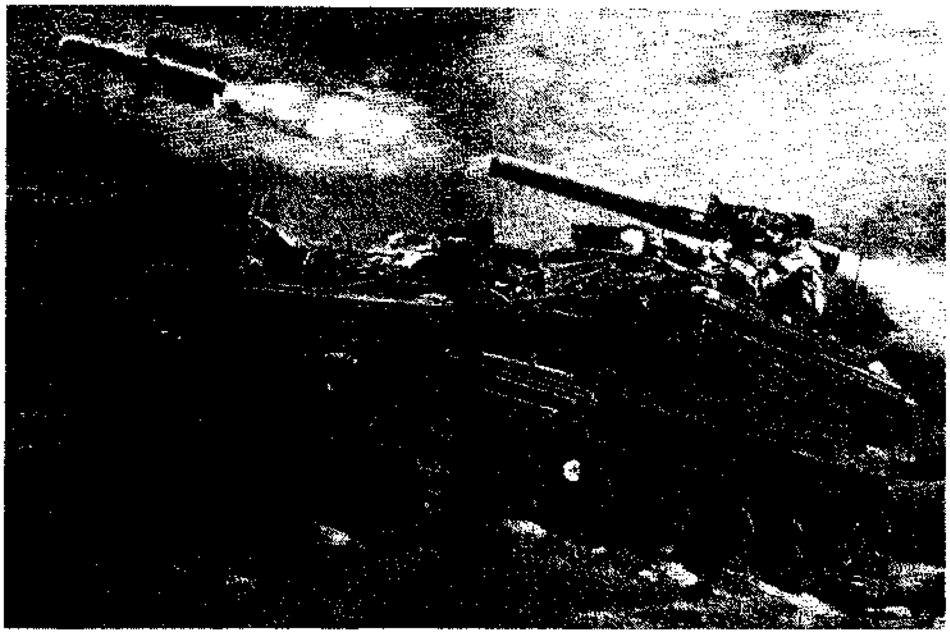
CVR(T) Recovery : Samson



CVR(T) Command : Sultan



CVR(T) GW : Striker missile launcher



Artist's impression of TOW ATGW system installed on Spartan

armed forces and for other customers overseas.

CHARACTERISTICS:

Crew: 3 (commander, gunner, driver)

Weight: 7.8 tonnes

Size: Height 2.1 m. Length (gun forward) 4.3 m. Width 2.18 m

Road Speed / Range: 87 km / h / 640 km

Main armament: 76 mm gun

Method of ranging: Commander's estimation or use of coaxial MG as ranging gun

Rounds carried: 40. Mixed HESH (armour defeating) high explosive

Maximum range of main armament: 5,000 m

Secondary armament: Coaxial 7.62 mm MG, which can be used as ranging gun

Turret rotation: 360°, by two-speed hand traverse mechanism

Armour type: Welded aluminium plate

Engine: Jaguar XK 6-cylinder petrol engine 4,200 cc 195 bhp at 5,000 rpm. The engine compartment is at the front, alongside the driver

Transmission: Semi-automatic, electrically actuated combined gearbox and steering unit, similar in design to that on Chieftain. Transmission compartment at front of vehicle, with drive to front sprockets.

Agility: Ground pressure 0.35 kg/sq cm. Max step 0.5 m. Max trench 2.06 m. Max gradient 60% (31°). Ground clearance 0.35 m. Power-to-weight ratio 26.3 bhp / tonne

Water crossing ability: Fording without preparation to 1.07 m. Inbuilt flotation screen can be speedily erected by the crew, to give swimming capability in inland waters, propulsion by tracks at 7.0 kph

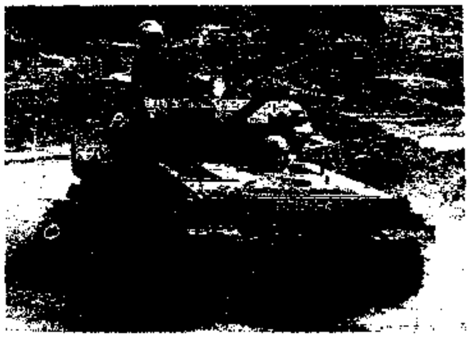
NBC protection: Vehicle can be pressurised, with a filter in the air intake. Detectors to indicate NBC attack can be fitted

Night vision aids: Passive sights for commander and gunner, and driver's viewer will be fitted as extra equipment on British and Belgian Army vehicles.

Variants: The following variants in the CVR series have been developed:

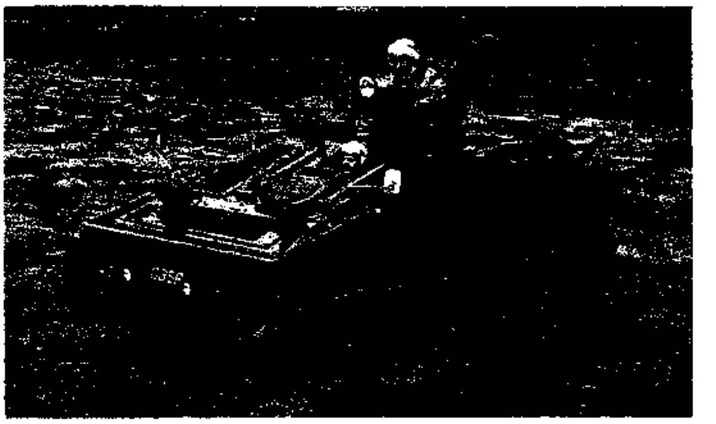
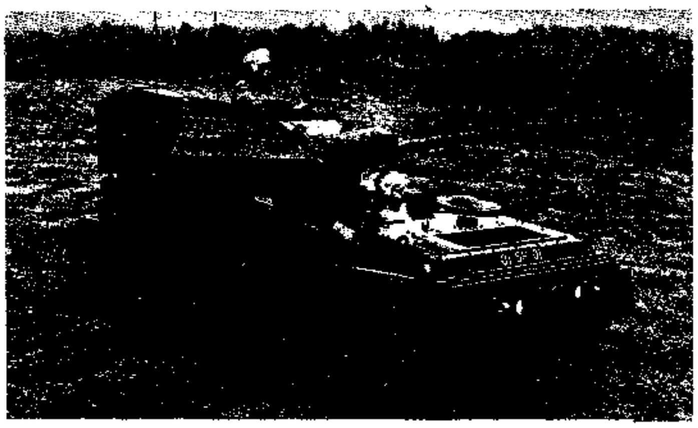
CVR(T) GW	Striker – 5 Swingfire launchers
CVR(T) 30	Scimitar – Rarden 30 mm cannon
CVR(T) APC	Spartan – APC
CVR(T) Command	Sultan – Command vehicle
CVR(T) Ambulance	Samaritan – Ambulance vehicle
CVR(T) Recovery	Samson – Recovery vehicle

Pictures of these variants are shown here. Striker, the missile launcher, was first publicly exhibited at the 1972 Farnborough Air Show. The



CVR(T) FS Scorpion

Swingfire missiles are carried in their protective launchers at the rear of the vehicle and are elevated for firing by an hydraulic ram. Spare missiles

Scimitar (left) uses the basic Scorpion hull and a turret modified to take the 30 mm Rarden cannon Spartan is an APC and can accommodate an assault section consisting of a commander and four men in addition to the driver and gunner. Periscopes, episcopes, a night sight and a spotlight are provided and the vehicle can carry Radar No. 14 on the roof

are carried under armour in the hull of the vehicle.

Scimitar uses the basic Scorpion hull and turret with the modifications necessary to incorporate the Rarden 30 mm cannon (**5504.103**) in place of the 76 mm gun.

As can be seen, Spartan has a box hull and this is designed to accommodate an assault section consisting of a commander and four men in addition to the driver and gunner. Periscopes, episcopes and a spotlight are provided; and the vehicle can also carry Radar No. 14 (**2490.153**) on the roof.

STATUS:

The Scorpion family is in production in the United Kingdom and Belgium. It is in service with Abu Dhabi, Belgium and United Kingdom. It is also reported that Canada and Iran have placed orders for members of the family.

MANUFACTURER:

Alvis-British Leyland UK Ltd., Holyhead Road, Coventry, England. Enquiries to Director of Sales (Army), Ministry of Defence, St. Christopher House, Southwark Street, London S.E.1., or to Sales Manager, Military Sales Dept, British Leyland Motor Corporation Ltd, 41-46 Piccadilly, London W1V 0BD, England.

5064.102
FOX ARMOURED CAR

DESCRIPTION:

The Fox is a logical development of the Ferret scout car (**5002.102**). Design started in 1965/66 and the first prototypes were completed by Daimler in 1967. After various trials and modifications a production order was awarded to the Royal Ordnance Factory at Leeds. The first production Fox was completed early in 1973 but by early 1974 the vehicle was still not in service.

The hull and turret of the Fox are constructed of light alloy armour to save weight: the vehicle is, however, some 2 tons heavier than the Ferret Mk. 2/3. It is powered by the same engine that is fitted to the Scorpion CVR(T) which gives a power-to-weight ratio of 32 bhp/ton and gives the vehicle an exceptional road and cross-country performance. The 30 mm Rarden cannon can fire all Hispano 831 L 30 mm ammunition as well as the specially developed British APDS round. The APDS round will kill any light AFV at ranges of at least 1,000 m, and also damage the sides of MBT. The spent cartridge cases are ejected outside the fighting compartment.

The Fox Armoured Car, travelling at speed

The design shows many unusual and interesting features. It would however, seem unlikely that the Fox will be anything like as successful as the Ferret. This does not imply that Fox is not a good vehicle, just that it has arrived a few years too late for, at any rate large, export orders.

CHARACTERISTICS:

Crew: 3 (commander/loader, gunner, driver)
Weight: 6.386 tonnes (loaded)
Size: Length 4.24 m (hull). Width 2.134 m. Height 2.2 m (overall)
Road Speed/Range: 104 km/hr/434 km
Main armament: Rarden 30 mm cannon with single shot or bursts (up to 6 rounds) capability (**5504.103**)
Method of ranging: Gunner has one periscope binocular x1 and x10 sight linked to main armament
Rounds carried: 96 rounds of 30 mm in clips of three. Uses Hispano 831 L ammunition plus an APDS round specially developed for this gun
Elevation: From +41° to −14°, permitting the engagement of light aircraft and helicopters
Turret rotation: 360°, power assisted hand traverse
Secondary armament: 7.62 mm co-axial MG, 2,600 rounds of MG ammunition carried
Engine: Jaguar XK 4.2 litres, 6 cylinder, petrol developing 185 bhp at 4,750 rpm
Transmission: Fluid flywheel and pre-selector 5 speed gearbox. Transfer box selects forward or reverse
Agility: Ground pressure 0.46 kg/cm^2. Max trench (with channels) 1.22 m. Ground clearance 0.3 m. Power-to-weight ratio 32 bhp/ton
Water crossing ability: Flotation screen permanently fitted can be erected in 1½ minutes. Water propulsion and steering by wheel spin at speed of 5 km/hr. Wading to a depth of 1.01 m without preparation
Night vision equipment: Gunner has passive night sight (optional) and driver has passive night periscope (optional)
Sensory equipment: As a reconnaissance vehicle Fox has been designed to carry a full complement of sensory and surveillance devices including the ZB298 (Type 14) battlefield radar (**2490.153**), IR and NBC detectors
Variants: The Vixen (FV 722) Combat Vehicle Reconnaissance (Wheeled) Liaison is being developed by MVEE. It will have a Fox type hull but be fitted with a simple turret mounting a single 7.62 mm MG, and will be able to carry four men. It is possible that the Fox turret may be retrospectively fitted to some FV 432s used by infantry battalions. Some work has also been carried out for fitting the Fox turret to the M-113.

MANUFACTURER:

Saladin was made by Alvis Ltd, Holyhead Road, Coventry, England but is no longer in production. rently in production at the Royal Ordnance Factory, Leeds, England.

5005.102
SALADIN ARMOURED CAR

DESCRIPTION:

Saladin was developed in parallel with the Saracen Armoured Personnel Carrier (**5001.102**), with which it shares many component parts. It entered service with British Reconnaissance Regiments in 1955, and has seen active service in a wide variety of internal security situations such as Malaya, Borneo, Aden, Kenya and Cyprus. It has also been in service with the armies of: Australia, Abu Dhabi, Bahrain, Germany (FRG), Ghana, Indonesia, Jordan, Kenya, Kuwait, Libya, Muscat, Nigeria, Quatar, Sudan, Tunisia and is still in widespread use. It has an accurate and hard hitting gun, and excellent cross-country mobility over countryside that favours wheels. It has proved to be well equipped to withstand mine damage, which is the principal source of danger to armoured vehicles in an internal security situation. On several occasions Saladins have been able to motor away from a mine incident with two wheel stations destroyed. Saladin probably represents the best combination of mobility, fire-power and protection available in any armoured reconnaissance vehicle currently in service. It has proved to be adaptable to a very wide range of climatic conditions, and to be well suited to transportation by air, by landing craft or by assault boat.

CHARACTERISTICS:

Crew: 3 (commander/loader, gunner, driver)
Weight: 11.6 t (laden)
Road Speed / Range: 72 km/h/160 km
Armament: 76 mm gun with 7.62 mm MG coaxially mounted and another 7.62 mm MG for the commander pintle-mounted on the roof
Method of ranging: Commander's estimate
Rounds carried: 42, mixed HESH, HE and smoke

STATUS:

The Saladin armoured car is used by Abu Dhabi, Bahrain, Great Britain, German Border Police, Ghana, Indonesia, Jordan, Kuwait, Libya, Muscat and Oman, Nigeria, Portugal, Qatar, South Yemen, Sudan, Tunisia and Uganda.

Saladin Armoured Car

MANUFACTURER:

Saladin was made by Alvis Ltd, Holyhead Road Coventry, England but is no longer in production.

5007.102
FV 432 ARMOURED PERSONNEL CARRIER

DESCRIPTION:

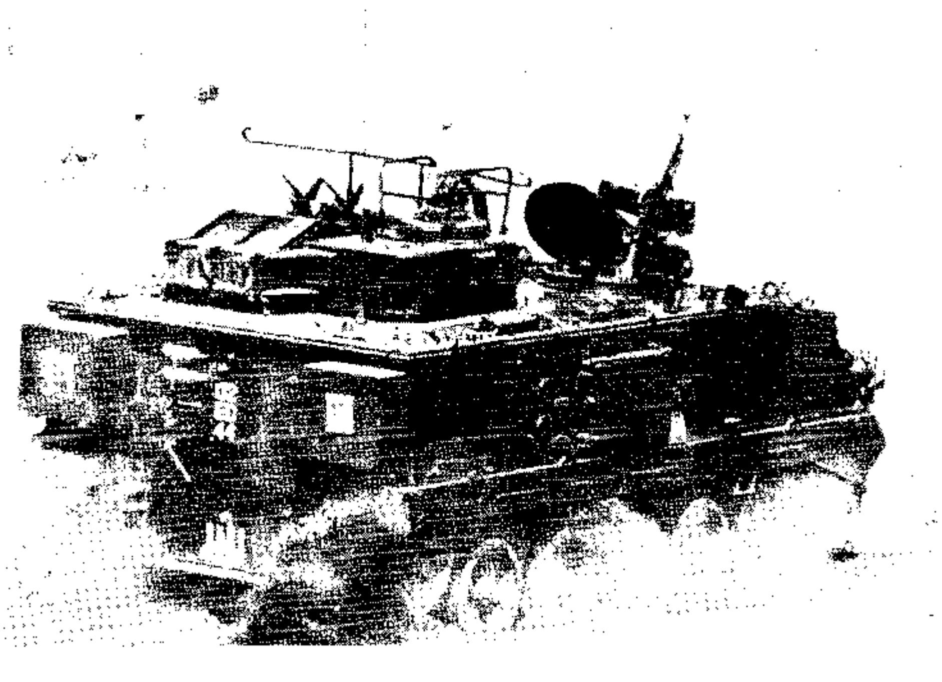
The FV 432 was developed between 1955 and 1961 to provide a high-mobility Armoured Personnel Carrier for the British Army in Germany. An order for about 1 000 vehicles was placed in 1961, and has now been delivered. FV 432 has been the standard APC with British mechanised infantry battalions since 1964.

The FV 430 series of vehicles was originally intended to provide the British Army with a range of armoured tracked vehicles for combat use, in the roles of artillery gun, APC, supply vehicle, recovery vehicle, ambulance and so on, all based on the same chassis. The scheme is now complete; and although various necessary compromises have resulted in some departures from the original plan the entry into service of FV 432 and its many derivatives has given the British Army a range of fast, reliable and versatile tracked vehicles.

CHARACTERISTICS:

Crew: 2 (commander, driver) plus a section of 10 men. The driver is situated right front, the commander central, with the engine at left front
Weight: 15.1 t
Size: Height (to roof) 1.88 m. Length 5.10 m. Width 2.97 m
Road speed / range: 52 km/hr/580 km
Armament: 7.62 GPMG, pintle-mounted on the roof, 2 000 rounds carried
Engine: Rolls-Royce K60 6 cylinder multi-fuel compression ignition opposed piston 2 stroke 240 bhp at 3,750 rpm
Transmission: Allison TX 200 4A heavy duty automatic gearbox, giving six forward and one reverse gears
Exit for Section: Single door at rear of vehicle swinging open on vertical hinges on right side of vehicle
Agility: Ground pressure 0.78 kg/cm. Maximum gradient 35°. Maximum step 0.6 m. Maximum trench 1.82 m. Ground clearance 0.4 m. Power-to-weight ratio 16 bhp/ton
Water crossing ability: Fording without preparation to 1.1 m. Collapsible screen available which can be erected in 1 minute, to provide amphibious capability.
Night vision equipment: Driver's IR viewers, combined with IR headlamp filters vehicle to be driven at night

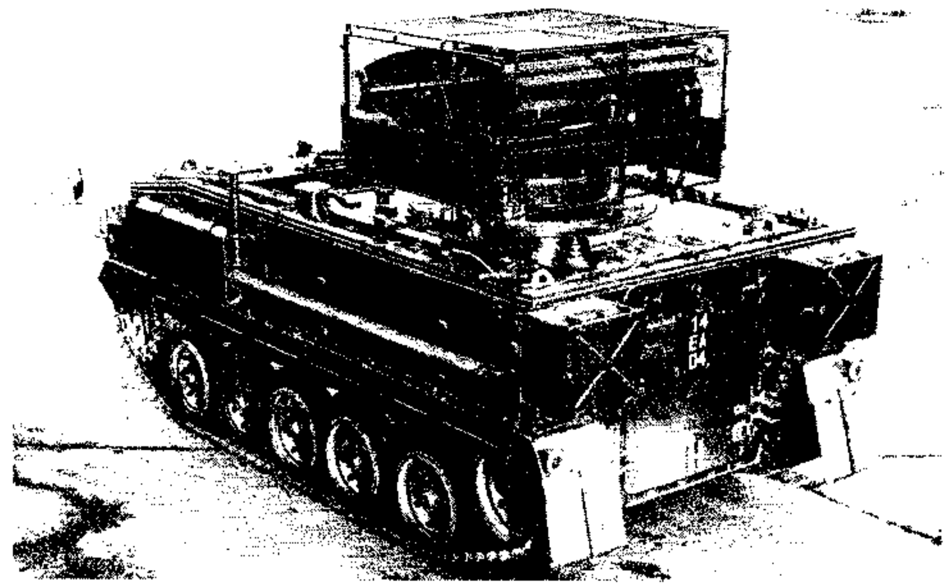
FV432 with Wombat recoilless anti-tank gun



FV438 Swingfire launch vehicle (Christopher F. Foss)

Derivatives:
The basic FV 432 chassis can be and has been, readily adapted to many roles. These include:
a. carriage for Wombat anti-tank gun and crew (**2476.103**)
b. command post
c. cargo vehicle, particularly for ammunition and fuel
d. carriage for 81 mm mortar and crew
e. ambulance (4 stretchers, or 2 stretchers with 5 sitting)
f. recovery vehicle (8 ton winch)
g. artillery observation post
h. carriage for Cymbeline Mortar locator radar (**1018.153**)
i. FACE vehicle (**2415.163**)
j. minelaying vehicle
k. navigation vehicle
l. Carl Gustav (**5557.103**) carrier
m. battlefield radar (No 14 – **2490.153**)
n. with Rarden turret (**5504.103**)
o. with GPMG turret

Other vehicles on the same chassis type include:
Abbot self-propelled gun (**5503.103**)
FV 434 recovery vehicle
FV 436 with the Green Archer mortar locating radar (**2412.151**)
FV 438 with Swingfire missiles (**2450.111**)



Rear view of FV432 with Cymbeline mortar locator mounted on it (reflector folded for transit)

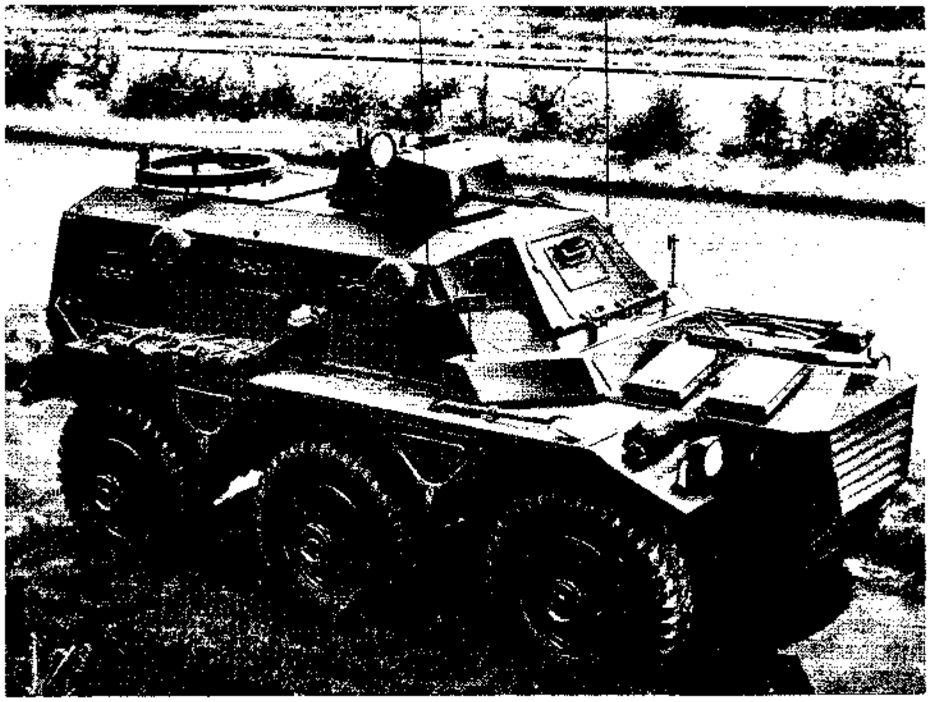
MANUFACTURER:
Joseph Sankey and Sons Ltd, Hadley Castle Works, Wellington, Shropshire, England.

5001.102
SARACEN ARMOURED PERSONNEL CARRIER

DESCRIPTION:
Developed between 1950 and 1953, Saracen was rushed into service to meet the requirements of the Malayan emergency. Since then it has more than proved its value as a versatile reliable and speedy personnel carrier. It has a remarkable cross-country performance, especially in dry, hard conditions, and can negotiate narrow, winding tracks through jungle or mountain with ease, achieved largely by its four wheeled, hydraulically assisted steering. Its road speed and silence makes it particularly valuable in internal security operations, and it has seen service in this role in such places as Malaya, Borneo, Kenya, Cyprus and Aden.

It has been in service with British mechanised infantry battalions and reconnaissance regiments and with the armed forces of Abu Dhabi, Australia, Brunei, Hong Kong, Indonesia, Jordan, Kuwait, Libya, Nigeria and Qatar. It is still in widespread use.

CHARACTERISTICS:
Crew: 2 (commander and driver) plus infantry section of 10 men
Weight: 10.4 tonnes (laden)
Road speed: 72 km/h
Armament: 0.30 Browning Machine gun in one-man turret
Rounds carried: 3,000 MG
Derivatives: In addition to the Saladin Armoured car (**5005.102**), built on essentially the same chassis, the following adaptions of Saracens have been produced:
Armoured Ambulance – 4 stretcher cases
Command vehicle – specially heightened body, and penthouse canvas shelters at back and sides. Map boards, racking and additional battery charging facilities
Specialist Cargo Vehicle – for engineer stores
Radar Vehicle – mounted radar No. 9 (Robert) long range ground surveillance radar.
For hot climates there was also a derivative using reverse flow cooling


Saracen Armoured Personnel Carrier

STATUS:
Saracens are still used by Abu Dhabi, Brunei, Great Britain, Hong Kong (Police), Indonesia, Jordan, Kuwait, Libya, Nigeria, Qatar, South Africa, Sudan, Thailand and Uganda.

MANUFACTURER:
Manufactured by Alvis Ltd, Holyhead Road, Coventry, England but no longer in production.

5002.102
FERRET SCOUT CAR Mks 1 & 2

DESCRIPTION:
The Ferret was developed between 1951 and 1953 from the famous Daimler Scout Car which had been in service since 1940. It has since been produced in very large numbers both for the British Army and the following foreign armies and police forces: Abu Dhabi, Australia, Bahrain, Brunei, Canada, Ceylon, Congo, France, Gambia, Ghana, India, Indonesia, Iran, Iraq, Jamaica, Jordan, Kenya, Kuwait, Libya, Malaysia, Muscat, Netherlands, New Zealand, Nigeria, Qatar, Ras al Khaima, Rhodesia, Singapore, Somalia, South Africa, South Arabia, Sudan, Uganda, United Nations and Zambia. It has seen service as a reconnaissance, liaison, escort and patrol vehicle in a wide variety of internal security and 'small war' situations in every sort of climate, and every sort of country. It has proved time and again that its reliability, mobility and ease of maintenance are well matched to its roles and to the standard of training of those who use it. It has been one of the most successful and best liked armoured vehicles developed since 1945, and has many more years of useful service ahead of it. The Mark 1 version has no turret, but can carry a machine gun on a pintle mounting for use by the commander. It can also carry a third person as passenger. The Mark 2 version has a one-man turret which can be traversed through 360° by the shoulder and arm movements of the commander, and which mounts a 7.62 mm MG.

CHARACTERISTICS:
Crew: 2 (commander, driver)
Weight: Mk. 1 – 4,218 kg (laden); Mk. 2 – 4,400

kg (laden)
Size: Height – Mk. 1 – 1.45 m; Mk. 2 – 1.87 m. Length 3.8 m. Width 1.9 m
Road speed / range: 93 km / h / 305 km
Armament: Mk. 1 – 0.30 Browning or .303 Bren on pintle mounting; Mk. 2 – .30 Browning in turret
Rounds carried: Mk. 1 – 450 rds; Mk. 2 – 2,500 rds
Turret rotation: Mk. 2 – 360 degrees, but restricted by Commander sitting on fixed seat whilst traversing with his shoulders and arms
Engine: Rolls-Royce B60, petrol, spark ignition, six cylinder, 6.4 to 1 compression ratio, 120 bhp at 3,300 rpm
Trans-: Daimler fluid coupling with 5 speed epicyclic gearbox and transfer box to give 5 forward and 5 reverse speeds
Agility: Max step 0.4 m. Max trench 1.2 m (with channels). Ground clearance 0.33 m. Max gradient 24 degrees. Shallow fording up to 0.9 m. Deep fording up to 1.5 m with preparation. Power-to-weight ratio 27 bhp / ton
Additional equipment: Infra-red headlamp filters used in association with driver's IR binoculars. Deep fording screen. Applique kit to mount 2 Vigilant anti-tank missiles ready-to-fire, plus 2 missiles stowed, on existing Mk. 2 or Mk. 1 vehicles

STATUS:
The Ferret is in service with Abu Dhabi, Bahrain, Brunei, Burma, Cameroons, Canada, Ceylon, Gambia, Ghana, Great Britain, Iran, Indonesia, Iraq, Jamaica, Jordan, Kenya, Kuwait, Libya, Malaysia, Mali, Muscat & Oman, New Zealand, Nigeria, Qatar, Ras Al Khaimah, Rhodesia, Sierra Leone, Somali, South Africa, South Arabia, South Yemen, Sudan, Uganda, Zaire and Zambia.

MANUFACTURER:
Manufactured by the Daimler Company Ltd, Radford, Coventry, England. Production ceased in August 1972 by which time some 4,400 Mk 1, Mk 2 and Mk 5 (**5065.102**) vehicles had been produced.

Vigilant missile launched from Ferret scout car


Ferret Mk 1 (Christopher F. Foss)


Ferret Mk 2 (Christopher F. Foss)

5065.102
FERRET Mk 5 MISSILE LAUNCH VEHICLE

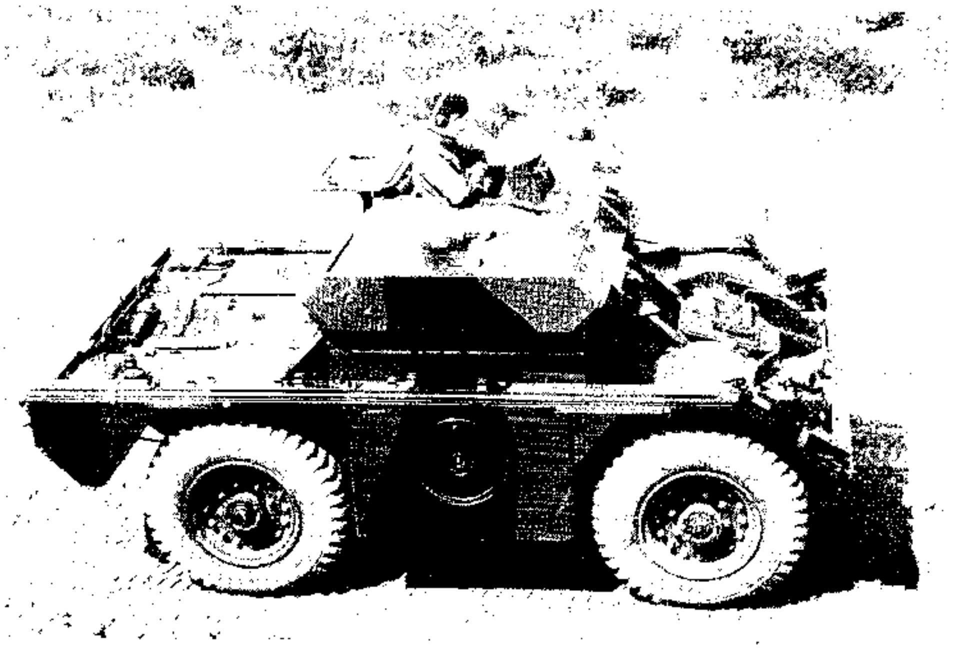
DESCRIPTION:

The Mk 5 Ferret is a logical development from the well-proven Mks 1 and 2. It is fitted with a special fully-rotating turret carrying four BAC Swingfire missiles giving an anti-tank range out to 3,000 m. The missiles can be fired either from the vehicle or remotely by a separation sight which can be carried to a position where the missile controller can observe the approach of targets, whilst the launch vehicle remains hidden. This system overcomes one of the main objections to the use of anti-tank missiles, which is the length of time the launch vehicle must remain exposed to attack during the time of flight of the missile. It also removes the need to provide a heavily protected launch vehicle.

The Mk 5 Ferret is wider, and heavier than Mks 1 and 2, and has a flotation screen permanently attached. The suspension system has been strengthened to allow a considerable improvement in cross-country performance, especially over rough ground. The special turret is fabricated of aluminium armour to keep the combat weight down to 5.89 t. At this weight the Mk 5 Ferret can be readily air-transported and parachute-dropped. It therefore offers a means of providing long-range anti-armour defence in air transported and amphibious operations. It also enables any army to provide itself with an effective long range anti-armour defence system at far less cost and complexity than by the use of tanks.

CHARACTERISTICS

Crew: 2 (driver and commander/controller)
Weight: 5.89 t
Size: Height 2.0 m. Length 4.1 m. Width 2.1 m
Road speed/range: 80 km/h/240 km
Armament: 4 Swingfire missiles housed in armoured containers forming part of a full-rotating turret. Further two Swingfire missiles carried. 7.62 mm MG mounted coaxially
Engine: Rolls-Royce B60 6 cylinder, 4.3 litre, petrol engine 6.4 to 1 compression ratio. 129 bhp at 3,750 rpm
Transmission: Daimler pre-selected epicyclic gearbox providing five speeds. Transfer box selects forward or reverse. Daimler fluid coupling
Power to weight ratio: 24 bhp/t
Water crossing ability: Unprepared wading to 1.0 m. Swims with screen erected, propulsion by wheel spin at 3.9 km/h

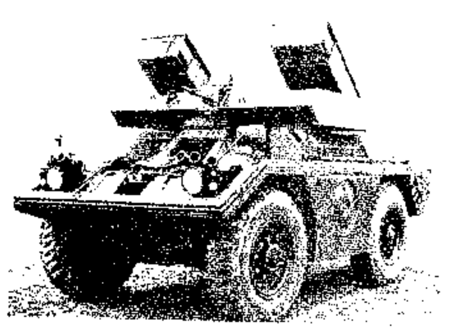


Ferret Mk 5 (Christopher F. Foss)

MANUFACTURER.

Vehicle: The Daimler Company Limited, Radford, Coventry, England.
Missile system British Aircraft Corporation, Guided Weapons Division, Stevenage, Hertfordshire, England

Production of Ferret Mk 1, Mk 2 (**5002.102**) and Mk 5 vehicles was completed in August 1972, by which time some 4,400 vehicles had been produced.



Ferret Mk 5, showing the four Swingfire missile containers in the elevated position ready for firing

5017.102
SHORLAND ARMOURED CAR

DESCRIPTION:

Developed by Short Brothers and Harland as a private venture between 1965 and 1966, this is essentially a long-wheelbase Landrover chassis clad in 8 mm armour plate, mounting a Ferret-type turret with a 7.62 millimetre machine gun. It is designed as an inexpensive, reliable and versatile internal security, patrol, escort and surveillance vehicle. With the increasing need for light armoured vehicles by armies and police forces in cities, it has been adapted to carry water cannon and tear gas equipment. It has been designed to withstand attack from small arms, 'Molotov cocktails', petrol bombs and hand thrown missiles.

Consideration has been given to the comfort and safety of the crew who may be required to remain 'closed down' for long periods, by providing heating or cooling fans, a spacious crew compartment, lined with polyurethane foam padding, and a number of quick access-safety hatches.

The Shorland can be driven by anyone who can drive a private car with no special training. Servicing and repair are both simple and cheap. It was the first vehicle designed to cope with the new sort of city warfare being experienced by armies and police forces all over the world. Fleets of these vehicles have been supplied to a large number of countries in many parts of the world. The Mk III version is detailed below. The Mk I and II have a lower powered 4-cylinder engine.

Shorland Armoured car

CHARACTERISTICS:

Crew: 3 (commander, driver, turret gunner)
Weight: 3.360 kg laden
Size: Height 2.29 m. Length 4.6 m
Road speed/range: 88 km/h/320 km (Standard tank) 640 km (long range tank)
Armament: 7.62 mm MG in turret. Stowage for 1,500 rounds
Turret rotation: 360° manually operated
Egnine: Rover petrol 2.6 litre 6 cylinder giving power/weight ratio of 27.6 bhp/ton
Transmission: Dry clutch, 2 and 4 wheel drive, manual gearbox, 4 forward, one reverse with lower ratio
Agility: Ground pressure 2.4 kg/sq cm. Max step 0.23 m. Ground clearance 0.25 m. Normal Landrover wading capability
Derivatives: If required a Vigilant ATGW in launcher box can be mounted either side of the turret. A more recent model is the SB 301 armoured personnel carrier, which does not have a turret and is designed to transport men.

STATUS:

The Shorland Armoured Patrol Car is in service with at least 16 countries.

MANUFACTURER:

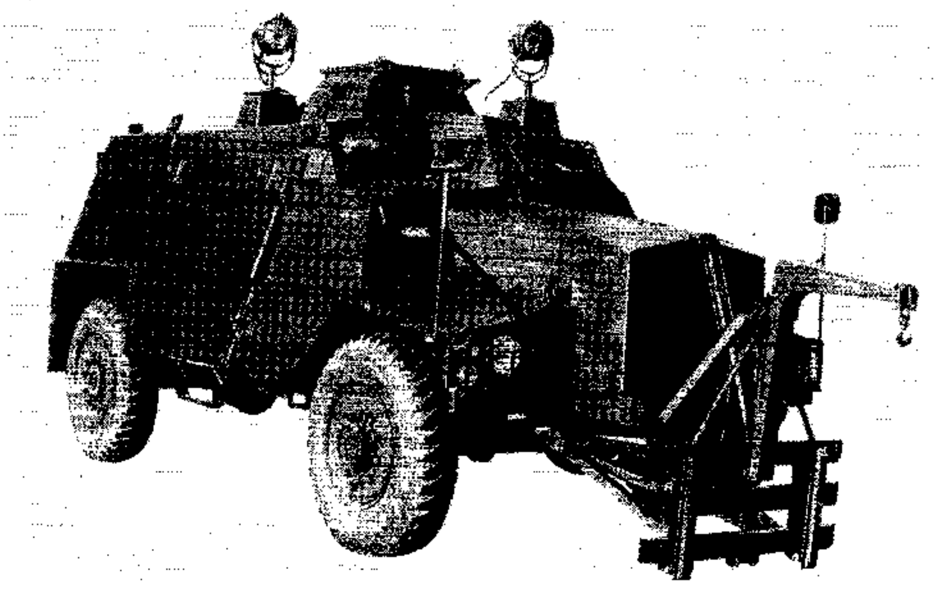
Short Brothers and Harland, Glen Works, Newtownards, Co. Down, N. Ireland

5117.102
AT 104 ARMOURED PERSONNEL CARRIER
DESCRIPTION:

The AT 104 Armoured Personnel Carrier is a 4 × 4 vehicle designed by GKN Sankey Limited specifically for internal security duties. It can transport up to 12 men and their equipment, and its hull provides protection from 5.56 mm and 7.62 mm AP rounds. For quick deployment double doors are provided at the rear and a single door in the side in addition to the driver's door. There are two gun ports in each side, a single gun port at the front and a further two gun ports in the rear of the vehicle.

In addition to being used as an APC the AT 104 can also serve as a command post or communications vehicle, ambulance, recovery vehicle, reconnaissance and airfield security vehicle. Many optional extras are available including a heating kit, air conditioning, searchlights on the roof, grenade dischargers, a turret with a 7.62 mm MG, a loudspeaker system, a barricade remover and a hydraulic winch with a maximum pull of t 5ons.

CHARACTERISTICS:
Crew: 2 plus 8 / 10 men
Weight: 8.9 t (loaded)
Size: Length 5.486 m. Width 2.438 m. Height 2.41 m
Road speed: 80 km / hr
Engine: GM Bedford 6 cylinder diesel developing 146 bhp at 2,800 rpm
Transmission: GM Allison AT.540 automatic gearbox with 4 forward and one reverse gears. GM Transfer box with two speeds



AT104 APC fitted with (detachable) barricade remover

Armament: fitted to customers requirements
STATUS:
In service with the Danish State Police.

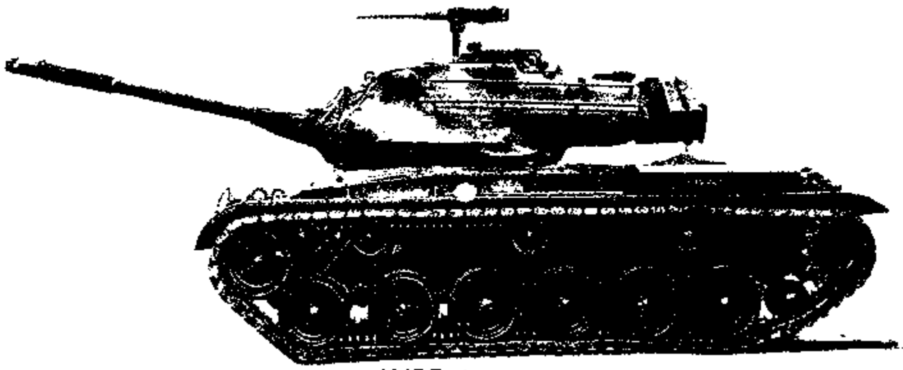
MANUFACTURER:
GKN Sankey Limited, Special Vehicle Division, Hadley Castle Works, Telford, Salop, England.

THE UNITED STATES OF AMERICA

5046.102
M47 MAIN BATTLE TANK
DESCRIPTION:

The design of the M47 originated with the Medium tank M26, which was taken into service in the US Army in 1945, as successor to the M4 (Sherman). With a better power plant, and other minor improvements M26 became M46 (Patton) in 1948. The M46 was then in turn improved to produce the M47 in 1951. The hull and suspension of the M46 were retained, but a more powerful engine was installed and a better-shaped turret was designed. It is believed that there are no longer any M46 tanks in service with any army, but M47 continues in service in many countries. Large numbers resulted from Korean War production, and these, as M48 replaced M47 in US Army service, were offered as Military Aid to Austria, Belgium, France, W. Germany, Greece, Italy, Pakistan, Persia, Spain and Yugoslavia during the middle and late 1950s. M47 is therefore one of the best-known tanks in the world, and has earned a reputation for mechanical reliability and good mobility.

CHARACTERISTICS:
Crew: 5 (commander, turret gunner, hull gunner, loader, driver)
Weight: 44 tons (laden)
Size: Height 2.96 m. Length (hull) 6.33 m. Width 3.50 m
Road speed / range: 40 km / h / 128 km
Main armament: 90 mm gun M-36
Method of ranging: Stereoscopic rangefinder
Rounds carried: 71 rounds HE and HVAP mixed
Turret rotation: 360° in 10 secs



M47 Tank

Secondary armament: One 0.3 m MG hull mounted. 0.3 in MG coaxially mounted. One 0.5 in MG pintle mounted on roof for AA defence
Engine: Continental V-12 air-cooled model AB-1790-5B. 29.4 litres. 810 bhp at 2,800 rpm
Transmission: Allison CD-850-4 cross drive system with hydraulic torque converter. Two forward speed ranges, one reverse
Agility: Ground pressure 0.94 kg/sq cm. Max step 0.91 m. Max trench 2.58 m. Max gradient 60%. Ground clearance 0.45 m. Power to weight ratio 18.5 bhp/ton
Water crossing ability: Wades to 1.22 m
Night vision equipment: Nil

Variants: Many variants have been produced either for US Army or by local manufacture in the countries to which M47s were supplied. These include:
- Recovery vehicle
- Armoured engineer vehicle
- Assault bridge

Reference may also be made to entries (**2006.102**) and (**2015.102**) for details of Italian and Austrian modifications.

STATUS:
No longer in line service with the US Army or USMC (although there may be some in reserve formations) but still in widespread service elsewhere.

5056.102
M48 MAIN BATTLE TANK
DESCRIPTION:

The M48 is a redesigned and 'stretched' version of the M47 main battle tank (**5046.102**), employing many of the M47 components. Its distinguishing features are the re-designed turret shape, with a much-reduced rear overlap, a new and rather conspicuous commander's cupola, and a transverse muzzle brake on the 90 mm gun. It was developed up to 1953, since when many thousands have been manufactured. The early marks used a petrol engine, which gave a rather poor radius of action; but from 1964 the M48 A3 was manufactured using many components of the M60 tank including the Continental V12 diesel engine which gives a greatly improved radius of action. The M48 A3 is still in service in large numbers with the US Army, and its reliability and simplicity, as demonstrated during extensive service in Vietnam, showed it to be still a very satisfactory tank. It is also used by the US Marine Corps as its main tank armament. It has been partly superseded by M60 A1 tanks in regular battalions of the US Army in USA and Germany and, beginning in FY 1974, it will progressively be replaced in USMC service by the M60 A1.

CHARACTERISTICS:
Crew: 4 (commander, gunner, loader, driver)
Weight: 47.6 tons

Size: Height 3.09 m. Length 6.87 m Width 3.63 m

Road speed/range: M48 (early marks) 48.3 km/h/160 km. M48 A3 48.3 km/h/400 km

Main armament: 90 mm. M41 gun (**2832.103**)

Method of ranging: Stereoscopic rangefinder on early marks. Replaced by coincidence rangefinder on M48 A3

Rounds carried: 60 rounds mixed HVAP, HEAT, HE, WP or canister

Turret rotation: 360°

Secondary armament: 7.62 mm MG coaxially mounted in turret. One 0.5 in Browning MG for anti-aircraft use by commander in turret-mounted cupola

Armour: Both the hull and turret are constructed of cast steel

Engine: M48 and M48 A1 powered by Continental AV-1790 SRS 12-cylinder petrol engine; 810 bhp at 2,800 rev/min. M48 A2 has AVL-1790-8 petrol engine: 825 hp at 2,800 rev/min. M48 A3 has Continental AVOS-1790-2A diesel: 750 hp at 2,400 rev/min

Transmission: Allison cross-drive hydraulic

Agility: Ground pressure 0.84 kg/sq cm. Max step 0.91 m. Max trench 2.59 m. Max gradient 60%. Ground clearance 0.39 m. Power-to-weight ratio 17 bhp/ton (M48 A3. 18.5 bhp/ton)

Water crossing ability: Wading without preparation to 1.2 m

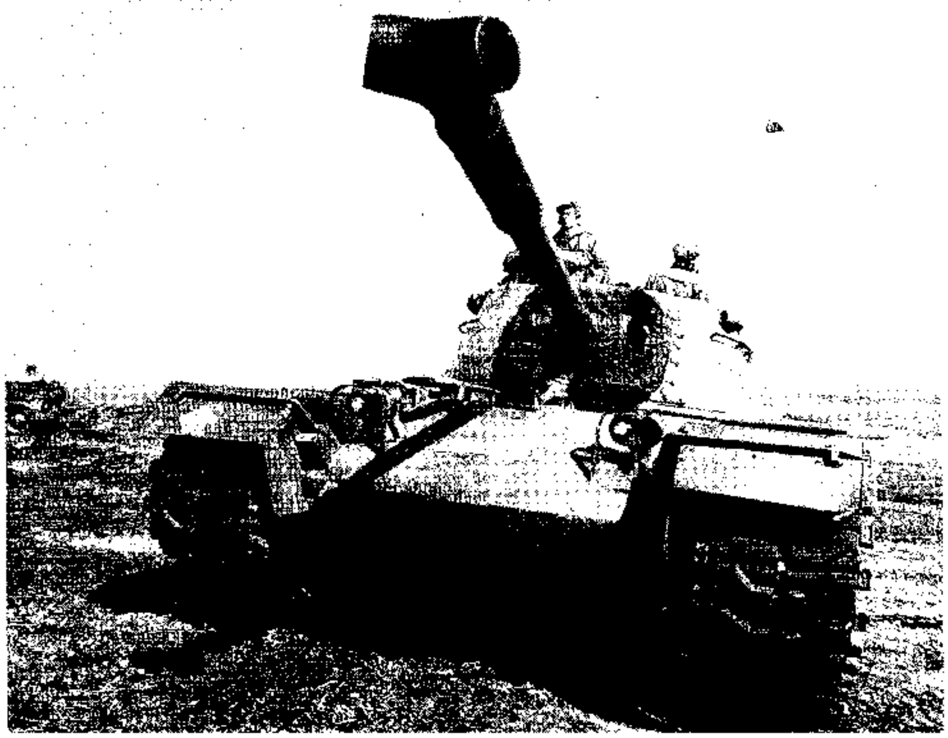
Night vision equipment: Driver's IR viewer can be fitted. A White light/IR search light can be fitted, for use in conjunction with IR gunner's and commander's sights.

Derivatives:

1. M48 Armoured Vehicle Launched Bridge. This carries a hydraulically launched scissors bridge which can be laid across ditches up to 18.29 m in width. It is very similar to the M-60 AVLB
2. The M88 Medium Armoured Recovery Vehicle uses many automotive components of the M48
3. All M-48s can be fitted with a dozer blade.
4. Flame-thrower tanks. Three separate marks have been developed, the M67, M67 A1 and M67 A2, none are at present in service.

STATUS:

The M48 is in service with Germany, Greece, Israel (some with 105 mm guns), Jordan, Norway, Pakistan, South Korea, South Vietnam, Spain, Taiwan, Turkey, Thailand and United States Army & Marines.



M-48A2 tank in German Army service

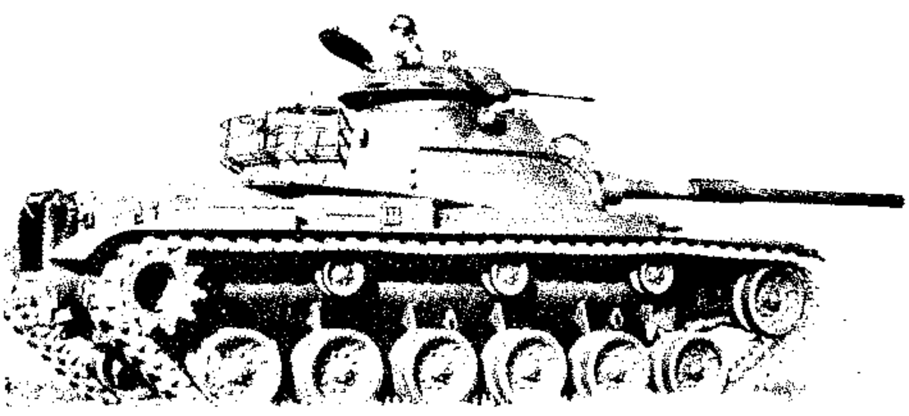
M48 Tank in service with the US Army

5024.102
M60 MAIN BATTLE TANK

DESCRIPTION:

M60 is the current main battle tank in service in considerable numbers in the US Army. It is a direct development of M47 and M48, the principal differences being the use of a diesel engine, giving a great improvement in range, a more powerful gun in the form of the British 105 mm gun, and additional armour protection, particularly on the turret. Development started in 1956, and the first production tanks were troop tested in 1959. Later production concentrated on M60 A1, which has a redesigned 'needle-nose' turret, and an improved gun control equipment, but is otherwise the same vehicle.

Now that the MBT70/XM803 tank has been cancelled the M60 will undoubtedly continue to be the operational main battle tank of the US Army for considerably longer than was originally envisaged. Consequently the Army has begun a product improvement programme for the M60 A1 version, which will extend over several years.



M60, early production series, during firing trials in May 1970

First stage in the programme was the incorporation of add-on stabilisation in a number of tanks in 1971. Other improvements will include the addition of a laser rangefinder, a solid-state ballistics computer, improved suspension, long-life tracks with replaceable pads, air cleaners and a more reliable engine and electrical systems.

In addition the Army requested funds in the Fiscal Year 1973 budget for prototyping and testing a thermal sight for the M60 A1. This sight, which will be mounted inside the turret and integrated with the fire control system, will help the crew to detect and engage targets in darkness or poor visibility conditions in daytime. The programme was expected to extend over two years and was aimed both at improving the M60 A1 and at establishing a design for subsequent tank development.

The product improvement programme for the M60 A1 has been under way since 1969 and will be carried out in three phases:

Phase 1 – The three main parts of this phase are the add-on stabilisation system, enabling the tank to have a shoot-on-the-move capability, and the new track, designated T-142, which will have twice the life of the T-97 track used at the present time. The vehicle will also be fitted with a top-loading air cleaner which increases engine life by reducing dust and dirt ingestion.

Phase 2 – This phase is scheduled to commence in 1976 and will involve installation of a laser rangefinder that can be used by both the commander and gunner by day and night; a solid-state computer will contain sensors for cross wind, vehicle cant, gun tube wear and ammunition grain temperature. The suspension will also be much improved by fitting the tube-over-bar suspension system, this will give the vehicle a significant increase in cross country mobility, a better gun platform and a smoother ride for the crew. The engine will be modified and improved by fitting a new turbo-charger, pistons and so on, and a new electrical system will be installed. This model will be known as the M60 A3.

Phase 3 – Work has started on this part of the programme and the improvements will include an engine with at least 900 hp coupled to a new four-speed hydrostatic transmission with new final drives. This will increase the acceleration as well as the top speed of the vehicle. Work has also started on a thermal night vision fire control system.

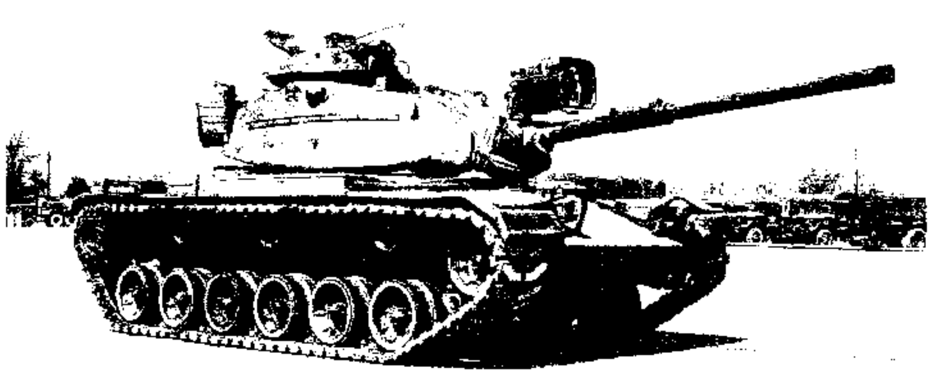
These phased improvements will be incorporated into production vehicles and have also been designed so that M60 A1s at present in service can be retrofitted as and when required.

STATUS

The M60 tank family will certainly continue to be the mainstay of the US armoured forces until the late 1970s. It is expected that the M60 A3 will be in production in FY 1975 after which existing stocks of M60 A1 will be progressively converted. In the meantime new procurement of M60 A1 will continue for replacement of obsolescent tanks in the US Army and the USMC.

CHARACTERISTICS (M60 A1):

Crew: 4 (commander, gunner, loader, driver)
Weight: 48 tons



M60 A1. The 'needle-nosed' turret is noticeable. The powerful Xenon IR / white light searchlight is fitted to the mantlet above the gun

Size: Height 3.26 m. Length (hull) 6.95 m. Width 3.63 m
Road speed / range: 48 km / h / 500 km
Main armament: 105 mm 51 calibre high velocity gun (British design, US manufacture) (**2451.103**)
Method of ranging: Monocular coincidence rangefinder with base of 2 m (But see text)
Armament: 63 rounds mixed APDS, HEAT, and HEP (equivalent to British HESH)
Secondary armament: 0.5 in commander's MG cupola mounted, with AA capability. 7.62 mm coaxial MG
Turret rotation: 360° electro-hydraulic or manual control
Engine: Continental 90° V-12 air cooled, twin turbocharged, diesel, 29.3 litres. 750 bhp at 2,400 rpm
Transmission: Allison hydraulic torque converter
Agility: Ground pressure 0.78 kg/sq cm. Max step 0.91 m. Max trench 2.58 m. Max gradient 60% (1 in 1.7). Ground clearance 0.46 m. Power-to-weight ratio 15.5 bhp/ton
Water crossing ability: Fording to 1.22 m without preparation. An appliqué schnorkel equipment permits fording to 4.11 m
Night vision equipment: A Xenon IR / white light searchlight can be fitted on the mantlet above the gun. Commander and gunner have interchangeable infra red sights. Driver has infra red viewer for use in conjunction with filtered headlights
NBC protection: Centralised filter system passes filtered air to the individual respirators of crew members.

DERIVATIVES

1. AVLB – Armoured Vehicle Launched Bridge on M60 A1 chassis can launch a 18 m bridge of classification 60 t in less than 2 minutes. Total weight 55 t. 2 man crew.
2. CEV – Combat Engineer Vehicle M728. Carries 165 mm demolition gun, winch with 11 t pull, an A-frame crane with 8 t lift, and a bulldozer blade. Total weight 50 t. 4 man crew.
3. The M60 A2 (separately described) is identical to M60 A1 below the turret ring.

STATUS:

The M60 and M60 A1 tanks are in service with Austria (120), Iran, Israel, Italy (200 M60 A1s have been built in Italy), Jordan, South Korea, Spain, Turkey and the United States. Future orders could come from Australia, Kuwait and Saudi-Arabia. The M60 A1 is in production by the Chrysler Corporation at the Detroit Tank Arsenal, which at the present time is the only tank plant in the USA. In the FY 1974 US Defence Budget a further 360 M60 A1s were to be built for the Army and 120 for the USMC. This total was increased by a supplemental to 613 (partly to cover sales to Israel) plus 155 covered by the proceeds of the sale of older tanks to Israel). For FY 1975 the purchase of 664 tanks – 154 M60 A1 for the USMC and 510 improved models for the Army – was proposed at an estimated cost of $229.2 million

MANUFACTURED BY:

Chrysler Corporation, PO Box 757, Michigan 48231, USA.

5025.102
M60 A2 (FORMERLY M60 A1 E2) MAIN BATTLE TANK

DESCRIPTION:

The M60 A2 tank (formerly known as the M60 A1 E2) is a basic M60 vehicle (**5024.102**) with the 105 mm turret replaced by a turret designed to house the XM 162 152 mm gun / launcher used with the Shillelagh missile (**2809.111**) but capable also of firing conventional 152 mm rounds.

The programme ran into design and engineering difficulties, and in 1969 official and service tests were suspended because of gun stabilisation and system reliability problems.

The turret is fully stabilised and incorporates for the first time an independently stabilised commander's cupola to provide a highly accurate shoot-on-the-move capability. The fire control system utilises a full solution ballistics computer coupled to a laser rangefinder, along with passive night vision for both the commander and gunner. With the exception of the missile, the commander has the same capability of aiming and firing all the weapons, day or night, with the same accuracy as the gunner. The commander has the capability of automatically lining up his cupola with the gunner to designate targets automatically to the gunner.

Over the next two years, however, these difficulties were overcome. In September 1971, the tank received Standard A classification and in

M60 A2 Tank, fitted with XM 162 gun / launcher system firing either the Shillelagh missile or a 152 mm high-explosive shell (US Army photograph)

November of that year it was decided that production and retrospective fitting could go ahead.

Procurement is now understood to be complete and it is believed that some 500 M60 A2 tanks have been completed. At least some of these are in service with US forces in Europe.

CHARACTERISTICS:
Crew: 4 (commander, gunner, loader, driver)
Weight: 58 tons
Size: Height 3.20 m. Length (hull) 6.95 m. Width 3.63 m
Road speed/range: 48 km/h/450 km
Main armament: XM 162 gun/launcher system (**2833.103**). Bore 152 mm
Method of ranging: Laser rangefinder
Ammunition carried: 13 Shillelagh missiles and 33 conventional rounds. Both systems use HEAT warheads as the principal anti-armour weapon
Accuracy and range: The range of Shillelagh is approximately 3,000 m. The conventional round, with a low muzzle velocity and short barrel lacks accuracy much above 1,500 m
Secondary armament: 0.5 in commander's MG cupola mounted, with AA capability. 7.62 mm coaxial MG
Turret rotation: 360°, electro-hydraulic or manual control
Engine: Continental 90° V-12 air cooled twin turbocharged diesel. 29.3 litres. 750 bhp at 2,400 rpm
Transmission: Allison hydraulic torque converter
Agility: Ground pressure 0.76 kg/sq cm. Max step 0.91 m. Max trench 2.58 m. Max gradient 60° (1 in 1.7). Ground clearance 0.41 m. Power-to-weight ratio 17 bhp/ton
Water crossing ability: Fording to 1.22 m unprepared. Prepared fording to 4.11 m
Night vision equipment: White light searchlight for use with daylight sights can be mounted on the left side of the turret. Passive night sights can be fitted for use of commander and gunner. Driver has IR viewer for use in conjunction with filtered headlamps
NBC protection: Centralised filter system passes filtered air to the individual respirators of crew members.

MANUFACTURER:
Chrysler Corporation, PO Box 757, Michigan, 48231, USA.

2853.102
XM-1 MAIN BATTLE TANK

DESCRIPTION
XM-1 is the successor of the cancelled US/FRG MBT-70 programme and the subsequent US-only XM-803 programme which was also cancelled. The reasons for cancellation mainly reflected over-specification leading to an unacceptably high unit cost. The sequence of programmes and cancellations is traced through the earlier editions of this book under entry number **5029.102**

Following the cancellation of the XM-803 project at the end of 1971 a task force was set up at the US Army Armour Centre at Fort Knox and required to make recommendations for a new design in August 1972. The XM-1 programme is the outcome of the activities of this task force

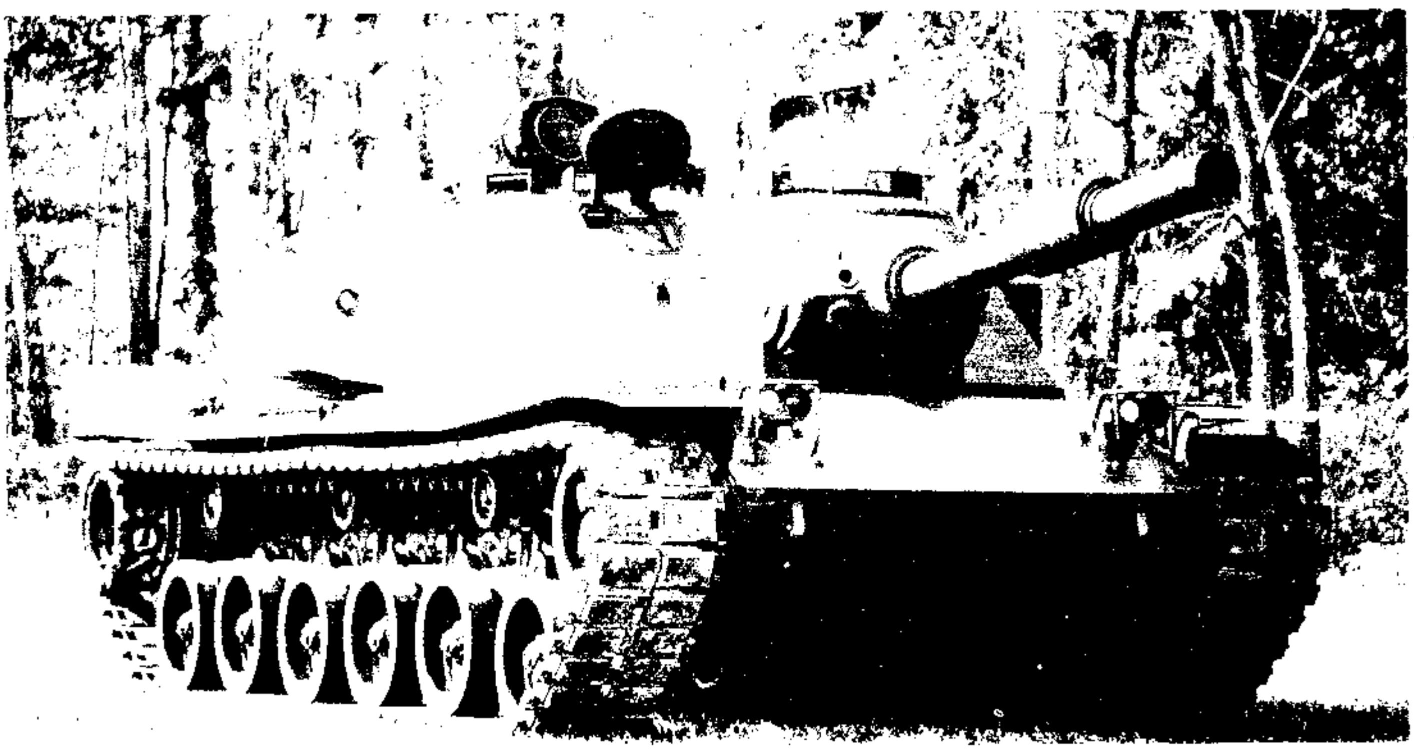
On 23rd January, 1973, the Project Manager of the XM-1 Programme, which is located at the Tank Automotive Command at Warren, Michigan, invited American companies to submit proposals for the new MBT. As a result of these proposals the Chrysler Corporation's Defense Operations Division (who build the current M60 A1 series) and the Detroit Diesel Allison Division of the General Motors Corporation, at Indianapolis, Indiana, (who built the MBT-70), both received contracts for the construction of one prototype tank, a mobility test rig, and a chassis and turret for ballistic tests. These should be completed by 1976/77 and tested for about three years: one of the companies will then be awarded a full development contract. The XM-1 is not expected to be in production until the early 1980's.

The Chrysler Company received a 34 month, $68.1 million contract of which some $8 million was for the further development of the Avco Lycoming AGT 1500 gas turbine which at present develops some 1500 hp with a further growth potential. The GMC vehicle will probably be powered by the Teledyne Continental engine, intended for the MBT-70, which developed some 1500 hp.

Very little information has been released on the XM-1 tank. In May, 1973, Brigadier General Robert J. Baer said "It will be well protected, with a low silhouette and good ballistic shielding against anti-tank weapons. Be fast and agile. Provide firepower options which are extremely effective even when on the move. Have good reliability to sustain it through long periods of combat with frequent engagements. Provide significant advances over the performance of the Army's present tank." On firepower, he said "(1) XM-1s weapons mix will provide a major gain in the tank's total battlefield potential. Complementing the main gun are a 20-30 mm coaxial cannon and two machine guns. (2). Increased range and lethality of the XM-1's complementary weapons against the wide range of soft targets will result in a kill factor five times greater than that of the Improved M60. (3). Fire control system will be similar to that of the Improved M60." He also said that XM-1 would have approximately the same weight (48 t) as the M60 A1, have much better acceleration (0-32 km/hr in less than 9 seconds) and be "75% more elusive" than the improved M60, and that the armour and compartmentalization of the XM-1 will make it "half as likely to be killed" if hit by enemy tank fire.

Prototypes will be armed with a 105 mm gun as used on the present M60 A1: production models will probably incorporate a 110 mm-120 mm gun: the 20-30 mm cannon is probably the Bushmaster at present under development for the ASRV: top road speed will be in the region of 75/80 km/hr. The US Army has a total requirement of some 3,300 XM-1s.

Acquisition cost is expected to be about twice that of the M60 A3. FY 1973 expenditure was $22 million: planned for FY 1974 $54 million: proposed for FY 1975 $69 million.



One of the MBT 70 tanks built in the international project which the XM-1 development replaces

5030.102
M551 SHERIDAN
LIGHT TANK

DESCRIPTION:

Sheridan is described by the US Army as an Armoured Reconnaissance Airborne Assault Vehicle (ARAAV). The emphasis nowadays is on the reconnaissance role, a role in which its high mobility is clearly important. Development started in 1959 against a specification which embodied two novel and important features: these were, first, the use of a dual-purpose gun and missile launcher – the missile being guided automatically to its target – and secondly, a combustible cartridge case to be used with the 152 mm anti-armour projectile. Associated with the first of these was, of course, the development of the missile itself – the Shillelagh (**2809.111**).

The combined gun/launcher was subsequently specified also for the M60 tank variant now known as the M60 A2 (**5025.102**) and for the ill-fated MBT-70 and XM-803 projects (**5029.102** and see **2853.102**). The latter projects had problems of their own which had nothing to do with the gun-launcher or the Shillelagh missile; it was the Sheridan project which had to bear the brunt of the criticism resulting from the teething troubles – both during development and when in service in Vietnam – which afflicted the innovations.

These criticisms have over the years diverted attention away from the good features of the Sheridan project. Sheridan is noted for its excellent cross-country mobility and the automotive side of the vehicle has been satisfactory. Following a modification programme to improve the reliability of the weapon system and provide better anti-mine protection the complete vehicle was operationally satisfactory: unfortunately, however, it had by then become an expensive vehicle and one that called for a high degree of crew training. It was therefore decided to limit procurement to a total of some 1,700 vehicles.

M551 Sheridan with XM 81 152 mm dual purpose gun/launcher

CHARACTERISTICS:

Crew: 4 (commander, gunner, loader, driver)
Weight: 15 tons (laden)
Size: Height (including MG) 3.0 m. Length 6.3 m. Width 2.8 m
Road speed/range: 70 km/h/600 km
Main armament: Gun launcher 152 mm M81
Method of ranging: Commander's estimation (an $8.3 million contract for the production of a laser rangefinder was awarded to Hughes in 1971)
Types of round: Shillelagh missile: Length 1.14 m. Weight 27.9 kg. Shaped charge warhead. Semi-automatic line of sight command guidance by Infra Red Command link. Maximum range 3,000 m. Conventional round: 152 mm diameter. HEAT warhead. Length 0.55 m. Weight 21.7 kg. Fully combustible cartridge. A canister round has also been developed
Rounds carried: 10 Shillelagh, 20 conventional
Secondary armament: One coaxial 7.62 mm MG. One 0.5 in MG on roof mounting for use by commander
Turret rotation: 360° in 10 seconds
Engine: GMC V-6 turbocharged compression ignition diesel, water cooled, 5.2 litres, 300 bhp at 2,800 rpm
Transmission: Hydraulic torque converter, with pivot steer capability
Agility: Ground pressure 0.48 kg/sq cm. Max step 0.84 m. Max trench 2.54 m. Max gradient 60°. Ground clearance 0.48 m. Power-to-weight ratio 20 bhp/ton
Water crossing ability: Swimming by the use of flotation screen permanently fitted, erected by crew in two minutes, gives 0.2 m freeboard. Water speed 5 kph
Night vision devices: Gunner and commander both equipped with passive image intensification night vision sights. Driver has active IR driving viewer, using filtered IR headlamps
NBC protection: An air filtration unit can be connected to the crew's face masks
Derivatives: It is believed that alternative turret arrangements include: 105 mm Howitzer, 155 mm Howitzer, Flame Thrower, Mortar carrier, anti-aircraft gun system and others. None are yet in service. The prototype of a bridgelayer on an M-551 chassis has been completed

STATUS:

Production complete. In service with US Army

MANUFACTURER:

Allison Division of General Motors, Indianapolis, Indiana, USA.

5033.102
V-100 COMMANDO M-706
ARMOURED PERSONNEL CARRIER

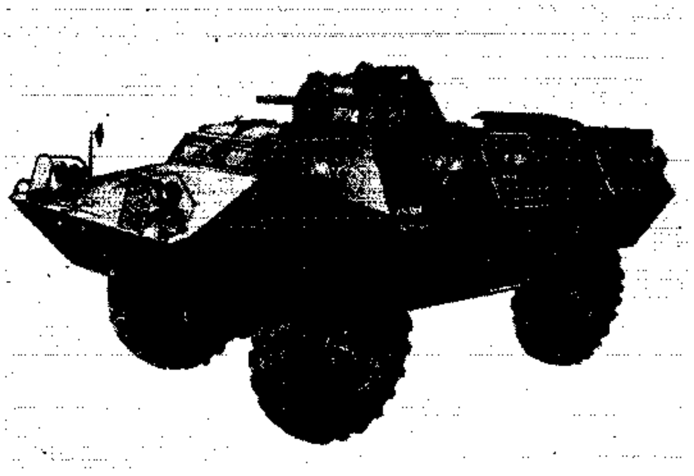
DESCRIPTION:

Developed between 1960 and 1965 as a private venture by the Cadillac Gage Company, to meet the requirements for a light, cheap, versatile armoured vehicle for convoy escort, police duties and border patrols. The high powered engine gives the vehicle a fast road speed and a good cross-country performance. It can swim unprepared, obtaining water traction from the spin of the wheels. Twelve firing ports in the hull enable the crew of 12 men to use their weapons from inside the vehicle. There are two versions. One with a rotating turret is capable of accepting a wide variety of weapon systems. The other version has a fixed roof, and is used purely as a personnel or load carrying vehicle. Several hundred of these vehicles have been manufactured. They are in service with the US Military and Air Force Police and the South Vietnamese Army in Vietnam, and are also in use in Lebanon, Malaysia, Muscat and Oman, Singapore, Somali and Sudan.

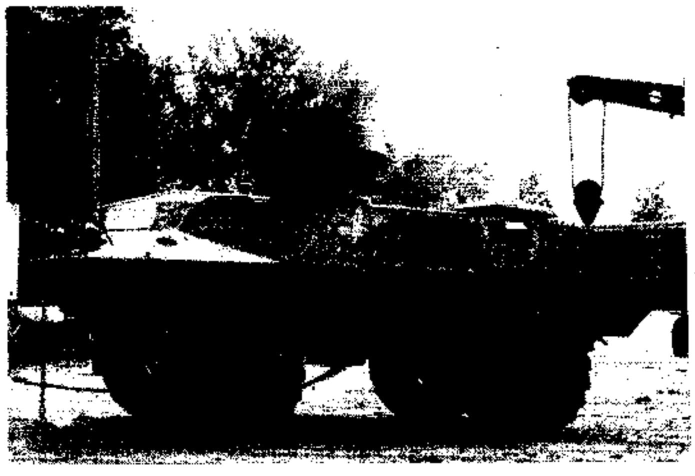
CHARACTERISTICS:

Crew: With rotating turret: 9 (commander, driver plus seven); without turret: 12 (commander, driver, plus ten)
Weight: 7.27 tons
Size: Length 5.68 m. Height (to top of turret) 2.44 m. Width 2.20 m
Road speed/range: 100 km/h/1,000 km
Armament: There are four established options for turret weapons and other possibilities have been explored:

1. Twin .30 in Browning MGs



M-706 Commando APC with twin .30 in Browning MGs in turret mounting



XM-706E1 – a version of the Commando APC with a 40 mm grenade launcher installation (US Army photograph)

2. Twin 7.62 mm Rheinmetal MG 42
3. One .50 in Browning MG and one .30 in Browning MG
4. One GE 7.62 mm Minigun

Ammunition: Option 1 and 2, 1,000 rounds Option 3, 200 rounds of .50, 500 rounds of .30, with additional ammunition storage in the body of the vehicle
Turret traverse: 360°, by handwheel
Engine: Chrysler V-8 361 petrol engine of 191 bhp
Transmission: Manual five speed synchromesh gearbox with single plate clutch
Agility: Max step 0.6 m. Max trench – only narrow ditch. Max gradient 60°. Ground clearance 0.4 m. Power-to-weight ratio 26.4 bhp/ton
Water crossing ability: Swims without preparation at 5 kmh, with a freeboard of 0.45 m
Additional equipment: A 5 ton winch is fitted at the front for self recovery

Product-improved M-706

Following the success of the M-706 in its original version the manufacturers have extended its range of capabilities by fitting it with a bigger engine (Chrysler 361 CID V-8 210 bhp with Allison 3-speed automatic transmission) and heavier duty (5 ton) axles. As a result the vehicle can carry an additional ton of payload.

With this improvement additional armament configurations have been developed. These include 20 mm and 90 mm two-man turrets, an 81 mm mortar version and an APC/Command version. A new twin M60 7.62 mm Cupola MG mounting in a balanced cradle has also been introduced. This has 400 ready rounds per gun and twelve grenade launchers are fixed to the turret and can be fired electrically from within. A communications slip-ring and coaxial spotlight have been added and the basket size increased to increase gunner efficiency.

MANUFACTURER:
The Cadillac Gage Company, PO Box 3806, Detroit, Michigan 48205, USA.

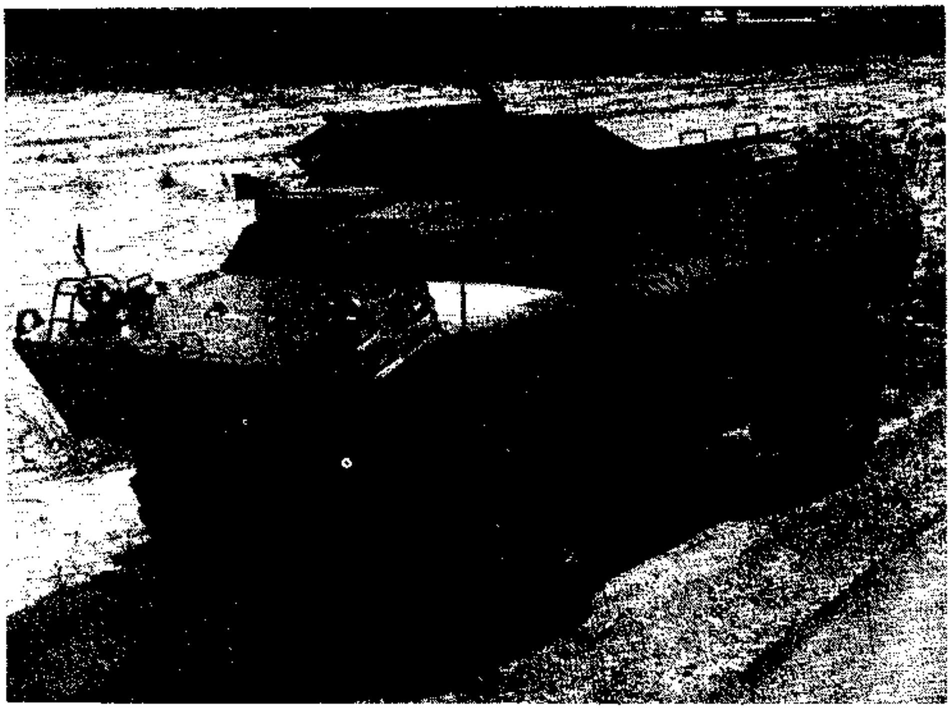
5066.102
V200 COMMANDO ARMOURED CAR

DESCRIPTION:

This vehicle has been developed from the lighter, smaller V100, and is available in a variety of configurations, as an armoured car with a 90 mm gun, or a 20 mm cannon, a personnel carrier carrying 12 men, a command vehicle, a recovery vehicle, or a mortar vehicle carrying either an 81 mm or 120 mm mortar. The 90 mm and 20 mm armoured car versions have been delivered to Singapore.

The 20 mm version is described below.

CHARACTERISTICS (20 mm cannon version):
Crew: 11 (commander, gunner, driver, co-driver plus 7 infantrymen)
Size: Height 2.7 m. Length 6.1 m. Width 2.4 m
Weight: (laden) 14.1 t
Road speed/range: 96 km/h/480 km
Armament: 20 mm cannon with coaxial 7.62 mm machine gun
Method of ranging: Commander's estimate
Rounds carried: 525 rds 20 mm, 5,000 rds 7.62 mm
Turret rotation: 360°, power assisted
Engine: Chrysler 440 diesel of 275 bhp
Transmission: Manual five-speed synchromesh gearbox with 2-speed transfer box to select forward and reverse. 4-wheel drive
Agility: Maximum step 0.61 m. Maximum trench – only very narrow ditches can be negotiated. Maximum gradient 60%. Ground clearance 0.43 m. Power-to-weight ratio 19.5 bhp/t
Water crossing ability: Amphibious, with 0.3 m freeboard. Propulsion by wheel-spin at 5 km/h
Additional features: Hydraulic winch at front with 6.8 t (nominal) line pull. Vision ports for crew through hull permit use of personal weapons from inside



V-200 Armoured Car with 81 mm mortar

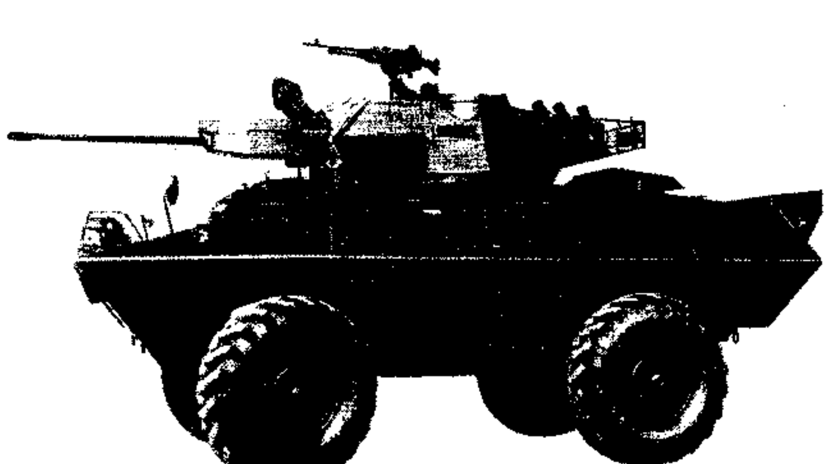
MANUFACTURER:
Cadillac Gage Company, PO Box 05006, Detroit, Michigan 48205, USA.

5078.102
V-150 COMMANDO ARMOURED PERSONNEL CARRIER

DESCRIPTION:

The V-150 was first shown in 1971 and its designed to fill the gap between the V-100 and V-200 vehicles. The hull is similar to that of the earlier V-100; but numerous improvements have been made including larger axles, increased wheel travel – and therefore improved cross country characteristics – improved brakes and brake failure warning system: a larger selection of engines (petrol or diesel) and transmissions (manual or automatic) can also be offered. Four basic models are available:

a. APC with a crew of two plus ten infantry. Armed with twin 7.62 mm MG or one 7.62 mm and one 12.7 mm MG plus smoke dischargers.
b. Mortar carrier with a crew of five and an 81 mm mortar.
c. Armed with a 20 mm Oerlikon gun in a turret with powered traverse and elevation, a co-axial 7.62 mm machine gun, a 7.62 mm anti-aircraft machine gun and smoke dischargers.
d. Armed with a turret-mounted 90 mm Mecar gun (**2491.103**), a 7.62 mm co-axial MG and a 7.62 mm anti-aircraft MG and smoke dischargers. Ammunition carried is 40 rounds of 90 mm, and 3,000 rounds of 7.62 mm.



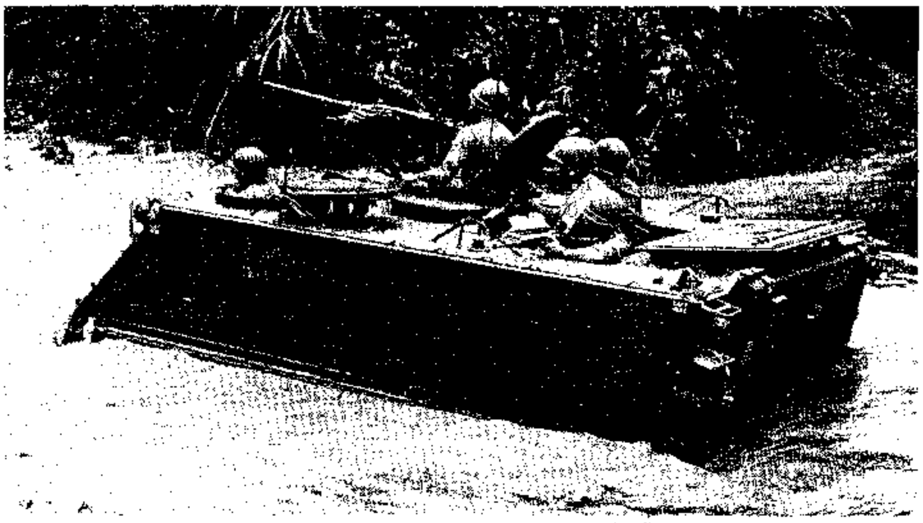
V-150 Commando with 20 mm cannon turret

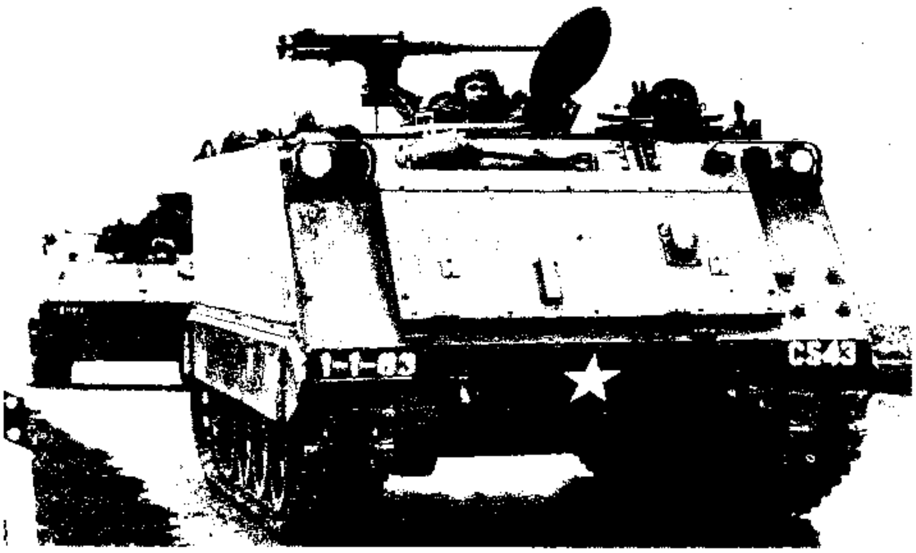
Other models available include TOW missile carrier, command and recovery vehicles.

CHARACTERISTICS:
Crew: Commander and driver plus ten infantry (depending on role of vehicle)
Weight: 9.55 t
Size: Length 5.69 m. Width 2.26 m. Height 2.54 m (including turret)
Road speed/range: 89 km/h/960 km
Main armament: depends on role, various types up to 90 mm can be fitted
Turret rotation: 360° with power traverse, traverse speed is 60° a second
Engine: Chrysler V-8 petrol engine developing

210 hp at 4,400 rpm or a V 6 diesel developing 155 hp
Transmission: 5 speed manual gearbox, an automatic gearbox is also available
Agility: Ground pressure 0.8 kg/cm². Max step 0.61 m. Max gradient 60%. Ground clearances (axles) 0.38 m
Water crossing ability: Fully amphibious, propelled in the water by its wheels at 4.8 km/hr
Night vision equipment: Can be fitted if required
NBC system: Nil
Winch: A winch with a capacity of 9 t is fitted at the front
STATUS:
In production. Commando armoured cars are used by 21 countries.
MANUFACTURER:
Cadillac Gage Company, PO Box 05006, Detroit, Michigan, USA.

5016.102
M-113 ARMOURED PERSONNEL CARRIER
DESCRIPTION:
The M-113 is the current APC in US Army service. It is the most widely used armoured fighting vehicle outside the Soviet bloc, with over 44,000 vehicles or derivatives manufactured.
The specification, written in 1956, called for a lighter, simpler and less expensive APC than the M59 which had been in service since 1953. The FMC Corporation submitted the chosen design, and a contract for the delivery of 900 units was placed in 1959. Further orders of 2,823 for the US Army, and 1,132 for the West German Army followed almost immediately. The Swiss Army ordered 540 in 1963, and a quantity were manufactured for the Italian Army by OTO Melara of La Spezia (**5072.102**).
Since then sales have proliferated to Australia, Denmark, Greece, Holland, Iran, Korea, Pakistan, Spain, Thailand, Turkey and Vietnam.
A large number of derivatives have been produced incorporating every conceivable load and weapon system. The basic version mounts a 0.5 inch Browning MG externally on an unprotected commander's cupola. Operations in Vietnam led to the introduction of an armour-plated turret for the commander's cupola. The Australians in Vietnam fitted a Saladin turret complete with 76 mm gun and vehicles thus modified are now in service in Australia.
The M-113 was the first armoured vehicle to be constructed from welded aluminium plate armour. Its high vertical sides, which can be criticised for their vulnerability to anti-armour attack, give it the ability to float, even when fully loaded, with about 0.3 m of free-board. The interior is roomy; this not only makes for crew comfort, but also enables the vehicle to carry those additional stores and ammunition which can never be predicted and allowed for at the design stage. It is therefore popular with the crews who use it.
The back of the vehicle is a door, hinged at the base and forming a ramp which permits very rapid exit by the 11 infantrymen on board. Attempts have been made to provide firing ports through the side to enable the infantry section to use their weapons whilst still in the vehicle. This has not been entirely successful, because it has been US Army doctrine, unlike that of the West German Army, to use the APC as an 'armoured taxi' to carry the infantry on to the objective supported by fire from tanks, guns and helicopters, rather than expect the APCs to fight themselves on to the objective (but see **5055.102** below). These contrary views on the correct use of APC have produced two very dissimilar designs from the two countries.
There is nevertheless no doubt that the M-113 has been one of the most successful vehicles ever in the US Army service, and has proved especially valuable in the special circumstances of the Vietnam war. The original version has been replaced by M-113 A1, developed in 1964, with a more powerful diesel engine. Details of both marks are given below.
CHARACTERISTICS:
Crew: 13 (commander, driver, plus eleven infantrymen)
Weight: 10.67 tonnes (M-113 A1 10.93 tonnes)
Size: Height 2.2 m. Length 4.68 m. Width 2.69 m
Road speed/range: 64 km/h/320 km. Range of M-113 A1 is 480 km, speed 68 km/hr
Armament: Browning 0.5 inch MG on Commander's cupola
Rounds carried: 2,000
Turret rotation: No turret fitted except on specially modified versions


M-113 Armoured Personnel Carrier, crossing stream in Vietnam



M-113 APC on exercises in Germany in 1973 (US Army photograph)


A later version of M-113 in service in Vietnam. In the foreground is a M-113A1 with protective cupola and shields fitted. This vehicle is known as M113 ACAV and is fitted with a 0.5 in (12.7 mm) MG in the turret and two 7.62 mm MGs at the sides. In the background is a M-132A1 flamethrower (US Army photograph)

Armour: Welded aluminium plate
Engine: Chrysler 75 M 5,915 cc. V-8 water cooled, petrol, spark ignition. 209 bhp at 4,000 rpm (M-113). The M-113 A1 is powered by a GMC Model 6V53 diesel developing 215 hp
Transmission: Allison TX-200-2A (M-113 A1 – Allison TX100). Hydraulic torque converter with epicyclic gearbox giving 6 forward, one reverse, gears
Agility: Ground pressure 0.53 kg/sq cm. Max step 0.61 m. Max trench 1.67 m. Power-to-weight ratio 19.9 bhp/ton. M-113 A1 – 20 bhp/ton. Ground pressure 0.54 kg/cm^2
Water crossing ability: Inherently amphibious, propulsion by tracks at 3.5 mph
Derivatives: The most important amongst numerous local adaptations of the standard vehicle are: Two versions for mounting the ATGW SS11, and TOW. Two versions for mounting radars AN/TPS-25 and AN/PPS-4
Command Vehicle.
Recovery and repair vehicle
Two Mortar vehicles for 107 mm mortar and 81 mm Mortar.
Flame thrower.
Ambulance.
It is also widely used without seats as a universal loadcarrier.

M-113 chassis or components are also used in the following vehicles: Lance (**2682.111**), Chaparral (**2542.131**), Hawk SAM (**2640.131**) and the Vulcan Air Defence System (**2850.131**).

STATUS:
The M-113 and its numerous variants are used by Argentina, Australia, Bolivia, Brazil, Cambodia, Canada, Chile, Denmark, Ecuador, Germany, Greece, Iran, Israel, Italy, Laos, Lebanon, Libya (from Italy), Netherlands, New Zealand, Norway, Pakistan, Phillipines, South Korea, South Vietnam, Spain, Switzerland, Thailand, Turkey, United States and Uruguay.

A supplemental to the FY 1974 Defence Budget provided for the procurement for $44 million of 923 M-113 A1s. Some of these were to replace vehicles supplied to Israel in 1973; but the bulk were for replacement of the M-114 three-man command and reconnaissance vehicles (**5044.102**) which the US authorities say has proved difficult to maintain.

MANUFACTURER:
FMC Corporation, San Jose, California, USA.

5067.102
M-132A1 FLAME-THROWER

DESCRIPTION:
M-132A1 is a modified M-113A1 developed as a close range assault weapon for use by armour and mechanised infantry units. The M10-8 flame gun mounted in a special fully-rotating cupola is connected to four fuel tanks in the cargo compartment. The flame liquid can be discharged in bursts or continuously. There is a two man crew. The production contract for these vehicles was given to FMC Corporation in early 1963, and later that year the first experimental vehicles were deployed in Vietnam. Production versions of M-132A1 (diesel engine) were deployed in 1964, and production was completed in 1967.

CHARACTERISTICS (where they differ from M-113A1):
Crew: 2
Weight: 10.8 t
Flame-thrower: Effective range 150 m. 32 secs sustained duration.

The M-132A1 Flame-thrower, being demonstrated (US Army photograph)

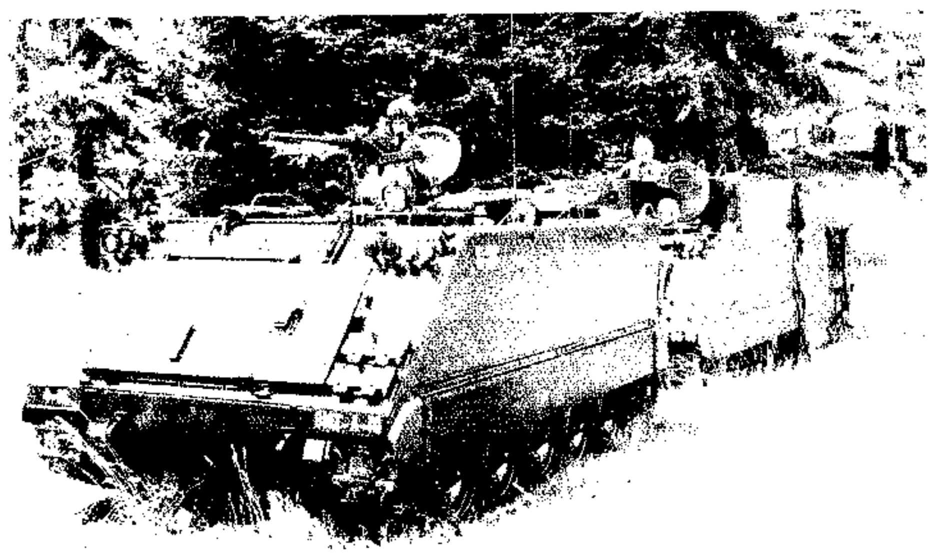
MANUFACTURERS:
Flame thrower: Consolidated Diesel Electric Corporation, Schenectady, New York, USA.
Vehicle: FMC Corporation, San Jose, California, USA.

5068.102
M-577A1 COMMAND POST VEHICLE

DESCRIPTION:
This vehicle is a derivative of the M-113A1 APC and is a mobile, self-contained command and control, communications and fire control vehicle for use by armoured and artillery formations and units. It can carry a wide variety of radio teletype and artillery control equipment. A penthouse tent can be erected at the rear of the vehicle to increase the working area of the five-man crew:

CHARACTERISTICS (where they differ from M-113A1):
Crew: 5
Weight: 11.0 t
Height: 2.68 m

MANUFACTURER:
FMC Corporation, San Jose, California 95108, USA.



A standard M-113 at the front contrasted with the M-577 Command Post Vehicle, with penthouse fitted, in the background (US Army photograph)

5069.102
M-106A1, M-125A1 MORTAR CARRIERS

DESCRIPTION:
These two vehicles are modified versions of the M-113A1 APC. M-106A1 is used as a firing platform and transporter for the 107 mm (4.2 inch) mortar, and M-125A1 for the 81 mm mortar. Both vehicles carry a crew of 6. Production of both vehicles began in 1964, and is still continuing.

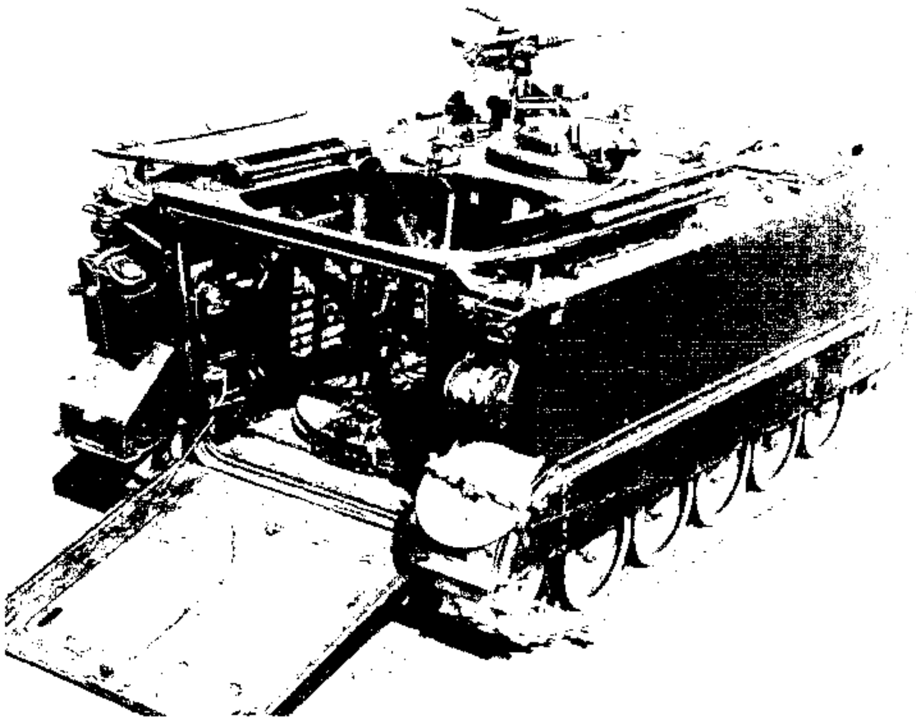
CHARACTERISTICS (where they differ from M-113A1):
Crew: 6
Weight: M-106A1 11.87 t. M-125A1 11.14 t

Armament: M-106A1, 107 mm mortar and 88 rounds. M-125A1 81 mm mortar and 114 rounds. Both vehicles also carry the 0.5 in Browning MG as on M-113A1

Traverse: In M-106A1 the traverse of the 107 mm mortar is restricted to 43° right and 46° left of the centre line. The mortar is fired over the rear of the vehicle. In M-125A1, the 81 mm mortar can be traversed through 360°

MANUFACTURER:

FMC Corporation, San Jose, California 95108, USA.



M-106A1 Mortar Carrier, with the 107 mm mortar in the firing position. The mortar can also be used dismounted using the baseplate shown fitted to the right hand rear track guard
(US Army photograph)

5043.102
COMMAND AND RECONNAISSANCE VEHICLE, C and R (LYNX)

DESCRIPTION:

This vehicle, variously known as M-113CR, M-113½, and Lynx was developed by FMC Corporation as a private venture from the M-113 Armoured Personnel Carrier. It is smaller, lighter, and more mobile than M-113, and with a gross weight of only 8.7 tons, is suitable for air lifting, para-dropping and amphibious operations. With a power to weight ratio of 25 bhp/t and a ground pressure of only 0.48 kg/cm², this vehicle has an exceptional cross-country mobility. Unlike the M-113, the engine and transmission is at the rear, insulating the crew from the noise and fumes, but resulting in the exit for the crew being either through the roof ports or through a small door on the right side of the vehicle. FMC Corporation put up this vehicle to the US Army as an alternative to M-114, but it was rejected. It has, however, been bought by the Canadian Army (174 vehicles) and by the Royal Netherlands Army (250 vehicles), and deliveries were completed in 1969.

CHARACTERISTICS:

Crew: 3 (commander, driver, observer/radio operator)

Weight: 8.78 tons laden

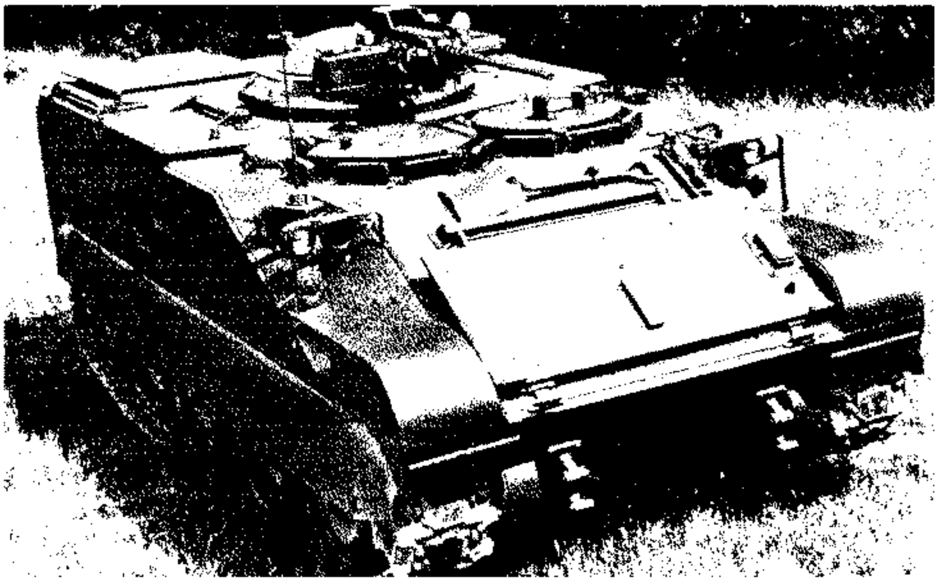
Size: Height 2.18 m. Length 4.60 m. Width 2.41 m

Road speed/range: 70 km/h/520 km

Armament: The standard vehicle has a 0.5 in Browning MG on Commander's cupola, and a 0.3 in MG on pivot mounting for the observer. Other variants exist (see below)

Rounds carried: Approx 1,100 rds 0.5 in or 2,000 rds 0.3 in

Cupola rotation: 360°, manual, with assistance from shoulder pads



Lynx in Canadian service

Armour: Welded aluminium plate

Engine: Detroit Diesel 6V53 V6 supercharged 2 stroke diesel water cooled, 5,210 cc, 215 bhp at 2,800 rpm

Transmission: Allison TX 100 torque converter, similar to that used in M-113. There are three forward and one reverse gear ratio

Agility: Ground pressure 0.48 kg/sq cm. Max step 0.61 m. Max trench 1.50 m. Max gradient 60% (1 in 1.5). Ground clearance 0.40 m

Power to weight ratio 25 bhp/ton

Water crossing capability: Inherent amphibian. Propulsion by tracks at 5.6 kph

Variants: A turret mounting a 20 mm cannon has been developed, increasing the height to 2.10 m. Other variants include versions for mounting a recoilless gun or an anti-tank guided weapons

MANUFACTURED BY:

FMC Corporation, San Jose, California 95108, USA.

5044.102
M-114
COMMAND AND RECONNAISSANCE CARRIER

DESCRIPTION

The requirements for this vehicle grew out of the need to replace the vulnerable Jeep and its 'soft skinned' counterparts with a better-protected and more mobile vehicle yet which was lighter, smaller and cheaper than the M-113 APC. M-114 was developed by the Allison Division of General Motors, to a US Army specification in competition with the M-113 CR vehicle put forward by the FMC Corporation. Production started in 1962, since when some 3,000 have been produced – production now being complete. It was deployed in Vietnam in 1965/66, but later withdrawn in favour of M-113 because of its relatively poor mobility in the special conditions of Vietnam. The original models used a 0.5 in Browning MG mounted on the commander's cupola but later versions have used a 20 mm Hispano Suiza cannon. Other weapon arrangements have also been tried

CHARACTERISTICS:

Crew: 3 (or 4 optional). Commander, driver, observer/radio operator, observer

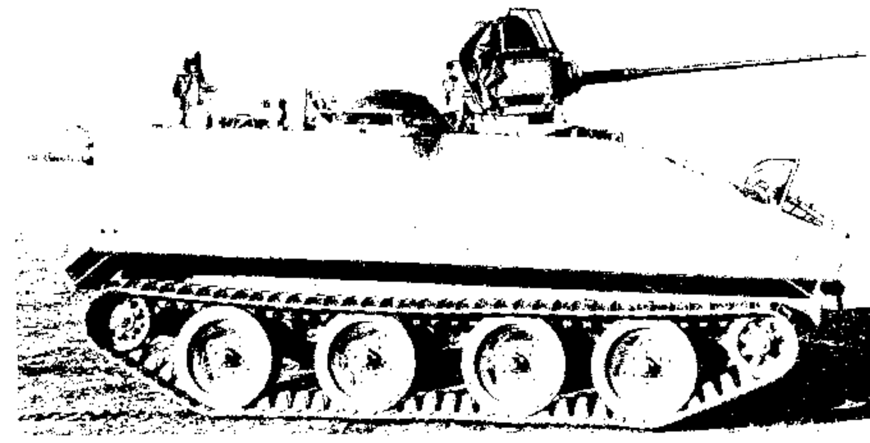
Weight: 6.85 tons

Size: Height 2.33 m. Length 4.46 m. Width 2.33 m

Road speed/range: 57 km/h/480 km
Armament: Browning 0.50 in MG in commander's cupola. 7.62 mm MG on front pintle mounting
Ammunition: 1,000 rds of 0.5 in
Turret rotation: M-114 Fixed cupola, commander must expose his body to fire MG. MG-114A1 – 360° cupola, with electrical firing gear, enabling commander to aim and fire whilst under armour
Armour protection: Welded aluminium plate
Engine: Chevrolet 90° V-8. 4 stroke spark ignition. 4,630 cc. Liquid cooled. 160 bhp
Transmission: GMC hydromatic, giving 4 forward and 1 manually selected reverse gears
Agility: Ground pressure 0.35 kg/sq cm. Max step 0.45 m. Max trench 1.52 m. Max gradient 44% (1 in 2.3). Ground clearance 0.41 m. Power to weight ratio 24 bhp/ton
Water crossing ability: Inherent amphibian. Propulsion by tracks at 4.8 kph
Night vision equipment: IR driver's and commander's viewers in conjunction with IR filtered headlamps
Variants: A variant mounting a 20 mm Hispano Suiza cannon has been developed and tested

Status:
In service, but scheduled to be replaced ultimately by the ARSV (see **5070.102** and **5125.102**). Because of maintenance difficulties some are being replaced by M-113A1 vehicles (see **5016.102**).

Manufacturer:
Allison Division of General Motors Corporation.



M-114A1 fitted with an Hispano Suiza 20mm cannon mounted on the commander's cupola and capable of being aimed and fired from under armour. This weapon is interchangeable with the normal 0.5 in Browning MG (US Army photograph)

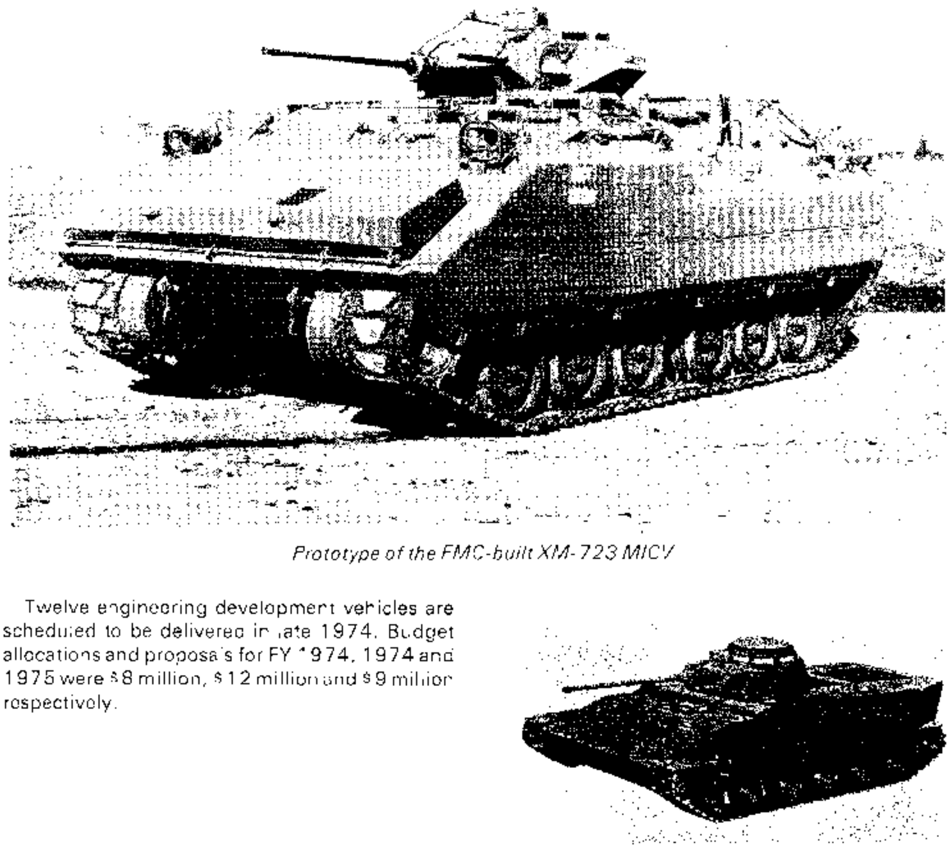
5055.102
XM 723 MECHANISED INFANTRY COMBAT VEHICLE (MICV)

Description:
The United States Army issued in 1972 a specification for a mechanised infantry combat vehicle (MICV). This specification resulted from the development of the US Army Tank/Infantry Doctrine that showed the need for an infantry vehicle from which the infantry could fight while protected from enemy fire.

In November, 1972, a development engineering contract was let to FMC Corporation, and as of winter 1973-74, one prototype and two automotive test rigs have been constructed and are undergoing extensive testing. The MICV is expected to provide high mobility, superior firepower, and more protection than any other infantry fighting vehicle in existence today. The MICV is powered by a Cummins VTA903 4-cycle diesel engine, coupled to a General Electric XM-2 hydromechanical automatic transmission. This power train provides 450 horsepower, allowing the MICV to keep pace with any of the MBTs in the inventory or projected for the near future. The vehicle weighs approximately 18.8 metric tons combat-loaded, it will cruise at 74 km/hr over a range of 480 km, and it is fully amphibious – water speed being 10 km/hr in the water.

The vehicle is armed with a 20 mm cannon mounted in an enclosed weapon station with a 360 degree continuous traverse and electrohydraulic stabilization. It is anticipated that production vehicles will be armed with the Bushmaster 20-30 mm cannon, when this is available. Secondary armament consists of a co-axial 7.62 mm machine gun. Squad members will fire M3A1 ball-mounted submachine guns through the six gun ports, two each side and two in the rear.

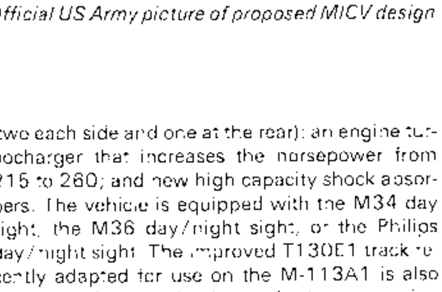
The MICV will provide more protection for its crew for less weight than any other comparable vehicle, with its aluminium and spaced laminate armour. It will carry an entire squad of infantrymen and deliver them to the battlefield in a ready-to-fight condition.



Prototype of the FMC-built XM-723 MICV

Twelve engineering development vehicles are scheduled to be delivered in late 1974. Budget allocations and proposals for FY 1974, 1974 and 1975 were $8 million, $12 million and $9 million respectively.

Manufacturer:
FMC Corporation, Ordnance Division, San Jose, California 95108, USA



Official US Army picture of proposed MICV design

5120.102
ARMOURED INFANTRY FIGHTING VEHICLE

Description:
In 1967, FMC Corporation built two XM765s for the United States Army. These vehicles used a number of M-113 components and were tested by the United States Army. FMC developed this vehicle further as a private venture, the end result being the AIFV, the first prototype of which was built in 1970. This has been tested in the USA and by the Belgian, Dutch and Italian Armies. The vehicle has been changed and improved in many ways, including spaced laminate armour attached to the hull; a power operated weapon station (turret) with a 20 or 25 mm automatic cannon and a co-axial 7.62 mm machine gun (alternative fits include a single 12.7 mm or 7.62 mm machine gun); five firing ports for the individual weapons (two each side and one at the rear); an engine turbocharger that increases the horsepower from 215 to 260; and new high capacity shock absorbers. The vehicle is equipped with the M34 day sight, the M36 day/night sight, or the Philips day/night sight. The improved T130E1 track recently adapted for use on the M-113A1 is also used. A unique torsion-bar-and-tube suspension system results in superior cross-country perform-

ance. The AIFV is fully amphibious, being propelled in the water by its tracks. It is fitted with infrared lights for night driving.

CHARACTERISTICS:

Crew: 10 (commander, gunner, driver, 7 infantrymen)

Weight: 12.7 tons (laden), 11.3 tons (empty)

Size: Length 5.36 m. Height 2.67 m (incl. turret). Width 2.85 m

Road speed / range: 62 km / h / 490 km

Armament: 20 or 25 mm automatic cannon, coaxial 7.62 mm machine gun

Rounds carried: 600 (20 mm) or 415 (25 mm)

Turret rotation: Continuous 360°, 45°/ second

Armour: Aluminium and steel

Engine: Detroit Diesel Model 6V53T 2-stroke turbo charged diesel, 5,210 cc, 260 bhp at 2,800 rpm

Transmission: Allison TX-100-1A single-stage automatic

Agility: Ground pressure (loaded) 0.62 kg/cm^2. Max step 0.64 m. Max trench 1.68 m. Max gradient 60%. Ground clearance 0.43 m. Gross horsepower-to-weight ratio 20.8 hp/ton; net horsepower-to-weight ratio 15.5 bhp/ton

Water crossing capability: Inherent amphibian. Propulsion by tracks at 5.5 km / hr

NBC System: Nil

MANUFACTURER:

FMC Corporation, San Jose, California 95108, USA.

AIFV with turret mounting 25 mm cannon

5070.102

FMC XM800 ARMOURED RECONNAISSANCE SCOUT VEHICLE (ARSV)

DESCRIPTION:

The Armoured Reconnaissance Scout Vehicle (ARSV) XM800 is a small, lightly armoured vehicle with exceptional mobility that will permit the US Army to carry out more effective reconnaissance missions either by day or by night. It will replace the M-114A1 (**5044.102**) at present used for this role. Normally, the ARSV will depend upon speed, agility, and quiet operation to accomplish its mission, but when necessary it will have firepower and armour to defend itself.

Both tracked and wheeled (**5125.102**) prototypes are being tested by the United States Army. The prime contractor for the tracked version is the Ordnance Division of FMC Corporation, with general Electric providing the turret power control and stabilisation, General Motors, Allison Division, providing the advanced hydrostatic steering transmission, and General Motors, Delco Electronics Division, providing the day / night sight.

The Detroit Diesel 6V53AT engine is coupled directly to the Allison X200 transmission. This power train is rear-mounted, and maintenance access points can be reached through the rear door.

The X200 hydrostatic steering transmission allows the ARSV to pivot about its own centre and permits excellent land and water manoeuvrability. The 12 inches of road wheel travel and the high power-to-weight ratio of 30 hp/ton provide fast response and high cross-country speeds. In addition to high-speed land travel, the ARSV swims at speeds of 7 km / hr, propelled only by its tracks.

A two-man, fully enclosed weapon station mounts a 20 mm M139 cannon and an auxiliary 7.62 mm M60D machine gun. The cannon is fired from inside the vehicle by the commander / gunner; the observer fires the auxiliary machine gun, which is on a skate mount around the observer's hatch, providing a 360° field of fire from an open hatch. Production vehicles will mount the Vehicle Rapid Fire weapon system (Bushmaster).

Prototypes of FMC's XM-800 ARSV

A 360° field of vision is provided to the commander by seven periscopes. The station is stabilised for both observation and firing by a General Electric all-electric power drive and stabilisation system (**2548.183**). A Delco Electronics day/-night sight provides 3x and 8x magnification for fire-control / surveillance capabilities from bright sunlight to starlight.

CHARACTERISTICS:

Crew: 3 (commander, observer and driver)

Weight: 8.25 tons

Size: Length 4.521 m. Width 2.438 m. Height 2.48 m

Road speed / range: 84 km / hr / 725 km

Armament: 20 mm M139 cannon and 7.62 mm M60D machine gun

Turret rotation: 360° powered traverse

Engine: Detroit Diesel 6V53AT, 300 hp at 2,800 rpm

Transmission: Allison X200

Agility: Max step 0.91 m. Gradient 60%. Ground clearance 0.406 m

Water crossing ability: Inherent amphibian. Propelled in the water by its tracks at 7 km / hr

STATUS:

Development. Defence budget funding for the two ARSV projects was $11.9 million in FY 1973, $10.4 million planned in FY 1974 and $33.4 million proposed for FY 1975 – including $25.3 million for the procurement of 35 vehicles. Note that these figures apply also to entry **5125.102**.

MANUFACTURER:

FMC Corporation, Ordnance Division, San Jose 95108, USA.

5125.102

LOCKHEED XM800 ARMORED RECONNAISSANCE SCOUT VEHICLE (ARSV)

DESCRIPTION:

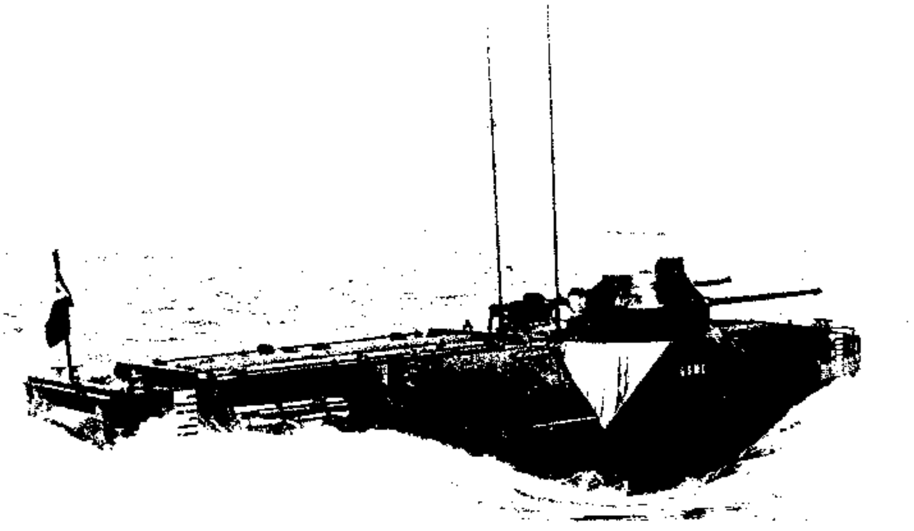
This is the wheeled model of the ARSV and has been developed under a $12.8 million contract awarded to the Lockheed Missile and Space Company. It is in competition with the FMC ARSV (**5070.102**). Three of these vehicles were handed over to the United States Army in the winter of 1973 / 74, as was a ballistic hull for test purposes; Lockheed retained one vehicle for test purposes.

The Lockheed development makes use of experience gained with their Twister 8 × 8 high mobility vehicle. Their ARSV entry is a 6 × 6 vehicle and has independently sprung walking beam suspension, roll-articulated front and rear bodies, and low pressure types. The vehicle is fully amphibious, being propelled in the water by waterjets. For US defence budget allocation see **5070.102**.

CHARACTERISTICS:
Crew: 3 (commander/gunner, observer, driver)
Weight: 7.7 tons
Size: Length 4.914 m. Width 2.438 m. Height 2.489 m
Road speed/range: 104 km/h/725 km
Armament: 20 mm M139 cannon and 7.62 mm M60D machine gun
Ammunition: 500 rounds of 20 mm and 2,000 rounds of 7.62 mm
Turret rotation: 360°, powered traverse
Engine: Detroit Diesel (turbocharged) Model 6V53T developing 280 hp at 2,800 rpm
Transmission: 5 speed automatic transmission
Agility: Max step 0.91 m. Gradient 60%. Ground clearance 0.41 m
Water crossing ability: Inherent amphibian, propelled in the water by water jets.
MANUFACTURER:
Lockheed Missiles and Space Company, Ground Vehicle Systems, Sunnyvale, California 94088, USA.

5071.102
LVTP 7
LANDING VEHICLE TRACKED PERSONNEL

DESCRIPTION:
The LVTP 7 is the US Marine Corps' latest amphibious assault vehicle. It was formerly known as LVTPX 12 and has replaced the LVTP 5, which has been in service since 1955. It is designed to transport 25 troops or 4.5t of stores onto beaches with slopes of up to 60%, and through surf of 3 m height. It is capable of continuing in the support role onto inland objectives. The hull is of welded aluminium plate, which reduces the combat weight to 22.6 t. The power from the diesel engine can either drive the tracks or be taken to the water jets, which can deliver a total thrust of 2t. The FMC Corporation were contracted to produce fifteen prototype LVTPX 12 vehicles by 1964, and these vehicles were very extensively tested at various tropic, arctic and temperate sites up to March 1969. The FMC Corporation were awarded a production contract in June 1970 for the production of 942 vehicles at a cost of $78.5 m. First deliveries began on schedule in August 1971, and the first 35 vehicles were assigned to the training base. Initial delivery to Marine field units began early in 1972 and the first Fleet Marine Force company to be equipped with the vehicle was activated on 31st March.

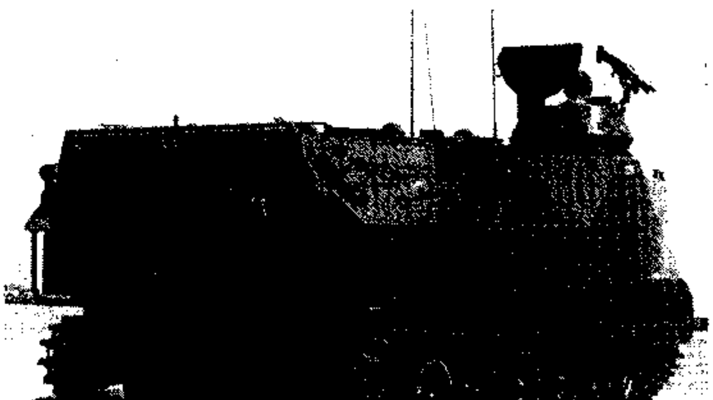


A production LVTP7 at sea. The impressive top speed in water of 13.5 km/h is well illustrated here

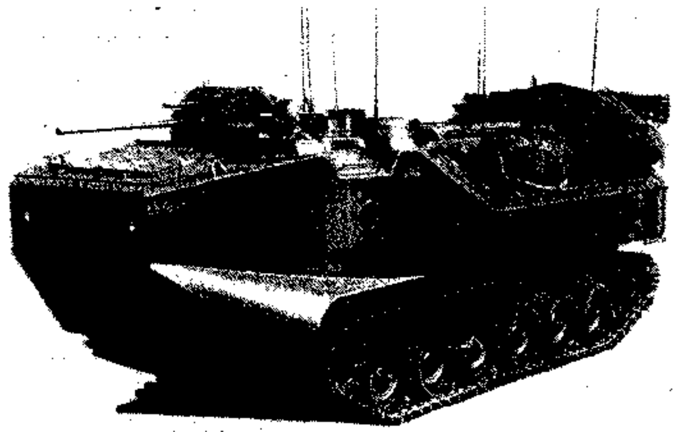
CHARACTERISTICS:
Crew: 3 plus 25 infantrymen
Weight: 23.66 t
Payload: 4.5t
Size: Height 3.26 m. Length 7.94 m. Width 3.27 m
Speed: Land 64 km/h. Water 13.5 km/h
Range: Land 480 km. Water 113 km
Armament: 12.7 mm M-85 MG: elevation +60°, depression −15°
Engine: General Motors diesel 8V53T of 6.9 litres, 406 bhp. The engine is in the bow section
Transmission: FMC HS 400 giving 4 forward, 2 reverse ratios. Power assisted, manually controlled
Agility on land: Ground pressure 0.58 kg/cm². Maximum step 0.9 m. Maximum trench 2.4 m. Maximum gradient 60%. Power to weight ratio 18 bhp/t
Exit: By tail gate, hinged against a water-tight seal.
Special Equipment:
1. An internal heater can keep crew compartment up to 26°C above the outside temperature.
2. A stretcher kit will provie for up to six stretcher cases.
3. Navigation lights are provided for coastal waters.
4. An arctic cupola provides protection for the driver in driving snow conditions.

VARIANTS:
1. LVTR 7 – Recovery vehicle (formerly LVTRX 2). Designed to recover similar vehicles from the open sea, surf or from swamps. Testing of two prototypes was completed in early 1970 and procurement was approved in April 1970.
2. LVTC 7 – Command/Communications Vehicle (formerly LVTCX 2). A mobile command post. Prototype testing was completed in early 1970 and procurement was approved in September 1970.
3. LVTE 7 – Mine and obstacle clearing vehicle (formerly LVTEX 3). To clear beaches during an amphibious assault. A linear charge to clear minefields is fired by rocket A bulldozer blade is fitted. Prototype testing was completed in April 1971. Procurement was approved but was subsequently cancelled.

STATUS:
LVTP-7s have now replaced all LVTP-5's in the United States Marine Corps. Production of the LVTP-7 is scheduled to continue until September 1974. The LVTP-7 has also been ordered by Italy and Spain.
MANUFACTURER:
FMC Corporation, San Jose, California 95103, USA.



Prototype LVTP-7 vehicle (USMC photograph)



Prototype LVTC-7 vehicle

THE UNION OF SOVIET SOCIALIST REPUBLICS

5112.102
T-70 MAIN BATTLE TANK
DESCRIPTION:

The T-70 is the new Soviet MBT which has started to replace the T-62 (**5047.102**) and which was previously known as the T-64 or M-1970.

It is believed that the T-70 entered production in 1970/71. Few details are available at the present time. Some reports suggest that it is armed with the same 115 mm gun as is fitted to the T-62, but others have suggested that it has a 122 mm gun. The chassis is new and is a departure from established Soviet practice: the suspension consists of six evenly spaced road wheels and four track support rollers – very similar, in fact, to that used on the Ganef missile carrying vehicle (**2934.131**) and the new tracked armoured minelayer, although both of these vehicles have seven road wheels. The glacis plate of the T-70 is well shaped and similar to that of the British Chieftain; the driver is in the centre – again similar to the Chieftain. The turret is similar to that of the T-62. The infra-red light for the commander is on the right turret hatch and the infra-red light for the gunner is on the left of the main armament – i.e. the reverse of the arrangement on the T-62. This indicates that the armament may well be different from that fitted to the T-62.

STATUS:

In service with the Soviet Army.

5047.102
T-62 MAIN BATTLE TANK
DESCRIPTION:

The T-62 is a logical development of the T-54/T-55 tanks which entered production in 1961/62. It has a wider and longer hull than those of the earlier tanks and has a new turret mounted slightly more to the rear. The main improvement over the earlier T-54/T-55 is that the T-62 has been fitted with the new 115 mm U-5TS (**2972.103**) smooth bore gun which fires a APFSDS (Armour-Piercing Fin Stabilised Discarding Sabot) round. The T-62s main armament is, like the earlier T-54/T-55, limited in gun depression.

Standard equipment on the T-62 includes the vulnerable external fuel tanks, NBC system, infra-red driving and fighting equipment and the capability to lay its own smoke screen. A more recent model of the T-62 is the T-62A; this is fitted with a 12.7 mm DShK anti-aircraft machine gun.

CHARACTERISTICS:

Crew: 4 (commander, gunner, loader, driver)
Weight: 37.5 tons
Size: Length (hull) 6.705 m. Width 3.352 m. Height 2.40 m
Road Speed: 55 km/hr
Road Range: 480 km
Main Armament: 115 mm smooth bore gun
Elevation/depression: +15°, −3°
Max anti-armour range: Not known, but unlikely to be in excess of 1,500 m owing to inaccuracy inherent in fin-stabilised rounds about that range
Method of Ranging: Stadiametric range finder in commander's sight. A laser rangefinder is believed to be under development
Rate of fire: 5 rounds per minute (maximum)
Ammunition: 40 rounds of HE, HEAT and APFSDS rounds carried
Turret traverse: 360°
Secondary Armament: 7.62 mm PKT co-axial machine gun. 12.7 DShK anti-aircraft machine gun
Engine: Model V-2-62, V-12 water cooled diesel, 700 hp at 2,200 rpm
Agility: Ground clearance 0.425 m. Ground pressure 0.8 kg/cm^2. Gradient 60%. Max step 0.8 m. Max trench 2.8 m
Power to weight ratio: 15.6 bhp/ton
Water crossing ability: 1.40 m without schnorkel, 3.96 m with schnorkel
Night vision equipment: A full range is fitted

T62A tanks on an exercise

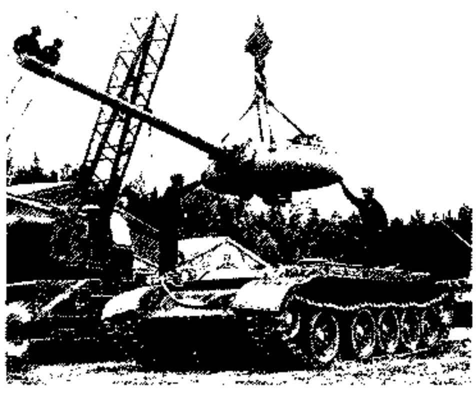
T62 tanks on a demonstration. The compact design of the turret, and the fume extractor on the 115 mm smooth bore gun can clearly be seen (Tass)

STATUS:

In production and service with Bulgaria, Czechoslovakia, East Germany, Egypt, Hungary, India, Poland, Romania, Soviet Union, Syria.

5049.102
T54/T55 MAIN BATTLE TANKS
DESCRIPTION:

The T55 is essentially a later mark of the T54, so these two tanks can be considered together. The T54 has been produced in greater quantity than any other tank in the world. It is believed some 30,000 of them were manufactured between 1948 and 1963, of which perhaps 5,000 to 6,000 were at one time stationed in East Germany. All the Warsaw Pact countries were equipped with these tanks, as was the United Arab Republic before the 1967 war, and Cuba in the early 1960s. Large numbers are still in service, although the regular Soviet Army has largely been re-equipped with T62s. At the time it was developed it was in the forefront of tank development, and its arrival into the Soviet Army inventory posed a challenge and a threat to the NATO powers. The design achieves the considerable feat of incorporating a 100 mm high velocity gun into a 35t low silhouette, long range and high mobility chassis. The armour protection is poor by Chieftain, Centurion and M60 standards, being about 85 mm of armour on the front plate of the hull, and 100 mm of armour on the front of the turret. This is to some extent compensated by the good ballistics shape of the turret, and the low silhouette. The turret as a result is cramped which makes for a



Tank repairs in the field (Tass)

A T54B leads two T54As over a water obstacle on exercise

slow rate of fire. The gun control equipment is crude by western standards, and throughout the tank the finish of the workmanship is rough. This certainly results in cheaper production costs, estimated at 40% to 50% of the cost of equivalent western tanks. The mobility of this tank is good, and its long range endurance is quite exceptional.

CHARACTERISTICS (Apply to T54 and T55 except where stated).

Crew: 4 (commander, gunner, loader, driver) N.B. The loader's position is on the right of the gun

Weight: 36.5 tonnes

Size: Length 9.02 m (gun forward), 6.57 m (hull) Width 3.27 m. Height 2.40 m (w/o AA MG)

Road speed: 48 km/hr

Range: 630 km road and 440 km cross country (including external tanks)

Main armament:
T-54 100 mm gun model D-10T
T-54A 100 mm gun model D-10TG
T-54B 100 mm gun model D-10T2S
T55 100 mm gun model D-10T2S
(see **2966.103**)

Elevation/depression: +17°, −4° (depression is very small by western standards)

Max anti-armour range: 1,000 m using AP or HEAT rounds

Method of ranging: Gunner has sight TSchZ-22 and a TTSch-16 as a secondary sight, commander has TPK-1 panoramic telescope

Rate of fire: 3 to 5 (maximum) rounds a minute

Ammunition: T-54 a total of 34 rounds and T-55 a total of 43 rounds (AP, APC, HVAP, HE and HEAT)

Turret traverse: 360° by power traverse

Secondary armament: 7.62 mm SGMT machine gun co-axial with main armament, 12.7 mm DShK anti-aircraft machine gun on roof of vehicle and a 7.62 mm SGMT machine gun mounted in bow and operated by the driver (not on T-55)

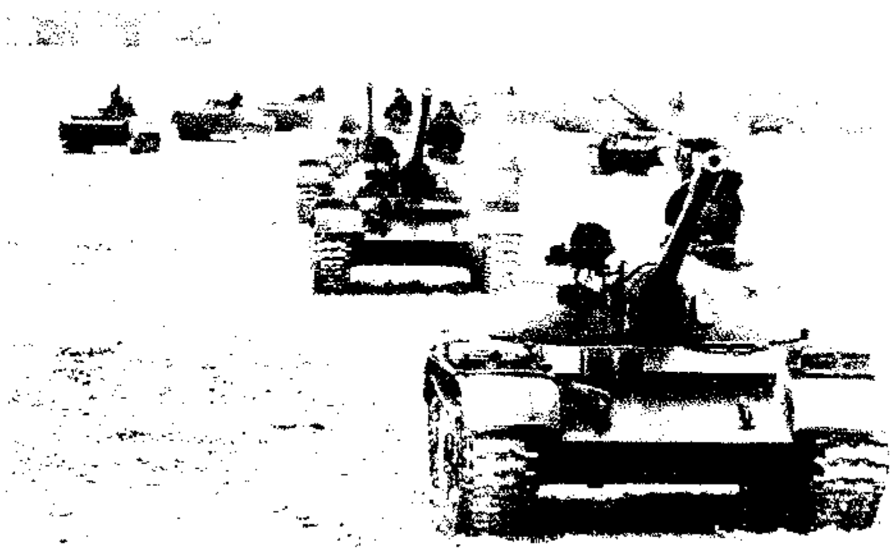
Engine: T-54 has V-2-54, V-12 water-cooled diesel, 520 hp at 2,000 rev/min. T-55 has V-2-55, V-12 water-cooled diesel; 580 hp at 2,000 rev/min

Transmission: Conventional manual gearbox with multi-plate clutch. Five forward, one reverse, gears

Agility: Ground pressure 0.80 kg/sq.cm. Max trench 2.74 m. Max gradient 60%. Ground clearance 0.43 m. Power-to-weight ratio 14.5 bhp/ton (T-54) and 16 bhp/ton (T-55)

Water crossing ability: Wades unprepared to 1.50 m. Schnorkelling equipment enables depths up to 5.4 m to be crossed at speed of 2 km/h. The equipment takes about 15 minutes to prepare, but can be blown off with an explosive charge immediately on leaving the water

Night vision equipment: Has been introduced



T55 tanks on exercise with M-1967 APCs in the background (Tass)

T54 tanks on winter exercises (Tass)

progressively in successive marks of T 54. Driver has infra-red viewer with range of 60 m; commander has infra-red/white searchlight; gunner has infra-red searchlight and infra-red driving lamps.

NBC Protection: Interior of tank can be pressurised, with incoming air pressure passing through a filter to the crew.

VARIANTS:

Summarising the main points of difference in marks, using the NATO designations.

T54. No muzzle bore evacuator. Bulge aft of the turret. 144 road wheel pattern.

T54A. Introduced in 1956. Muzzle bore evacuator fitted. Full hemispherical shape to turret. New road wheels. Gun stabilised in elevation.

T54B. Introduced in 1959. Improved gun sight and optical rangefinder noticeable by increased size of gun sight fairing forward of the commander's cupola.

The IR searchlight mountings, which were sometimes taken to distinguish different marks of T54, are now thought to be transferable to all T54 marks.

T55. No MG fitting on loader's hatch. Improved fittings for 'Snorkel' tower for deep wading. IR searchlight can be linked to gun tube.

Variants based on the T54/55 chassis include:

SU57: Anti aircraft tank.

T54 MTU: Bridge layer, capable of laying a 12 m bridge of capacity 50 t.

Mine roller: For clearing minefields.

Engineer tank in various forms as bulldozer, crane and tractor.

Repair/Recovery tank.

STATUS:

The T-54/T-55 is no longer in production. In addition to being built in the Soviet Union it has also been built in Czechoslovakia, Poland and China (under the designation T-59 **5042.102**). T 54/T 55 tanks are used by Albania, Algeria, Afghanistan, Bulgaria, China, Cuba, Cyprus, Czechoslovakia, East Germany, Finland, Egypt, Hungary, India, Iraq, Israel, Libya, Mongolia, Morocco, North Korea, North Vietnam, North Yemen, Pakistan, Peru, Poland, Romania, South Yemen, Soviet Union, Sudan, Syria, Yugoslavia.

5048.102

T-10 HEAVY TANK

DESCRIPTION

The T-10 replaced the JS-111 (**2288.102**) in the Russian Army in the 1950's. It is no longer in large scale use with the Army, although large numbers of them are held in reserve; it does however, remain in service with many members of the WPF as well as some Middle East countries. The original T-10 was armed with a 122 mm gun, a 12.7 mm M1938/46 DShK MG and a similar anti-aircraft MG. The later model was the T-10M, the improvements of which over the earlier T-10 included the replacement of the 12.7 mm MGs by 14.5 mm KPV MGs, the fitting of infra-red driving and fighting equipment and the fitting of a stowage box on the turret rear (not all models). Some T-10Ms have been fitted with a schnorkel and have a stabiliser for the main gun.

Although the T-10 is classed in the West as a heavy tank it should be remembered that it is in fact lighter than the British Chieftain and only slightly heavier than the American M60A1 however, the T-10 does lack mobility. The 122 mm gun fires separate loading ammunition, which accounts for its low maximum rate of fire of three rounds a minute. The T-10 was found to be a difficult tank to destroy by the Israelis in the 1967 campaign, its armour (maximum is 210 mm) was difficult to penetrate, but the auxiliary fuel tanks at the rear were highly vulnerable.

CHARACTERISTICS:

Crew: 4 (commander, gunner, loader, driver)

Weight: 49 tonnes

Size: Length 10.29 m (including gun), 7.40 (hull). Width 3.44 m. Height 2.26 m (w/o A/A MG)

Road speed/range: 35 km/350 km

Main armament: 122 mm gun

Elevation/depression: +17°, −3°

Rate of fire: 3 rounds a minute

Ammunition: 30 rounds of HEAT, HE and APHE. HEAT projectile weighs 14.1 kg and has a M/V of 900 m/s; HE projectile weighs 25.5 kg and has a M/V of 800 m/s, APHE projectile weighs 35 kg and has a M/V of 905 m/s. APHE has an effective range of 1,200 m

Turret traverse: 360° by power traverse

Secondary armament: 14.5 mm KPV co-axial MG and 14.5 mm KPV anti-aircraft MG (on T-10M)

Engine: Model V-2-IS, 12 cylinder water cooled diesel 690 hp at 2,000 rpm

Transmission: Manual gearbox with 5 forward and 1 reverse gears

Agility: Ground pressure 0.71 kg/sq cm. Step 0.9 m. Max trench 3 m. Max gradient 60%. Ground clearance 0.456 m. Power-to-weight ratio 13.6 bhp/ton

T-10 heavy tank

Water crossing ability: Wades to a depth of 1.2 m, some T-10Ms can be fitted with a schnorkel

Night vision equipment: Driver has IR viewer, commander has IR searchlight with range of 500 m, gunner's IR light has range of 1,000 m

NBC Protection: A NBC system is fitted

STATUS:

In service with Bulgaria, Czechoslovakia, East Germany, Egypt, Hungary, North Vietnam, Poland, Romania, Soviet Union and Syria.

2288.102

JS III HEAVY TANK

DESCRIPTION:

Developed from the earlier JS (Joseph Stalin) I tank, the JS III entered service in 1945. Now superseded by the T-10 (**5048.102**) and later tanks in all major formations, the JS III still exists as a tank in some of the Warsaw Pact states, its chassis exists in rather more places because of its use as a missile carrier.

CHARACTERISTICS:

Crew: 4

Weight: 4.6 t

Size: Length 9.6 m (gun forward) 6.8 m (chassis only. Width 3 m. Height 2.44 m

Main Armament: 122 mm gun 25 rounds carried

Secondary Armament: 7.62 mm coaxial MG 12.7 AA MG

Engine: V-12 diesel 520 hp

STATUS:

Although obsolete in Russia the JS III remains in service with Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania and Syria.

5113.102

M-1970 LIGHT TANK

DESCRIPTION:

This new Soviet light tank was shown for the first time in November, 1973, although it has been in service for at least two years. It is fully amphibious being propelled in the water by waterjets. A turret similar to that fitted to the BMP 76PB (**5054.102**) is mounted in the centre of the vehicle. A Sagger ATGW is mounted over the 76 mm gun and a 7.62 mm MG is probably fitted. A crew of three is carried and there is a personnel compartment for six men behind the turret. At the time of writing the exact role of the M 1970 is uncertain, but it is known that it has entered service with Soviet airborne units.

STATUS:

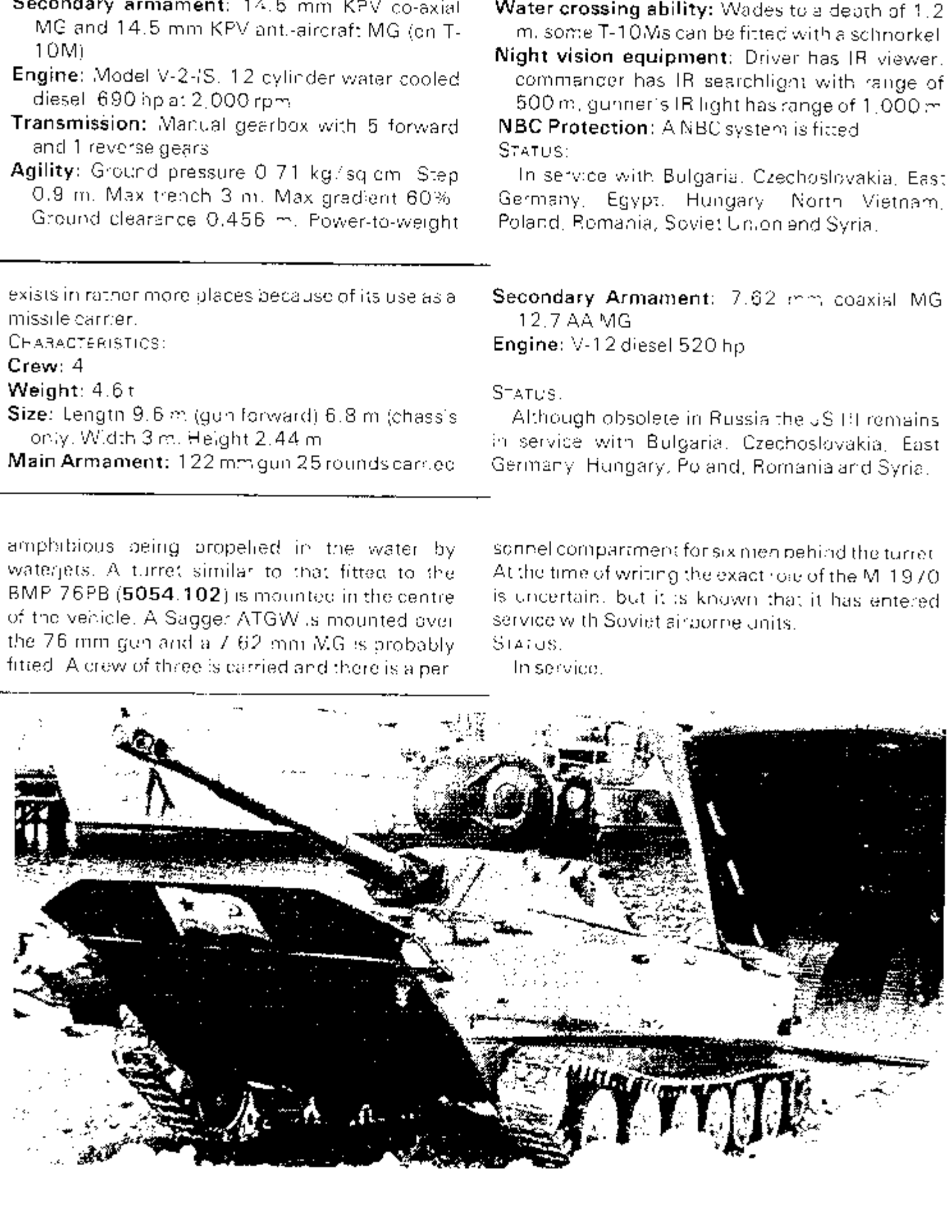
In service.

5038.102

PT76 LIGHT AMPHIBIOUS TANK

DESCRIPTION:

This light tank is used in considerable numbers as the main reconnaissance vehicle of the Soviet Army and other Warsaw Pact Armies. It was first publicly seen around 1950. It is one of a family of light track vehicles designed at the same time, which includes the ASU-85 assault gun, the Frog Rocket launcher, and the BTR 50 armoured personnel carrier. Its design has been determined by the amphibious requirement, which results in it being unnecessarily large for its weight class, and reduces its armour protection below that of other light tanks. The water jet propulsion system gives



PT76 light tank with D-56M gun (Tass)

it the capability to operate in a fast flowing river and in the open sea. The fact that the commander is also the gunner and radio operator reduces his effectiveness as an observer. It is a reliable, highly mobile vehicle, ideal as a reconnaissance platform, but with limitations as a fighting vehicle.

Apart from numerous minor variations, there are four production models of the PT-76, distinguished by differences in the main armament

Model 1. D-56T gun with no bore evacuator and a long multi-baffle brake.

Model 2. D-56TM gun with bore evacuator and double baffle brake.

PT-76B. As *Model 2* but with gun stabilisation.

Model 3. Clean barrel gun.

For details of Chinese developments of the PT-76 see entry **5103.102**.

CHARACTERISTICS:

Crew: 3 (commander, gunner, driver)

Weight: 14 t

Size: Height 2.20 m. Length (hull) 6.91 m. Width 3.18 m

Road speed / range: 44 km/h / 250 km

Main armament: 76 mm low velocity gun

Method of ranging: Visual

Max effective range: 1,000 m

Rate of fire: 6-8 rounds / min

Ammunition: 40 rounds of mixed HVAP, HE and HEAT. The HVAP and HEAT rounds should achieve penetration of APCs and other light armoured vehicles

Turret rotation: 360° in 20 secs by manual and electrical traverse

Secondary armament: 7.62 mm coaxial MG

Engine: V-6 in line diesel, 240 bhp

Transmission: Mechanical gearbox with multi-plate clutch

Agility: Ground pressure 0.49 kg/sq cm. Max step 1.06 m. Max trench 2.74 m. Max gradient 28°. Ground clearance 0.35 m. Power-to-weight ratio 17.3 bhp/tonne

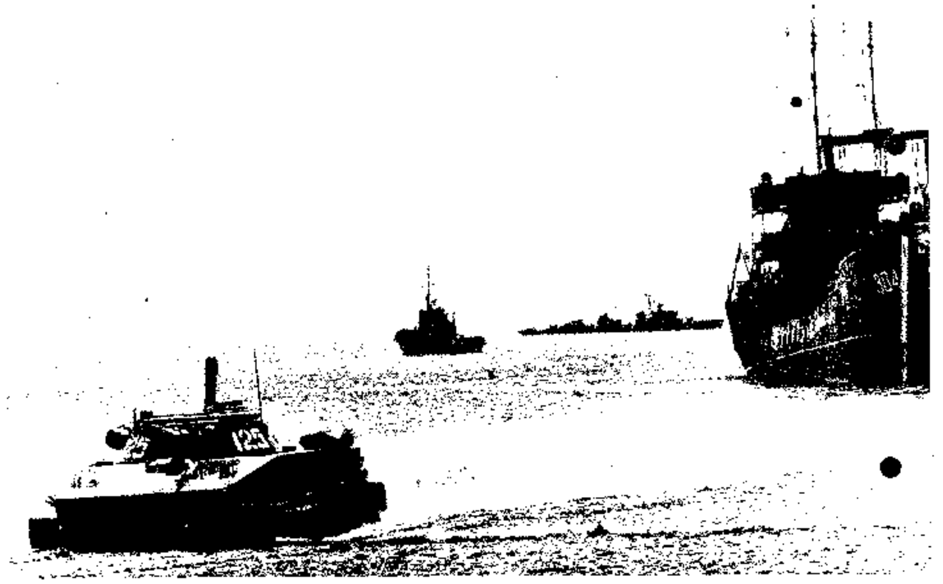
Water crossing ability: An amphibian, with water jet propulsion. Speed in water 11 kph. Designed for easy exit and entry to water.

Night vision equipment: Apparently nil, which puts it behind other Soviet AFVs in this respect

NBC Protection: None

STATUS:

The PT-76 is used by Afghanistan, Bulgaria, China, Cuba, Czechoslovakia, East Germany, Egypt, Finland, Hungary, India, Indonesia, Iraq, Laos, North Korea, North Vietnam, Pakistan, Poland, Soviet Union, Syria and Yugoslavia.



PT 76 tanks swimming ashore from vessels of the Soviet Baltic fleet

PT 76s with D-56T gun (Tass)

5050.102 ASU-57 ASSAULT GUN

DESCRIPTION:

The Soviet Army has a tradition of assault guns of limited traverse mounted on armoured chassis. The two current equipments are the light weight ASU-57, and the heavier ASU-85. ASU-57 is now a fairly old equipment having been in service certainly since 1957. It carries a 57 mm high velocity gun on a 5 tonne chassis. The armour protection is slight, there is no roof to the crew compartment, and the mobility is not up to that of more modern Soviet vehicles.

Two types of gun barrel are known to exist: one (Type A) has a multi-slot muzzle brake while the other (Type B) has a double baffle muzzle brake. Type B barrels appear to be more common than the others. There are also known to be two vehicle types, one being slightly smaller than the other and significantly lighter as a result of using light alloys in its construction

CHARACTERISTICS (standard version):

Crew: 3. Driver plus two (with room for two more)

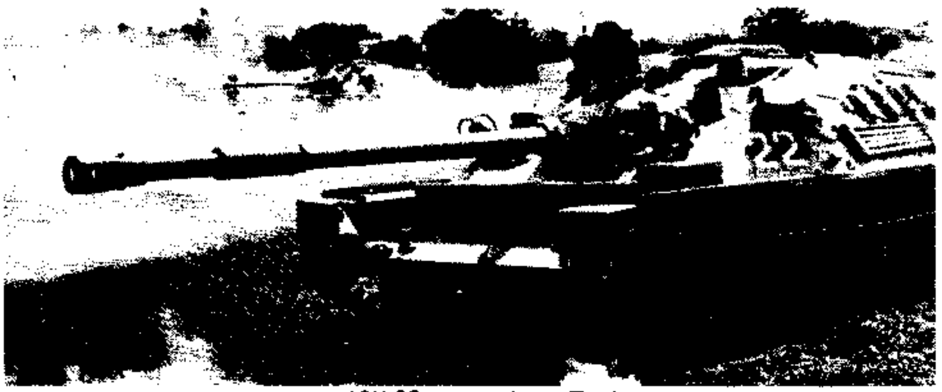
Weight: 5.4 tons

ASU 57 assault gun on an air-mobility exercise (Tass)

Size: Height 1.65 m. Length 3.73 m. Width 2.21 m
Main armament: 57 mm high velocity anti-tank gun
Engine: Diesel of 100 bhp
STATUS:
In use in Warsaw Pact countries and in Yugoslavia.

ASU-57s at speed (Novosti)

5051.102
ASU-85 ASSAULT GUN



ASU-85s on exercises (Tass)

DESCRIPTION:
The ASU-85 has been in service with the airborne units of the WPF since 1962 and is based on components of the PT-76 light tank (**5038.102**). Its main armament is an 85 mm gun which has a double baffle muzzle brake and a bore evacuator. The ASU-85 is airportable but has thin armour, the glacis plate being only 40 mm thick.
CHARACTERISTICS:
Crew: 4 (commander, gunner, loader and driver)
Size: Length 8.54 m (including gun), 6.10 m (hull). Width 2.80 m. Height 2.10 m
Road speed/range: 44 km/hr/250 km
Main armament: 85 mm gun
Elevation/depression: +15°, −4°
Traverse: Total 12°
Rate of fire: 3 to 4 rounds a minute
Ammunition: 40 rounds of HE, APHE and HVAP carried. HVAP rounds will penetrate 130 mm of armour at 1,100 m. HE projectile 9.5 kg and M/V 792 m/s. APHE projectile 9.3 kg, M/V 792 m/s and HVAP projectile weighs 5 kg and has M/V of 1,030 m/s
Secondary armament: One 7.62 mm PKT coaxial MG
Engine: V-6, 6 cylinder diesel, 240 hp at 1,800 rpm
Agility: Ground pressure 0.48 kg/sq cm. Max step 1.1 m. Max trench 2.8 m. Max gradient 70%. Ground clearance 0.4 m
Water crossing ability: Can ford to a depth of 1.1 m; no amphibious capability
Night vision equipment: IR commander's spotlight, IR searchlight over main gun, IR driving lights. More recent models have passive night vision equipment
STATUS:
In service with East Germany, Poland and the Soviet Union.

ASU-85 Assault Gun (Novosti)

5035.102
ARMOURED PERSONNEL CARRIER
BTR 50 P

DESCRIPTION:
BTR 50 P forms one of the family of light armoured vehicles of which the light tank PT-76 (**5038.102**) is the most numerous. It was introduced into the Soviet Army in 1955. It can carry a total of 15 men, making it one of the most capacious APCs in service. It has a performance similar to PT 76, and is likewise amphibious with hydrojet propulsion. It is in service with the reconnaissance units of the Soviet Army in support of PT-76. It is also in service with other Warsaw Pact armies, and in the United Arab Republic. The original version had an open top. This was modified by the addition of large roof doors to make BTR 50 PK in 1960. A command and radio version known as BTR 50 PU appeared in 1962. In all versions the crew mount and dismount through the roof openings.
CHARACTERISTICS:
Crew: 15 (3 plus 12 infantrymen)
Weight: 14 tons
Size: Height 2.0 m. Length 6.90 m. Width 3.18 m
Road speed/range: 43 km/h/250 km
Armament: Up to four MGs can be carried on roof mountings, of calibre 14.5 mm, 12.7 mm or 7.62 mm as desired
Engine: 6 cylinder, water-cooled diesel of 240 bhp

BTR-50PK armoured personnel carriers (Tass)

Transmission: Conventional manual gearbox with 5 forward, one reverse, gears, and dry plate clutch
Agility: Ground pressure 0.63 kg/sq cm. Max step 0.19 m. Max trench 2.8 m. Max gradient 30° (1 in 1.75). Ground clearance 0.35 m. Power-to-weight ratio 17 bhp/tonne
Water crossing ability: Amphibian propelled by

twin hydro-jets at 10 km/h

Night fighting equipment: Latest vehicles are fitted with IR headlamps and driver's IR viewer

NBC Protection: Basic BTR 50P has no NBC system, but systems are fitted to BTR-50PK and BTR-50PU

Variants: A Czechoslovak version of BTR 50 P known as OT 62 (Topas) has twin cupolas at the front, the right hand one mounting a turret with a 7.62 mm MG and 82 mm rocket launcher (**5109.102**)

STATUS:

In service with Albania, Bulgaria, China, Czechoslovakia, East Germany, Egypt, Finland, Hungary, India, Iran, North Vietnam, Poland, Romania, Somalia, Soviet Union, Syria, Yugoslavia.

A group of BTR-50PU command and radio vehicles provide an umpire headquarters on an exercise (Tass)

5054.102
ARMOURED PERSONNEL CARRIER
BMP-76 PB

DESCRIPTION:

This vehicle, which first appeared in a public display in 1967, hence its former NATO designation M1967 until the Russian designation was known, is in the forefront of the world's Armoured Personnel Carriers. The only other APC which matches its combination of mobility, fire power and protection is the German Marder (**5013.102**), which is bigger, heavier, and certainly considerably more expensive. It is the first Soviet APC that has been developed from the start as such, for it is not an adaptation of any other vehicle. It does, however, use some of the components of the PT 76 family (**5038.102**). It is likely to replace both BTR 50 (**5035.102**) and BTR 60 (**5034.102**) as the standard APC of the Soviet Army.

BMP-76 PB is an extremely interesting vehicle. It represents a radical change in the Soviet Army's concept of mechanised infantry operations. BTR 50 and BTR 60 are little more than 'armoured taxis' designed to carry a large body of infantry with some slight armoured protection into the vicinity of the battlefield, and there to leave them to proceed to the objective on foot. BMP-76 PB, like the German Marder, is designed to accompany the tanks into the assault and right onto and beyond the objective. It is the sort of vehicle the US Army is specifying for the Mechanised Infantry Combat Vehicle (MICV) (**5505.102**). But unlike the US vehicle, BMP-76 PB is already in service.

Although BMP-76 PB is an amphibian, it does not employ the hydrojets used in PT 76, but obtains its propulsion in water from the tracks. The engine is right front, with the driver on the left looking down a long sloping front plate which has a rather strange ridged surface, probably designed as a strengthening device. The drive is taken to the front sprocket. Directly behind the driver, and certainly with a very restricted view forward and rear when closed down, is the commander. Behind him, in the centre of the vehicle, is the one-man turret containing a 76 mm gun. It is believed that this gun fires a fin-stabilised HEAT round to a range of about 1,000 m. However, clearly the rate of fire is slow if the gunner is also the loader. Behind the turret sits a section of 8 infantrymen, sitting back to back on a wooden bench down the middle of the vehicle. They must be extremely cramped, and would have difficulty in using their weapons, as proposed, through the weapon ports which exist in the side of the compartment. Exit for the infantry section is through two rear doors, which are believed to have fuel tanks incorporated into them.

The combination of effective anti-armour fire power, high mobility and adequate protection which BMP-76 PB represents, makes it a formidable addition to the armoury of the Soviet Army.

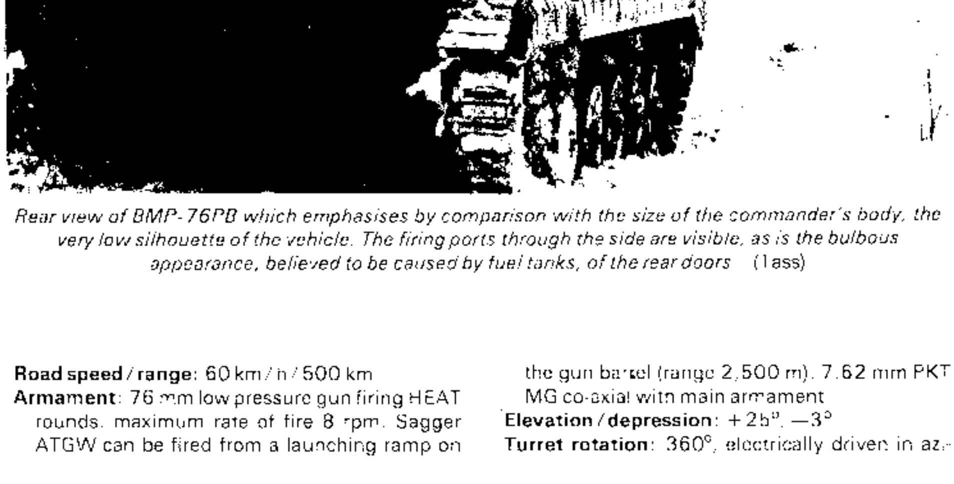
CHARACTERISTICS:

Crew: 3 plus 8 infantrymen

Weight: 12 tonnes

Size: Length 6.3 m Width 3.05 m. Height 1.83 m (including turret)

Front view of BMP-76PB showing the positions of gunner, commander and driver, the ridges on the front plate, and the 76 mm gun (Tass)



Rear view of BMP-76PB which emphasises by comparison with the size of the commander's body, the very low silhouette of the vehicle. The firing ports through the side are visible, as is the bulbous appearance, believed to be caused by fuel tanks, of the rear doors (Tass)

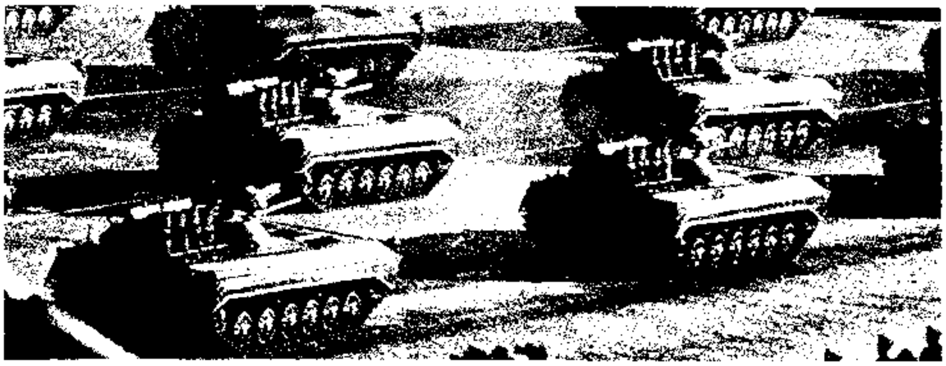
Road speed/range: 60 km/h/500 km

Armament: 76 mm low pressure gun firing HEAT rounds, maximum rate of fire 8 rpm. Sagger ATGW can be fired from a launching ramp on the gun barrel (range 2,500 m). 7.62 mm PKT MG co-axial with main armament

Elevation/depression: +25°, −3°

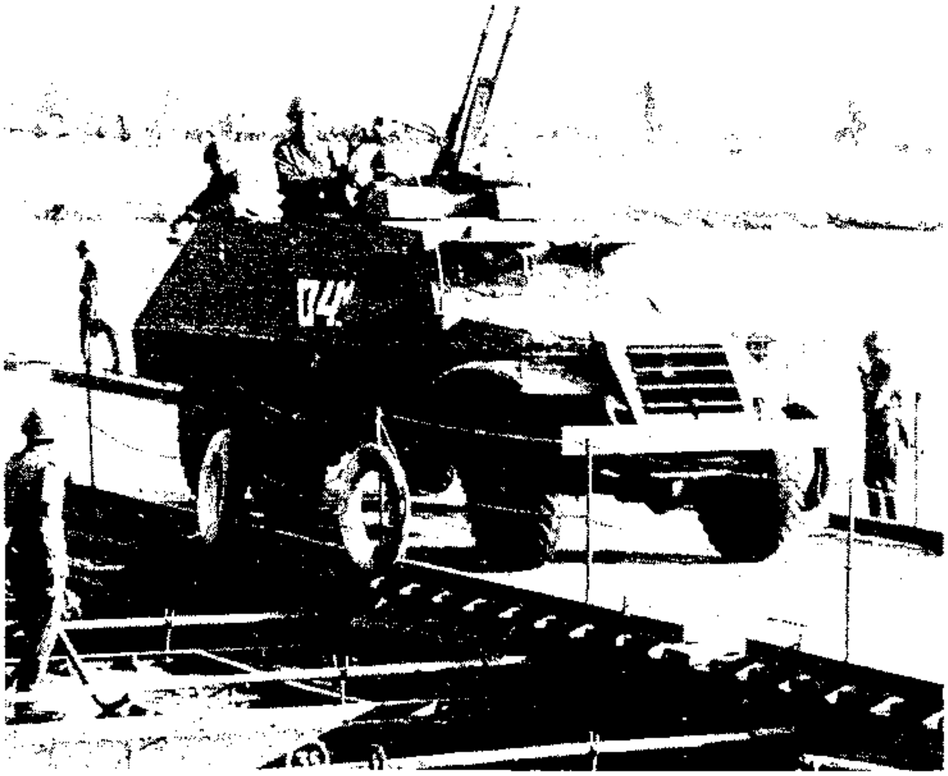
Turret rotation: 360°, electrically driven in az-

muth. Hand elevation
Engine: V 6, 6 cylinder diesel 280 hp
Agility: Max step 1.1 m. Max trench 2 m. Gradient 60%. Ground clearance 0.4 m
Water crossing ability: Amphibious, propelled in the water by its tracks at 6 km/hr
Night vision aids: IR searchlight fitted to commanders cupola. IR sight for gunner and an IR viewer for both commander and driver
NBC protection: The vehicle has a NBC system
STATUS:
In service with members of the WPF including Poland and the Soviet Union. Late in 1973 some were delivered to Egypt.



BMP-76PBs on parade. The Sagger missiles mounted above the main gun can be seen. The cramped space available to the 8 infantrymen is evident (Tass)

5082.102
ARMOURED PERSONNEL CARRIER
BTR-152
DESCRIPTION:
This is an early wheeled APC that in its original version dates from the immediate post-war years. It has, however, gone through several marks, the last of which appears to date from the early 1960s, and the vehicle is still in service in many countries. Original models were based on the ZIL 151 chassis but the ZIL-157 was used for later models (BTR-152V).
Ignoring minor variants there are three versions of the vehicle – a basic APC armed with a 7.62 mm or 12.7 mm MG, a command vehicle, normally unarmed, with a higher roof (BTR-152U) and an AA vehicle fitted with twin 14.5 mm AA guns.
CHARACTERISTICS:
Weight: 8.6 tons
Engine: Petrol. 110 bhp at 3,000 rev/min
Road speed/range: 75 km/h/600 km
Length: 6.7 m
Width: 2.35 m
Height: 2.0 m (as APC)
Crew: 2 plus 15 men (as APC)
STATUS:
Operational in Warsaw Pact countries and in almost every other country that has ever acquired military equipment from Russia.



BTR-152V APC with twin 14.5 mm AA guns (Novosti)

5034.102
ARMOURED PERSONNEL CARRIER
BTR-60
DESCRIPTION:
This 8-wheeled vehicle was first on public view at the 1961 Moscow parade, as an open top armoured personnel carrier with a crew of 14 men (driver plus 13 infantrymen), and this version is known as BTR-60P. In 1964, a hard top version (BTR 60 PK) appeared, and this was followed in 1965 by a version (BTR-60 PB) with two front cupolas for driver and co-driver, and a small MG turret for the commander. All versions are still in service with Soviet Army, though the original open-top version is now obsolescent. They are the standard equipment of the Motorised Infantry Battalions and are also seen in the Reconnaissance Battalions. They are also in service with the East German and Romanian Armies. The vehicle is an amphibian, with hydro-jet propulsion in the water, and has a good cross-country performance in conditions that favour wheels. It is believed however that the suspension is inadequate for hard driving over rough ground and this is a tactical limitation. Clearly the need for the crew to mount and dismount through the top hatches is also a tactical disadvantage. It is likely that the BTR-60 range will be gradually replaced by BMP-76PB (**5054.102**) during the 1970s
CHARACTERISTICS (apply to BTR-60 PB, unless stated):
Crew: 12 (driver, commander plus 10 infantrymen) (14 for BTR 60 P and 60 PK)

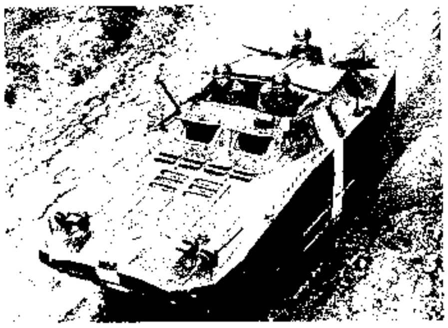
BTR-60P eight wheeled personnel carrier, in the open topped version

Weight: 10 tons
Size: Height (to top of turret) 2.29 m. Length 7.20 m. Width 2.80 m
Road speed/range: 80 km/h/500 km
Armament: 14.5 mm heavy MG and 7.62 mm MG in turret mounting. Sometimes has a rocket/flare launcher on right hand track guard and an anti tank rocket launcher fitted over the left hand track guard (BTR 60P and 60 PK have one 7.62 mm MG)
Elevation/depression: +30°, −10°
Turret rotation: 360°, manually traversed

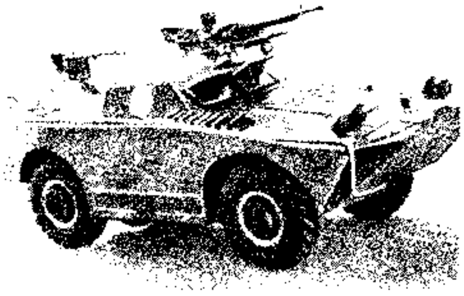
Engines: Two 6-cylinder GAZ-40P water cooled petrol engines located at the rear of the vehicle. 90 bhp at 3,400 rpm from each engine. 180 bhp
Water crossing ability: Swims, propulsion by single hydrojet, steering in water by wheels and (possibly) small rudders. Speed in water 10 km/h
Night vision devices: Driver's IR receiver for use with filtered headlamps
NBC Protection: Nil, except for that afforded by the armour
STATUS:
In service with Bulgaria, Cuba, East Germany, Egypt, Iran, Libya, Mongolia, Poland, Romania, Soviet Union, Syria and Yugoslavia.

BTR 60PK (hard top) version (Tass)

5037.102
RECONNAISSANCE CAR
BRDM-1/BTR40P
DESCRIPTION:
The history of BRDM-1 goes back to BTR-40 of 1945-48 vintage, which was almost a direct copy of the famous US Army White Scout car. This later was given an armoured top to become BTR-40K in the early 1950s. A major re-design of this vehicle, giving it swimming capability with hydrojet propulsion, and a greatly improved cross-country performance by means of four additional wheels that could be lowered between the front and back wheels, produced BRDM-1 or BTR-40P. These were manufactured in large quantities between 1960 and 1966, and formed the mainstay of the Soviet reconnaissance forces during these years. They have also been supplied to other Warsaw Pact armies, to the United Arab Republic, Cuba, and elsewhere. They are now being replaced by BRDM-2 in the Soviet Army.
CHARACTERISTICS:
Crew: 5 (commander, driver, plus 3)
Weight: 5 6 tons
Size: Height 1.9 m. Length 5.7 m. Width 2.25 m
Road speed/range: 80 km/h/500 km



BRDM-1 on the move



BRDM-1 shown here with a 12.5 mm MG mounted on roof

Armament: One 7.62 mm MG on front mounting for commander. Sometimes another MG on a rear mounting
Engine: 6-cylinder petrol engine, 3.48 litres. 90 bhp at 3,400 rpm. Engine and transmission are at the front of the vehicle
Drive: Normally 4 × 4, but an additional four wheels can be dropped to give 8 wheel drive across country
Power-to-weight ratio: 13.8 bhp/ton
Water crossing capability: Swims with hydrojet propulsion
Variants: The following variants of the basic vehicle are known
- Radio and command vehicle
- NBC monitoring vehicle
- Anti-tank guided weapon vehicles for Snapper, Swatter or Sagger missiles.

5036.102
RECONNAISSANCE CAR
BRDM-2/BTR40PB
DESCRIPTION:
The BRDM-2, or BTR-40PB as it is sometimes known, was first seen in 1966 and since then has replaced some of the earlier BRDM-1 vehicles in members of the WPF. The BRDM-2 is bigger than the earlier vehicle and has two engines mounted at the rear; it retains the rectractable auxiliary wheels. The turret fitted is the same as that mounted on the BTR-60PB (**5034.102**) and the Czech OT 64 Model 3 (**5074.102**), and is unusual in that it has no top hatch opening.
CHARACTERISTICS:
Crew: 4 (commander, gunner, driver and co-driver)
Weight: 7 tonnes
Size: Length 5.5 m. Width 2 18 m. Height 2 15 m
Road speed/range: 100 km/h/750 km
Armament: 14.5 mm KPVI and 7.62 mm PKT MG turret mounted
Elevation/depression: +30°, −10°
Turret rotation: 360° (hand)
Engines: Two M-21 4 cylinder petrol engines. 70 hp at 4,000 rpm (each)
Agility: Max step 0.47 m. Max trench 1.25 m. Gradient 60%. Ground clearance 0.315 m
Water crossing ability: Swims, with propulsion by twin hydrojets. Water speed 10 km/hr
Night vision aids: IR spotlight and IR driving lights
NBC Protection: NBC system is fitted

A group of BRDM-2 Armoured Cars showing the side by-side positioning of the commander and the driver, and the two man turret mounting a 14.5 mm MG and a 7.62 mm MG. The retractable auxiliary wheels can also be seen on the second vehicle from the left (Tass)

VARIANTS:
BTR-40PB (Sagger) This is a BTR-40PB with the turret removed and a launching system for six Sagger ATGW (**2950.111**) fitted. It was used in the Middle East campaign of 1973.
BTR-40PB (SAM) – This is a BTR-40PB with the turret removed and replaced by a launching system for 4 or 8 SA-7 (Grail) anti-aircraft missiles (see entry **2941.131**)
The Hungarians have a similar vehicle called the FUG M-1966 (**2189.102**).
STATUS:
The BTR-40PB is used by members of the WPF including East Germany, Poland and the Soviet Union. It is also used by Egypt and Syria.

F2 FIGHTING SHIPS

AIRCRAFT CARRIERS
(6502.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Aircraft	Other Weapons
ARGENTINA					
25 de Mayo: Ex-British *Colossus*	1945	1	19,896	Capacity 21: Official complement: 8 x fixed-wing aircraft 6 x helicopters	Guns, AA: 10 x 40 mm
AUSTRALIA					
Melbourne: Modified *Majestic* class	1955	1	19,966	6 x S-2E *Tracker* anti-submarine 8 x A-14G *Skyhawk* fighter/bombers 10 x *Wessex* AS-31B	12 x 40 mm Bofors
BRAZIL					
Minas Gerais: Ex-British *Colossus* class	1945	1	19,890	Capacity 20 7 x S-2A *Tracker* 4 x *Sea King*	Guns, AA: 10 x 40 mm Guns, saluting: 2 x 47 mm
FRANCE					
Clemenceau, Foch: Clemenceau class	1961–63	2	32,780	Capacity 40, each carries 3 Flights: 1 of *Etendard IV;* 1 of *Crusader;* 1 of *Breguet Alizé*	Guns, AA: 8 x 3.9 in (100 mm)
INDIA					
Vikrant: Ex-British *Majestic* class	1961	1	19,500	Capacity 21: For *Seahawk* strike, *Alouette, Breguet Alizé,* A/S aircraft (order for Soviet VTOL being considered)	Guns, AA: 15 x 40 mm
SPAIN					
Dédalo: Helicopter carrier	1943	1	16,416	Capacity 20 for helicopters *(Sea Kings, Huey Cobras, S55* or *Bell 212's)*	Guns, AA: 26 x 40 mm
UNITED KINGDOM					
Ark Royal	1955	1	50,786	30 x Fixed wing *(Phantom* and *Buccaneer Mk. II)* 6 x Helicopters	Missiles, AA: fitted for 4 x quadruple *Seacat* (not fitted)
Hermes: Commando carrier	1959	1	28,700	20 x Helicopters *(Sea Kings* and *Sioux)*	Missiles, AA: 2 x quadruple *Seacat*
Bulwark: Commando carrier	1954	1	27,705	20 x Helicopters *(Wessex* and *Sioux)*	Guns, AA: 8 x 40 mm
UNITED STATES					
Nimitz, Dwight D. Eisenhower: Under construction: Nuclear powered attack aircraft carrier	1973–75 (1981 for proposed carrier)	2 + 1	91,400	Approx 90	Missiles: 3 x BPDMS (Basic Point Defence Missile System) launchers with *Sea Sparrow*
Kitty Hawk, Constellation, America: Attack aircraft carriers	1961–65	3	80,800	85/95	Missiles, AA: 2 x twin *Terrier* launchers
John F. Kennedy: Attack aircraft carrier	1968	1	87,000	95	Missiles: 3 x BPDMS launchers with *Sea Sparrow*
Enterprise: Nuclear powered attack aircraft carrier	1961	1	89,600	95	Missiles: 3 x BPDMS launchers with *Sea Sparrow*
Forrestal, Saratoga, Ranger, Independence: Attack aircraft carriers	1955–59	4	78,000	85	Missiles: 1 x BPDMS launcher with *Sea Sparrow* in *Forrestal* Guns, dual purpose: 4 x 5 in (127 mm) in *Saratoga, Ranger* and *Independence*

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Aircraft	Other Weapons
Midway, Franklin D. Roosevelt, Coral Sea: Attack aircraft carriers	1945–47	3	64,000 (approx)	75	Guns, dual purpose: 4 x 5 in (127 mm) in *F. D. Roosevelt* 3 x 5 in (127 mm) in others
Intrepid, Ticonderoga, Shangri-la Oriskany, Hancock, Bon Homme Richard, Lexington: Hancock class: Attack aircraft carriers *(Bon Homme Richard, Hancock, Shangri-la* in reserve) *Intrepid, Shangri-la* and *Ticonderoga* are ASW Support Carriers (CVS) *Lexington* — Training	1943–50	7	44,700 *(Oriskany, Bon Homme Richard, Hancock)* 42,000 (others)	70/80 *(Oriskany, Bon Homme Richard, Hancock)* 45 (others)	Guns, dual purpose: 4 x 5 in (127 mm) (not *Lexington)*
USSR					
Kiev: Aircraft carrier *(Minsk* building)	1974	1 + 1	35,000	Possibly 40/50 VTOL and/or *Hormone A* helicopters	2 Twin SA-N-3 for *Goblet* missiles 3 Twin SA-N-4 launchers 1 launcher A/S Guns: 28 — 57 mm
Leningrad, Moskva: Cruiser helicopter carriers	1967–68	2	18,000	18 x Ka25 *(Hormone A)*	Missiles: 2 x SA-N-3 (Twin) systems and 1 x AS launcher. (Twin) Guns: dual purpose: 4 x 57 mm AS: 2 x 12 tube mortars Torpedo tubes: 10 x trainable 21 in (533 mm) AS

SHIPS CARRYING TACTICAL SURFACE-TO-SURFACE MISSILES (6503.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
ALGERIA					
Osa class: Guided missile boats	1965 approx	3	200	4 x SSN-2 launchers in two pairs abreast for *Styx*	Guns: 4 x 30 mm
Komar class: Guided missile boats	1965 approx	6	80	2 x *Styx* launchers	Guns: 2 x 25 mm
BRAZIL					
Niteroi class: Guided missile leaders *Constituicão Defensorá Independencia Liberal Niteroi União*	1976–79	6	3,900	2 Twin *Exocet*, (in GP version) (3) *Ikara* (in AS version) (3) 2 Triple *Seacat*	Guns: 2 x 4.5 in (115 mm) (in GP version) 2 x 40 mm 1 x 4.5 in (115 mm) (in AS version) 1 x WG 13 AS helicopter 1 Bofors 375 mm AS launcher 2 Triple Mk. 32 torpedo tubes 1 DC rail
BRUNEI					
Pahlawan: Fast patrol boat	1967	1	114	8 x SS12	Guns: 1 x 40 mm 1 x 20 mm
BULGARIA					
Osa class: Missile boats	—	3	200	4 x SS-N-2 launchers in pairs abreast for *Styx*	Guns: 4 x 30 mm
CHILE					
Riveros, Williams: Almirante class: Destroyers	1960	2	3,300	4 x *Exocet* launchers Quadruple *Seacat*	Guns: 4 x 4 in 5 x 40 mm AS: 2 *Squid* Torpedo tubes 5 x 21 in

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
Condell, Lynch: Leander class: Frigates	1974–75	2	2,962	4 x *Exocet* launchers 1 quadruple *Seacat*	2 x 4.5 in 1 AS Helicopter
CHINA (PEOPLE'S REPUBLIC)					
Luta class: Destroyers	1971 onwards	5 + 2	3,750	Two twin SSN-2 type	4 x 130 mm 8 x 57 mm 8 x 25 mm 2 AS rocket launchers
Osa and *Hola* class: Guided missile boats	1965 onwards	40	200	4 x *Styx* launchers in two pairs abreast	Guns: 4 x 30 mm
Komar and *Hoker* class: Guided missile boats	1965 onwards	40	80	2 x *Styx* launchers	Guns: 2 x 25 mm
Kiangtung class: Frigates	1973 onwards	1 + ?1	2,000 approx	1/2 twin SSN-2	4 or 8 x 3.9 in
Gordy class: Frigates *Anchan, Chang Chun, Chi Lin, Fu Chun*	1941–45	4	2,040	1 twin SSN-2	4 x 5.1 in 8 x 37 mm 8 x DCT
Riga class: Frigates *Ch'eng Tu, Kuei Yang, Kuei Lin, K'un Ming*	1956–58	4	1,600	1 twin SSN-2	3 x 3.9 in 4 x 37 mm 4 DC projectors 3 x 21 in torpedo tubes
CUBA					
Ex-USSR *Komar* class: Guided missile boats	1962–66	18	80	2 x *Styx* launchers	Guns: 2 x 25 mm
Ex-USSR *Osa* class: Missile boats		2	200	4 x *Styx* launchers in two pairs abreast	Guns: 4 x 30 mm
EGYPT					
Ex-USSR *Osa* class: Missile patrol boats		8	200	4 x *Styx* launchers in two pairs abreast	Guns: 4 x 30 mm
Ex-USSR *Komar* class: Missile patrol boats		4	80	2 x *Styx* launchers	Guns: 2 x 25 mm
FINLAND					
Isku: Missile craft	1970	1	115	4 x *Styx* in two pairs abreast	Guns: 2 x 30 mm
FRANCE					
Duguay – Trouin, Tourville, De Grasse New construction: *Tourville* class, (F67 Type): Guided missile destroyers	1972–75	3	5,745	6 x *Exocet*	AS *Malafon* rocket/ homing torpedoes Guns AA: 3 x 3.9 in (100 mm) 2 x *Lynx* WG 13 ASW helicopters 2 tube mountings
Georges Leygues, Dupleix, Montcalm New construction DDG C70 Type	1977–79	3 (24 planned by 1985)	4,100	4 x *Exocet* *Masurca* (in AA version) *Malafon* (in AS version)	Guns: 2 x 3.9 in (100 mm) 2 x WG 13 helicopters 10 AS Torpedo tubes
La Combattante: Patrol vessel	1964	1	202	1 x quadruple launcher for SS11 (*Exocet* fitted for trials)	Guns: 1 x 30 mm
Type 47 modified *Du Perré*		1	3,900	4 x *Exocet*	1 x 3.9 in 3 torpedo tubes 1 *Lynx* helicopter
Aconit destroyer	1971	1	3,800	*Exocet* *Malafon*	2 x 3.9 in 1 AS mortar 2 torpedo tubes
GERMANY (DEMOCRATIC REPUBLIC)					
Ex-USSR *Osa* class: Missile boats	1964 onwards	12	200	4 x *Styx* launchers in two pairs abreast	Guns: 4 x 30 mm

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
GERMANY (FEDERAL REPUBLIC)					
New Construction: Type 148: Missile boats	1973–75	20	265	4 x *Exocet*	Guns: AA 1 x 3 in (76 mm) 1 x 40 mm AA
New Construction: Type 143: Missile boats	1974–76	10	378	4 x *Exocet*	Guns: 2 x 3 in (76 mm) AA Torpedoes: 2 x 21 in (533 mm) (wire guided)
GREECE					
Calypso, Euniki, Kymothoi, Navsithoi: New construction missile boats	1972	4	255	4 x *Exocet*	Guns: 4 x 35 mm AA Torpedo tubes: 2 x AS
INDIA					
MTB1–8 *Osa* class	–	8	200	4 x SS-N-2A launchers for *Styx*	Guns: 4 x 30 mm
INDONESIA					
Ex-USSR *Komar* class: Guided missile boats	1961–65	12	80	2 x *Styx* launchers	Guns: 2 x 25 mm AA
IRAN					
Faramaz, Rostam, Saam, Zaal: Saam class: Frigates	1971–72	4	1,290	1 x quintuple *Seakiller* 1 x triple *Seacat*	1 AS x Limbo 3-barrelled DC mortar Guns: 1 x 4.5 (115 mm) 2 x 35 mm AA
IRAQ					
Ex-USSR *Osa* class	–	5	200	4 x *Styx*	4 x 30 mm
ISRAEL					
Saar class: Missile boats	1967–70	12	250	6-8 x *Gabriel*	Guns, AA: 1.3 x 40 mm or 1 x 3 in (76 mm) Torpedo (for surface or AS): 2 x side launchers for 21 in (533 mm) torpedoes
Saar IV class: Missile boats	1973+	6+	415	7 x *Gabriel*	Guns: 2 x 76 mm Depth charge 4
ITALY					
Swordfish class: Hydrofoil gunboat	1973	1	62.5	2 x *Otomat*	1 x 3 in (76 mm)
IVORY COAST					
Le Vigilant: Patrol boat	1968	1	240	8 x SS12	Guns: 2 x 40 mm AA
KOREA (NORTH)					
Ex-USSR *Osa* class: Missile boats	–	8	200	4 x *Styx* in two pairs abreast	Guns: 4 x 30 mm
Ex-USSR *Komar* class: Missile boats	–	10	80	2 x *Styx*	Guns: 2 x 25 mm AA
LIBYA					
Susa, Sirte, Sebha: Fast patrol boats	1967–68	3	114	8 x SS12	2 x 30 mm AA
MALAYSIA					
Gempita, Handalan, Pendekar, Perkasa: Perkasa class: Fast missile boats	1966	4	114	8 x SS 12M in quadruple launchers	Guns: 1 x 40 mm AA 1 x 20 mm AA
Perdana, Ganas, Serang, Ganyang: Perdana class: Fast missile boats	1972–73	4	265	2 x *Exocet*	Guns: 1 x 57 mm 1 x 40 mm
NETHERLANDS					
S-class: Frigates	1978–80	4	3,600	Surface to surface system *Sea Sparrow*	1 x 76 mm 6 AS torpedo tubes

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
NORWAY					
Bergen, Narvik, Oslo, Stavanger, Trondheim: Oslo class: Frigates	1966–67	5	1,745	*Penguin* *Terne* AS missiles	Guns: 4 x 3 in (76 mm) Torpedo launchers: 2
Snögg class: Missile torpedo boats	1970+	6	125	4 x *Penguin*	Guns: 1 x 40 mm Tubes: 4 x 21 in
Storm class: Missile boats	1965 onwards	20	125	6 x *Penguin*	Guns: 1 x 3 in (76 mm) 1 x 40 mm AS: DCT
PAKISTAN The acquisition of 6 *Shanghai* class gunboats is reported, some to be converted for SSM launchers					
POLAND					
USSR *Osa* class: Missile boats	1967	12	200	4 x *Styx* launchers	Guns: 4 x 30 mm
ROMANIA					
Ex-USSR *Osa* class: Missile boats	1961 onwards	6	200	4 x *Styx* launchers	Guns: 4 x 30 mm AA
SINGAPORE					
Sea Wolf class: Missile boats	1972 onwards	4 + 2	230	5 x *Gabriel*	1 x 57 mm 1 x 40 mm
SWEDEN					
Halland, Smaland: Halland class: Destroyers	1955–56	2	3,400	1 x Rocket launcher RB 08	Guns, dual purpose: 4 x 4.7 in (120 mm) Guns, AA: 2 x 57 mm 6 x 40 mm AS: 2 x 4-barrelled DC mortars Torpedo tubes: 8 x 21 in (533 mm) Mines: can be fitted for minelaying
Jägaren class: Fast missile patrol boats	1972+	1 + 16 projected	140	4 x *Penguin*	Guns: 1 x 57 mm Bofors 4 x 21 in torpedo tubes
SYRIA					
Ex-USSR *Osa* class	–	3	200	4 x *Styx* launchers	Guns: 4 x 30 mm
Ex-USSR *Komar* class: Missile boats		3	80	2 x *Styx* launchers	Guns: 2 x 25 mm AA
TUNISIA					
Bizerte, Horria: Patrol boats	1970–74	2 + 1	250	8 x SS12M missiles	Guns: 2 x 40 mm AA
TURKEY 4 x 400 ton missile boats ordered					
UNITED KINGDOM					
Invincible: Through deck Type: Cruiser	1978–79	1	20,000 (estimated)	1 x quadruple *Exocet* 2 x twin *Sea Dart*	Aircraft: 9 x *Sea Kings*
County class: Light cruisers *Fife, Glamorgan, Antrim, Norfolk*	1966–70	4	6,200	*Exocet* Twin *Sea Slug* 2 x quad *Sea Cats*	2 x 4.5 in 2 x 20 mm 1 x *Wessex* helicopter
Type 22: Frigates	?1978	1 ordered	3,800	2 x twin *Exocet* 2 x *Sea Wolf*	2 x 40 mm 2 triple torpedo tubes 2 x *Lynx* helicopters
Leander class: Frigates	1966–67	8 to be fitted	2,860	*Exocet* *Seacat*	2 x 40 mm 1 x *Wasp* helicopter
UNITED STATES					
Antelope, Ready: Asheville class: Patrol gunboats	1967–68	2	245	2 x *Standard* missiles	Guns: 1 x 3 in (76 mm) 4 x 50 cal MG
PHM 1, 2: Patrol hydrofoil missile boats: Proposed	–	2	170	4 x *Harpoon* missile launchers	Guns: 1 x 3 in (76 mm) 2 x 20 mm AA

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
USSR					
Kara class	1973	1 + 1	10,000	8 x SS-N-10 launchers 4 x SA-N-4 4 x SA-N-3	1 helicopter 2 x 16-barrelled MBU's 2 x 6-barrelled MBU's 10 x 21 in torpedoes Guns: 4 x 76 mm 4 x 30 mm
Kresta I class: Guided missile cruisers	1967–68	4	6,500	2 x twin SS-N-3 launchers 2 x twin SA-N-1	Helicopter: 1 Guns: 4 x 57 mm AA 2 x 12-barrelled launchers 2 x 6-barrelled launchers Torpedo tubes: 10
Kresta II class: Guided missile cruisers	1968–71	6	7,500	2 x quadruple SS-N-10 launchers 2 x twin SA-N-3 launchers	Aircraft: 1 x helicopter AS: 2 x 12-barrelled and 2 x 6-barrelled rocket launchers Torpedo tubes: 10 x 21 in (533 mm) Guns dual purpose: 4 x 57 mm 8 x 30 mm AA
Kynda class: Guided missile cruisers	1962	4	6,000	2 x quadruple mounts for SS-N-3 1 x twin SA-N-1	Guns, AA: 4 x 3 in (76 mm) AS: 2 x 12-barrelled rocket launchers Torpedo tubes: 6 x 21 in (533 mm)
Krivak class: Guided missile destroyers	1971+	7	5,200	4 x SSN 10 launchers 2 SA-N-4 launchers	Guns: dual purpose 4 x 3 in (76 mm) 4 x 30 mm AS: 2 x 12-barrelled rocket launchers Torpedo tubes: 8 x 21 in (533 mm)
Krupny class: Guided missile armed destroyers	1960	2	4,650	2 x SS-N-1 launchers	Guns, AA: 16 x 57 mm 2 x 16-barrelled MBU's Torpedo launchers: 6 for AS torpedoes
Kildin class: Guided missile armed destroyers	1957	3	4,000	4 x SS-N-11 replacing SS-N-1	AS: 2 x 16-barrelled rocket launchers 4 x 21 in torpedo tubes Guns, AA: 16 x 57 mm 4 x 76 mm
Nanuchka class: Missile boats	1969+	9	800 (normal approx.)	6 x SS-N-9 launchers 2 x SA-N-4	Guns: 2 x 57 mm AA AS: 1/2 x ASW rocket launcher
Osa class: Missile boats	1959+	120	200	4 x SS-N-2 launchers	Guns: 4 x 30 mm
Komar class: Missile boats	1960–61	25	80	2 x SS-N-2 launchers	Guns: 2 x 25 mm AA
VENEZUELA					
Vosper Thornycroft 37 m class: FPB	1973 onwards	3	150	*Otomat*	
YUGOSLAVIA					
Ex-USSR *Osa* class: Fast missile boats	1965–69	10	200	4 x *Styx* launchers	Guns: 4 x 30 mm

SHIPS CARRYING AA and/or AS GUIDED MISSILES (6504.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
ARGENTINA					
General Belgrano: Ex-US *Brooklyn:* Cruiser	1939	1	13,645	2 x quadruple *Seacat*	Guns: 15 x 6 in (153 mm) 8 x 5 in (127 mm) 28 x 40 mm AA 16 x 20 mm AA 4 x 47 mm saluting Aircraft: 2 x helicopters

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
Type 42: New construction: Destroyers *Hercules, Santissima, Trinidad*	1975–76	2	3,500	2 x *Sea Dart*	Guns: 1 x 4.5 in (115 mm) 2 x 20 mm Aircraft: 1 x AS helicopter
AUSTRALIA					
Brisbane, Hobert, Perth: Perth class: Guided missile armed destroyers	1965–68	3	4,618	AA: *Tartar* single launcher AS: Long range *Ikara* system with two single launchers	Guns, dual purpose: 2 x 5 in (127 mm) Torpedo tubes; 6 (2 triple banks) for AS torpedoes
Yarra, Parramatta, Stuart, Derwent, Swan, Torrens: River class: Destroyer escorts	1961–71	6	2,700	AA: 1 quadruple launcher for *Seacat* AS: 1 launcher for *Ikara* long range system	AS: 1 Limbo 3-barrelled DC mortar Guns, dual purpose: 2 x 4.5 in (115 mm)
BRAZIL					
Mariz E. Barros, Marcilio Dias: ex-US *Gearing* class: Destroyer	1945	2	3,500	1 ASROC	Guns, dual purpose: 4 x 5 in (127 mm) Torpedo tubes: 6 x 21 in (533 mm) triple
Fletcher class: *Maranhão*	1945	1	3,050	1 quadruple *Seacat*	5 x 5 in 10 x 40 mm 5 x 21 in torpedo tubes
CANADA					
Algonquin, Athabaskan, Huron, Iroquois: Iroquois class: Destroyers	1972–73	4	4,200	*Sea Sparrow*	2 x *Sea King* helicopters Guns: 1 x 5 in AS: 1 x Limbo 6 x Mk. 32 torpedo tubes
Restigouche, Gatineau, Kootenay, Terra Nova: Frigates	1958–59	4	2,900	ASROC	AS: 1 x Limbo 3-barrelled DC mortar Guns, AA: 2 x 3 in (76 mm)
Preserver, Protecteur: Operational support ships	1969–70	2	24,000	1 x *Sea Sparrow*	Guns, AA: 2 x 3 in (76 mm) Helicopters: 3 x CHSS-2
DENMARK					
Falster, Fyen, Moen, Sjaelland: Falster class: Minelayers	1963–64	4	1,900	*Sea Sparrow* Dual purpose:	Mines: 400 4 x 3 in (76 mm)
FRANCE					
Colbert: Cruiser	1958	1	11,300	1 x twin Masurca SAM	Guns: 2 x 3.9 mm (100 mm) 12 x 57 mm
Suffren, Duquesne: Suffren class (FLE 60 Type): Guided missile destroyers	1965–68	2	6,090	AA: *Masurca* twin launcher AS: *Malafon* rocket/homing torpedo single launcher (13 missiles carried)	Guns, AA: 2 x 3.9 in (100 mm) 2 x 30 mm Torpedo launchers: 4 for AS homing torpedoes
La Galissonniere: Destroyer	1962	1	3,740	AS: *Malafon* rocket/homing torpedoes, 1 launcher	Aircraft: 1 AS helicopter Guns, AA: 2 x 3.9 in (100 mm) Torpedo tubes: 6 x 21.7 in (550 mm)
Bouvet, Du Chayla, Dupetit Thouars, Kersaint: Surcouf class: Destroyers	1956–57	4	3,740	AA: Single *Tartar* Mark 13 (40 missiles)	Guns, AA: 6 x 57 mm 1 x 375 mm AS launcher Torpedo tubes: 6 x 21.7 in (550 mm) AS
Casabianca, D'Estrees, Guepratte, Maillé Brézé, Vauquelin: Surcouf class: Destroyers	1956–57	5	3,900	AS: 1 x *Malafon* missile launcher	Guns, AA: 2 x 3.9 in (100 mm) 2 x 20 mm Torpedo tubes: 6 x 21.7 AS Bofors rocket launcher: 1

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
Aconit: Guided missile frigate	1971	1	3,800	AS: *Malafon* rocket/homing torpedo *(Exocet* to be fitted)	Guns, AA: 2 x 3.9 in (100 mm) AS: 1 quadruple 12 in (305 mm) mortar Torpedo tubes: 2 launchers
GERMANY (FEDERAL REPUBLIC) *Lutjens, Molders, Rommel:* Modified *Charles F. Adams* class: Guided missile armed destroyers	1969–70	3	4,500	AA: *Tartar* launcher AS: *ASROC* launcher	Guns, dual purpose: 2 x 5 in (127 mm) AS: 2 x triple torpedo launchers 1 x DCT
GREECE *Kontouriotis, Kanaris,* +1 ex-US *Gearing* Fram I	1944–45	3	3,500	ASROC	4 x 5 in 6 torpedo tubes Facilities for helicopter
INDIA *Himqiri, Nilgiri* + 4: *Leander* class: Frigates	1972+	6	2,800	2 x quadruple *Seacat*	Guns: 2 x 4.5 in (115 mm) 2 x 40 mm AS: 1 x Limbo 3-barrelled DC mortar Aircraft: 1 x *Wasp* helicopter
IRAN *Artemiz:* Ex-British *Battle* class: Destroyer	1946	1	3,360	AA: 1 x quadruple *Seacat*	Guns, surface: 4 x 4.5 in (115 mm) Guns, AA: 8 x 40 mm AS: 1 *Squid* 3-barrelled DC mortar
Babr, Palang: Ex-*Allen M. Sumner*	1944–45	2	3,320	4 x standard launchers	2 x *Hedgehogs* 8 torpedo tubes 2 x *Drone* helicopters 6 x 5 in
ITALY *Vittoria Veneto:* Guided missile cruiser	1969	1	8,850	AA/AS: 1 x *Terrier/ASROC* twin launcher	Helicopters: 9 x A/B 204B Guns, AA: 8 x 3 in (76 mm) Torpedo tubes: 2 triple for AS torpedoes
Andrea Doria, Caio Duilio: Guided missile light cruisers	1964	2	6,500	AA: 1 x *Terrier* twin launcher	Guns: AA: 8 x 3 in (76 mm) Helicopters: 4 x A/B 204B Torpedo tubes: 2 triple for 12 in AS torpedoes
Audace, Ardito: Guided missile destroyers	1972–73	2	4,400	AA: 1 x RIM 66A standard launcher	Helicopters: 2 light AS Guns, dual purpose: 2 x 5 in (127 mm) Guns, AA: 4 x 3 in Torpedo tubes: 6 x AS 4 fixed
Impavido, Intrepido: Guided missile armed destroyers	1963–64	2	3,851	AA: 1 x *Tartar* launcher	Helicopters: 1 x AS light helicopter Guns, AA: 2 x 5 in (127 mm) 4 x 3 in (76 mm) Torpedo tubes: 2 triple for AS torpedoes
JAPAN *Haruna:* DDH class: Destroyers Hiei	1973–77	2 + 1	4,700	AS: *ASROC*	Guns: 2 x 5 in (127 mm) Torpedo tubes: 6 x 21 in (533 mm) Aircraft: 3 x AS helicopters

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
DD168	Laid down Feb. 1973 Completed 1976–77	2	3,850		Standard RIM 60A SAM Guns: 2 x 5 in *Asroc* 2 Triple Torpedo tubes
Takatsuki class: Destroyers	1967–70	4	3,050	AS: octuple *ASROC*	Helicopters: 1 helicopter Guns, dual purpose: 2 x 5 in (127 mm) AS: 1 x 4-barrelled rocket launcher Torpedo launchers: 2 x triple for AS homing torpedoes
Yamagumo class: Destroyers	1965–74	5	2,150	*ASROC*	Guns, AA: 4 x 3 in (76 mm) AS: 1 x 4-barrelled rocket launcher Torpedo launchers: 2 x triple for AS homing torpedoes
Amatsukaze: Destroyer	1965	1	4,000	AA: 1 x single *Tartar* launcher AS: *ASROC*	Guns, AA: 4 x 3 in (76 mm) 2 x Hedgehog Torpedo dropping gear; 1 each side for AS short torpedoes
Chikugo class: Frigates	1970–77	7 + 5	1,750	AS: octuple *ASROC*	Dual purpose: 2 x 3 in (76 mm) AA: 2 x 40 mm Torpedo launchers: 2 x triple 12.7 in (324 mm)
LIBYA					
Dat-Assawari: New construction: Frigate	1973	1	1,625	AA: 2 x triple *Seacat*	AS: 1 x Mk 10 mortar Guns: 1 x 4.5 in (115 mm) 2 x 40 mm 2 x 35 mm
MALAYSIA					
Rahmat: Yarrow Type: Frigate	1971	1	1,600	AA: 1 x quadruple *Seacat*	Helicopters: 1 Guns, dual purpose: 1 x 4.5 in (115 mm) Guns, AA: 2 x 40 mm AS: 1 x Limbo 3-barrelled DC mortar
NETHERLANDS					
De Zeven Provincien: Cruiser	1953	1	11,850	AA: 1 x twin *Terrier* launcher	Guns, surface: 4 x 6 in (152 mm) Guns, AA: 6 x 57 mm 4 x 40 mm
De Ruyter, Tromp: New construction: DDG Type: Guided missile frigates	1974	2	5,400	AA: 1 x *Tartar* launcher *Seasparrow* PDMS	Helicopters: 1 x lightweight helicopter Guns: 2 x 4.7 in (120 mm)
Van Speyk class: Frigates	1967–68	6	2,850	AA: 2 x quadruple launchers for *Seacat*	Helicopters: 1 x lightweight helicopter Guns: 2 x 4.5 in (115 mm) AS: 1 Limbo 3-barrelled DC mortar
NEW ZEALAND					
Canterbury, Waikato: Leander class: Frigates	1966–71	2	2,860 2,990 *(Canterbury)*	AA: 1 x *Seacat* quadruple launcher	Helicopters: 1 x *Wasp* helicopter Guns: 2 x 4.5 in (115 mm) 2 x 20 mm AA AS: *Waikato:* 1 x Limbo 3-barrelled DC mortar *Canterbury:* 2 x TF Mk 32 torpedo tubes

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
Otago, Taranaki: Rothesay class, Type 12: AS frigates	1960–61	2	2,557	AA: 1 x *Seacat* quadruple launcher	Guns: 2 x 4.5 in (115 mm) 2 x 40 mm (in *Taranaki* only) AS: 2 x Limbo 3-barrelled DC mortars
NORWAY					
Uller: Gor class: Coastal minelayer	1942	1	1,250	*Terne* system	Guns: 1 x 3 in (76 mm) 1 x 40 mm AA 1 x DCT
Aeger, Sleipner: Sleipner class: Corvettes	1965–67	2	780	*Terne* system	Guns: 1 x 3 in (76 mm) 1 x 40 mm
POLAND					
Warszawa: Destroyer	1964	1	3,885	1 x twin SAN-1 for *Goa* missiles	2 x 5.1 in 4 x 45 mm 4 x 30 mm 2 x 16-barrelled MBU's 4 x AS: side thrown DC's
SPAIN					
Baleares class: Guided missile frigates	1974–76	5	4,177	1 x *Standard* missile *ASROC*	Guns: 1 x 5 in (127 mm) Torpedo tubes: 4 x AS and 2 x general purpose
Gravina class: ex *Gearing:* Destroyers	1945	5	3,480	*ASROC*	Guns: 4 x 5 in Torpedo tubes: 2 Triple Mk 32 Facilities for small helicopter
SWEDEN					
Ostergotland class: Destroyers	1958–59	4	2,600	1 x quadruple *Seacat*	Guns, surface: 4 x 4.7 in (120 mm) Guns, AA: 4 x 40 mm AS: Triple-barrelled DC mortar Torpedo tubes: 6 x 21 in (533 mm) Mines: 60 can be carried
TAIWAN					
Ex-*Gearing* class: Destroyers	1945–47	4	3,500	*ASROC* (except 1)	4 x 5 in 6 torpedo tubes
THAILAND					
Makut Rajaikumarn: Frigate	1973	1	1,900	1 x quadruple *Seacat* launcher	Guns: 2 x 4.5 in (114 mm) 2 x 40 mm AS: 1 x triple-barrelled Limbo-mortar 2 x DCT
TURKEY					
Gearing class: *Adatepe, Gayret, Çakmak:* Destroyers	1946	3	3,500	1 x *ASROC* 8-tube launcher	AS: 2 x triple torpedo tubes Guns: 4 x 5 in (127 mm) dp Aircraft: can carry small helicopter
UNITED KINGDOM					
Fearless, Intrepid: Assault ships	1965–67	2	12,120	4 x *Seacat* systems	Helicopters: Facilities for 5 x *Wessex* Guns, AA: 2 x 40 mm Bofors
Blake, Tiger: Cruisers	1959–61	2	12,080	2 x quadruple *Seacat*	Helicopters: 4 x AS *Sea King* Guns: 2 x 6 in (152 mm) 2 x 3 in (76 mm) AA

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
Sheffield, Birmingham, Coventry, Cardiff, Newcastle, Glasgow: Type 42: New construction: Guided missile armed destroyers	Est. 1973	3 + 3	3,500 (approx)	1 x *Sea Dart*	Helicopters: 1 x Twin engined *Lynx* AS helicopter Guns: 1 x 4.5 in (115 mm) automatic 2 x 20 mm Oerlikon AS: Torpedoes carried by helicopter
Bristol: Type 82: New construction: Guided missile armed light cruisers	1973	1	6,750	AA: 1 x *Sea Dart* AS: 1 x *Ikara*	Helicopters: Facilities for 1 *Wasp* helicopter Guns, dual purpose: 1 x 4.5 in (115 mm) AS: 1 x Limbo 3-barrelled DC mortar
County class: Guided missile armed light cruisers	1962–63	4	6,200	AA: 1 x *Seaslug* twin launcher 2 x *Seacat* quadruple launchers	Helicopters: 1 x *Westland Wessex* Guns, dual purpose 4 x 4.5 in (115 mm) 2 x 20 mm
Amazon, Antelope, Active, Ambuscade, Arrow, Alacrity, 07, 08: Type 21: *Amazon* class: New construction: Frigates	1973 onwards	8	2,500	AA: 1 x quadruple *Seacat* (later ships will have *Seawolf*)	Helicopters: 1 x twin engined *Lynx* AS helicopter Guns: 1 x 4.5 in (115 mm) 2 x 20 mm Oerlikon AS: Torpedoes dropped by helicopter Torpedo tubes: 6
Leander class: Frigates	1963–67	18	2,860 (2,962 in last ten)	1 x *Seacat* (2 in *Ikara* conversions) *Ikara* being fitted in *Leander, Ajax, Aurora, Euryalus, Galatia, Arethusa, Naiad, Penelope*	Helicopters: 1 x *Wasp* helicopter armed with homing torpedoes Guns, dual purpose: 2 x 4.5 in (115 mm) (None in *Ikara* fitted ships) Guns, AA: 2 x 40 mm 2 x 20 mm AS: 1 x Limbo 3-barrelled DC mortar
Nubian, Mohawk, Zulu, Gurkha, Ashanti: Tribal class: Type 81: Frigates	1961–64	5	2,700	AA: 2 x *Seacat* quadruple launchers	Helicopters: 1 x *Westland Wasp* Guns, dual purpose: 2 x 4.5 in (115 mm) Guns, AA: 2 x 20 mm AS: 1 x Limbo 3-barrelled DC mortar
Rothesay, Yarmouth, Plymouth, Rhyl, Londonderry, Lowestoft, Falmouth, Berwick, Brighton: Rothesay class: Frigates	1960–61	9	2,800	AA: 1 x quadruple *Seacat* launcher	Helicopters: 1 x *Westland Wasp* Guns: 2 x 4.5 in (115 mm) 2 x 20 mm AS: 1 Limbo 3-barrelled DC mortar
Lincoln, Salisbury: Salisbury class: Type 61: AD frigates	1957–60	2	2,408	AA: 1 x quadruple *Seacat*	Guns: 2 x 4.5 in (115 mm) 2 x 20 mm AS: 1 x *Squid* 3-barrelled DC mortar
UNITED STATES *Albany, Chicago, Columbus: Albany* class: Guided missile cruisers	1945–46	3	17,500	AA: 2 x twin *Talos* launchers 2 x twin *Tartar* launchers AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 2 x 5 in (127 mm) AS: 2 x triple torpedo tubes Mk 32 Aircraft: Utility helicopter
Long Beach: Nuclear powered guided missile cruiser	1961	1	17,350	AA: 1 x twin *Talos* launcher 2 x twin *Terrier* launchers AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 2 x 5 in (127 mm) AS: 2 x torpedo tubes Mk 32 Aircraft: Utility helicopter

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
Galveston, Little Rock, Oklahoma City, Providence, Springfield, Topeka: Guided missile light cruisers	1944–45	6	14,600	AA: 1 x twin *Talos* launcher or 1 x twin *Terrier* launcher	Guns: 3 x 6 in (152 mm) 2 x 5 in (127 mm) dual purpose or 6 x 6 in (152 mm) 6 x 5 in (127 mm) dual purpose Aircraft: Utility helicopter
Virginia, Texas and *DLGN 40:* Nuclear powered guided missile light cruisers	1975–76	3	10,000	2 x combination twin *Tartar D/ASROC* launchers	AS: 6 torpedo tubes Guns: 2 x 5 in (127 mm) 2 Helicopters
California, South Carolina: Nuclear powered guided missile light cruisers	1973–74	2	10,150	AA: 2 x *Tartar D* launchers AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 2 x 5 in (127 mm) (Lightweight gun systems) AS: Torpedo tubes
Truxtun: Nuclear powered guided missile light cruiser	1967	1	9,200	AA/AS: 1 x twin *Terrier/ASROC* launcher	Guns, dual purpose: 1 x 5 in (127 mm) Guns, AA: 2 x 3 in (76 mm) AS: 4 x torpedo tubes Mk 32 Helicopters: Facilities for helicopters
Bainbridge: Nuclear powered guided missile light cruiser	1962	1	8,580	AA: 2 x twin *Terrier* launchers AS: 1 x *ASROC* 8-tube launcher	Guns, AA: 4 x 3 in (76 mm) AS: 2 x triple torpedo tubes Mk 32
Belknap class: Guided missile destroyers	1964–67	9	7,930	AA/AS: 1 x twin *Terrier/ASROC* launcher	Guns, dual purpose: 1 x 5 in (127 mm) Guns, AA: 2 x 3 in (76 mm) AS: 2 x triple torpedo tubes Mk 32 Helicopters: 1 x SH-2D Light Airborne Multi-Purpose System (Lamps)
Leahy class: Guided missile destroyers	1962–64	9	7,800	AA: 2 x twin *Terrier* launchers AS: 1 x *ASROC* 8-tube launcher	Guns, AA: 4 x 3 in (76 mm) AS: 2 x triple torpedo tubes Mk 32
Coontz class: Guided missile destroyers	1959–61	10	5,800	AA: 1 x twin *Terrier* launcher AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 1 x 5 in (127 mm) Guns, AA: 4 x 3 in (76 mm), (Removed in modernised ships) AS: 2 x triple torpedo tubes Mk 32
Mitscher, John S. McCain: 2 *Mitscher* class: Guided missile destroyers	1953	2	5,200	AA: 1 x single *Tartar* launcher AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 2 x 5 in (127 mm) AS: 2 x triple torpedo tubes Mk 32
Norfolk: Destroyer	1953	1	7,300	AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 8 x 3 in (76 mm) AS: 2 x triple torpedo tubes Mk 32
Charles F. Adams class: Guided missile destroyers	1960–64	23	4,500	AA: DDG 2–14: 1 x twin *Tartar* launcher DDG 15–24: 1 x single *Tartar* launcher AS: 1 x *ASROC* 8-tube launcher 1 x *Chaparral*	Guns, dual purpose: 2 x 5 in (127 mm) AS: 2 x triple torpedo tubes Mk 32
Decatur DDG 31, *John Paul Jones* DDG 32, *Parsons* DDG 33, *Somers* DDG 34: Guided missile destroyers	1956–59	4	4,150	AA: 1 x single *Tartar* launcher AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 1 x 5 in (127 mm) AS: 2 x triple torpedo tubes Mk 32

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
DD 963–968+: Spruance class: Destroyers	1974–78	16 + 7	6,900	*ASROC* launcher: Basic Point Defence. Missile systems (BPDMS) with *Sea Sparrow* missiles	Guns, dual purpose: 2 x 5 in (127 mm) AS: Torpedo tubes Mk 32 Aircraft: Light Airborne Multi-purpose system, (Lamps), helicopter
Forrest Sherman class: Destroyers ASW Mod.	1956–59	8	4,050	1 x *ASROC* 8-tube launcher	Guns: 2 x 5 in (127 mm) dual purpose 2 x triple torpedo tubes Mk 32
Modernised Gearing class, (Fram 1): Destroyers	1945–49	67	3,480 to 3,520	AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 4 x 5 in (127 mm) AS: 2 x triple torpedo tubes Mk 32; facilities for small helicopter
Carpenter, Robert A. Owens: Destroyers	1946–49	2	3,410	AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 2 x 5 in (127 mm) AS: 2 x triple torpedo tubes Mk 32; facilities for small helicopter
Knox class: Escort ships	1969–74	46	4,100	*Sea Sparrow* AS: 1 x *ASROC* 8-tube launcher	Guns, dual purpose: 1 x 5 in (127 mm) 1 x 20 mm *Vulcan* AS: 4 x fixed torpedo tubes Mk 32 Aircraft: 1 x SH-2D LAMPS helicopter
Brooke and *Garcia* classes: Guided missile escort ships, (DEG); Escort ships (DE).	1964–68	10 (DE) 6 (DEG)	DE: 3,400 and DEG: 3,425	AA: DEG: 1 x Single *Tartar* launcher AS: DEG and DE; 1 x *ASROC* 8-tube launcher	Guns, dual purpose: DEG: 1 x 5 in (127 mm) DE: 2 x 5 in (127 mm) AS: 2 x triple torpedo tubes Mk 32 DEG: 2 x fixed torpedo tubes Mk 32 Facilities for small helicopter
Bronstein, McCloy: Escort ships	1963	2	2,650	AS: 1 x *ASROC* 8-tube launcher	Guns, AA: 3 x 3 in (76 mm) AS: 2 x triple torpedo tubes Mk 32 Aircraft: Facilities for small helicopter
Boston, Canberra: Heavy cruisers	1943	2	17,500	AA: 2 x twin *Terrier* launchers	Guns: 6 x 8 in (203 mm) 10 x 5 in (127 mm) dual purpose 8 x 3 in (76 mm) AA
Glover: Escort research ship	1965	1	3,426	1 x *ASROC* 8-tube launcher	Guns, dual purpose: 1 x 5 in (127 mm) AS: 2 x triple torpedo tubes Mk 32 Aircraft: Facilities for small helicopter
Tarawa class: Amphibious assault ships	1975–76	5	39,300	2 x BPDMS	Guns: 3 x 5 in (127 mm) 6 x 20 mm Aircraft: Troop helicopters. Possibly AV-8 V/STOL close support aircraft
Okinawa: Amphibious assault ship	1962	1	18,300	1 x BPDMS launcher with *Sea Sparrow*	Guns: 6 x 3 in (76 mm) Helicopters: 20-24 (CH-46) medium, 4 (CH-53) heavy, 4 (HU-1) observation

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
USSR					
Dzerzhinski, Admiral Senyavin, Zhdanov: Sverdlov class: Cruisers	1955	3	19,200	AA: Twin SA-N-2 launcher for *Guideline* missile in *Dzerzhinski* 2 x SA-N-4 in *Senyavin* and *Zhdanov*	Guns, surface: 9 x 6 in (153 mm) (6 in *Senyavin)* Guns, dual purpose: 12 x 3.9 in (100 mm) Guns, AA: 16 x 37 mm 8 x 30 mm Torpedo tubes: 10 x 21 in (533 mm) Mines: 150 (except *Zhdanov* and *Senyavin)*
Kashin: Guided missile armed destroyers	1962 onwards	19	5,200	AA: 2 x twin SA-N-1 launchers	Guns, AA: 4 x 3 in (76 mm) Torpedo tubes: 5 x 21 in (533 mm) AS: 2 x 12-barrelled ASW rocket launchers 2 x 6-barrelled ASW rocket launchers
Sam Kotlin class: Guided missile armed destroyers	1962, 1966–69	8	3,885	AA: 1 x twin SA-N-1 launcher	Guns, dual purpose: 2 x 5.1 in 8 x 30 mm (later ships) Guns, AA: 4 x 57 mm AS: 6 x side-thrown DC projectors or 2 x 12-barrelled ASW rocket launchers
Kanin class: Guided missile destroyers	1967+	6	4,600	AA: 1 x twin SA-N-1 launcher	Guns: 8 x 57 mm 8 x 30 mm AS: 3 x 12-barrelled rocket launchers Torpedo tubes: 10 x 21 in (533 mm) AS
Grisha class: Coastal escorts	1969 onwards	14	750	2 x SA-N-4 launcher	Guns: Dual purpose: 2 x 57 mm AS: 2 x 12-barrelled rocket launchers Torpedo tubes: 4 x 16 in AS
VENEZUELA					
Nueva Esparta: Destroyer	1953	1	3,670	2 x quadruple *Seacat*	Guns: Dual purpose: 6 x 4.5 in (115 mm) AA: 4 x 40 mm AS: 2 x DCT 2 x DC racks, *Squids*

SHIPS CARRYING 16 in GUNS (6505.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
UNITED STATES					
Iowa, New Jersey, Missouri, Wisconsin: Battleships	1943–44	4	59,000	9 x 16 in (406 mm) 20 x 5 in (127 mm) dp Several 40 mm guns in all except *New Jersey*, which has 4 x *Zuni* rocket launchers	

Category (JWS) Name /Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
SHIPS CARRYING 7.1 in or 8 in GUNS (6506.202)					
SPAIN					
Canarias: Cruiser	1936	1	13,969	Surface: 8 x 8 in (203 mm) 8 x 4.7 in (120 mm) AA: 4 x 1.5 in (38 mm) 4 x 40 mm 2 x 20 mm	
UNITED STATES					
Salem, Des Moines, Newport News: Heavy cruisers	1948–49	3	21,500	9 x 8 in (203 mm) 12 x 5 in (127 mm) dual purpose, AA: 4 x 3 in (76 mm) in *Newport News:* 20 x 3 in guns in others	
Rochester: Heavy cruiser	1946	1	17,500	9 x 8 in (203 mm) 12 x 5 in (127 mm) dual purpose 20 x 3 in (76 mm) AA	
Baltimore class: Heavy cruisers (in reserve)	1943–46	7	17,200	9 x 8 in (203 mm) 12 x 5 in (127 mm) dp (10 in *St Paul)* 20 x 3 in (76 mm) AA (Except 48 x 40 mm AA in *Quincy)*	
USSR					
Slava: Cruiser *(Kirov:* Training ship)	1944 (1938 *Kirov)*	1 1	9,060	Surface: 9 x 7.1 in (180 mm) Dual purpose: 6 x 3.9 in (100 mm) AA: *(Kirov:* 18 x 37 mm, 2 older guns) *Slava:* 12 x 37 mm	Mines: 180
SHIPS CARRYING 6 in or 5.9 in GUNS (6507.202)					
ARGENTINA					
Nueve De Julio: Ex-US *Brooklyn:* Cruiser	1939	1	13,645	Surface: 15 x 6 in (153 mm) 8 x 5 in (127 mm) AA: 28 x 40 mm Saluting 4 x 47 mm	2 helicopters
La Argentina: Cruiser	1939	1	8,630	Surface: 9 x 6 in (153 mm) AA: 14 x 40 mm	Torpedo tubes 6 x 21 in (533 mm)
BRAZIL					
Tamandaré: Cruiser	1939	1	13,500	Surface: 15 x 6 in (153 mm) Dual purpose: 8 x 5 in (127 mm) AA: 28 x 40 mm 8 x 20 mm	1 helicopter
CHILE					
Pratt, O'Higgins: Cruisers	1938	2	*Pratt:* 13,500 *O'Higgins* 13,000	Surface: 15 x 6 in (153 mm) 8 x 5 in (127 mm) AA: 28 x 40 mm 24 x 20 mm	1 x *Bell* helicopter

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Latorre: Tre Kronor class: Cruiser	1947	1	9,200	Surface: 7 x 6 in (153 mm) AA: 4 x 57 mm 11 x 40 mm	Torpedo tubes 6 x 21 in
INDIA					
Mysore: Cruiser	1940	1	11,040	Surface: 9 x 6 in (153 mm) AA: 8 x 4 in (102 mm) 12 x 40 mm	
Delhi: Cruiser	1933	1	9,740	Surface: 6 x 6 in (153 mm) AA: 8 x 4 in (102 mm) 14 x 40 mm	
PERU					
Capitan Quiñones, Coronel Bolognesi: Cruisers	1942–43	2	*Capitan Quiñones:* 11,090 *Coronel Bolognesi:* 11,110	Surface: 9 x 6 in (153 mm) Dual purpose: 8 x 4 in AA: *Capitan Quiñones:* 12 x 40 mm *Coronel Bolognesi:* 18 x 40 mm	
Almirante Grau: Cruiser	1953	1	11,850	8 x 6 in 8 x 57 mm 8 x 40 mm	
SWEDEN					
Alvsnabben: Minelayer	1943	1	4,250 (standard)	Surface: 2 x 6 in (153 mm) 2 x 57 mm Bofors 2 x 40 mm AA 4 x 37 mm	
USSR					
Sverdlov class: Cruisers	1956+	9	19,200	Surface: 12 x 6 in (152 mm) Dual purpose: 12 x 3.9 in (100 mm) AA: 16 x 37 mm 8 x 30 mm	Torpedo tubes: 10 x 21 in (533 mm) (except in *Oktyabrskaya Revolutsia* and *Murmansk).* Mines: 150 capacity
Komsomolets, Zheleznyakov: Chapaer class: Training cruisers	1948–50	2	15,000	Surface: 12 x 6 in (152 mm) Dual purpose: 8 x 3.9 in (100 mm) 24 x 37 mm	Mines: 200 capacity

SHIPS CARRYING 5–5.25 in GUNS
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Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
ARGENTINA					
Brown, Rosales, Espora Domecq Garcia, Almirante Storni: Ex-US *Fletcher:* Destroyers	1943	5	3,050	Surface: 4 x 5 in (127 mm) AA: 6 x 3 in (76 mm)	Torpedo tubes: 5 x 21 in (533 mm) quintupled AS: 2 fixed Hedgehogs 1 DC rack AS torpedo racks: 2 side-launching
Bonchard, Segui: Allen M. Sumner class: Destroyers	1944	2	3,320	6 x 5 in 4 x 3 in	6 torpedo tubes 2 Hedgehogs Facilities for helicopter
Py: Gearing class: Destroyers	1945	1	3,500	6 x 5 in	2 Hedgehogs 6 torpedo tubes Facilities for helicopter

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
BRAZIL					
Ex-US *Sumner* class	1944–45	5	3,320	Surface: 6 x 5 in (127 mm)	AS: 2 fixed Hedgehogs DCs *(Mato Grosso)* Tubes: 2 Triple MK 32 Facilities for helicopter
Amazonas class: Destroyers	1949–51	3	2,180	Surface: 3 x 5 in (127 mm) AA: 4 x 40 mm 2 x 20 mm	AS weapons: 4 x DCT Torpedo tubes: 6 x 21 in (533 mm) two triple
Ex-US Fletcher Type: *Para* class: Destroyers	1942–45	4	3,050	Dual purpose: 5 x 5 in (127 mm) (4 x 5 in (127 mm) in *Pernambuco)* AA: 10 x 40 mm, except in *Pernambuco* which has 6 x 3 in (76 mm) and 6 x 40 mm in *Para*	Torpedo tubes: 5 x 21 in (533 mm) AS: 2 x Hedgehogs 1 x DC rack 2 x side launching torpedo racks
CHILE					
Blanco Encalada, Cochrane: Ex-US *Fletcher* class: Destroyers	1943–44	2	2,750	Dual purpose 4 x 5 in (127 mm) AA: 6 x 3 in (76 mm)	Torpedo tubes: 5 x 21 in (533 mm) AS: 2 x Hedgehogs 2 x side launching torpedo racks 1 x DC rack 6 x K DCT
Serrano, Orella, Riquelme, Uribe: APD Transport Type: Frigates	1944	4	2,130	1 x 5 in (127 mm) 6 x 40 mm AA	
CHINA (PEOPLE'S REPUBLIC)					
Kuang Chou: Ex-Canadian *Castle:* Escort	1944	1	1,100 (standard)	Surface: 2 x 5.1 in (130 mm) 10 x 37 mm	
Nan Chang	1940	1	950	2 x 5.1 in 5 x 37 mm	
Chen Yang	1945	1	745	2 x 5.1 in 6 x 37 mm	
COLUMBIA					
Antioquia: Destroyer	1943	1	2,952	4 x 5 in (127 mm) 6 x 3 in (76 mm)	Torpedo tubes: 5 x 21 in (533 mm) AS: 2 x fixed Hedgehogs 1 x DC rack 2 x side launching torpedo racks
Caldas, Santander: Ex-US *Allen M. Sumner* class	1944	2	3,320	6 x 5 in 4 x 3 in	2 x fixed Hedgehogs 6 torpedo tubes Facilities for helicopter *(Santander)*
Almirante Brion Almirante Tono, Cordoba: Destroyer transports	1945	3	2,130	Dual purpose: 1 x 5 in (127 mm) 6 x 40 mm AA	
DENMARK					
Peder Skram, Herluf Trolle: Peder Skram class: Frigates	1966–67	2	2,720	Surface: 4 x 5 in (127 mm) AA: 4 x 40 mm	AS: DC
ECUADOR					
25 De Julio: Ex-US APD Type: Escort destroyer	1943	1	2,130	1 x 5 in (127 mm) 4 x 40 mm	DC racks

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
EGYPT					
Al Nassar, Al Zafr, Damiet, Suez: Ex-USSR Skory Type: Destroyers	1952	4	3,500	Surface: 4 x 5.1 in (130 mm) AA: 2 x 3.4 in 8 x 37 mm (un Mod) 4 x 57 mm } (Mod) 4 x 37 mm } (Mod)	AS: 4 x DCT (un Mod) Torpedo tubes: 10 x 21 in (533 mm) (un Mod) 5 x 21 in (Mod) Mines: 80 2 x 12-barrelled MBU's (Mod)
FRANCE					
Forbin, Jauréguiberry, La Bourdonnais, Tartu: Aircraft direction (T 53) Type: Destroyers	1958	4	3,740	6 x 5 in (127 mm) 4 x 5 in (Forbin) AA: 6 x 2.25 in (57 mm) Bofors 2 x 20 mm	AS: Sextuple Bofors *lance roquettes* howitzer Torpedo tubes: 6 x 21.7 (550 mm) ASM (can launch ordinary torpedoes) Facilities for helicopter (Forbin)
Cassard, Chevalier Paul: Surcouf class: Destroyers	1956	2	3,740	Dual purpose: 6 x 5 in (127 mm) AA: 4 x 57 mm	Torpedo tubes: 6 for ASM torpedoes
GERMANY (FEDERAL REPUBLIC)					
Z2-5: Ex-US *Fletcher:* Destroyers	1942–43	4	2,750	Dual purpose: 4 x 5 in (127 mm) AA: 6 x 3 in (76 mm)	AS: 2 x Hedgehogs 1 x DC rack Torpedo tubes: 5 x 21 in (533 mm) 2 x ASW tubes
GREECE					
Ex-US *Fletcher* class: Destroyers	1942–43	6	2,750	Dual purpose: 4 or 5 x 5 in (127 mm) AA: 10 x 40 mm or 6 x 3 in (76 mm)	AS: Hedgehogs DCs Torpedo tubes: 5 x 21 in (533 mm) except in two ships Torpedo racks: side launching for AS torpedoes
Themistocles: ex-*Gearing* Fram II: Destroyer	1944	1	3,500	6 x 5 in	2 fixed Hedgehogs 6 torpedo tubes
Miaoulis: Destroyer	1944	1	3,320	Dual purpose 6 x 5 in (127 mm)	AS: 2 x triple torpedo launchers Mk 32 2 x Hedgehog
ITALY					
San Giorgio: Destroyer	1943	1	4,350	Surface: 4 x 5 in (127 mm) AA: 3 x 3 in (76 mm)	AS: 1 x 3-barrelled mortar 2 x triple torpedo tubes
Impetuoso, Indomito: Destroyers	1958	2	3,800	AA: 4 x 5 in (127 mm) 16 x 40 mm	AS: 1 x 3-barrelled mortar 4 x DCT 1 x DC rack Torpedo tubes: 2 x triple for AS torpedoes
Fante, Geniere: Ex-US *Fletcher* class: Destroyers	1943–44	2	2,940	2 x 5 in (4 in *Geniere)* 4 x 3 in AA (6 in *Geniere)*	AS: 1 x DC rack 2 x side launching torpedo racks 2 x Hedgehogs
Aviere: Destroyer	1941	1	2,580	Surface: 1 x 5 in (127 mm) 2 x 3 in	AS: 4 x DCT 2 x DC racks

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
JAPAN					
Akizuki, Teruzuki: Akizuki class: Destroyers	1960	2	2,890	Dual purpose: 3 x 5 in (127 mm) AA: 4 x 3 in (76 mm)	Torpedo tubes: 4 x 21 in (533 mm) AS: 1 x US model Mk 108 rocket launcher 2 x Hedgehogs 2 x Y-mortars 2 x DCT
Harusame, Murasame, Yudachi: Murasame class: Destroyers	1959	3	2,500	Dual purpose: 3 x 5 in (127 mm) AA: 4 x 3 in (76 mm)	AS: 8 short torpedoes 1 x Hedgehog 1 x DC rack 1 x Y-gun
Harukaze, Yukikaze: Harukaze class: Destroyers	1956	2	2,340	Dual purpose: 3 x 5 in (127 mm) AA: 8 x 40 mm	AS: Tubes for short homing torpedoes 2 x Hedgehogs 1 x DC rack 4 x K-guns
KOREA (REPUBLIC OF)					
Chung Mu, Seoul, Pusan: Ex-US *Fletcher* class: Destroyers	1943	3	3,050	Dual purpose: 5 x 5 in (127 mm) AA: 10 x 40 mm Bofors (Except *Seoul)*	AS: 2 x fixed Hedgehogs 1 x DC rack Torpedo tubes: 6 x 12.7 in (324 mm)
Dae Gue +1: Ex-*Allen M. Sumner*	1944	2	3,320	6 x 5 in	6 torpedo tubes 2 x fixed Hedgehogs
Chung Buk, Jeong Buk: Ex-*Gearing* class	1945	2	3,500	Dual purpose: 6 x 5 in (127 mm)	AS: 2 x fixed Hedgehogs Torpedo tubes: 6 x 12.7 in (324 mm)
Chung Nam: Ex-US *Rudderow* class: Destroyer escort	1944	1	1,890	Dual purpose: 2 x 5 in (127 mm) AA: 4 x 40 mm	AS: 1 x Hedgehog DC's Torpedo tubes: 6 x 12.7 in (324 mm)
Ex-US APD Type: Escort transports	1944–45	6	2,130	Dual purpose: 1 x 5 in (127 mm) 6 x 40 mm AA	AS: DC's
MEXICO					
Cuauthemoc, Cuitahuac: Ex-US *Fletcher* class: Destroyers	1943	2	3,050	5 x 5 in (127 mm) 14 x 40 mm	Torpedo tubes: 5 x 21 in (533 mm) quintupled AS: 8 x DCT 2 x Hedgehog
Ex-US *APD* class: Frigates	1943–45	5	2,130	1 x 5 in (127 mm) AA: 6 x 40 mm 6 x 20 mm	
PAKISTAN					
Babur: Light cruiser	1944	1	7,560	Surface: 8 x 5.25 in (133 mm) AA: 14 x 40 mm	Torpedo tubes: 6 x 21 in (533 mm)
PERU					
Villar, Guise: 2 Ex-*Fletcher* class: Destroyers	1943	2	3,050	Dual purpose: 4 x 5 in (127 mm) AA: 6 x 3 in (76 mm)	AS: 2 x fixed Hedgehogs 1 x DC rack Torpedo tubes: 5 x 21 in (533 mm) Torpedo racks: 2 x side launching for AS weapons
POLAND					
Grom, Wicher: Ex-USSR *Skory* class: Destroyers	1949	2	3,500	Surface: 4 x 5.1 in (130 mm) AA: 2 x 3.4 in 8 x 37 mm	AS: 4 x DCT Torpedo tubes: 10 x 21 in (533 mm) Mines: capacity 80

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
SPAIN					
Marqués de la Ensenada, Roger de Lauria: AS Destroyers	1969–70	2	3,587	Surface: 6 x 5 in (127 mm)	Helicopters: 1 x AS helicopter 2 x triple launchers for 324 mm torpedoes Torpedo tubes: 2 x 21 in (533 mm)
Ex-US *Fletcher* class: Destroyers	1943–44	5	3,050	Surface: 4 or 5 x 5 in (127 mm) AA: 6 x 40 mm Bofors and 5 or 6 x 20 mm or 6 x 3 in (76 mm)	AS: 2 x Hedgehogs 4/6 x DCT 1/2 x DC racks Torpedo tubes: 3 x 21 in (533 mm) Torpedo racks: 2 x side launching for AS torpedoes (3 each)
Legazpi, Vicente Yanex Pinzon: Frigates	1949–51	2	2,228	Surface: 2 x 5 in (127 mm) AA: 4 x 40 mm	AS: 2 x Hedgehogs 8 x mortars 2 x DC racks Torpedo racks: 2 x side launching for AS torpedoes
TAIWAN (China)					
Hsiang Yang, Heng Yang, Haia Yang, Yuen Yang, Huy Yang, Po Yang: Ex-US *Allen M. Sumner* class: Destroyers	1944–45	6	3,320	Dual purpose: 6 x 5 in (127 mm) up to 6 x 3 in AA 8 x 40 mm in 2	AS: 6 x 12.75 in (324 mm) torpedo tubes Mk 32 2 x fixed Hedgehogs DC's in some ships
Kwei Yang, Ching Yang, An Yang, Kuen Yang: Ex-US *Fletcher* class: Destroyers	1943	4	3,050	Dual purpose: 5 x 5 in (127 mm) (4 in *Ching Yang)* AA: 6 x 40 mm in *An Yang, Kuen Yang,* 6 x 3 in (76 mm) in others	AS: 2 x Hedgehogs DC's; 6 x 12.75 in (324 mm) torpedo tubes in *Kwei Yang, Ching Yang.* 5 x 21 in (533 mm) in *Kuen Yang.*
Nan Yang, Hsien Yang: Ex-US *Gleaves* class: Destroyers	1940–42	2	2,575	*Hsien Yang:* 3 x 5 in (127 mm) AA: Several 40 mm and 20 mm *Nan Yang:* 4 x 5 in (127 mm) AA: Several 40 mm and 20 mm	DC's
Han Yang, Lo Yang: Ex-US *Benson* class: Destroyers	1940	2	2,575	Dual purpose: 4 x 5 in (127 mm) AA: 4 x 40 mm 6 x 20 mm	AS: DC's
Fu Yang: Ex-US *Gearing* class: Destroyer	1945	1	3,500	Dual purpose: 6 x 5 in (127 mm) Several 40 mm	AS: 6 x 12.75 in (324 mm) Torpedo tubes 2 x Hedgehogs
Tai Yuan: Ex-US Rudderow Type: Frigate	1944	1	2,000	Dual purpose: 2 x 5 in (127 mm) AA: 4 x 40 mm 4 x 20 mm	AS: 6 x 12.75 in (324 mm) Torpedo tubes 1 x Hedgehog DC's
Tai Hu: Ex-US *Bostwick* class: Frigates	1944	1	1,900	Dual purpose: 2 x 5 in (127 mm) AA: 8 x 40 mm 4 x 20 mm	AS: 6 x 12.75 in (324 mm) Torpedo tubes 1 x Hedgehog DC's
Ex-US APD Type: Frigates	1943–45	12	2,130	Dual purpose: 2 x 5 in (127 mm) AA: 6 x 40 mm 4/8 x 20 mm	AS: 6 x 12.75 in (324 mm) Torpedo tubes Some have 2 Hedgehogs DC's

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
TURKEY					
Gelibolu, Gemlik: Destroyers	1941–42	2	2,580	Surface: 3 or 4 x 5 in (127 mm) AA: 4 x 3 in (76 mm) or 4 x 40 mm	AS: 2 x Hedgehogs Homing torpedoes Torpedo tubes: 5 x 21 in (533 mm)
Kocatepe, Tinaztepe: Destroyers	1945	2	3,500	Dual purpose: 4 x 5 in (127 mm)	AS: 1 x Hedgehog Torpedo tubes: 2 x triple Mk 32 2 x Mk 28 Aircraft: can carry small helicopter
Zafer, Muavenet: Destroyers	1944–45	2	3,375	6 x 5 in (127 mm) 12 x 40 mm } *Muavenet* 11 x 20 mm }	2 x Hedgehogs } *Zafer* 8 torpedo tubes } Mines: 80 *(Muavenet)*
Izmir, Istanbul, Icel, Iskenderun, Izmit: Ex-*Fletcher* class: Destroyers	1943–44	5	3,050	Surface: 4 x 5 in (127 mm) AA: 6 x 3 in (76 mm)	AS: 2 x Hedgehogs Torpedo tubes: 5 x 21 in (533 mm)
UNITED STATES					
Northampton: Command ship (in reserve)	1953	1	17,200	Dual purpose: 1 x 5 in (127 mm)	Helicopters: 2 normally carried not armed
Wilkinson: Frigate	1954	1	4,730	Dual purpose: 2 x 5 in (127 mm)	AS: 2 x triple torpedo tubes Mk 32 4 x torpedo tubes Mk 23 Facilities for helicopters
Norris, McCaffery: Modernised *Gearing* class (FRAM II): Destroyers	1945	2	3,500 approx	Dual purpose: 4 x 5 in (127 mm)	AS: 1 x Hedgehog Mk 15 2 x triple torpedo tubes, Mk 32 Aircraft: Facilities for small helicopter
Modernised *Allen M. Sumner* class: Destroyers	1944–45	24	3,320	Dual purpose: 6 x 5 in (127 mm)	AS: 2 x triple torpedo tubes Mk 32 2 x ahead firing Hedgehogs Aircraft: Facilities for small helicopter
Later *Fletcher* class: Destroyers (in reserve)	1943–44	17	3,050	Dual purpose: 4 or 5 x 5 in (127 mm) AA: 10 x 40 mm or 6 x 3 in (76 mm)	AS: DC's 2 x fixed Hedgehogs 2 x triple torpedo tubes Mk 32 in some ships Torpedo tubes: 5 or 10 x 21 in (533 mm) (removed from some ships)
Fletcher class: Destroyers (all in reserve)	1942–44	15	3,050	Dual purpose: 4 or 5 x 5 in (127 mm) AA: 6 x 40 mm or 6 x 3 in (76 mm)	AS: DC's 2 x fixed Hedgehogs 2 x triple torpedo tubes Mk 32 in some ships Torpedo tubes: 5 or 10 x 21 in (533 mm)
John C. Butler class: Escort ships	1944	5	2,100	Dual purpose: 2 x 5 in (127 mm) AA: 2/8 x 40 mm	AS: 1 x Hedgehog DC racks
Vandivier, Wagner: Converted *John C. Butler* class: Radar picket escort ships	1943	2	2,100	Dual purpose: 2 x 5 in (127 mm)	AS: 1 x trainable Hedgehog (Mk 15) DC's
Former LSMR Inshore fire support ships	1945	7	1,084	1 x 5 in (127 mm) dp 4 x 40 mm AA	8 x twin launchers for 5 in rockets
Carronade: Inshore fire support ship	1955	1	1,500	1 x 5 in (127 mm) dp 4 x 40 mm AA 2 x 20 mm AA	8 x rapid fire launchers for 5 in rockets

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Mount McKinley class: Amphibious command ships	1944–46	4	12,560	Dual purpose: 1 x 5 in (127 mm) AA: 4 x 40 mm	Utility helicopter carried
Ozark: Mine countermeasures ship	1944	1	9,040	2 x 5 in (127 mm)	Helicopters: 2 x RH-3A helicopters
US COAST GUARD					
Hamilton class: High endurance cutters	1967–72	12	3,050	Dual purpose: 1 x 5 in (127 mm) 2 x 81 mm mortars 4 x .50 cal MG	Helicopters: 1 x HH-52A or HH-3 helicopter AS: 2 x Hedgehogs (not in all ships) 2 x triple torpedo launchers Mk 32 (in ships without Hedgehog)
Owasco class: High endurance cutters	1945–46	11	1,913	Dual purpose: 1 x 5 in (127 mm) 2 x 81 mm mortars Several .50 cal MG	
Campbell class: High endurance cutters	1936–37	6	2,414	Dual purpose: 1 x 5 in (127 mm) Several .50 cal MG 2 x 81 mm mortars	
Unimak: Training cutter	1943	1	2,800	1 x 5 in	
USSR					
Kotlin class: Destroyers	1954–57	18	3,885	Dual purpose: 4 x 5.1 in (130 mm) AA: 16 x 57 mm 8 x 30 mm (in some)	AS: 6 x side thrown DC projectors or 2 x 16-barrelled ASW rocket launchers Torpedo tubes: 10 x 21 in (533 mm) Mines: 80 capacity
Neustrashimy: Tallin class: Destroyer	1954	1	4,300	Dual purpose: 4 x 5.1 in (130 mm) AA: 16 x 57 mm	AS: 2 x DC rocket launchers 2 x 16-barrelled ASW rocket launchers Torpedo tubes: 10 x 21 in (533 mm) Mines: 70 to 90 according to size
Skory class: Destroyers	1947 onwards	40	3,500	Surface: 4 x 5.1 in (130 mm) AA: 2 x 3.4 in (85 mm) 8 x 37 mm (4 twin) (5 x 57 mm in modernised ships)	AS: 4 x DCT Torpedo tubes: 10 x 21 in (533 mm) Mines: 80 capacity (Modernised ships have only 5 torpedo tubes and 2 x 16-barrelled ASW rocket launchers)
VIETNAM (REPUBLIC OF)					
Ex-US 311 ft. Coast Guard cutters: Frigates	1943–44	7	2,800	Dual purpose: 1 x 5 in (127 mm) several .05 cal Machine Gun	1 or 2 x 81 mm mortars in some
YUGOSLAVIA					
Split: Destroyer	1958	1	3,000	Surface: 4 x 5 in (127 mm) AA: 12 x 40 mm	AS: 2 x *Squids* 6 x DCT 2 x DCR Torpedo tubes: 5 x 21 in (533 mm) Mines: Capacity 40

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons

SHIPS CARRYING 4.5–4.7 in GUNS (6509.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
AUSTRALIA					
Vampire, Vendetta, Duchess: Daring class: Destroyers	1951–56	3	3,600	Surface: 6 x 4.5 in (115 mm) (4 in *Duchess)* AA: 6 x 40 mm (2 x 40 mm in *Duchess)*	AS: 1 x 3-barrelled DC mortar
BURMA					
T201, T202, T203, T204, T205: Torpedo boats	1956–57	5	64	AS MGB: 1 x 4.5 in (115 mm) 1 x 40 mm AA As MTB: 2 x 20 mm AA	Tubes: As MTB: 4 x 21 in (533 mm)
COLOMBIA					
Siete De Agosto, Veinte De Julio: Modified Swedish Halland Type: Destroyers	1958	2	3,300	Surface: 6 x 4.7 in (120 mm) AA: 4 x 40 mm	Torpedo tubes: 4 x 21 in (533 mm) AS: 1 x quadruple DC rocket launcher
EGYPT					
El Fateh: Ex-British Z Type: Destroyer	1944	1	2,575	Dual purpose: 4 x 4.5 in (115 mm) AA: 6 x 40 mm	AS 2 x DCT
FINLAND					
Karjala, Turunmaa: Corvettes	1968	2	770	Dual purpose: 1 x 4.7 in (120 mm) 2 x 40 mm AA 2 x 30 mm AA	AS: DC projectors
INDIA					
Rana, Rajput, Ranjit: Destroyers	1942	3	2,424	Surface: 4 x 4.7 in (120 mm) AA: 4 x 40 mm AA	AS: 4 x DCT Torpedo tubes 8 x 21 in (533 mm) *(Rana)*
Beas, Betwa, Brahmaputra: Leopard class: Anti-aircraft frigates	1958–60	3	2,515	Surface: 4 x 4.5 in (115 mm) 4 x 40 mm AA	AS: 1 x *Squid* 3-barrelled DC mortar
Talwar, Trishul: Whitby class: AS frigates	1960	2	*Talwar:* 2,545 *Trishul:* 2,557	Surface: 2 x 4.5 in (115 mm) AA: 4 x 40 mm	AS: 2 x Limbo 3-barrelled DC mortars
NETHERLANDS					
Friesland class: Frigates	1956–58	8	3,070	Surface: 4 x 4.7 in (120 mm) AA: 2 or 4 x 40 mm	AS: 2 x 4-barrelled DC mortars
Holland class: Frigates	1955	2	2,765	Surface: 4 x 4.7 in (120 mm) AA: 1 x 40 mm	AS: 2 x 4-barrelled DC mortars
PAKISTAN					
Badr: Battle class: Destroyer	1946	1	3,361	Surface: 4 x 4.5 in (115 mm) AA: 10 x 40 mm	AS: 1 x *Squid* triple DC mortar Torpedo tubes: 8 x 21 in (533 mm)
Shah Jahan: CH class: Destroyer	1945	1	2,545	Surface: 3 x 3.4 in (115 mm) AA: 6 x 40 mm	AS: 2 x *Squid* triple DC mortars Torpedo tubes: 4 x 21 in (533 mm)
Alamgir, Jahangir: CR class: Destroyers	1946	2	2,560	Surface: 3 x 4.5 in (115 mm) AA: 6 x 40 mm	AS: 2 x *Squid* triple DC mortars Torpedo tubes: 4 x 21 in (533 mm)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
PARAGUAY *Humaita, Paraguay:* River gunboats, (also fitted for minelaying)	1931	2	865	4 x 4.7 in (120 mm) 3 x 3 in AA 2 x 40 mm AA	Mines: 6
PERU *Ferre, Palacios: Ferre* class: Destroyers	1953–54	2	3,600	Surface: 6 x 4.5 in (115 mm) AA: 2 x 40 mm	AS: 1 x *Squid* 3-barrelled DC mortar Torpedo tubes: 5 x 21 in (533 mm)
SOUTH AFRICA *President Kruger, President Pretorius, President Steyn: President* class: AS frigates	1962–64	3	2,800	Surface: 2 x 4.5 in (115 mm) AA: 2 x 40 mm Bofors	AS: 1 x Limbo 3-barrelled DC mortar Aircraft: 1 x *Wasp* helicopter
SPAIN *Oquendo:* AS destroyer	1960	1	3,005	Surface: 6 x 4.7 in (120 mm) AA: 6 x 40 mm	AS: 2 x Hedgehogs 2 x Mk 4 torpedo racks with 3 Mk 32 homing torpedoes
SWEDEN *Öland, Uppland: Öland* class: Destroyers	1947–49	2	2,400	Dual purpose: 4 x 4.7 in (120 mm) AA: 6 x 40 mm	AS: 1 x triple-barrelled DC mortar Torpedo tubes: 6 x 21 in (533 mm) Mines: 60
Karlskrona: Frigate	1940	1	1,400	Dual purpose: 3 x 4.7 in (120 mm) AA: 4 x 40 mm	AS: 2 x triple-barrelled DC mortars
Visby class: Frigates	1943	4	1,320	Dual purpose: 3 x 4.7 in (120 mm) AA: 3 x 40 mm 2 x 57 mm (in two)	AS: 1 x 4-barrelled DC mortar 5 x 21 in tubes (in two)
UNITED KINGDOM *Eskimo, Tarter: Tribal* class, Type 81: General purpose frigates	1962–63	2	2,700	2 x 4.5 in (115 mm) 2 x 40 mm AA	Aircraft: 1 Westland *Wasp* AS: 1 x Limbo 3-barrelled DC mortar
Whitby class: Type 12: AS frigates	1956–58	4	2,560	Dual purpose: 2 x 4.5 in (115 mm) AA: 1 x 40 mm Bofors	AS: 2 x Limbo 3-barrelled DC mortars (*Eastbourne* disarmed)
Jaguar, Leopard, Lynx: Leopard class, Type 41: Anti-aircraft frigates	1957–59	3	2,520	Dual purpose: 4 x 4.5 in (115 mm) AA: 1 x 40 mm	AS: 1 x *Squid* 3-barrelled DC mortar
Chichester, Llandaff: Salisbury class, Type 61: Aircraft direction frigates	1958	2	2,408	Dual purpose: 2 x 4.5 in (115 mm) AA: 2 x 40 mm *(Llandaff)* 4 x 40 mm 2 x 20 mm *(Chichester)*	AS: 1 x *Squid* 3-barrelled DC mortar
VENEZUELA *Aragua, Zulia:* Destroyers	1954–56	2	3,670	Dual purpose: 6 x 4.5 in (115 mm) AA: 16 x 40 mm	AS: 2 x Hedgehogs 2 x DC racks Torpedo tubes: 3 x 21 in (533 mm)

SHIPS CARRYING 3.9–4.1 in GUNS (6510.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
ARGENTINA					
King class: Corvettes	1945	2	1,032	Surface: 3 x 4.1 in (105 mm) AA: 4 x 40 mm Bofors 2 x MG	AS: 4 x DCT
BULGARIA					
Druzki, Smeli: Riga class: Medium escort frigates	1956	2	1,600	3 x 3.9 in (100 mm) 4 x 37 mm	Tubes: 3 x 21 in (533 mm) 2 x 16-barrelled MBUs 4 DCT
BURMA					
Mayu: Ex-British *River class:* Frigate	1943	1	2,170	Dual purpose: 1 x 4 in (102 mm) AA: 4 x 40 mm	
Yan Myo Aung: Ex-British *Algerine* class: Escort minesweeper	1945	1	1,335	Surface: 1 x 4 in (102 mm) AA: 4 x 40 mm	
CHINA (PEOPLE'S REPUBLIC)					
Kiangnan class: Destroyers	1965–69	5	1,350	Dual purpose: 3 x 3.9 in (100 mm) 6 or 8 x 37 mm 4 or 8 x 25 mm	
Chang Pai: Ex-Japanese *Etorofu:* Escort	1942	1	870 (standard)	Surface: 3 x 3.9 in (100 mm) 3 x 37 mm	
Kai Feng, Lin I: Ex-British *Flower:* Escorts	1941	2	1,020 (standard)	Surface: 2 x 3.9 in (100 mm)	
Loyang	1941	1	815	2 x 3.9 in 4 x 37 mm	
DOMINICAN REPUBLIC					
Cristobal Colon, Juan Alejcandro Acosta: Ex-Canadian *Flower* class: Corvettes	1943–44	2	1,350	Surface: 1 x 4 in (102 mm) AA: *(Acosta)* 1 x 40 mm 6 x 20 mm 2 x 0.5 in (12.7 mm) MG AA: *(C. Colon)* 2 x 40 mm 8 x 20 mm 4 x 0.5 in (12.7 mm) MG	
Mella: Ex-Canadian *River* class: Frigate	1944	1	2,125	1 x 4 in (102 mm) 2 x 47 mm 1 x 40 mm 4 x 20 mm	
ECUADOR					
Presidente Alfaro, Presidente Velasco Ibarra: Ex-British *Hunt* (Type 1) class: Escort Destroyers	1940–41	2	1,490	Surface: 4 x 4 in (102 mm) AA: 2 x 20 mm	AS: DC throwers DC racks
EGYPT					
Tarik: Ex-British *Black Swan* class: Escort	1943	1	1,925	Surface: 6 x 4 in (102 mm) AA: 4 x 40 mm 2 x 20 mm	AS: 4 x DCT
Raschid: Ex-British *River* class: Escort	1942	1	2,216	Surface: 1 x 4 in (102 mm) AA: 2 x 40 mm 6 x 20 mm	AS: 4 x DCT

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Port Said: Ex-British *Hunt* class: Escort	1940	1	1,490	Surface: 4 x 4 in (102 mm) AA: 2 x 37 mm 2 x 50 mm	AS: 2 x DCT
El Sudan: Ex-British *Flower* class: Escort	1940	1	1,340	Surface: 1 x 4 in (102 mm) AA: 2 x 20 mm	
Nasr: Ex-British *Bangor* class: Corvette	1941	1	900	1 x 4 in (102 mm) 1 x 3 in (76 mm) 2 x 40 mm AA	AS: 2 x DCT
FINLAND					
Matti Kurki: Training frigate	1946	1	2,420	Surface: 4 x 4 in (102 mm) AA: 6 x 40 mm	
Hameenmaa, Uusimaa: Uusimaa class: Frigates	–	2	1,600	Dual purpose: 3 x 3.9 in (100 mm) AA: 2 x 40 mm	AS: 1 x Hedgehog 4 x DC projectors Torpedo tubes: 3 x 21 in (533 mm) Mines: 50 capacity
FRANCE					
Jeanne D'Arc: Helicopter cruiser	1964	1	12,365	AA: 4 x 3.9 in (100 mm)	Aircraft: 4 x Heavy AS helicopters (8 in wartime)
Commandant Riviere class: Frigates	1962–71	9	2,250	AA: 3 x 3.9 in (100 mm) (2 in 3 only) 2 x 30 mm	AS: 1 x 12 in (305 mm) quadruple mortar Torpedo tubes: 6 x 21 in (533 mm) ASM 1 x light helicopter land aft
Le Brestois: Le Corse class: Frigate	1954	1	1,702	AA: 1 x 3.9 in (100 mm) 4 x 57 mm 2 x 20 mm	AS: 2 x mortars 1 x DC rack 1 x sextuple *lance roquettes* Torpedo tubes: 12 x ASM tubes for homing torpedoes
New construction Type A69: Escorts	1974 onwards	12	1,170	AA: 1 x 3.9 in (100 mm) 2 x 20 mm	AS: 1 x sextuple mortar (375 mm) 4 x fixed torpedo tubes
GERMANY (DEMOCRATIC REPUBLIC)					
Ex-USSR Riga Type: Escorts		2	1,600	3 x 3.9 in (100 mm) 4 x 37 mm AA	Tubes: 3 x 21 in (533 mm) AS: 4 x DC projectors 2 rocket launchers
GERMANY (FEDERAL REPUBLIC)					
Hamburg, Bayern, Hessen, Schleswig Holstein: Hamburg class: Destroyers	1964–68	4	4,400	Dual purpose: 4 x 3.9 in (100 mm) AA: 8 x 40 mm	AS: 2 x Bofors 4-barrelled DC mortars Torpedo tubes: 5 x 21 in (533 mm) 2 x 12 in for AS torpedoes
Koln class: Frigates	1961–64	6	2,550	Dual purpose: 2 x 3.9 in (100 mm) AA: 6 x 40 mm	AS: 2 x Bofors 4-barrelled DC mortars (Rocket launchers) Torpedo tubes: 2 for ASW torpedoes
Rhein class: Support ships	1961–64	13	2,800 (except *Lech* and *Lahn* 2,680)	AA: 2 x 3.9 in (100 mm) *Lech* and *Lahn:* 4 x 40 mm	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
GHANA					
Kromantse class: Corvettes	1964 65	2	500	1 x 4 in (102 mm) 1 x 40 mm AA	AS: 1 x *Squid* 3-barrelled DC mortar
INDIA					
Ganga, Godavari, Gomati: Hunt class Type II: Escort destroyers	1941	3	1,610	Dual purpose: 6 x 4 in (102 mm) AA: 4 x 20 mm	
Kistna, Kaveri: Kistna class: Frigates	1943	2	1,925	Surface: 4 x 4 in (102 mm) AA: 4 x 40 mm	AS: 2 x DCT
Tir: River class: Training frigate	1942	1	1,934	Surface: 1 x 4 in (102 mm) AA: 1 x 40 mm 2 x 20 mm	
INDONESIA					
Surapati class: Frigates	1958	2	1,500	AA: 4 x 4 in (102 mm) 6 x 20 mm	AS: 2 x Hedgehogs 4 x DCT Tubes: 3 x 21 in (533 mm)
Ex-USSR *Riga* class: Frigates	–	4	1,600	Dual purpose: 3 x 3.9 in (100 mm) AA: 4 x 37 mm	AS: 4 x DC projectors Tubes: 3 x 21 in (533 mm) Fitted with mine rails
LIBYA					
Tobruk: Corvette	1966	1	500	1 x 4 in (102 mm) 4 x 40 mm AA	
MEXICO					
Durango: Frigate	1936	1	2,000	Surface: 2 x 4 in (102 mm) 2 x 57 mm AA: 4 x 20 mm	
Guanajuato, Potosi, Queretaro: Guanajuato class: Frigates	1934	3	1,950	Surface: 3 x 4 in (102 mm) AA: 4 x 20 mm	
MOROCCO					
Al Maouna: Frigate	1944	1	2,150	Surface: 2 x 4.1 in (105 mm) AA: 3 x 40 mm 2 x 20 mm	Helicopters: 1 AS: 1 x Hedgehog 4 x DCT 2 x DC racks
NIGERIA					
Nigeria: Frigate	1965	1	2,000	Dual purpose: 2 x 4 in (102 mm) AA: 5 x 40 mm	AS: 1 x 3-barrelled DC mortar
Dorina, Otobo: Mk 3 Vosper Thornycroft Type: Corvettes	1972	2	650	2 x 4 in (102 mm) 2 x 40 mm 2 x 20 mm	
PAKISTAN					
Tippu Sultan, Tughril: Frigates	1941–42	2	2,300	Dual purpose: 2 x 4 in (102 mm) AA: 5 x 40 mm	AS: 2 x *Squid* triple DC mortars Torpedo tubes: 4 x 21 in (533 mm)
POLAND					
Blyskawica 271: Destroyer	1937	1	3,383	Dual purpose: 8 x 3.9 in AA: 10 x 37 mm	AS: 4 x DCT 22 x DC and racks Torpedo tubes: 3 x 21 in (533 mm)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
PORTUGAL					
Commandante Joao Belo class: Frigates	1967–69	4	2,230	AA: 2 x 3.9 in (100 mm) 2 x 40 mm	AS: 1 x 12 in (305 mm) quadruple Torpedo tubes: 6 x 21.7 in (550 mm) ASM
SOUTH AFRICA					
Jan Van Riebeeck, Simon Van Der Stel: Destroyers	1944	2	2,850	Surface: 4 x 4 in (102 mm) AA: 2 x 40 mm	Helicopters: 2 x Westland *Wasps* Torpedo tubes: 4 x 21 in (533 mm) AS: 2 x DCT 2 x DC racks 6 x AS tubes
Vrystaat: Frigate	1944	1	2,880	Surface: 2 x 4 in (102 mm) AA: 2 x 40 mm Bofors	AS: 2 x *Squid* triple DC mortars
Good Hope, Transvaal: Frigates	1944–45	2	2,450	Surface: 2 x 4 in (102 mm) AA: *Transvaal:* 6 x 40 mm Bofors *Good Hope:* 2 x 40 mm Bofors	AS: 2 x *Squid* triple DC mortars
Pietermaritzburg: Escort minesweeper	1943	1	1,330	Surface: 2 x 4 in (102 mm) AA: 2 x 40 mm Bofors	AS: 4 x DCT
SRI LANKA					
Gajabahu: Ex-Canadian *River* class: Frigate	1944	1	2,360	Surface: 1 x 4 in (102 mm) AA: 3 x 40 mm	
THAILAND					
Phosamton: Escort minesweeper	1945	1	1,335	Surface: 1 x 4 in (102 mm) AA: 6 x 20 mm	AS: 4 x DCT
TURKEY					
Alanya, Ayvalik: Escorts	1942	2	1,025	Surface: 1 x 4 in (102 mm) AA: 1 x 40 mm 4 x 20 mm	AS: 2 x DCT
UNITED KINGDOM					
Mermaid: Frigate	1973	1	2,520	Surface: 2 x 4 in AA: 4 x 40 mm	AS: 1 *Squid*
USSR					
Kola class: Frigates	1950–52	6	1,900	Dual purpose: 4 x 3.9 in (100 mm) AA: 4 x 37 mm	AS: DCTs and racks Torpedo tubes: 3 x 21 in (533 mm)
Riga class: Frigates	1952 59	40	1,600	Dual purpose: 3 x 3.9 in (100 mm) AA: 4 x 37 mm	AS: 2 x 16-barrelled rocket launchers 4 x DC projectors Torpedo tubes: 3 x 21 in (533 mm)
VENEZUELA					
Almirante Clemente class: Frigates	1956- 57	6	1,500	Dual purpose: 4 x 4 in (102 mm) AA: 4 x 40 mm 8 x 20 mm in some ships only	AS: 2 x Hedgehogs 4 x DCT 2 x racks Modified group: 1 x *Squid* 4 x DCT 2 x racks Torpedo tubes: 3 x 21 in (533 mm) in non-modified group only

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
VIETNAM (REPUBLIC OF)					
Ex-US Monitors: Riverine craft	1965	42	80–90	1 x 105 mm howitzer 2 x 20 mm 3 x .30 cal MG	2 x 40 mm grenade launchers

SHIPS CARRYING 3.4–3.7 in GUNS
(6511.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
ALBANIA					
Kronstadt class: Corvettes	1956	4	380	1 x 3.5 in 2 x 37 mm AA 3 x 20 mm AA	AS: DC
BULGARIA					
Kronstadt class: Corvettes	–	2	380	1 x 3.5 in 2 x 37 mm AA 3 x 20 mm AA	AS: DC
CHINA (PEOPLE'S REPUBLIC)					
Ex *Ying Hao:* River defence vessel	1933	1	185 (standard)	1 x 3.7 in howitzer	
Ex *Nan Chiang:* River defence vessel	1931	1	372 (standard)	1 x 3.7 in howitzer 2 x 6 pdr	
Kronstadt Type: Corvettes	1950–57	20	380	1 x 3.5 in 2 x 37 mm AA 3 x 20 mm AA	AS: 2 x Rocket launchers
CUBA					
Ex-USSR Kronstadt Type: Corvettes		6	380	1 x 3.5 in 2 x 37 mm AA 3 x 20 mm AA	AS: DC 6 mines
GERMANY (DEMOCRATIC REPUBLIC)					
Krake class: Minesweepers	1956–58	6	650 (standard)	1 x 3.4 in (86 mm) 10 x 25 mm AA	AS: 4 x DCT
INDONESIA					
Ex-USSR Bk class: Coastal gunboats	1960	18	120	1 x 85 mm 4 x 25 mm AA	
Ex-USSR Kronstadt Type: Corvettes	1951–54	14	380	1 x 3.5 in 2 x 37 mm AA 3 x 20 mm AA	AS: Depth charge projectors Mines: fitted for laying
IRAQ					
No. 1, No. 2, No. 3, No. 4: Patrol boats	1937	4	67	1 x 3.7 in howitzer 4 x MG	AS: 2 x 3 in (76 mm) mortars
POLAND					
Ex-USSR *Kronstadt* class: Corvettes	1953–55	2	380	1 x 3.5 in 2 x 37 mm AA 4 x 13 mm MG AA	
ROMANIA					
Kronstadt class: Corvettes	1950	3	380	1 x 3.5 in 2 x 37 mm AA 6 x .5 MG	AS: DC
USSR					
Kronstadt class: Corvettes	1948–56	20	380	1 x 3.5 in 2 x 37 mm AA	AS: DC projectors

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons

SHIPS CARRYING 3 in or 3.1 in GUNS (6512.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
ALGERIA					
Sidi Fradj: Training ship	1945	1	270	1 x 3 in (76 mm) 2 x 20 mm AA	
ARGENTINA					
Intrepida, Indomita: New Construction: Fast patrol vessels	1974	2	240	1 x 3 in (76 mm) AA 2 x 40 mm AA	2 x 21 in torpedo tubes
BRAZIL					
Ex-US DE Type: *Bertioga* class: Frigates	1943	4	1,900	Dual purpose: 3 x 3 in (76 mm) AA: 2 x 40 mm 4 x 20 mm	Torpedo tubes: 3 x 21 in (533 mm) 2 x DC racks
Imperial Marinheiro class: Corvettes	1955	10	911 (standard)	1 x 3 in (76 mm) 4 x 20 mm AA	
Parnaiba: River monitor	1937	1	720	1 x 3 in (76 mm) 2 x 47 mm 2 x 40 mm AA 6 x 20 mm AA	
BURMA					
Yan Taing Aung: Patrol vessel	1943	1	903	1 x 3 in (76 mm) 2 x 40 mm AA 8 x 20 mm AA	AS weapons: 1 x Hedgehog 2 x DCT 2 x DC racks
Yan Gyi Aung: Patrol vessel	1944	1	945	1 x 3 in (76 mm) 4 x 40 mm AA 4 x 20 mm AA	
CANADA					
Annapolis, Nipigon: Annapolis class: Destroyer helicopter escorts	1964	2	3,000	2 x 3 in (76 mm)	AS: 1 x Limbo 3-barrelled depth charge mortar Aircraft: 1 x CHSS-2 *Sea King* helicopter
Mackenzie, Qu'appelle, Saskatchewan, Yukon: Mackenzie class: Destroyer escorts	1962–63	4	2,890	4 x 3 in (76 mm)	AS: 2 x Limbo 3-barrelled depth charge mortars
St Laurent class: Destroyer escorts	1956–57	6	2,800	2 x 3 in (76 mm)	AS: 1 x Limbo 3-barrelled depth charge mortar 1 Helicopter
CHILE					
Lautaro, Lientur: Patrol vessels	1942–44	2	835	1 x 3 in (76 mm) AA 2 x 20 mm AA	
Aldea: Patrol vessel	1943	1	1,675	1 x 3 in (76 mm) AA	
CHINA (PEOPLE'S REPUBLIC)					
Chang Sha, Chi Nan, Hsi An, Wu Chang, Tung An: Ex-Japanese D: Escorts	1944 45	5	740 (standard)	2 x 3 in (76 mm) or 5 x 37 mm	
Ex-US YMS Type: Coastal minesweepers	1942 43	4	350	1 x 3 in (76 mm) 2 x 20 mm	2 x DCT
Ting Hsin, Tung Teh: Coast defence vessels		2	500 (standard)	1 x 3 in (76 mm) 4 x 47 mm	
Ex-*Chang Teh:* River defence vessel	1923	1	305 (standard)	2 x 3 in (76 mm)	
Ex *Ying Shan:* River defence vessel	1927	1	310 (standard)	2 x 3 in (76 mm) AA	
Ex *Mei Yuan,* Ex *Tai Yuan:* River defence vessels	1927	2	370 (standard)	2 x 3 in (76 mm)	
Ex *Kiang Kun:* River defence vessel	1921	1	180 (standard)	2 x 3 in (76 mm)	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Ex *Fahu:* River defence vessel	1921	1	201 (standard)	1 x 3 in (76 mm) AA	
Ex *Ho Hsueh:* River defence vessel	1911	1	215 (standard)	2 x 3 in (76 mm)	
Fu Chiang, Ex *Chiang Hsi:* River defence vessels	1939–40	2	320 (standard)	1 x 3.1 in 8 x 25 mm	
Ex *No. 4, No. 201:* Ex-Japanese AMS Type: Coastal minesweepers	1943	2	222	1 x 3.1 in (78 mm) 4 x 25 mm (*No. 201:* 1 x 40 mm 1 x 25 mm 2 x 13 mm 3 x 7.7 mm)	
Ex-British Bar Type: Boom defence vessel	1938	1	1,000	1 x 3 in (76 mm) dp 6 x MG	
Ex-US Tree Type: Boom defence vessels		5	805	1 x 3 in (76 mm) AA	
COLOMBIA					
Cartegena: River gunboat	1930	1	142	2 x 3 in (76 mm) 1 x 20 mm AA 4 x MG	
Arauca, Leticia, Riohacha: River gunboats	1956	3	184	Dual purpose: 2 x 3 in (76 mm) 4 x 20 mm	
DENMARK					
Hvidbjornen, Fylla, Ingolf, Vaedderen: Hvidbjornen class: +1 building: Frigates	1962–63	4 + 1	1,650	Dual purpose: 1 x 3 in (76 mm)	Helicopters: 1 x Alouette III
Triton, Bellona, Diana, Flora: Triton class: Corvettes	1955–57	4	873	Surface: 2 x 3 in (76 mm) AA: 1 x 40 mm	AS: 2 x Hedgehogs 4 x DCT
Missile boats	1975–76	8	220	1 x 3 in (76 mm) or 1 x 57 mm	Torpedo tubes: 4 x 21 in (533 mm) Guided weapons: to be installed
DOMINICAN REPUBLIC					
Cap General Pedro Santana, Gregorio Luperon: Ex-US *Tacoma* class: Frigates	1944	2	2,415	Surface: 3 x 3 in (76 mm) AA: 4 x 40 mm 6 x 20 mm 4 x 0.5 in (12.7 mm) MG	
Separacion, Tortugero: Ex-US MSF Type: Minesweepers	1944	2	900	1 x 3 in (76 mm) 2 x 40 mm AA 6 x 20 mm AA	
Independencia, Libertad, Restauracion: Ex-US CG, WPC Type: Patrol vessels	1932–33	3	337 (standard)	1 x 3 in (76 mm) 1 x 40 mm AA 1 x 20 mm AA	
ECUADOR					
Esmeraldas, Manabi: Ex-US PCE Type: Escort patrol vessels	1943–44	2	903	Dual purpose: 1 x 3 in (76 mm) AA:	AS: 4 x DCT 2 DC racks
FINLAND					
Tursas: Coast guard vessel	1933	1	400	1 x 3 in (76 mm) 1 x 40 mm AA 2 x 20 mm AA	
GABON					
President Leon M'ba: Patrol boat	1968	1	85 (standard)	1 x 75 mm 1 x 12.7 mm MG	
GREECE					
Aetos, Ierax, Leon, Panthir: Ex-US *Bostwick* DE class: Frigates	1943–44	4	1,900	Dual purpose: 3 x 3 in (76 mm) AA: 6 x 40 mm 14 x 20 mm	AS: Hedgehog 8 x DCT 1 x DC rack Torpedo racks: Side launching for AS torpedoes

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Ex-British Algerine Type: Corvettes (*Mahitis* not included as she carries no armament)	1942–43	4	1,325	Dual purpose: 2 x 3 in (76 mm) (1 in *Pirpolitis*) AA: 4 x 20 mm 2 x MG	AS: 2/4 x DCT
Antiploiarkhos Pezopoulos, Plotarkhis Arslanoglou, Plotarkhis Chantzikonstandis: PGM Type: Patrol vessels	1943–44	3	439	1 x 3 in (76 mm) 6 x 20 mm AA	AS: Hedgehog Side launching torpedo racks; DCs
Plotarkhis Maridakis, Plotarkhis Vlachavas: LSSL Type: Patrol vessels	1944	2	395	1 x 3 in (76 mm) 4 x 40 mm AA 4 x 20 mm AA	
INDIA					
Androtch, Anjadip, Arnala, Kadmatt, Kamorta, Kavaratti, Katchal, Kiltan: Petya class: Frigates	approx 1965	8	1,150	Dual purpose: 4 x 3 in (76 mm)	Tubes: 5 or 3 x 16 in 4 x MBUs
INDONESIA					
Pattimura, Sultan Hasanudin: Pattimura class: Frigates	1958	2	1,200	AA: 2 x 3 in (76 mm) 2 x 30 mm	AS: 2 x Hedgehog 4 x DCT
Ex-US PC Type: Patrol vessels	1942–43	4	450	1 x 3 in (76 mm) 1 x 40 mm AA 2 x 20 mm AA	AS: 4 x DCT
Ex-Yugoslavian Kraljevica Type: Patrol boats	1958	6	245	1 x 3 in (76 mm) 1 x 40 mm AA 6 x 20 mm AA	AS: 1 x DC
IRAN					
Bayandor, Kahnamuie, Milanian, Naghdi: US PF Type: Corvettes	1964–69	4	1,135	Surface: 2 x 3 in (76 mm) AA: 2 x 40 mm	AS: 1 x Hedgehog 4 x DCT
ITALY					
Alpino, Carabiniere: Frigates	1968	2	2,700	Dual purpose: 6 x 3 in (76 mm)	Helicopters: 2 x AB 204B ASW AS: 1 single-barrelled DC mortar Tubes: 2 x triple 12 in (305 mm) for AS torpedoes
Aldebaran: Frigate	1944	1	1,900	Surface: 3 x 3 in (76 mm) AA: 6 x 40 mm 18 x 20 mm	AS: 1 x Hedgehog 8 x DCT 2 x DC racks
Centauro, Canopo, Cigno, Castore: Centauro class: Frigates	1957–58	4	2,250	AA: 3 x 3 in (76 mm)	AS: 1 x 3-barrelled DC mortar Torpedo tubes: 6 x launchers for AS torpedoes
Carlo Bergamini, Carlo Margottini, Luigi Rizzo, Virginio Fasan: Bergamini class: Frigates	1961–62	4	1,650	AA: 2 x 3 in (76 mm)	AS: 1 x single-barrelled DC mortar Torpedo tubes: 6 x 12 in (305 mm) for A/S torpedoes Helicopters: 1 x A/B-47 J3
Licio Visintini, Pietro De Cristofaro, Salvatore Todaro, Umberto Grosso: De Cristofaro class: Corvettes	1965–66	4	1,020	Dual purpose: 2 x 3 in (76 mm)	AS: 1 single-barrelled DC mortar Torpedo tubes: 2 x triple for AS torpedoes

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
JAPAN					
Ayanami class: AS destroyers	1958–60	7	2,500	AA: 6 x 3 in (76 mm)	AS: 2 x US model Mk 15 Hedgehogs 2 x Y-guns 2 x DC racks Torpedo tubes: 4 x 21 in (533 mm) Torpedo launchers: 4 fixed, for AS homing torpedoes
Isuzu, Kitakami, Mogami, Oi: Isuzu class: Frigates	1961–64	4	1,700	Dual purpose: 4 x 3 in (76 mm)	AS: 1 x 4-barrelled rocket launcher 1 x DCT 1 x DC rack *Isuzu:* Mk 108 rocket launcher Torpedo tubes: 4 x 21 in (533 mm) Torpedo launchers: 2 x triple for AS homing torpedoes
Ikazuchi, Inazuma: Ikazuchi class: Frigates	1956	2	1,300	Dual purpose: 2 x 3 in (76 mm) AA: 2 x 40 mm	AS: 1 x Hedgehog 8 x K-guns 2 x DC racks
Akebono: Frigate	1956	1	1,350	AA: 2 x 3 in (76 mm) 1 x 40 mm	AS: 4 x K-guns 1 x Hedgehog 1 x DC rack
Asahi, Hatsuhi: Asahi class: Frigates	1943	2	1,900	Dual purpose: 3 x 3 in (76 mm)	AS: 8 x K-guns 1 x DCT
Sooya: Minelayer	1971	1	2,500	2 x 3 in (76 mm)	Torpedo tubes: 6 x AS type 200 mines
Erimo, Satsuma: Large patrol boats (MSA)	1965–66	2	1,009 (normal)	1 x 3 in (76 mm) 1 x 20 mm AA	
Kojima: Large patrol vessel (MSA)	1964	1	1,100	1 x 3 in (76 mm) 1 x 40 mm AA 1 x 20 mm AA	
Muroto class: Large patrol vessels (MSA)	1950	2	840 (normal)	1 x 3 in (76 mm) 2 x 20 mm AA	
Chifuri class: Medium patrol vessels (MSA)	–	5	483 (normal)	1 x 3 in (76 mm) 1 x 20 mm AA	
Rebun class: Medium patrol vessels (MSA)	1951	14	495 (normal)	1 x 3 in (76 mm) 1 x 20 mm AA	
KHMER REPUBLIC					
E311, E312: Ex-US PC Type: Patrol vessels	–	2	400	1 x 3 in dp (76 mm) 1 x 40 mm AA 4 x 20 mm AA	
P111: Ex-US LSIL Type: Support gunboat	–	1	387	1 x 3 in (76 mm) 1 x 40 mm AA 2 x 20 mm AA	
P112: Ex-US LSIL Type: Support gunboat	–	1	350	1 x 3 in (76 mm) 5 x 20 mm AA	
KOREA (REPUBLIC OF)					
Kyong Ki, Kang Won: Ex-US *Bostwick* class: Frigates	1944	2	1,700	Dual purpose: 3 x 3 in (76 mm) AA: 6 x 40 mm 4 x 20 mm	AS: 1 x Hedgehog DC's Torpedo tubes: 6 x 12.7 in (324 mm)
Paek Ku: Patrol vessel	1970	1	245	AA: 1 x 3 in (76 mm) 1 x 40 mm 4 x .50 cal MG	
Shin Song, Sunchon, Koje: Ex-US *Auk:* MSF Type: Patrol vessels	1942–44	3	1,250	AA: 2 x 3 in (76 mm) 4 x 40 mm 4 x 20 mm	Tubes: 3 x 12.7 in (324 mm) AS: DC's 1 x Hedgehog

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Ex-US 185 ft Steel PCE Type: Patrol vessels	1943–44	8	950	AA: 1 x 3 in (76 mm) 6 x 40 mm (4 x 40 mm in *Ko Jin)* 4/8 x 20 mm	1 x Hedgehog (except *Ko Jin)* DC's
Ex-US 173 ft Steel PC Type: Patrol vessels	1942–44	3	450	AA: 1 x 3 in (76 mm) 1 x 40 mm 4 x 20 mm	AS: 1 x Mousetrap DC's
MEXICO					
Ex-US MSF Type: Escort minesweepers	1943–44	15	945	Dual purpose: 1 x 3 in (76 mm) 2 x 40 mm AA 4/6 x 20 mm	
Ex-US *Auk* class	1945	19	1,250	1 x 3 in (76 mm) 2 or 4 x 40 mm	
MOROCCO					
Lieutenant Riffi: Patrol vessel	1964	1	374	Dual purpose: 1 x 3 in (76 mm) 2 x 40 mm AA	AS: 2 x ASM mortars 1 x DC rack
NETHERLANDS					
Wolf class: Corvettes	1954	6	975	Dual purpose: 1 x 3 in (76 mm) AA: 6 x 40 mm *(Jaguar* and *Panter:* 4 x 40 mm) 8 x 20 mm	AS: 1 x Hedgehog 2 x DCT *(Jaguar* and *Panter:* 4 x DCT) 2 x DC racks
NORWAY					
Brage, Gor, Tyr: Gor class: Coastal minelayers	1942–44	3	1,250	1 x 3 in (76 mm) 4 x 20 mm AA	AS: 2 x Hedgehogs 3 x DCT
PARAGUAY					
Captain Cabral: River patrol boat	1907	1	206	1 x 3 in (76 mm) Vickers 2 x 37 mm Vickers 4 x MG	
PERU					
Castilla, Aguirre, Rodriguez: Ex-US *Canon* class: Destroyer escorts	1943	3	1,900	Dual purpose: 3 x 3 in (76 mm) AA: 6 x 40 mm 10 x 20 mm	AS: 1 x Mk 10 ahead throwing mortar 8 x K-mortars 2 x DC racks
Galvez, Diez Canseco: Ex-US *Auk* class: Patrol vessels	1945	2	1,250	Dual purpose: 1 x 3 in (76 mm) 2 x 40 mm AA	AS: 1 x Hedgehog
Bondy, San Martin: Ex-US *YMS* class: Coastal minesweepers	1943	2	325	1 x 3 in (76 mm) 2 x 20 mm AA	
Maranon, Ucayali: Maranon class: River gunboats	1951	2	365	Dual purpose: 2 x 3 in (76 mm) 7 x 20 mm AA	
Loreto, Amazonas: Loreto class: River gunboats	1934	2	250 (standard)	1 x 3 in (76 mm) 2 x 47 mm 2 x 20 mm AA	
Chimbote: LST	1943	1	4,050	1 x 3 in	
PHILIPPINES					
Datu Kalantiaw: Frigate	1943	1	1,620	AA: 3 x 3 in (76 mm) 6 x 40 mm 2 x 20 mm	AS: 6 x 12.75 in (324 mm) torpedo tubes DC's
Cebu, Iloilo, Leyte, Negros Occidental, Pangasinan: Patrol vessels	1943–45	5	850	1 x 3 in (76 mm) 3 or 6 x 40 mm 4 x 20 mm	AS: 2 x 12.75 in (324 mm) torpedo tubes DC's Hedgehogs (in some)
Quezon, Rizal: Ex-US *Auk* class: Escort vessels	1943–44	2	1,250	AA: 2 x 3 in (76 mm) 4 x 40 mm 4 x 20 mm	AS: 3 x 12.75 in (324 mm) torpedo tubes 1 x Hedgehog DC's

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Batangas, Nueva Ecija, Nueva Viscaya, Capiz: Patrol vessels	1942–44	4	450	1 x 3 in (76 mm) 1 x 40 mm AA 5 x 20 mm AA	AS: DC's
PORTUGAL					
Almirante Pereira Da Silva class: Fast frigates	1966–68	3	1,914	Dual purpose: 4 x 3 in (76 mm)	AS: 2 x Bofors 4-barrelled mortars 2 x DCT Torpedo tubes: 6 x for AS torpedoes
Pero Escobar: Fast frigate	1957	1	1,390	Dual purpose: 4 x 3 in (76 mm)	AS: 2 x *Squid* triple DC mortars Torpedo tubes: 6 x for AS torpedoes
Joao Countinho class: Corvettes	1970 onwards	6 + 4	1,380	Dual purpose: 2 x 3 in (76 mm) 2 x 40 mm AA Last 4 to mount 1 x 3.9 in	AS: 1 x Hedgehog 2 x DCT 2 x DC racks
SINGAPORE					
Sovereignty, Daring, Dauntless: Fast patrol craft	1971–72	3	130	1 x 3 in (76 mm) Bofors 1 x 20 mm Oerlikon	
SPAIN					
Audaz class: Destroyers	1960–65	5	1,550	Dual purpose: 2 x 3 in (76 mm) 2 x 40 mm AA	AS: 2 x Hedgehogs 8 x mortars 2 x DC racks Torpedo racks: 2 x side launching for AS torpedoes (6 torpedoes)
Alava, Liniers: Alava class: Destroyers	1950–51	2	2,287	3 x 3 in (76 mm) 3 x 40 mm AA	AS: 2 x Hedgehogs 8 x DC mortars 6 x DC racks Torpedo racks: 2 side-launching, 6 AS torpedoes
Jupiter, Vulcano: Jupiter class: Frigates	1937	2	2,360	4 x 3 in (76 mm) 2 x 40 mm AA	AS: 2 x Hedgehogs 8 x mortars 2 x DC racks Mines: *Jupiter* 254, *Vulcano* 238
Atrevida class: Corvettes	1959–60	4	1,135	Dual purpose: 1 x 3 in (76 mm) AA: 3 x 40 mm	AS: 2 x Hedgehogs 8 x mortars 2 x DC racks Mines: 20 can be carried
SYRIA					
Ex-French CH Type: Patrol vessels	1940	3	131	1 x 3 in (76 mm) 2 x 20 mm AA	AS: DC
TAIWAN (CHINA)					
Wu Sheng, Chu Yung, Mo Ling: Ex-US MSF Type: Patrol vessels	1942–45	3	1,250	2 x 3 in (76 mm) AA 4 x 40 mm AA 4 x 20 mm AA	AS: 1 x Hedgehog 3 x 12.75 in (324 mm) torpedo tubes DC's
THAILAND					
Pin Klao: Ex-US Bostwick: Destroyer escort	1944	1	1,900	Dual purpose: 3 x 3 in (76 mm) AA: 6 x 40 mm	AS: 8 x DCT Torpedo tubes: 6 x for AS torpedoes
Tapi, Khirirat: Corvette type	1971–73	2	1,135	Surface: 2 x 3 in (76 mm) AA: 2 x 40 mm	AS: Torpedoes, DC's Hedgehogs

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Prasae, Tahchin: Prasae class: Frigates	1943–44	2	2,100	Dual purpose: 3 x 3 in (76 mm) AA: 2 x 40 mm 9 x 20 mm	AS: 8 x DCT
Bangrachan, Nhong Sarhai: Coastal minelayers	1936	2	408	AA: 2 x 3 in (76 mm) 2 x 20 mm	Mines: 142 capacity
Trad class: Corvettes	1935–37	7	470	AA: 2 x 3 in (76 mm) 1 x 40 mm 2 x 20 mm *(Chumporn, Puket, Trad* 2 x 40 mm*)*	Tubes: 4 x 18 in *(Chumporn, Puket, Trad* 2 x 18 in*)*
Klongyai class: Patrol vessels	1937	3	135	1 x 3 in (76 mm) 1 x 20 mm	Tubes: 2 x 18 in
Liulom class: Patrol vessels	1941–43	7	400	AA: 1 x 3 in (76 mm) 1 x 40 mm 5 x 20 mm	AS: 2 x ASW torpedo tubes (except *Sarasin)*
TURKEY					
Nusret N 110: Minelayer	1965	1	1,880 (standard)	Dual purpose: 4 x 3 in (76 mm)	Mines: 400 capacity
Berk, Peyk: New construction: Frigates	1972–74	2	1,950	4 x 3 in (76 mm)	Tubes: 6 x 12.6 in (320 mm) Aircraft: 1 x helicopter
Candarli, Carsamba, Cesme, Edincik, Cardak: Corvettes	1942–43	5	1,250	1 x 3 in (76 mm) 6 x 40 mm	
AG6: Boom defence vessel	1952	1	902	1 x 3 in (76 mm) 4 x 20 mm AA	
AG4: Boom defence vessel	1941	1	805	1 x 3 in (76 mm) AA	
AG1-2-3: Boom defence vessels	1937–38	3	1,000	1 x 3 in (76 mm) AA	
Akhisar class: Patrol vessels	–	6	412	Dual purpose: 1 x 3 in (76 mm) AA: 1 x 40 mm	AS: 4 x DCT
UNITED STATES					
Claud Jones: Escort ships	1959–60	3	1,750	1 or 2 x 3 in (76 mm)	AS: 2 x triple torpedo tubes Mk 32 DC rack (removed from *Charles Berry* and *John R. Perry)*
Dealey and *Courtney* class: Escort ships	1954–58	7	1,900	2 x 3 in (76 mm)	AS: 2 x triple torpedo tubes Mk 32 Helicopter facilities in DE 1021–26
Bostwick class: Escort ships (in reserve)	1943	3	1,900	AA: 3 x 3 in (76 mm) up to 6 x 40 mm (several 20 mm)	AS: 1 x Hedgehog DC's
Buckley class: Escort ships (in reserve)	1943–44	4	2,170	2 or 3 x 3 in (76 mm) AA Up to 8 x 40 mm AA (removed entirely from some ships)	AS: DC racks
Edsall class: Escort ships (in reserve)	1943	6	1,850	AA: 3 x 3 in (76 mm) (2 in *Peterson)* up to 8 x 40 mm (Removed in some ships)	AS: 1 x Hedgehog DC rack
Converted *Edsall* class: Radar picket escort ships (all in reserve except *Calcaterra* and *T. J. Gary)*	1943–44	18	1,850	2 x 3 in (76 mm) AA 2 x 20 mm AA (in *Calcaterra* and *T. J. Gary)*	AS: 2 x triple torpedo launchers Mk 32, in most ships 1 x trainable Hedgehog (Mk 15) (removed from *Calcaterra)* DC's (removed from *Calcaterra* and *Thomas J. Gary)*

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
La Salle: AGF	1964	1	13,900	AA: 8 x 3 in (76 mm)	
Arlington: Command ship	1945	1	19,600	8 x 3 in (76 mm)	
Annapolis: AGMR	1945	1	22,500	8 x 3 in (76 mm)	
Blue Ridge, Mount Whitney: Amphibious command ships	1970 71	2	19,290	4 x 3 in (76 mm) AA	Utility helicopter carried
Iwo Jima class: Amphibious assault ships	1961–70	6	18,300	AA: 8 x 3 in (76 mm)	Helicopters: 20-24 (CH 46) medium. 4 (CH-53) heavy. 4 (HU-1) observation
Asheville class: Patrol gunboats	1966–69	13	245	1 x 3 in (76 mm) 1 x 40 mm 4 x .50 cal MG	
Sacramento class: Fast combat support ships	1964–70	4	53,000	8 x 3 in (76 mm) AA	Helicopters: 2 x UH-46 *Sea Knights*
US COAST GUARD					
Reliance class: Medium endurance cutters	1967–69	16	1,000	1 x 3 in (76 mm) 2 x .50 cal MG	1 x HH52 or HH-3 helicopter
USSR					
Mirka I and *II* class: Frigates	1964–69	25	1,100	4 x 3 in (76 mm) AA (in *Mirka I*)	AS: 4 x 12-barrelled rocket launchers *(I)* 2 x 16-barrelled launchers *(II)* Torpedo tubes: 5 x 16 in AS *(I)* 10 x 16 in AS *(II)*
Petya I and *II:* Frigates	1960–64	45	1,150	Dual purpose: 4 x 3 in (76 mm) (2 ships without guns)	AS: 4 x 16-barrelled rocket launchers Torpedo tubes: 5 x 16 in (Later versions have 10 torpedo tubes and 2 x 12-barrelled rocket launchers)
URUGUAY					
Artigas, Uruguay: Destroyer escorts	1943	2	1,900	Dual purpose: 3 x 3 in (76 mm) AA: 2 x 40 mm	AS: Hedgehog 8 x DCT 1 x DCR
Comandante Pedro Campbell: Escort	1942	1	1,250	Dual purpose: 1 x 3 in (76 mm) AA: 2 x 40 mm	
VENEZUELA					
Vosper Thornycroft: 37 metre FPBs	1973+	3	150	1 x 76 mm	
Ex-US PC Type: Patrol vessels		10	430	Dual purpose: 1 x 3 in (76 mm) AA: 2 x 40 mm 2 x 20 mm	AS: Provision for 4 x DCT
VIETNAM (REPUBLIC OF)					
Dong Da II, Ngoc Hoi, Van Kiep II: Patrol vessels	1943–44	5	903	1 x 3 in (76 mm) AA 2 x 40 mm AA 8 x 20 mm AA	AS: 1 x Hedgehog DC's
Chi Lang II, Ky Hoa, Nhut Tao, Chi Linh, Ha Hoi: Patrol vessels	1943–44	5	945	1 x 3 in (76 mm) AA 2 x 40 mm AA up to 8 x 20 mm	AS: 1 x Hedgehog DC's
Tran Hung Dao, Tran Khanh Du: Ex-US DER Type: Frigates	1943–44	2	1,850	2 x 3 in (76 mm) AA	AS: Trainable Hedgehog: DC rack 6 x 12.75 in (324 mm) torpedo tubes
Ex-US CG *Point* class: Patrol vessels		26	67	1 x 81 mm/50 cal MG 2/4 x .50 cal MG or 1 x 20 mm	
Van Don: Patrol vessel	1944	1	450	1 x 3 in (76 mm) AA 1 x 40 mm AA 4 x 20 mm AA	AS: 2 x Mousetrap launchers DC's

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load—tons	Type and No. of Guns	Other Weapons
YUGOSLAVIA					
Mornar, Borac: Patrol vessels	1959–65	2	430	2 x 3 in (76 mm) 2 x 40 mm AA 2 x 20 mm AA	AS: 2 x DCT 2 x DC racks 2 x Hedgehogs
Kraljevica class: Patrol boats	1953–59	16	250	1 x 3 in (76 mm) 1 x 40 mm AA 4 x 20 mm AA	AS: DC Plus Mousetrap in some

SHIPS CARRYING 47 or 57 mm GUNS
(6513.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load—tons	Type and No. of Guns	Other Weapons
CHINA (PEOPLE'S REPUBLIC)					
Ex *Yung An*, Ex *Yung Ping:* River defence vessels	1929	2	170 (standard)	1 x 47 mm AA 5 x 25 mm AA	
FRANCE					
Le Normand class: (E 52 Type): Fast frigates	1956–60	14	1,795	6 x 57 mm (4 only in 771, 772, 773) 2 x 20 mm	AS: Sextuple Bofors ASM mortar (except F776, F777, F778 with 1 x 12 in (305 mm) quadruple mortar) 2 x DC mortars 1 x DC rack Torpedo tubes 12 x ASM for homing torpedoes
Le Corse, Le Bordelais, Le Boulonnais: Le Corse class (E50 Type): Fast frigates	1955–56	3	1,702	6 x 57 mm 2 x 20 mm	AS: 1 x sextuple rocket launcher Torpedo tubes: 12 x ASM tubes for homing torpedoes
ICELAND					
Aegir: Coastguard patrol vessel	1968	1	1,150	1 x 57 mm	
Albert: Coastguard vessel	1957	1	200	1 x 47 mm	
Odinn: Coastguard vessel	1960	1	1,000	1 x 57 mm	
Thor: Coastguard vessel	1951	1	920	2 x 57 mm	
ROMANIA					
Ex-USSR T 301: Inshore minesweepers	1958	22	130	2 x 45 mm 4 x .5 in (12.7 mm) MG	
V31, V32, V33: Poti class: Coastal escorts	1965	3	650	2 x 57 mm	Tubes: 4 x 16 in AS: 2 x 12-barrelled rocket launchers
SPAIN					
RR 10, RR 19, RR 20, RR 28, RR 29: Auxiliary patrol vessels	1943	5	498	1 x 47 mm or 1 x 1.5 in (38 mm) 1 x 20 mm	
SWEDEN					
Sundsvall, Visby: Visby class: Fast AS frigates	1943	2	1,320	2 x 57 mm	Helicopters: 1 AS: 1 x 4-barrelled DC mortar Torpedo tubes: 5 x 21 in (533 mm)
Capella, Spica, Castor, Vega, Sirius, Virgo: Spica I class: Fast attack craft	1966–68	6	230	1 x 57 mm Bofors	Tubes: 6 x 21 in (533 mm)
Spica class: Repeat: Fast attack craft	1973+	12	230	1 x 57 mm Bofors	Torpedo tubes: 6 x 21 in (533 mm)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
USSR					
T 58 class: Fleet minesweepers	1957–64	20	900	4 x 57 mm	
Poti class: Corvettes	1961–68	70	650	2 x 57 mm	Tubes: 4 x 16 in AS AS: 2 x 12-barrelled rocket launchers
Sasha class: Coastal minesweepers		35	280	1 x 57 mm 4 x 25 mm	

SHIPS CARRYING 40 mm GUNS
(6514.202)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
ARGENTINA					
Chaco, Formosa, Chubut, Neuquen, Rio Negro, Tierra Del Fuego: Ex-British *Ton:* Minesweepers	1952	6	425	1 x 40 mm AA	
Thompson, Goyena: Ex-US tug type: Patrol vessels	1943	2	1,863	2 x 40 mm Bofors 2 x 20 mm	
Spiro: Patrol vessel	1937	1	650	4 x 40 mm	
AUSTRALIA					
Aitape, Ladava, Acute, Archer, Adroit, Ardent, Advance, Arrow, Lae, Madang, Assail, Attack, Barbette, Aware, Barricade, Samarai, Bayonet, Bombard, Buccaneer: Patrol boats	1966–69	19	146	1 x 40 mm 2 x medium MG (no guns in *Aware, Madang)*	
Modified *Ton: Curlew, Snipe,* Minehunters: *Gull, Hawk, Ibis, Teal,* Minesweepers	1952	6	445	2 x 40 mm AA *(Curlew, Snipe* 1 x 40 mm)	
BELGIUM					
US MSO (Ex-AM) Type 498: Ocean minesweepers	1955–66	7	780	1 x 40 mm AA	
US MSC (Ex-AMS) Type 60: Coastal minesweepers	1954–55	9	390	1 x 40 mm AA	
Zinnia: Support ship	1967	1	2,435	3 x 40 mm AA	1 x helicopter
Godetia: Support ship	1966	1	2,300	4 x 40 mm AA	1 x helicopter
BRAZIL					
New construction: *Schutze (Aratu)* class: Minesweepers	1971 onwards	4 + 2	280	1 x 40 mm AA	
Pedro Teixeira, Raposo Tavares: River patrol gunboats	1973–74	2	700	1 x 40 mm 1 x .50 cal MG	2 x 81 mm mortar
BURMA					
Y 301-Y 310: Yugoslavian-built Y type: River gunboats	1958	10	120	2 x 40 mm 1 x 2 pdr	
PGM 401–PGM 406: US-built PGM Type: Patrol gunboats		6	100	1 x 40 mm AA 2 x 0.5 US Browning MG	
Sagu, Setkaya, Shwepazun, Saban, Seinda, Setyahat, Shwethida, Sinmin: River gunboats		8	98	1 x 40 mm 3 x 20 mm	
Ex-US CGC Type: Motor gunboats	1960	7	66	1 x 40 mm AA 1 x 20 mm AA	
Nagakyay, Nawarat: Burmese-built large Type: River gunboats	1960	2	450	2 x 40 mm AA 2 x 25 pdr	
CAMBODIA					
VRI, VRII: Ex-Yugoslav 108 Type: Fast attack craft		2	60	1 x 40 mm AA 4 x 12.7 mm MG	Tubes: 2
CHILE					
Fresia, Guacolda, Quidora, Tegualda: Fast attack craft	1965	4	134	2 x 40 mm AA	Tubes: 4 x 21 in (533 mm)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Papudo: Patrol vessel	1971	1	450	1 x 40 mm 4 x 20 mm	AS: 1 x Hedgehog 4 x K DCT 1 x DC rack
CHINA (PEOPLE'S REPUBLIC)					
Ch'ang Chiang: Coast defence vessel	1929	1	464 (standard)	4 x 40 mm 4 x 25 mm	
COLOMBIA					
General Rafael Reyes, General Vasques Cobo: Coastguard vessels	1956	2	146	1 x 40 mm	
CYPRUS					
Ex-German R-boat Type: Patrol boats		2	125	1 x 40 mm 1 x 20 mm	
DENMARK					
Langeland class: Coastal minelayer	1951	1	332	2 x 40 mm 2 x 20 mm Masden	
Daphne class: Seaward defence craft	1961–65	9	170	1 x 40 mm AA	AS: 2 x 51 mm rocket launchers DCs
Soloven class: Torpedo boats	1964–67	6	114	2 x 40 mm Bofors	Tubes: 4 x 21 in (533 mm)
Falken class: Torpedo boats	1962–63	4	119	1 x 40 mm 1 x 20 mm	Tubes: 4 x 21 in (533 mm)
Flyvefisken class: Torpedo boats	1954–55	6	110	1 x 40 mm 1 x 20 mm	Tubes: 2 x 21 in (533 mm)
Maagen, Mallemukken: Maagen class: Patrol craft	1960	2	190	1 x 40 mm	
DOMINICAN REPUBLIC					
Betelgeuse: US PGM Type: Coastguard vessel	1966	1	145.5	1 x 40 mm 4 x 20 mm 2 x 0.5 in MG	
ECUADOR					
Guayaquil, Quito: Ex-US PGM Type: Gunboats		2	101	1 x 40 mm 2 x 20 mm	
Manta, Nuevo Rocafuerte, Tulcan: PTB Type: Torpedo boats	1970–71	3	134	1 x 40 mm 1 x 20 mm	Torpedo tubes: 2 x 21 in (533 mm)
EGYPT					
Ex-Yugoslavian Type: Motor torpedo boats		6	56	1 x 40 mm	Torpedo tubes: 4
ETHIOPIA					
PC 11, 12, 13, 14, 15: Patrol craft	1961–62	5	145.5	1 x 40 mm 1 x .50 cal MG	
MS 41: Coastal minesweeper	1954–56	1	417	2 x 40 mm	
FINLAND					
Keihässalmi: Coastal minelayer	1957	1	360	2 x 40 mm 4 x 30 mm	Mines: 100
Ruotsinsalmi: Coastal minelayer	1941	1	310	2 x 40 mm 2 x 20 mm	Mines: 100
Nuoli class: Fast patrol boats	1961–63	13	64	1 x 40 mm 1 x 20 mm	
Vasama 1, 2: *Vasama* class: Fast patrol boats	1955–57	2	70	2 x 40 mm	
Raisio, Roytta, Ruissalo: Patrol boats	1959	3	130	1 x 40 mm Bofors 1 x 20 mm Masden	
Rihtniemi, Rymattyla: Patrol boats	1957	2	110	1 x 40 mm Bofors 1 x 20 mm Masden	
FRANCE					
US MSO (ex-AM) Type: *Berneval* class: Ocean minesweepers	1953–56	12	780	1 x 40 mm	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
British Type: *Sirius* class: Coastal minesweepers	1953 57	17	424	1 x 40 mm Bofors 1 x 20 mm Oerlikon (several have 2 x 20 mm)	
Ex-Canadian Bay Type: *La Dunkerquoise* class: Coastal minesweepers	1951–54	6	412	1 x 40 mm	
Le Fougueux class: Coastal escorts	1955–59	14	400	2 x 40 mm Bofors 2 x 20 mm	AS: 1 x Hedgehog 4 x DC mortars (and 2 DC racks) 1 x 120 mm ASM mortar* 2 x DCT* 1 x DC rack* *except in *L'Agile; Le Fougueux; L'Opiniâtre* Tubes: 1 in *L'Intrépide*
Grillon class: Boom defence vessels	1954	5	850	1 x 40 mm Bofors 4 x 20 mm	
Ex-British *Ham* class: Inshore minesweepers	1951–53	3	140	1 x 40 mm Bofors 1 x 20 mm Oerlikon	
GERMANY (FEDERAL REPUBLIC)					
Hans Burkner: Corvette	1963	1	1,100	2 x 40 mm	AS: 1 x DC mortar 2 x DC racks
Thetis, Hermes, Hajade, Theseus, Triton: Corvettes	1961–63	5	680	2 x 40 mm	AS: 1 x Bofors DC mortar *(Hermes:* 2 tubes)
Jaguar class: Fast attack craft	1957–62	19	190	2 x 40 mm	Tubes: 4 x 21 in (533 mm) (two torpedo tubes can be removed for 4 mines)
Type 142: Fast attack craft	1957–62	10	225	2 x 40 mm	Tubes: 2 x 21 in (533 mm) (wire guided)
Lindau class: Coastal minesweepers and minehunters	1958–60	18	425	1 x 40 mm	
Schütze class: Fast minesweepers *(Stier* not included as she carries no weapons)	1959–64	23	226	1 x 40 mm (Some still have the designed 2 x 40 mm)	
Frauenlob class: Inshore minesweepers	1965–68	10	230	1 x 40 mm	
Hansa, Niobe: Inshore minesweepers	1958	2	180	1 x 40 mm	
Ariadne class: Inshore minesweepers	1960–63	8	210	1 x 40 mm	
GHANA					
Ejura: Ton class: Coastal minesweeper	1952	1	425	1 x 40 mm 2 x 20 mm	
Elmina, Komenda: Ford class: Seaward defence boats	1962	2	160	1 x 40 mm Bofors	AS: DCT
GREECE					
Aktion, Amvrakia: Minelayers	1944–45	2	1,100	Dual purpose: 8 x 40 mm 6 x 20 mm	Mines: Capacity 100 to 130
Andromeda, Kastor, Pigassos, Kykonos, Toxotis: Tjeld class: Fast attack craft	1967	5	76	2 x 40 mm	Torpedo tubes: 4 x 21 in (533 mm)
Astrapi: Vosper *Brave* class: Fast attack craft	1962	1	110	2 x 40 mm	Torpedo tubes: 4 x 21 in (533 mm) side launching
Aiolos: Vosper Ferocity Type: Fast attack craft	1962	1	80	2 x 40 mm	Torpedo tubes: 4 x 21 in (533 mm) side launching

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Delphin, Foinix, Draken, Polikos, Polidefkis: Silbermowe Type: Torpedo boats	1951–56	5	155	1 x 40 mm 2 x 20 mm	Torpedo tubes: 2 x 21 in (533 mm)
HAITI					
La Crète à Pierrot, Vertières: Coastguard Patrol vessels		2	100	1 x 40 mm	
16 Août 1946: Coastguard patrol vessel	1943	1	138	2 x 40 mm 2 x 20 mm	
INDIA					
Kirpan, Kuthar: Blackwood class 2nd rate: AS Frigates	1959	2	1,456	AA: 3 x 40 mm	AS: 2 x Limbo 3-barrelled DC mortars
Cannanore, Kuddalore, Kakinada, Karwar: Ton class: Coastal minesweepers	1955–56	4	425	1 x 40 mm 2 x 20 mm	
Ajay class: Seaward defence boats	1960	2	151	1 x 40 mm	
INDONESIA					
German built *Jaguar* Type: Torpedo boats	1959–60	7	190	2 x 40 mm	Torpedo tubes: 4 x 21 in (533 mm)
R class: Coastal minesweepers	1945–57	10	139.4 (standard)	1 x 40 mm 2 x 20 mm	
Kalahitam, Kelabang, Kompas: Mawar class: Patrol craft	1967	3	147	40 mm	
Ex-Netherlands RP 138: Motor launch		1	54	1 x 40 mm 2 x 20 mm	AS: 3 x DCT
IRAN					
Kayvan, Mahan, Mehran, Tiran: PGM Type: Patrol craft	1955–59	4	107	1 x 40 mm	AS: 8-barrelled 7.2 in projector 8 x 300 lb DCs
Battraam, Nahid, Parvin: Improved PGM Type: Patrol boats	1967–70	3	146	1 x 40 mm 2 x 20 mm 2 x .50 cal MG	
IRELAND (REPUBLIC OF)					
Banba, Fola, Grainne: Ex-British *Ton* class: Coastal minesweepers	1954–59	3	425	1 x 40 mm 2 x 20 mm	
ITALY					
Albatros, Airone, Alcione, Aquila: Albatros class: Corvettes	1955–56	4	950	AA: 4 x 40 mm Bofors	AS: 2 x Hedgehogs Mk II 2 x DCT 1 x DC rack Tubes: 2 x triple AS to be fitted
Bombarda, Sfinge, Gabbiano: Ape class: Corvettes	1943–51	3	771	4 x 40 mm *Chimera* *Sfinge* 2 x 40 mm and 2 x 20 mm *Bombarda*	AS: 1 x Hedgehog Mk 10
Salmone, Squalo, Sgombro, Storione: Salmone class: Ocean minesweepers	1956	4	750	1 x 40 mm	
Bracco, Mastino, Molosso, Segugio, Spinone: Alano class: Support gunboats		5	430	5 x 40 mm 4 x 20 mm 4 x 12.7 mm	
Vedetta: Patrol vessel	1955	1	450	2 x 40 mm Bofors 2 x 20 mm	AS: 1 x Hedgehog 4 x DCT 2 x DC racks
MS 441, MS 443, MS 453: Fast attack craft		3	64	1 x 40 mm 2/3 x 20 mm	Torpedoes: 2 x 17.7 in
MS 472, MS 473, MS 474, MS 481: Fast attack craft	1942–43	4	72	1/2 x 40 mm	Tubes: 2 x 17.7 in

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Freccia, Saetta: Freccia class convertible Type: Fast attack craft	1966	2	205	As gunboat: 3 x 40 mm or 2 x 40 mm As fast minelayer: 1 x 40 mm AA with 8 mines As torpedo boat: 1 x 40 mm	Tubes: (as torpedo boat) 2 x 21 in (533 mm)
Baleno, Lampo: Lampo class convertible Type: Fast attack craft	1963	2	196	As gunboat: 3 x 40 mm As torpedo boat: 1 x 40 mm	Tubes: (as torpedo boat) 2 x 21 in (533 mm)
Folgore: Fast attack craft	1955	1	190	2 x 40 mm	Tubes: 2 x 21 in (533 mm)
IVORY COAST					
Vigilant: Patrol boat	1968	1	240	2 x 40 mm	
JAPAN					
Mizutori class: Corvettes	1960–66	8	420–450 (standard)	2 x 40 mm	AS: 1 x Hedgehog 1 x DC rack 6 x Homing torpedo launchers
Umitaka class: Corvettes	1959–70	4	440–480 (standard)	2 x 40 mm	AS: 1 x Hedgehog 1 x DC rack 2 x triple AS torpedo launchers
Hayabusa: Corvette	1957	1	360 (standard)	2 x 40 mm	AS: 1 x Hedgehog 2 x Y-guns 2 x DC racks
Kamome, Kari, Kiji, Misago, Taka, Tsubame, Washi: Corvettes	1957	7	330 (standard) *Kari; Kiji; Taka; Washi* 310 (standard)	2 x 40 mm	AS: 1 x Hedgehog 2 x Y-guns 2 x DC racks
Erimo: Minelayer	1955	1	630 (standard)	2 x 40 mm 2 x 20 mm	AS: 1 x Hedgehog 2 x K-guns 2 x DC racks
PT11–15: Fast attack craft	1962–74	5	100–120	2 x 40 mm	Tubes: 4 x 21 in (533 mm)
Tokachi, Tatsuta: Medium patrol vessels (MSA)	1954	2	*Tokachi:* 381 (normal) *Tatsuta:* 369 (normal)	1 x 40 mm	
Teshio: Medium patrol vessel (MSA)	1955	1	421.5 (normal)	1 x 40 mm	
Yahagi class: Medium patrol vessels (MSA)	1956–61	6	375.7	1 x 40 mm	
Nagara, Kitakami, Tone: Nagara class: Small patrol vessels (MSA)	1952	3	260	1 x 40 mm	
Kuma class: Small patrol vessels (MSA)	1951	17	275 (normal)	1 x 40 mm	
KENYA					
Brooke Marine 37.5 m.: Patrol craft Mariba	1974	1	160	2 x 40 mm	
Brooke Marine 32 m.: Patrol craft	1975	3	145	2 x 40 mm	
Chui, Ndovu, Simba: British Vosper Type: Patrol craft	1966	3	109	2 x 40 mm Bofors	
KOREA (REPUBLIC OF)					
Ex-US YMS Type: Coastal minesweepers	1941–42	4	350	1 x 40 mm 2 x 20 mm	
LEBANON					
Tarablous: Patrol boat	1959	1	105 (standard)	2 x 40 mm	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
LIBERIA					
Alert: Motor gunboat	1967	1	100	1 x 40 mm	
LIBYA					
Garian, Khawlan, Merawa, Sabratha: Garian Type: Patrol boats	1969–70	4	159	1 x 40 mm 1 x 20 mm	
MALAGASY					
Malaika: Patrol vessel	1967	1	235 (light)	2 x 40 mm	
Fanantenana: Patrol vessel	1959	1	1,200	2 x 40 mm	
MALAYSIA					
Ex-British *Ton* class: Coastal minesweepers	1955	6	425	1 x 40 mm 2 x 20 mm	
Kedah class, *Sabah* class, *Kris* class: Patrol craft	1963–68	6, 4, 14: (24)	109	2 x 40 mm	
Hang Tuah: Training ship	1944	1	2,400	6 x 40 mm	
MOROCCO					
Al Bachir: Patrol vessel	1967	1	154	2 x 40 mm MG	
NETHERLANDS					
Onversaagd, Onbevreesd Onvervaard: Escorts *Onverschrokken, Onverdroten:* MCM Group HQ and support ships	1954–55	5	790	1 x 40 mm	AS: 2 x DC
Balder, Bulgia, Freyr, Hadda, Hefring: Patrol vessels		5	225	1 x 40 mm 3 x 20 mm	AS: 2 x DCT Mousetrap
Dokkum class, *Wildervank* class: Coastal minesweepers and mine hunters	1955–56	18, 2 (20)	417	2 x 40 mm	
Poolster, Zuiderkruis: Fast combat support ships	1964–75	2	16,800	2 x 40 mm	Aircraft: 5 x helicopters (official complement 3 x SH-34J)
NEW ZEALAND					
Inverell, Kiama: Bathurst class: Escort minesweepers	1943–44	2	1,025	AA: 2 x 40 mm	
NIGERIA					
Ford class: Seaward defence boats	1961	6	160	1 x 40 mm Bofors 2 x 20 mm Oerlikon	AS: DC rails
NORWAY					
Tjeld class: Fast attack craft	1960–62	20	82	1 x 40 mm 1 x 20 mm	Tubes: 4 x 21 in (533 mm)
OMAN					
Brooke Marine 37.5 m.: Patrol craft	1973	3	153	2 x 40 mm	
PAKISTAN					
Rajshahi: Town class: Patrol craft	1965	1	143	2 x 40 mm Bofors	
PARAGUAY					
Hermandez, Mesa, Nanahua: Bouchard class: Patrol vessels	1938	3	650	4 x 40 mm Bofors 2 x MG	
PERU					
Rio Piura, Rio Tumbes, Rio Zarumilla: Rio class: Patrol launches	1960	3	37	2 x 40 mm	
Rio Sama, Rio Chira: Gunboats		2	147	2 x 40 mm 2 x 0.5 MG	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
PHILIPPINES					
The President: Command ship	1959	1	2,200	2 x 20 mm	
Antique, Camarines, La Union, Mismamis Occidental, Sulu: Patrol boats	1955–59	5	144	1 x 40 mm 2 x 20 mm 2 x MG	1 x 60 mm mortar
PORTUGAL					
S. Jorge class: Ocean minesweepers	1955	4	780	1 x 40 mm	
Maio class: Corvettes (French built)	1954–55	2	400	2 x 40 mm 2 x 20 mm	AS: 1 x Hedgehog 4 x DCT 2 x DC tracks
Maio class: Corvettes	1956–58	3	400	2 x 40 mm 2 x 20 mm	
Cacine class: Coastal patrol vessels	1969–72	8	310	2 x 40 mm	1 x 32-barrelled (37 mm) rocket launcher
Argos class: Patrol craft	1963–65	10	210	2 x 40 mm	
SAUDI ARABIA					
Jaguar Type: Torpedo boats	1969	3	190	2 x 40 mm	Tubes: 4 x 21 in (533 mm)
Ryadh: Patrol boat	1954	1	100 (standard)	1 x 40 mm	
SENEGAL					
Sénégal: Patrol boat	1943	1	138	1 x 40 mm 3 x 20 mm	
SINGAPORE					
Panglima: Seaward defence boat	1956	1	134	1 x 40 mm	
Independence, Freedom, Justice: Fast patrol craft	1970	3	100 (standard)	1 x 40 mm 1 x 20 mm	
SOUTH AFRICA					
British *Ton* class: Coastal minesweepers	1958	10	425	1 x 40 mm Bofors 2 x 20 mm	
British *Ford* class: Seaward defence boats	1954–59	5	160	1 x 40 mm	AS: 2 x DCT in *Haerlem; Oosterland; Rijger*
SPAIN					
Ex-US *Agile* class: Ocean minesweepers	1943	4	750	1 x 40 mm 2 x 20 mm	
Candido Perez: Patrol vessel	1942	1	138	1 x 40 mm 3 x 20 mm	AS: 2 x DCT 2 x Mousetrap Mk 20
Cr 1: Boom defence vessel	1955	1	831	1 x 40 mm 4 x 20 mm	
SWEDEN					
Alvsborg, Visborg, MO4: New construction: Minelayers and submarine depot ships	1971+	2 + 1	2,700	3 x 40 mm Bofors	
Aldebaran, Altair, Antares, Arcturus, Argo, Astrea, Plejad, Polaris, Pollux, Regulus, Rigel: Fast attack craft	1960	11	170	2 x 40 mm Bofors	Tubes: 6 x 21 in (533 mm)
T 32 class: Fast attack craft	1951–53	4	40 (standard) (T 41 : 45 standard)	1 x 40 mm Bofors AA 4 x MG	Tubes: 2 x 21 in (533 mm)
T 42 class: Fast attack craft	1956–59	15	40–45 (standard)	1 x 40 mm Bofors AA 2 x MG	Tubes: 2 x 21 in (533 mm)
Arko class: Coastal minesweepers	1958–64	12	300	1 x 40 mm AA	
Hano class: Coastal minesweepers	1954	6	270 (standard)	2 x 40 mm AA	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Orust and *Hisingen* classes: Inshore minesweepers	1948–64	7	140 (standard) (*Hisingen* 115)	1 x 40 mm AA	
M31 class: New construction: Inshore minesweepers		3	120 (standard)	1 x 40 mm AA	
SUDAN					
Gihad, Horriya, Istiglal, Shaab: Patrol boats	1961–62	4	100	1 x 40 mm AA 1 x 20 mm AA 2 x 7.6 mm MG	
Fasher, Khartoum: Yugoslav PBR 512 Type: Patrol boats		2	245	2 x 40 mm AA 2 x 20 mm AA	
TAIWAN (CHINA)					
Fuh Kwo, Tian Kwo: Fast attack craft		2	53	1 x 40 mm AA 2 x .50 cal MG	Torpedo launchers: 2
Fuh Chow, Hsueh Chih: Japanese Type: Fast attack craft		2	40	1 x 40 mm AA 2 x 20 mm AA	Torpedo launchers: 2 x 18 in
THAILAND					
SC 7, SC 8: Patrol boats	1954–55	2	125	1 x 40 mm 3 x 20 mm	AS: DCs Mousetrap
T91: Gunboats	1971	3	87.5	1 x 40 mm AA 1 x 20 mm AA	
T 11, T 12, T 13, T 14, T 15, T 16, T 17, T 18, T 19, T 110: Gunboats	1966	10	147	AA: 1 x 40 mm 4 x 20 mm 2 x .50 cal	
TRINIDAD AND TOBAGO					
Courland Bay, Trinity: Patrol craft	1965	2	123	1 x 40 mm Bofors	
TUNISIA					
Sakiet Sidi Youssef: Patrol vessel		1	400	1 x 40 mm 2 x 20 mm	AS: 1 x Hedgehog 2 x DCT 2 x DC racks
TURKEY					
Tirebolu, Tekirdag, Terme, Trabzou: Coastal minesweepers		4	412	1 x 40 mm	
Marmaris, Meric, Mersin, Mordogan, Murefte: Coastal minelayers	1945	5	1,100	2 x 40 mm AA 2 x 20 mm AA	
Kartal class: Fast attack craft	1966–68	9	190	2 x 40 mm AA	Tubes: 4 x 21 in (533 mm)
AB 21–24: Gunboats	1967	4	147	2 x 40 mm 2 x 20 mm	
AB 25–34: Patrol craft	1967+	10	170	2 x 40 mm	
AG5: Boom defence vessel	1961	1	960	1 x 40 mm AA 3 x 20 mm AA	
UNITED KINGDOM					
Blackwood class, Type 14: AS frigates	1955–57	7	1,456	AA: 2 x 40 mm Bofors	AS: 2 x Limbo 3-barrelled DC mortars
Modified *Ton* class: Coastal patrol vessels	1953–60	5	425	2 x 40 mm AA	
Ton class: Coastal minesweepers and minehunters	1953–60	38	425	1 x 40 mm AA (removed in some ships) 2 x 20 mm AA (2 x 40 mm in minehunters)	
Wilton: New construction, GRP Type: Coastal minesweeper and minehunter		1	500 (standard)	1 x 40 mm	
Aveley, Isis: Lee class, M 2001 series: Inshore minesweepers		2	164	1 x 40 mm AA or 1 x 20 mm AA	
Dee, Droxford: Ford class: Seaward defence boats	1953–57	2	142	1 x 40 mm Bofors AA	AS: DC rails; large and small DC

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
UNITED STATES					
Wright: Command ship (in reserve)	1963	1	19,600	8 x 40 mm AA	Helicopters: 5/6 carried
Tucumcari: Hydrofoil gunboat	1968	1	58	1 x 40 mm AA 6 x 20 mm AA	
PTF 23–26: Fast patrol boats	1967–68	4	105	1 x 40 mm 2 x 20 mm 1 x 50 cal MG	1 x 81 mm mortar
PTF 17 22: Fast patrol boats	1967–70	6	85	1 x 40 mm 2 x 20 mm 1 x .50 cal MG	1 x 81 mm mortar
PTF 3, 5, 6, 7, 10, 11, 12: Nasty Type: Fast patrol boats	1964	7	85	1 x 40 mm 2 x 20 mm 1 x .50 cal MG	1 x 81 mm mortar
Acme class: Ocean minesweepers (2 in reserve)	1956–58	4	780	1 x 40 mm AA 2 x .50 cal MG	
Agile class: Ocean minesweepers	1953–58	40	750	1 x 40 mm AA 2 x .50 cal MG (replaced by twin 20 mm mount in some ships) Few ships unarmed after modernisation	
URUGUAY					
Maldonado: Patrol vessel		1	795	1 x 40 mm AA	
Salto: Patrol vessel	1935	1	180	1 x 40 mm AA	
VIETNAM (REPUBLIC OF)					
Ex-US PGM Type: Motor gunboats		20	117	1 x 40 mm AA 4 x 20 mm AA 2 x MG	
Ex-US LCM monitors: Riverine craft		22	75	1 x 40 mm 1 x 20 mm 2 x .50 cal MG possibly 4 x .30 cal MG	1 x 81 mm mortar or 2 x M10–8 flame throwers
YUGOSLAVIA					
Hrabri, Slobodni, Smeli, Snazni: Coastal minesweepers	1956	4	424	1 x 40 mm AA 1 x 20 mm AA	
Type 101: Torpedo boats		30	60	1 x 40 mm AA 2 x 12.7 mm MG	Tubes: 2 x 18 in
M 117, 118, 119, 121, 122, 123: Inshore minesweepers	1966–68	6	131	1 x 40 mm 2 x 12.7 mm MG	
M 141–144: Inshore minesweepers		4	164	1 x 40 mm or 1 x 20 mm	
Type 101: Inshore minesweepers	1950–56	2	95	1 x 40 mm 1 x 20 mm	

LIGHTLY ARMED VESSELS CARRYING GUNS, TORPEDOES and/or A/S WEAPONS (6515.202)

ABU DHABI					
Kawkab Type: Patrol craft	1969	3	32	2 x 20 mm	
ALBANIA					
Ex-USSR P-4: Motor torpedo boats	1955	12	25	2 or 4 x 12.7 mm AA MG	Tubes: 2 x 18 in (457 mm)
Ex-USSR T43 class: Fleet minesweepers		2	610	4 x 25 mm 4 x 37 mm	
Ex-USSR T301 class: Inshore minesweepers		6	180	2 x 37 mm 2 x 25 mm	
Hu Chwan: Hydrofoils	1968	30	45	4 x 12.7 mm	Tubes: 4 x 21 in
ALGERIA					
S.O.1 class: Coastal escorts		6	250 (normal)	4 x 25 mm	
Ex-USSR P6: Torpedo boats		6	75	4 x 25 mm	Tubes: 2 x 21 in (533 mm)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
ARGENTINA					
Ex-US ATA Type: Patrol vessels	1945	6	800	2 x 20 mm	
BRAZIL					
Ex-US MSC Type *Javari* class: Coastal minesweepers	1943	2	350	4 x 20 mm	AS weapons 2 x DCT
BRUNEI					
Masna, Saleha, Norair: Coastal patrol boats		3	25	2 x 20 mm 2 x MG	
BULGARIA					
S.O.1 Type: Coastal escorts		6	250	4 x 25 mm	AS: 4 five-barrelled ahead throwing rocket launchers
P 4 Type: Motor torpedo boats		8	25	2 x 25 mm	Tubes: 2 x 18 in
Shershen Type: Torpedo boats		4	160	4 x 30 mm	Tubes: 4 x 21 in (533 mm)
T 43 Type: Minesweepers		2	600	4 x 25 mm 4 x 37 mm	
T 301 Type: Inshore minesweepers		4	180	2 x 37 mm 2 x 25 mm	
Vanya class: CMS	1970	4	275	2 x 30 mm	
CAMEROON					
Vigilant: Patrol boats	1958	2	82	2 x 20 mm	
Valeureux: Patrol boat	1970	1	45	2 x 20 mm	
CHINA (PEOPLE'S REPUBLIC)					
Shanghai II, III and IV Type: Fast attack craft		300	155	4 x 37 mm 2 x 25 mm	Torpedo tubes: 2 (not fitted in later boats)
Shanghai I Type Fast attack craft	1959	25	100	4 x 37 mm	
Swatow Type: Fast attack craft		60	80	4 x 37 mm 2 x 12.7 mm	AS: 8 x DC
Huchwan class: Fast attack craft	1966 (approx)	70	45	4 x 12.7 mm	2 x 21 in (533 mm) torpedo tubes
Hainan class: Patrol craft		5		4 x 37 mm 4 x 25 mm	
Soviet T43 class: Fleet minesweepers		20	610	4 x 37 mm	
P 4 Type: Fast attack craft		70	25	2/4 x 25 mm	Tubes: 2 x 18 in
P 6 Type: Fast attack craft	1966+	80	75	4 x 25 mm	Tubes: 2 x 21 in (533 mm)
CUBA					
Ex-USSR S.O.1 Type: Patrol craft		12	250	4 x 25 mm	AS: 4 x five-barrelled rocket launchers
Ex-USSR P 6 Type: Fast attack craft		12	75	4 x 25 mm	Tubes: 2 x 21 in (533 mm)
Ex-USSR P4 Type: Fast attack craft		12	25	2 x 25 mm	Tubes: 2 x 18 in
CYPRUS					
Ex-USSR P 4 Type:		6	25	2 x 25 mm	Tubes: 2 x 18 in
DENMARK					
Tejsten: Patrol boat	1951	1	130	1 x 37 mm	
Ertholm: Patrol boat	1945	1	70	1 x 20 mm	
Faeno class: Coastguard cutters	1941	7	74	1 x 20 mm	
MHV 70-71-72: Coastguard cutters	1958	3	76	1 x 20 mm	
Laaland, Lougen: Coastal minelayers	1946	2	260	2 x 20 mm	
Sund class: Coastal minesweepers	1954–56	8	376	2 x 20 mm	
Vig class: Inshore minesweepers		4	180	2 x 20 mm	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
EGYPT					
Ex-USSR: S.O.1 Type: Patrol craft		12	250	4 x 25 mm	4 x 5-barrelled ahead throwing rocket launchers
Ex-USSR T43: Fleet minesweepers		6	610	4 x 37 mm 4 x 25 mm	
Ex-USSR Yurka Type: Fleet minesweepers		4	550	4 x 30 mm	
Ex-USSR T301: Inshore minesweepers		2	180	2 x 37 mm 2 x 25 mm	
Ex-USSR Shershen Type: Fast attack craft		6	160	4 x 30 mm	Torpedo tubes: 4 x 21 in (533 mm)
Ex-USSR P6 Type: Fast attack craft		24	75	4 x 25 mm	Torpedo tubes: 2 x 21 in (533 mm)
EL SALVADOR					
GC1, 2: Patrol boats	1959	2	46	1 x 20 mm	
FINLAND					
Viima: Patrol boat	1964	1	135	1 x 20 mm	
Koskelo class: Patrol boats	1956–60	8	97	2 x 20 mm	
FRANCE					
VC Type: Seaward patrol craft	1958–59	2	82	2 x 20 mm	
US MSC Type: *Acacia* class: Coastal minesweepers		24	370	2 x 20 mm	
Mercure: Special Type: Coastal minesweeper	1958	1	400	2 x 20 mm	
Marcel Le Bihan: Boom defence vessel	1937	1	1,000	4 x 20 mm	
GERMANY (DEMOCRATIC REPUBLIC)					
USSR S.O.1 Type: Patrol vessels		12	250	4 x 25 mm	AS: 4 x ahead throwing launchers 2 x DCT.
Ex-USSR P 6 Type: Motor torpedo boats		8	75	4 x 25 mm	Tubes: 2 x 21 in (533 mm)
Kondor class: Coastal minesweepers	1970–71	41	280	2 x 25 mm or 2 x 30 mm	
Shershen class: Fast attack craft		15	160	4 x 30 mm	Tubes: 4 x 21 in (533 mm)
Iltis class: Fast attack craft		40	20		Tubes: 2 x 21 in (533 mm)
Hai class: Patrol boats	1963–69	14	370	4 x 25 mm or 4 x 37 mm	AS: 2 x 4-barrelled rocket launchers
GREECE					
Aedon, Aigli, Argo, Avra, Alkyon, Daphni, Doris, Kichli, Pleias, Kissa: Coastal minesweepers		10	370	2 x 20 mm	
Antiopi, Atalanti, Niovi, Phedra, Thalia: Coastal minesweepers		5	402	2 x 20 mm	
GUINEA					
Ex-USSR P6 class: Fast attack craft		4	75	4 x 25 mm	Tubes: 2 x 21 in (533 mm) (or mines, or DCs)
INDIA					
HDML Type: Patrol craft		4	54	2 x 20 mm	
INDONESIA					
Ex-USSR P6 Type: Fast attack craft		14	75	4 x 25 mm	Tubes: 2 x 21 in (533 mm)
Ex-HDML Type: Seaward defence boats	1943–46	25	54	1 x 37 mm 2 x 20 mm Oerlikon MG	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
Ex-USSR T43 Type: Fleet minesweepers		6	610	4 x 37 mm 4 x 25 mm	
Ex-US *Bluebird* class: Coastal minesweepers		6	370	2 x 20 mm	
Alkai class: Auxiliary patrol craft	1950	12	247	1 x 37 mm 4 x MG	
DKN Type: Auxiliary patrol craft		5	140	4 x 20 mm	
IRAQ					
Ex-USSR S.O.1 Type: Patrol vessels		3	250	4 x 25 mm	AS: 4 x 5-barrelled ahead throwing rocket launchers
Ex-USSR P 6 Type: Fast attack craft		12 (some non-operational)	75	4 x 25 mm	Tubes: 2 x 21 in (533 mm)
ISRAEL					
Kedma, Negba, Yama, Zafona: Kedma class: Patrol boats	1968	4	32	2 x 20 mm	
Swift Type: Patrol boats		10	22.5	3 x .50 cal MG	1 x 81 mm mortar
Yarden, Yarkon: Yar class: Patrol boats	1957	2	109	2 x 20 mm	
ITALY					
Abete class: Coastal minesweepers		17	405	2 x 20 mm	
Agave class: Coastal minesweepers		19	405	2 x 20 mm	
IVORY COAST					
Perseverance: Patrol boat	1958	1	82	2 x 20 mm	
KHMER REPUBLIC					
VP 212: Ex HDML Type: Patrol boat		1	54	2 x 20 mm 4 x 7.5 mm MG	
KOREA (NORTH)					
Ex-USSR *P 4* class: Fast attack craft	1951–57	45	25	4 x 25 mm	
USSR *SO-1* class: Patrol vessels		8	250	4 x 25 mm	AS: 4 x five-barrelled launchers
Shanghai II class: Fast attack craft		15	120	4 x 37 mm 2 x 25 mm	
Ex-USSR P 6: Fast attack craft		30	75	4 x 25 mm	Tubes: 2 x 21 in
KOREA (REPUBLIC OF)					
FB 1, 2, 3, 5, 6, 7, 8, 9, 10: 65 ft Sewart Type: Patrol vessels		9	33	2 x 20 mm	
Ex-US MSC Type: Coastal minesweepers		8	370	2 x 20 mm	
MAURITANIA					
Dar El Barka, Tichitt: Patrol boats	1969	2	82	2 x 20 mm	
MOROCCO					
Es Sabiq: Seaward patrol craft	1958	1	82	2 x 20 mm	
NETHERLANDS					
Beemster class: Mine countermeasures vessels	1953–54	14	384	2 x 20 mm	
NIGERIA					
Ex-USSR P 6 class: Fast attack craft		3	75	4 x 25 mm	AS: 2 x DCT 2 x DC racks

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
PANAMA					
Panquiaco, Ligia Elena: Patrol boats	1971	2	123	2 x 20 mm	
PAKISTAN					
MSC Type: Coastal minesweepers		7	375	2 x 20 mm	
SDML 3517, 3520: Seaward defence motor launchers		2	54	1 x 3 pdr 1 x 20 mm	
PARAGUAY					
P1, P2: Patrol launches	1944	2	16	2 x 20 mm	
PERU					
Vosper Type: Fast patrol craft	1965	6	100	2 x 20 mm	
America: River gunboat	1904	1	240	2 x 3 pdr 4 x 12.7 mm	
PHILIPPINES					
Camiguin, Siquijor: Hydrofoil patrol boats	1965	2	36	1 x 20 mm	
100 ft PGM Type: Patrol gunboats	1960	4	122	2 x 20 mm 2 x .50 cal MG	
POLAND					
Oksywie class: Patrol boats		4	170 (standard)	4 x 37 mm	
Gdansk class: Patrol boats	1960	9	120	2 x 37 mm	AS: DCs
Ex-USSR P 6 Type: Fast attack craft		16	75	4 x 25 mm	AS: 8 x DC Tubes: 2 x 21 in
Wisla class: Fast attack craft	1970+	4	70	2 x 30 mm	Tubes: 4 x 21 in (533 mm)
Krogulec class: Fleet minesweepers	1963+	12	500	6 x 25 mm	
USSR *T 43* class: Fleet minesweepers	1957–62	12	610	4 x 37 mm 8 x 13 mm MG	
Obluze class: Patrol boats	1965+	12	170	2 x 37 mm	
ROMANIA					
Ex-German M 40 Type: Minesweepers	1943	4	775	6 x 37 mm	AS: 2 x DCT
Ex-USSR P 4 Type: Fast attack craft		6	25	2 x 25 mm	Tubes: 2 x 18 in
SOMALI REPUBLIC					
Ex-USSR P 4 class: Fast attack craft		4	25	2 x 25 mm	Tubes: 2 x 18 in
Ex-USSR *Poluchat I* class: Patrol boats		6	120	2 x 25 mm	
SPAIN					
LAS 10, 20, 30: SDVs	1963–64	3	63	1 x 20 mm 2 x 7 mm	AS Launchers: 2 x Mk 20 for 8 light rockets of Hedgehog type
LT 30, LT 31, LT 32: Torpedo boats	1956+	3	116	1 x 20 mm	Tubes: 2 x 21 in (533 mm)
Guadiaro class: Fleet minesweepers	1953–55	7	770	2 x 20 mm	
Ex-US AMS Type: Coastal minesweepers		12	384	2 x 20 mm	AS: 2 x Mousetrap Mk 20 rocket launchers
Pegaso, Procyon: Patrol vessels	1951	2	498	2 x 20 mm	

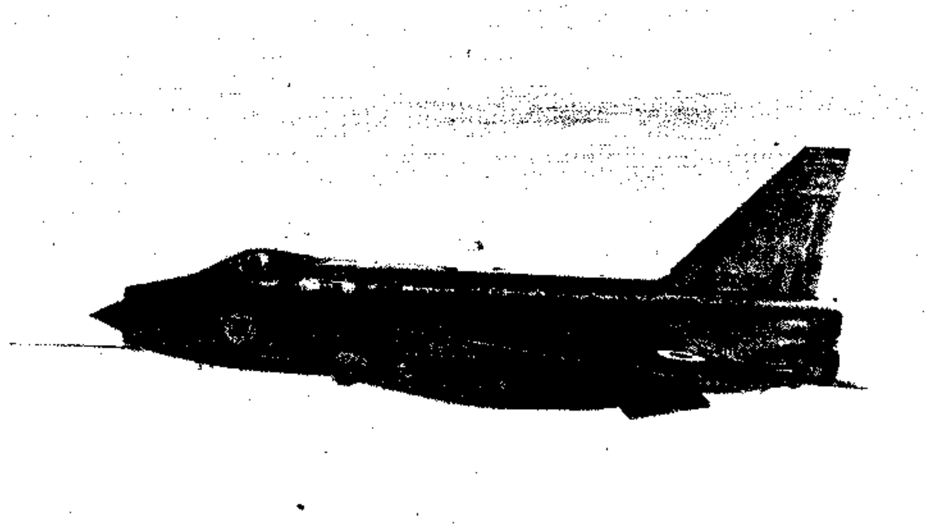
Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
SWEDEN					
V57: Patrol boat	1953	1	115 (standard)	2 x 20 mm	
SYRIA					
Ex-USSR P 4 Type: Fast attack craft		17	25	2 x 25 mm	Tubes: 2 x 18 in (533 mm)
Hittine, Yarmouk: Ex-USSR T 43 Type: Minesweepers		2	610	4 x 37 mm 4 x 25 mm	
TAIWAN (CHINA)					
MSC Type: Minesweepers		13	380	2 x 20 mm (in 155–161)	
Faan Fong, Sao Tang: 71 ft Type: Fast attack craft		2	46	1 x 20 mm 4 x .50 cal MG	Torpedo launchers: 2
TANZANIA					
Ex-Chinese *Shanghai* class: Fast attack craft		6	100	4 x 37 mm	
THAILAND					
CGC 3, CGC 4, CFC 5, CGC 6: Coastguard vessels		4	95	1 x 20 mm	AS: 2 x DC racks 2 x Mousetraps
CGC 1: Coastguard vessel		1	44.5	1 x 20 mm	AS: 2 x DC racks 2 x Mousetraps
Bangkeo, Ladya, Donchedi, Tadindeng: Coastal minesweepers		4	362	2 x 20 mm	
TRINIDAD AND TOBAGO					
Bucco Reef, Chaguaramus: Patrol craft	1972	2	125	1 x 20 mm	
TUNISIA					
Al Jala, Joumhouria, Istiklal, Remada: Patrol craft	1958	4	82	2 x 20 mm	
TURKEY					
LS9, 10, 11, 12: Motor launches		4	63 (standard)	1 x 20 mm	AS: 2 x Hedgehogs
MSC Type: Coastal minesweepers		12	370	2 x 20 mm	
AB 1, 2, 3, 4, 6, 7: Motor launches	1940–42	6	115	2 x 20 mm 1 x 3 pdr 4 x MG	
UNITED KINGDOM					
Engadine: Helicopter support ship	1967	1	9,000		Aircraft: 4 x *Wessex* 2 x *Wasp* or 2 x *Sea King* helicopters
UNITED STATES					
PBR Mk 11: River patrol boats	1967–72+	35	8	3 x .50 cal MG	1 x 40 mm grenade launcher 1 x 60 mm mortar (in some boats)
Swift Type: Inshore patrol craft	1965+	5	22.5	3 x .50 cal MG	1 x 81 mm mortar
Programme V: Assault support patrol boats		3	36.25	1 or 2 x 20 mm (with 1 x .50 cal MG on boats with 1 x 20 mm) 2 x .30 cal MG	2 x 40 mm high-velocity grenade launchers
Bluebird class: Coastal minesweepers	1953–56	13	370	2 x 20 mm	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
US COAST GUARD					
WPB: Patrol boats (95 ft)	1953–59	26	106 105 98	2 x .50 cal MG	1 x 81 mm mortar (16 cutters only)
WPB: Patrol boats (82 ft)		53	67	1 or 2 x .50 cal MG	1 x 81 mm mortar (in class C boats)
USSR					
Stenka class: Fast attack craft	1967–68+	35	210	4 x 30 mm	Torpedo tubes: 4 x 16 in (406 mm) AS: 2 x DC racks
S.O. 1 class: Corvettes	1957+	80	250 (normal)	4 x 25 mm	AS: 4 x 5-barrelled ahead throwing rocket launchers
Natya class: Fleet minesweepers	1971	13	650	4 x 30 mm 4 x 25 mm	AS: 2 x rocket launchers
Yurka class: Fleet minesweepers	1963–69	45	550	4 x 30 mm	
T 43 class: Fleet minesweepers	1948–57	110	610	4 x 37 mm 4 x 25 mm	
Vanya class: Coastal minesweepers	1961+	70	275	2 x 30 mm	
T 301 class: Coastal minesweepers	1946–56	10	180	2 x 37 mm 2 x MG	
Zhenya: Coastal minesweepers	1971+	3	320	2 x 30 mm	
RT 40 class: Coastal minesweepers		40	60	2 x 25 mm 2 x MG	
MO VI class: Fast attack craft	1956–60	15	73	4 x 24 mm AA	AS: 2 x DC mortars 2 x DC racks
Shershen class: Fast attack craft	1962+	40	160	4 x 30 mm AA	Tubes: 4 x 21 in (533 mm) AS: 12 DC
P6, P8, P10 classes: Fast attack craft	1951–65	100	75	4 x 25 mm AA	Tubes: 2 x 21 in (533 mm) (or DC or mines)
P4 class: Fast attack craft	1952–58	10	25	2 x MG	Tubes: 2 x 18 in
URUGUAY					
Rio Negro: Coastal minesweeper		1	405	2 x 20 mm AA	
VENEZUELA					
Torbes: Coastguard vessel		1	47	1 x 20 mm	AS: 4 x DCT
VIETNAM (REPUBLIC OF)					
Ham Tu, Chuong Duong II: Coastal minesweepers		2	370	2 x 20 mm AA	
Ex-US ASPB Type: Riverine craft		84	36.25	1/2 x 20 mm (2 x .50 cal MG on boats with one 20 mm) 2 x .30 cal MG	2 x 40 mm grenade launchers
Ex-US ATC Type: Riverine craft		100	66	1/2 x 20 mm 2 x .50 cal MG several .30 cal MG	2 x 40 mm grenade launchers
Ex-US CCB Type: Riverine craft		9	80	3 x 20 mm 2 x .30 cal MG	2 x 40 mm grenade launchers
VIETNAM (NORTH)					
Ex Chinese Shanghai Type: Fast attack craft		4	120	4 x 37 mm 2 x 12.7 mm	
Ex-Chinese Swatow Type: Fast attack craft		24	67	4 x 37 mm 2 x 20 mm	AS: 8 x DC

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Guns	Other Weapons
USSR S.O. 1 Type: Corvettes		3	250	4 x 25 mm	AS: 4 x ahead throwing rocket launchers 2 x DCT
USSR P6 Type: Fast attack craft		6	75	4 x 25 mm AA	Tubes: 2 x 21 in (533 mm) Mines: 4
USSR P4 Type: Fast attack craft		12	25	2 x 25 mm AA	
YUGOSLAVIA					
PC 134 Type: Patrol vessels		9	120	2 x 20 mm AA	
Shershen Type: Fast attack craft		14	160	4 x 25 mm AA	Torpedo tubes: 4 x 21 in (533 mm)

ALL WEATHER INTERCEPTORS

8004.302
LIGHTNING F Mk 53
BAC (UK)
Role(s): Single-seat supersonic all-weather interceptor, strike and reconnaissance aircraft
Power Plant: 2 × Rolls-Royce Avon 302-C turbojet engines (each 16,300 lb (7,393 kg) st with reheat)
Wing Span: 34 ft 10 in (10.61 m)
Length Overall: 55 ft 3 in (16.84 m)
Weapons:
Interceptor role weapons:
2 × Red Top or 2 × Firestreak missiles.
44 × 2 in rockets.
2 × 30 mm Aden guns with 120 rounds each.
Ground attack role weapons:
Guns and 44 × 2 in rockets plus 144 × 68 mm SNEB rockets in two Matra Type 155 launchers, or 6 × 1,000 lb (454 kg) HE, retarded or fire bombs
Max Level Speed: At operational height, above Mach 2
In Service with: The Air Forces of Saudi Arabia and Kuwait.



BAC Lightning interceptor armed with Red Top missiles

8005.302
LIGHTNING F Mk 6
BAC (UK)
Role(s): Single-seat supersonic fighter
Power Plant: 2 × 16,360 lb (7,420 kg) st Rolls-Royce Avon 301 turbojets with reheat
Wing Span: 34 ft 10 in (10.61 m)
Length Overall: 55 ft 3 in (16.84 m)
Installed Weapons: None
Other Weapons: 2 Red Top or Firestreak air-to-air missiles on pylons projecting from fuselage. Provision for 48 × 2 in unguided air-to-air rockets in 2 Microcell reinforced plastic retractable packs
Max Level Speed: Over Mach 2
In Service with: Royal Air Force.

8016.302
F-102A DELTA DAGGER
CONVAIR (USA)
Role(s): Single-seat all-weather interceptor fighter
Power Plant: 1 × 11,700 lb (5,307 kg) (17,200 lb (7,082 kg) with reheat) Pratt and Whitney J-57-P-23 or -25 turbojet
Wing Span: 38 ft 1½ in (11.62 m)
Length Overall: 68 ft 4½ in (20.84 m)
Max Take-Off Weight: 32,000 lb (approx) (14,515 kg)
Other Weapons: 6 × Hughes AIM-4A, -4C, -4E or -4F Falcon air-to-air missiles in internal missile bay, plus 24 × 2.75 in rockets in missile bay doors
Max Level Speed: Mach 1.25 at 36,000 ft (11,000 m)
Typical Range: Approx 1,100 miles (1,770 km)
In Service with: US Air Force, Greek and Turkish Air Forces.

F-102A Delta Dagger interceptor

8017.302
F-106A DELTA DART
CONVAIR (USA)
Role(s): Interceptor fighter
Power Plant: 1 × 17,200 lb (7,801 kg) st (24,500 lb (11,123 kg) with reheat) Pratt and Whitney J75-P-17 turbojet
Wing Span: 38 ft 3½ in (11.67 m)
Length Overall: 70 ft 8¾ in (21.56 m)
Max Take-Off Weight: 35,000 lb (15,875 kg)
Other Weapons: 1 × Douglas AIR-2A Genie or rocket and 4 × Hughes AIM-4E or AIM-4F Super Falcon air-to-air missiles in internal weapon bay
Max Level Speed: Mach 2.3 at 36,000 ft (11,000 m)
Typical Range: 1,150 miles (1,850 km)
In Service with: US Air Force.

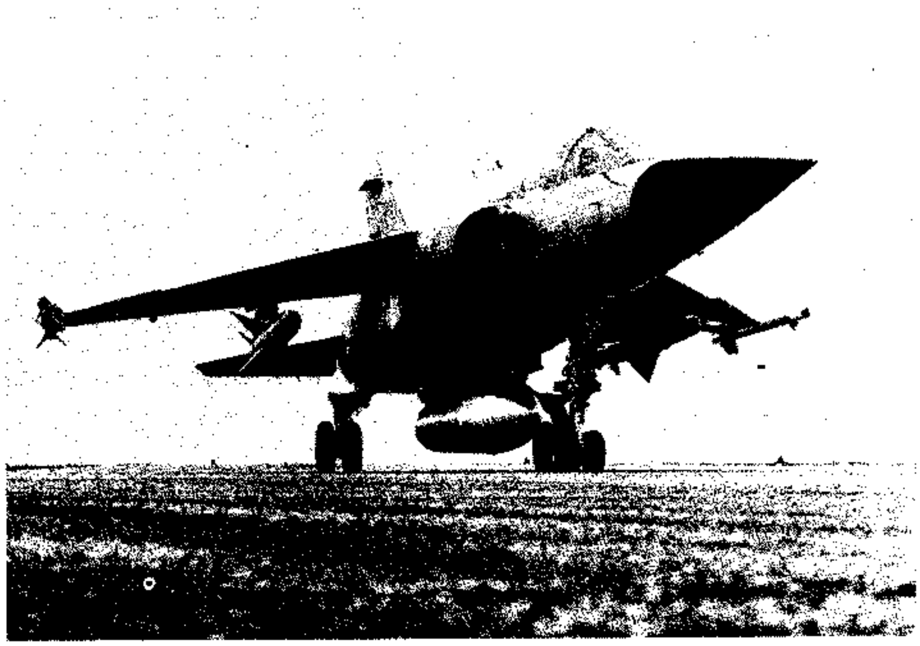
F-106A Delta Dart interceptor

8019.302
MIRAGE IIIC
DASSAULT (FRANCE)
Role(s): Single-seat fighter
Power Plant: 1 × SNECMA Atar 9B turbojet engine with afterburner 13,225 lb (6,000 kg) st, or Rolls-Royce RB 146 turbojet engine with afterburner 15,650 lb (7,100 kg) st plus optional and jettisonable SEPR 841 single-chamber rocket motor 3,700 lb (1,680 kg) st
Wing Span: 27 ft 0 in (8.22 m)
Length Overall: 43 ft 10 in (13.35 m)
Max Take-Off Weight: 27,700 lb (12,560 kg)
Installed Weapons: Provision for 2 × 30 mm DEFA cannon in fuselage, each with 125 rounds of ammunition
Other Weapons:
Normal interceptor armament comprises of:
1 × MATRA R 530 air-to-air missile under fuselage or 2 × underwing missiles.
Ground attack armament can include:
3 × Nord AS 20 or AS 30 air-to-surface missiles or bombs.
Alternative underwing stores include:

JL-50 pod containing 36 × 37 mm unguided rockets.
JL-100 pod with 16 rockets, (plus an amount of fuel) or JL-200 with 36 rockets, (plus an amount of fuel)
Max Level Speed: Mach 2.15 at 36,000 ft (11,000 m)
Typical Range: At Mach 1.8 at 59,000 ft (18,000 m), 365 ml (590 km). At Mach 0.85 at 39,370 ft (12,000 m), 930 miles (1,500 km)
In Service with: French Air Force, South African Air Force and Israeli Air Force.

The two-seat IIIB and IIID versions are also used by the Air Forces of Argentina, Australia, Brazil, France, Israel, Lebanon, Pakistan, Switzerland, Spain, South Africa and Venezuela.

8023.302
MIRAGE F1
DASSAULT (FRANCE)
Role(s): Single-seat all-weather multi-purpose fighter
Power Plant: 1 × 15,785 lb (7,160 kg) st (with reheat) SNECMA Atar 9K-50 turbojet
Wing Span: 27 ft 10½ in (8.50 m)
Length Overall: 49 ft 2½ in (15.00 m)
Max Take-Off Weight: 32,630 lb (14,800 kg)
Weapons: Standard armament comprises 2 Matra R 530 semi-active radar homing or infra-red homing air-to-air missiles. In addition, 2 Sidewinder air-to-air missiles and 2 30 mm guns can be carried. For ground attack duties, the 2 30 mm guns are supplemented by external stores carried on 6 underwing attachments and 1 underfuselage attachment.
Typical loads are:
14 × bombs.
72 × air-to-ground rockets or 2 × Nord AS 30 air-to-surface missiles.
Provision is made for carrying the AS 37 Martel anti-radar missile
Max Level Speed: (Above) Mach 2.2
Typical Range: With max fuel 2,050 miles (3,300 km)
In Service with: French Air Force, South African Air Force and Spanish Air Force.



Mirage F1 carrying 1,100 litre external fuel tank, two Matra R.530 missiles and two Sidewinders

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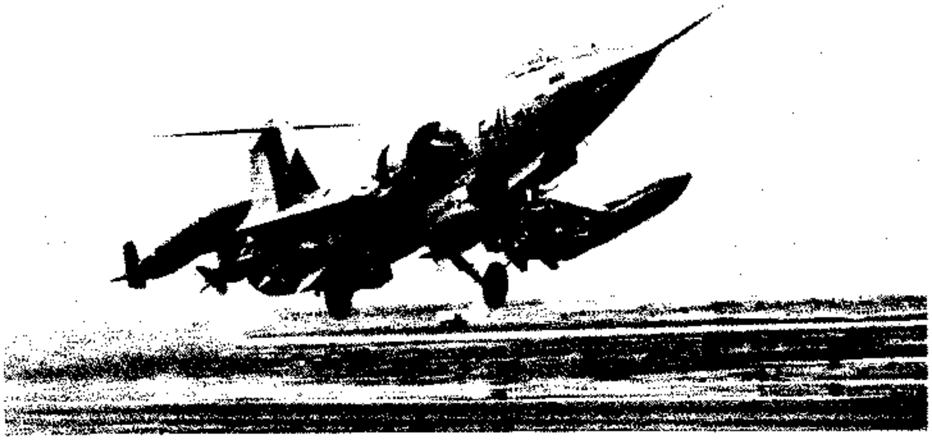
8024.302
SUPER MYSTERE B-2
DASSAULT (FRANCE)
Role(s): Single-seat interceptor and tactical strike fighter
Power Plant: 1 × 7,495 lb (3,399 kg) st SNECMA Atar 101G turbojet
Wing Span:
34 ft 5¾ in (10.51 m)
46 ft 1 in (14.04 m)
Max Take-Off Weight: 22,046 lb (10,000 kg)
Installed Weapons: 2 × 30 mm DEFA cannon and a pack of 55 air-to-air rockets in fuselage
Other Weapons:
Under-wing loads made up of:
38 × rockets in two honeycomb launchers, or
2 × 1,100 lb (500 kg) bombs, or
2 × napalm tanks, or
12 × heavy air-to-surface rockets, or
2 × Matra air-to-air guided missiles
Max Level Speed: Mach 1.13 at 36,000 ft (11,000 m)
Typical Range: 600 miles (965 km)
In Service with: French Air Force, Indian Air Force and Israeli Air Force.

8052.302
F-104S STARFIGHTER
LOCKHEED (USA)
Role(s): Interceptor aircraft
Power Plant: General Electric J79/J10 turbojet with redesigned afterburner, giving 17,900 lb (8,120 kg) st
Wing Span: Without tip-tanks 21 ft 11 in (6.68 m)
Length Overall: 54 ft 9 in (16.69 m)
Other Weapons: 9 external attachments for stores, including rockets, bombs and Sidewinder missiles. Normal primary armament will consist of Raytheon Sparrow air-to-air missiles
Max Level Speed: Mach 2.4
In Service with: Italian Air Force.

Other versions of the Starfighter are in service with the Air Forces of China (Taiwan), Jordan, Pakistan, West Germany, Belgium, Denmark, Greece, Netherlands, Norway, Spain, Turkey, Canada and Japan.

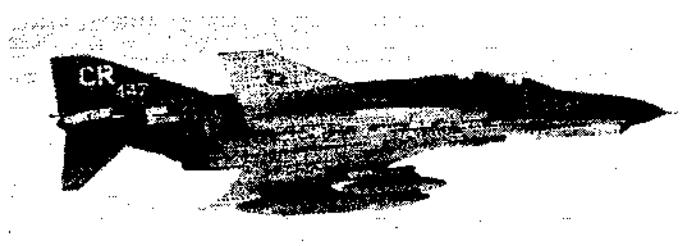


Italian F-104S Starfighter

1669.302
F-15A EAGLE
McDONNELL DOUGLAS (USA)
Role(s): Air superiority fighter
Power Plant: 2 × Pratt and Whitney F100-PW-100 turbofan engines of about 29,000 lb (13,155 kg) st
Wing Span: 49 ft 9¾ in (13.05 m)
Length Overall: 69 ft 9¾ in (19.45 m)
Max Take-Off Weight: 40,000 lbs (18,144 kg) approx
Weapons: 4 × AIM-7F Sparrow, or 4 × AIM-9L Sidewinder missiles. Internally mounted M61A1 20 mm gun
In Service with: US Air Force.

1408.302
PHANTOM II F-4E
McDONNELL-DOUGLAS (USA)
Role(s): 2-seat all-weather interceptor and tactical interdictor
Power Plant: 2 × General Electric J79-GE-17 17,900 lb (8,120 kg) st turbojet engines
Wing Span: 38 ft 5 in (11.70 m)
Length Overall: 58 ft 3 in (17.76 m)
Max Take-Off Weight: 54,600 lb (24,765 kg)
Installed Weapons: 1 × M61 Vulcan gun
Other Weapons:
6 × Sparrow III AAM or
4 × Sparrow III + 2 × Sidewinder AAM,
5 external weapon pylons for 16,000 lb (7,250 kg) weapons, eg Nuclear or HE bombs
Rockets
Bullpup ASM
Flares
Napalm / external fuel
Max Level Speed: Mach 2.4
Typical Range: 1,500 nm (2,780 km) plus

In Service with: (in different marks) US Navy, USAF, USMC, RAF, RN, Federal German AF, Japanese ASDF, Israel AF, and the Air Forces of Iran, South Korea, Turkey and Greece.



Phantom II F-4

8059.302
MiG-25 (NATO "FOXBAT")
MIKOYAN (USSR)
Role(s): Single-seat supersonic interceptor and strike reconnaissance aircraft
Power Plant: 2 × turbojets with reheat, giving 24,250 lb (11,000 kg) st each at take-off
Wing Span: (Estimated) 40 ft 0 in (12.30 m)
Length Overall: (Estimated) 69 ft 0 in (21.00 m)
Weapons: 4 × Ash or Atoll air-to-air missiles. Other unspecified armament options provide for ground attack operations
Max Level Speed: Mach 3
In Service with: Soviet Air Force, Egyptian Air Force.

8071.302
J35F DRAKEN
SAAB (SWEDEN)
Role(s): Interception/ground attack
Power Plant: 1 × 18,000 lb (8,164 kg) st (with afterburning) Svenska Flygmotor RM6C (Rolls-Royce Avon 300 srs)
Wing Span: 30 ft 10 in (9.4 m)
Length Overall: 50 ft 4 in (15.4 m)
Max Take-Off Weight: 35,280 lb (16,000 kg)
Max Weapon Load: 9,000 lb (4,080 kg)
Installed Weapons: 2 × 30 mm Aden guns with 100 rpg
Other Weapons: 6 attachments under wings, 3 under fuselage
Typical weapon loads:
(a) With internal fuel only:
9 × 1,000 lb (453 kg) bombs.
14 × 500 lb (226 kg) bombs.
4 × 19-round air-to-air rocket packs.
(b) With 2,280 IG (1,275 litre) drop tanks:
4 × 1,000 lb (453 kg) bombs.
8 × 500 lb (226 kg) bombs.
2 × air-to-surface missiles
12 × 13.5 cm Bofors air-to-ground rockets.
(c) With 2,280 IG (1,275 litre) and 2,110 IG (500 litre) drop tanks:
2 × 1,000 lb (453 kg) bombs.
4 × 500 lb (226 kg) bombs
Max Level Speed: Mach 2
Typical Range: Radius of action (hi-lo-hi, internal fuel) 350 miles (564 km). Radius of action (hi-lo-hi, 2 drop tanks, 2 × 1,000 lb (453 kg) bombs) 447 miles (720 km)
In Service with: Swedish Air Force (J35F, 35E, 35C), Danish Air Force (35X), Finnish Air Force (J35XS)

Saab J35F interceptor/ground attack aircraft

Draken Variants: Developed from the Swedish Air Force J35F, the 35X version is a long-range fighter/attack and reconnaissance aircraft. It has increased internal tankage as well as considerably increased external load carrying capability. The 35X has two internally mounted 30 mm Aden guns and can carry up to 4,500 kg of external stores distributed between nine attachment points. Stores can include heavy radio-directed air-to-surface missiles, air-to-surface rockets, bombs, and fuel tanks. Two reconnaissance versions exist. The Swedish Air Force version is the 35E, used mainly for pure photo-recce and equipped with seven cameras. Five of these are in the pressurised nose, and two in the gun compartments. Up to four external fuel tanks can be mounted to increase range. Cameras can be supplemented by ECM and other reconnaissance equipment. A variant of the 35E is for combined ground attack and reconnaissance. The trainer version is designated 35C.

8082.302
Su-9 (NATO "FISHPOT")
SUKHOI (USSR)
Role(s): Single-seat all-weather fighter
Power Plant: 1 × 22,046 lb (10,000 kg) st (with afterburning) TRD 31 turbojet
Wing Span: 26 ft 0 in (7.90 m)
Length Overall: 56 ft 0 in (17.0 m)
Other Weapons: 2 × "Anab" missiles under wings, one with radar homing head and one with infra-red homing head
Max Level Speed: Mach 1.8 at 36,000 ft (11,000 m)
In Service with: Soviet Air Force.

8083.302
Su-11 (NATO "FLAGON-A")
SUKHOI (USSR)
Role(s): Single-seat interceptor
Power Plant: 2 × turbojets with reheat
Wing Span: 30 ft 0 in (9.15 m) (estimated)
Length Overall: 68 ft 0 in (20.5 m) (estimated)
Other Weapons: 2 × "Anab" air-to-air missiles under wings
Max Level Speed: Mach 2.5
In Service with: Soviet Air Force.

Su-11, Flagon-A interceptor, armed with Anab missiles

8087.302
Tu-28 (NATO "FIDDLER")
TUPOLEV (USSR)
Role(s): Twin-jet all-weather fighter
Power Plant: 2 × unidentified turbojets with afterburners, dry rating about 18,000 lb (8,164 kg) st each
Wing Span: 65 ft 0 in (20.0 m)
Length Overall: 58 ft 0 in (25.9 m)
Max Take-Off Weight: 100,000 lb (45,000 kg)
Other Weapons: 2 air-to-air missiles under each wing (NATO "Ash"), one usually of radar homing type and the other of the infra-red homing type
Max Level Speed: Mach 1.75
In Service with: Soviet Air Force

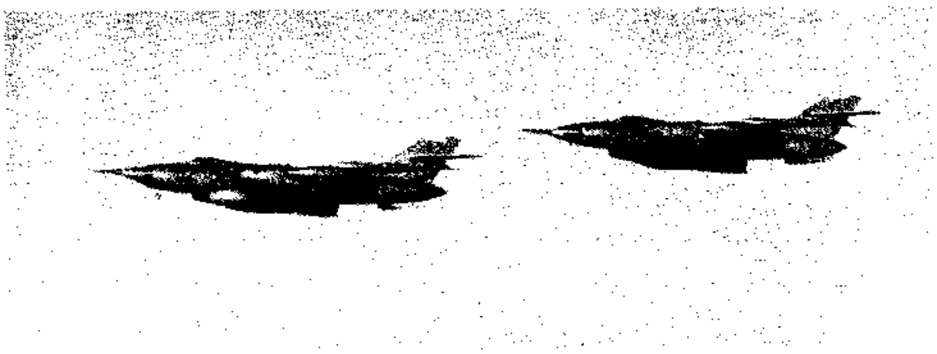
8090.302
Yak-25 (NATO "FLASHLIGHT-A")
YAKOVLEV (USSR)
Role(s): 2-seat all-weather fighter
Power Plant: 2 × 8,818 lb (4,000 kg) st Type 37V turbojets
Wing Span: 36 ft 0 in (10.97 m)
Length Overall: 51 ft 0 in (15.54 m)
Max Take-Off Weight: 22,000 lb (9,979 kg)
Installed Weapons: 2 × 37 mm guns in lower front fuselage
Other Weapons: Provision for an under-fuselage pack of unguided air-to-air rockets
Max Level Speed: Mach 0.9 at sea level
Typical Range: Low level radius of action at Mach 0.75 200 miles (321 km)
In Service with: Soviet Air Force

8091.302
Yak-25 (NATO "FLASHLIGHT-D")
YAKOVLEV (USSR)
Role(s): 2-seat all-weather fighter and tactical reconnaissance aircraft
Power Plant: 2 × 8,820 lb (4,000 kg) st Type 37V turbojets
Wing Span: 38 ft 6 in (11.75 m)
Length Overall: 62 ft 0 in (18.90 m)
Max Take-Off Weight: 25,000 lb (11,350 kg)
Installed Weapons: 1 × 30 mm gun in fairing under starboard side of front fuselage
Other Weapons: Provision for bombs, missiles or rocket pods under wings
Max Level Speed: Mach 0.95 at 36,000 ft (11,000 m)
In Service with: Soviet Air Force

8092.302
Yak-28 (NATO "FIREBAR")
YAKOVLEV (USSR)
Role(s): 2-seat all-weather fighter
Power Plant: 2 × TDR Mk R37F turbojets (with afterburning)
Other Weapons: "Anab" air-to-air missile under each wing. Can also carry an "Atoll" under each wing
Max Level Speed: Mach 1.1
In Service with: Soviet Air Force.

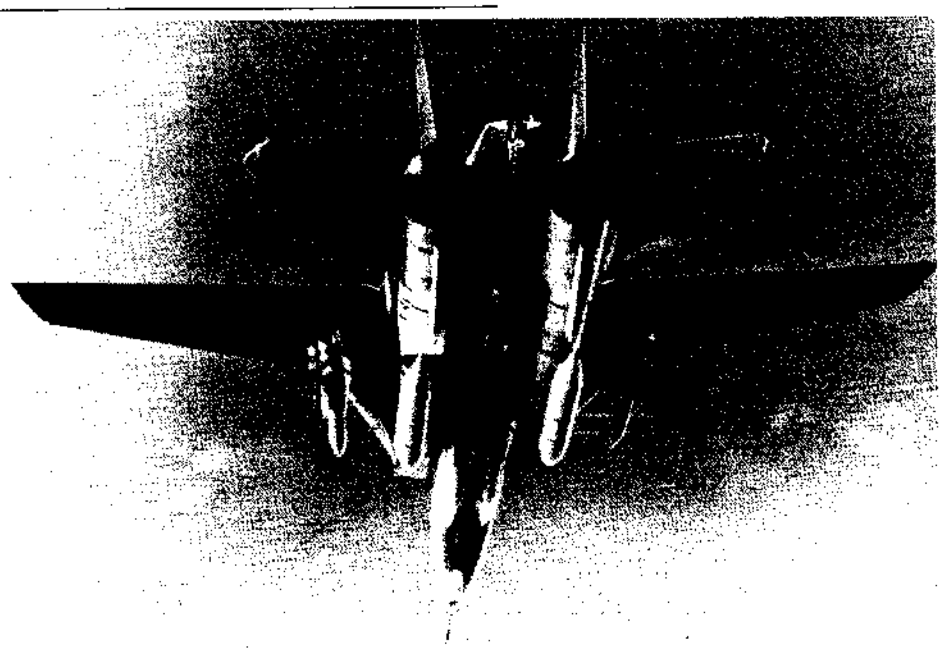
Yak-28 Firebar interceptor, armed with Anab missiles

8093.302
Yak-28 (NATO "BREWER")
YAKOVLEV (USSR)
Role(s): Two-seat all-weather fighter
Power Plant: 2 × 9,500 lb (4,309 kg) st TDR Mk R37F turbojets, with afterburning on current aircraft
Wing Span: 38 ft 6 in (11.73 m)
Length Overall: 59 ft 0 in (17.98 m)
Max Take-Off Weight: 35,000 lb (15,875 kg)
Installed Weapons: Semi-submerged guns in each side of fuselage on some aircraft
Other Weapons: Internal bomb-bay between the under-fuselage radome and the rear main landing gear unit
Max Level Speed: Mach 1.1
In Service with: Soviet Air Force.



Yak-28 Brewer all-weather interceptor

1407.302
TOMCAT F-14A
GRUMMAN (USA)
Role(s): 2-seat naval all-weather interceptor
Power Plant: 2 × Pratt & Whitney TF-30-P-412 22,500 lb (10,205 kg) st
Wing Span: 64 ft 1½ in (19.47 m) swept forward; 32 ft 11½ in (10.05 m) swept back
Length Overall: 61 ft 10 in (18.86 m)
Max Take-Off Weight: 53,000 lb (24,040 kg)
Installed Weapons: 1 × 20 mm Vulcan gun
Other Weapons:
4 × Sparrow III AAM
8 × Sidewinder AAM
Other external stores on 2 underwing pylons
Max Level Speed: Mach 2 +
In Service with: US Navy, Iran (ordered).



F-14 Tomcat armed with six AIM-54 Phoenix missiles

BASIC TRAINERS AND LIGHT STRIKE AIRCRAFT

8000.302
MB 326
AERMACCHI (ITALY)

Role(s): Two-seat basic trainer and tactical ground-attack aircraft

Power Plant: 1 × 3,410 lb (1,547 kg) st Rolls-Royce Bristol Viper 20 Mk 540 turbojet engine

Wing Span: Without tip-tanks 33 ft 3¾ in (10.15 m)

Max Take-Off Weight: With 1,695 lb (769 kg) armament 11,500 lb (5,216 kg)

Other Weapons:

Up to 4,000 lb (1,814) kg of armament can be carried on 6 underwing attachments.

Typical weapon loads include the following alternatives:

2 × LAU-3/A packs each containing 19 2.75 in FFAR rockets and 2 × packs each containing 8 Hispano-Suiza SURA 80 mm rockets.

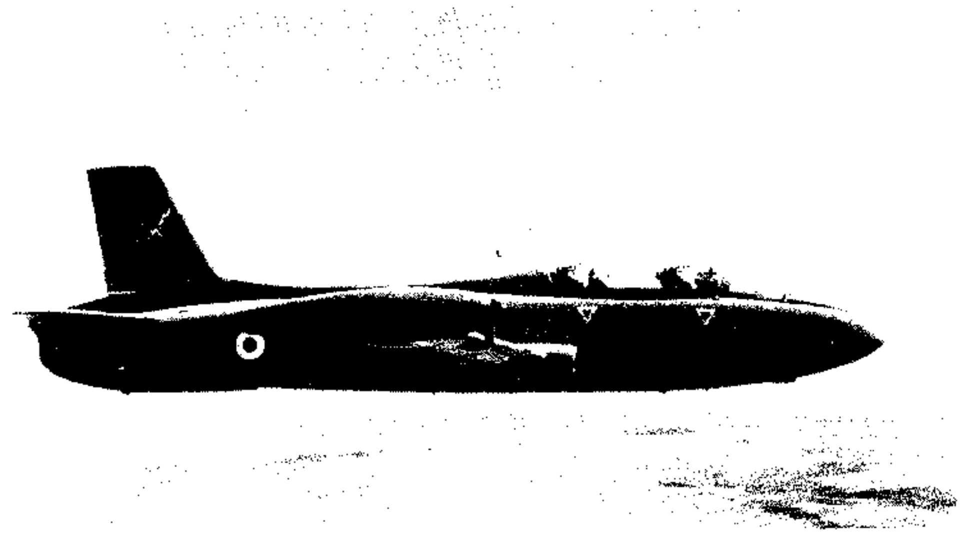
2 × 12.7 mm gun pods and 4 packs each containing 6 SURA 80 mm rockets.

1 × 7.62 Minigun, 1 × 12.7 mm gun pod, 2 × Matra 122 rocket packs and 2 × packs each containing 6 SURA 80 mm rockets.

2 × 500 lb (226 kg) bombs and 8 5 in HVAR rockets.

2 × Nord AS 12 missiles

1 × 12.7 mm gun pod, plus drop tanks and reconnaissance pack or 2 × Matra SA-10 packs each containing a 30 mm Aden gun and 150 rounds



MB326 strike/trainer aircraft

Max Level Speed: 539 mph (867 kmh)

Typical Range: With max fuel, 1,695 lb (769 kg) armament, 200 lb (90 kg) fuel reserve, out at 20,000 ft (6,100 m), return at 25,000 ft (7,620 m) 403 miles (648 km)

In Service in: Argentina, Australia, Bolivia, Brazil, Congo, Ghana, Italy, South Africa, Tunisia and Zambia.

1580.302
ALPHA JET
DORNIER/DASSAULT-BREGUET (FRANCE/WEST GERMANY)

Role(s): Two-seat multi-purpose strike/trainer aircraft. For basic and advanced training, and can also be used for close air support missions

Power Plant: 2 × SNECMA-Turbomeca Larzac 04 fan jet engines, each of 2,975 lb (1,349 kg) st

Wing Span: 30 ft 1 in (9.16 m)

Length Overall: 39 ft 5 in (12.05 m)

Max Take-Off Weight: 13,230 lb (6,000 kg)

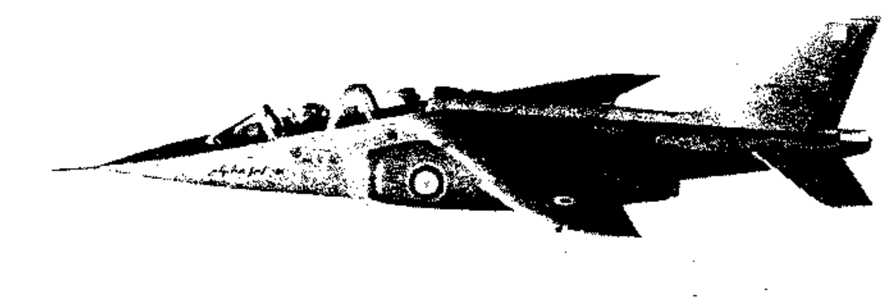
Weapons: Underwing hardpoints will be provided for bombs, cluster dispensers, or rocket pods, and a removable 30 mm gun will be carried under the fuselage of some versions. Armament arrangements will vary between the several French versions of the Alpha Jet and the West German version

Max Level Speed: Mach 0.85

Ceiling: 50,000 ft (15,240 m)

In Production for: French and German air forces

Systems Description: French and German avionics fits will differ. The former will include UHF, VHF, Tacan, VOR, and IFF; German aircraft will have installations that include UHF/VHF, Tacan and radio altimeter.



Franco/German Alpha Jet strike trainer

8003.302
BAC 167
BAC (UK)

Role(s): Light attack aircraft

Power Plant: 1 × Rolls Royce (Bristol) Viper Mk 535 turbojet engine (3,410 lb (1,547 kg) st)

Wing Span: 35 ft 4 in (10.77 m)

Length Overall: 33 ft 7½ in (10.25 m)

Max Take Off Weight: 11,500 lb (5,215 kg)

Max Weapon Load: 3,000 lb (1,360 kg)

Installed Weapons: 2 × 7.62 mm FN machine-guns

Other Weapons: Typical underwing loads include

12 × 3 in Mk 6 rockets with 60 lb (27 kg) warheads.

32 × Hispano Suiza Sura Type 3 rockets.

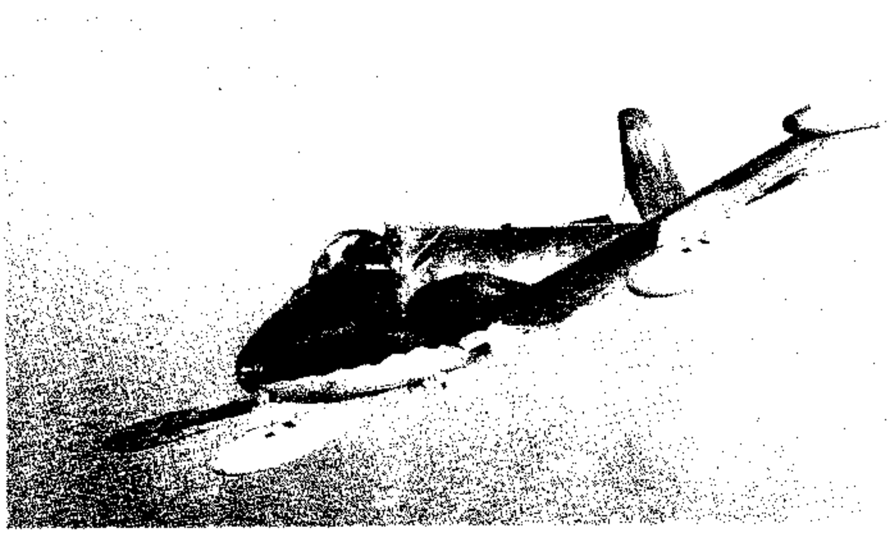
96 × 2 in Mk 1 rockets with 3¼ lb (1.47 kg) warheads in four pods.

4 × 500 lb (266 kg) bombs.

2 × 50 gallon (227 litre) napalm tanks.

72 × 2 in rockets in two pods

Max Level Speed: With 50% fuel, clean 470 mph (756 kmh) at sea level



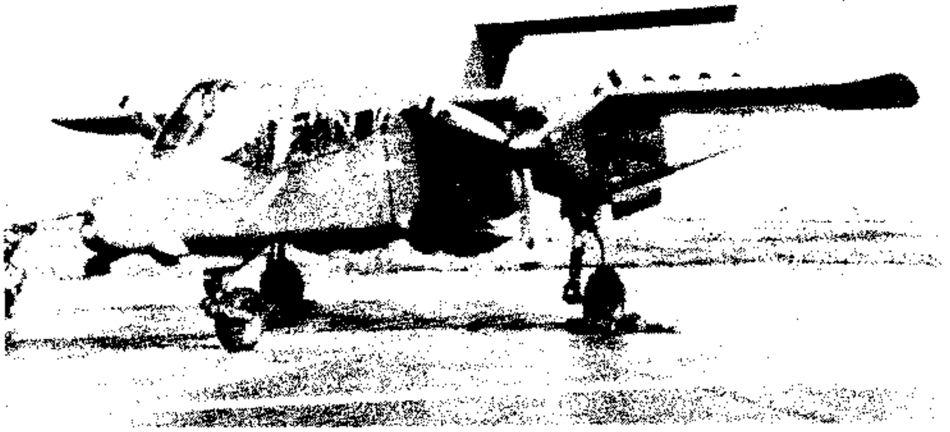
BAC 167 Strikemaster of Singapore Air Defence Force

Typical Range: 10% fuel reserve. With full internal fuel at 40,000 ft (12,200 m) 777 miles (1,250 km). With max fuel at 30,000 ft (9,150 m) over 1,380 miles (2,225 km)
In Service in: Ecuador, Kenya, Kuwait, Muscat, New Zealand, Oman, Saudi Arabia, Singapore, South Yemen.

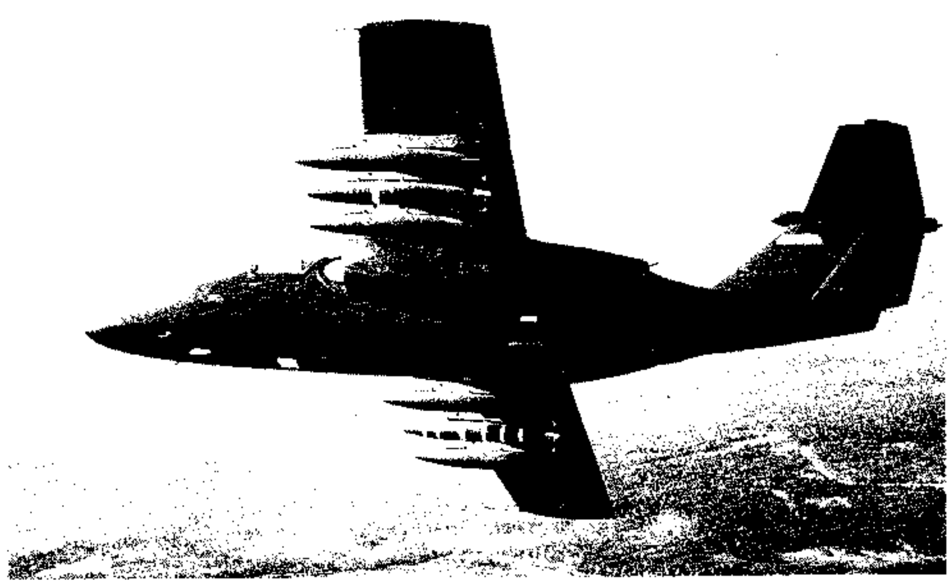
8014.302
F-51D MUSTANG
CAVALIER (USA)
Role(s): 2-seat fighter bomber and operational trainer
Power Plant: 1 × 1,695 hp Packard V-1650-7 (Rolls Royce Merlin) piston engine
Wing Span: 37 ft 0½ in (11.29 m)
Length Overall: 32 ft 2⅓ in (9.81 m)
Max Take-Off Weight: 12,500 lb (5,669 kg)
Installed Weapons: 6 × 0.50 in machine-guns
Other Weapons:
Stores are carried on 4 hard points under each wing
Each inboard hard-point can carry 1 × 1,000 lb (454 kg) bomb or 110 US gallon (415 l tre) fuel tank.
The other 6 hard-points carry 5 in (12.7 cm) air-to-surface rockets
Max Level Speed: 457 mph (735 kmh) at 28,000 ft (8,534 m)
Typical Range: 1,980 miles (3,186 km) at 290 mph (466 kmh)
In Service with: Standard single-seat North American F-51D Mustangs of World II vintage remain in first-line service in Bolivia, Dominica, El Salvador, Guatemala and Indonesia.

8015.302
A-37B
CESSNA (USA)
Role(s): Light attack aircraft
Power Plant: 2 × 2,850 lb (1,293 kg) st. General Electric J85 GE-17A turbojets
Wing Span: 35 ft 9½ in (10.91 m)
Length Overall: 29 ft 3 in (8.92 m)
Max Take-Off Weight: 12,800 lb (5,805 kg)
Max Weapon Load: Over 5,000 b (2,267 kg)
Installed Weapons: 1 × 7.62 mm multi-barrel Minigun
Other Weapons:
Each wing has 4 pylon stations, the 2 inner ones carrying 800 lb (363 kg) each, the intermediate one 600 lb (272 kg) and the outer one 500 lb (227 kg). The following weapons in various combinations, can be carried on those underwing pylons:
SUU-20 bomb and rocket pod.
MK-81 or MK-82 bomb.
BLU/32/B fire bomb.
SUU-11/A gun pod.
CBU-24/B or CBU-25/A dispenser and bomb.
M117 demolition bomb.
LAU-3/A rocket pod.
CBU-12/A, CBU 14/A or CBU-22/A dispenser and bomb
BLU-1C/B fire bomb.
LAU-32/A or LAU 59/A rocket pod.
CBU-19/A canister cluster and SUU-25/A flare launcher
Max Level Speed: 476 mph (766 kmh)
Typical Range: Ferry range 1,200 miles (1,931 km)
In Service with: US Air Force, South Vietnamese Air Force, Guatemala.

8064.302
OV-10A BRONCO
NORTH AMERICAN (USA)
Role(s): 2-seat observation and COIN aircraft
Power Plant: 2 × 715 shp Garrett AiResearch T76-G-10/12 turboprops
Wing Span: 40 ft 0 in (12.19 m)
Length Overall: 41 ft 7 in (12.67 m)
Max Take-Off Weight: 14,466 lb (6,563 kg)
Max Weapon Load: 3,600 lb (1,633 kg)
Installed Weapons: 2 × 0.30 in M60C machine-guns carried in each sponson
Other Weapons:
4 weapon attachment points, each with a capacity of 600 lb (272 kg), under short sponsor extending from bottom of fuselage on each side, under wings.
Fifth attachment point, capacity 1,200 lb (544 kg) under centre fuselage.
Provision for carrying Sidewinder AAM on each wing
Max Level Speed: 281 mph (452 kmh) at sea level without weapons
Typical Range: Combat radius with max weapon load, no loiter 228 miles (367 km). Ferry range with auxiliary fuel 1,428 miles (2,300 km)
In Service with: US Marine Corps, US Air Force, Germany (Fed. Republic), Thailand, Venezuela.


OV-10A ground attack aircraft

1583.302
105 G
SAAB-SCANIA (SWEDEN)
Role(s): Two-seat light close support and trainer aircraft. Missions include: ground attack, training, reconnaissance, limited air-to-air combat
Power Plant: 2 × 2,650 lb (1,293 kg) st General Electric J85-17B turbojet engines
Wing Span: 31 ft 2 in (9.5 m)
Length Overall: 35 ft 6 in (10.8 m)
Max Take-Off Weight: 14,330 lb (6,500 kg)
Weapons: Six underwing hardpoints are provided with a total capacity of 5,180 lb (2,350 kg), and a variety of weapon options are possible, depending upon the range and mission profiles selected. 30 mm gun-pods, rockets, bombs and missiles can be carried at speeds up to Mach 0.86. Camera pod, Sidewindar, 110 US gal tanks, Saab RB05A air-to-surface missiles, or IR homing Swedish-built Falcon air-to-air missiles, can also be carried
Max Level Speed:
Ground level 525 kt (970 km/h).
At 10,000 m – 475 kt (875 km/h)
Attack Radius:
6 × 500 lb bombs:
hi-lo-hi 375 nm (695 km)
lo-lo-lo 162 nm (300 km)
4 × 500 lb bombs, plus 2 external tanks:
hi lo-hi 538 nm (995 km)
lo-lo-lo 224 nm (415 km)
Systems Description: The 105 G has a new nav-attack system which is available in four different versions:
(1) 2 × VHF or VHF plus UHF
ADF/DME
VOR/ILS
IFF
Dual flight instruments
Gyro sight, with depressed sight line facility.
(2) 2 × UHF or UHF plus VHF


Saab 105G close support and trainer aircraft

Tacan or ADF
VOR/ILS (optional)
IFF
Dual flight instruments
Gyro sight, with depressed sight-line facility.

(3) 2 × UHF
Tacan
IFF
Twin gyro-platform.
Single flight instruments
Gyro sight head
BT9R ballistic computer and laser range-finder.

(4) 2 × UHF
Doppler with TANS computer
IFF
Twin gyro-platform
Air data computer
Single flight instruments
Roller map display
BT9 ballistic computer with laser range-finder.
Gyro sight head.

Standard equipment for these options is as follows:

Communications – Collins
IFF – Hazeltine
Twin gyro-platform – Sperry (UK)
Doppler – Decca
TANS and Roller map – Decca
Gyro sight – Ferranti
BT9R Ballistic computer – Saab
Laser range-finder – LME, Bofors, or Ferranti.
Air Data System – Elliott

In Service with: Royal Swedish Air Force – SK60A, B, and C versions. Austrian Air Force – 105XT, (OE) version

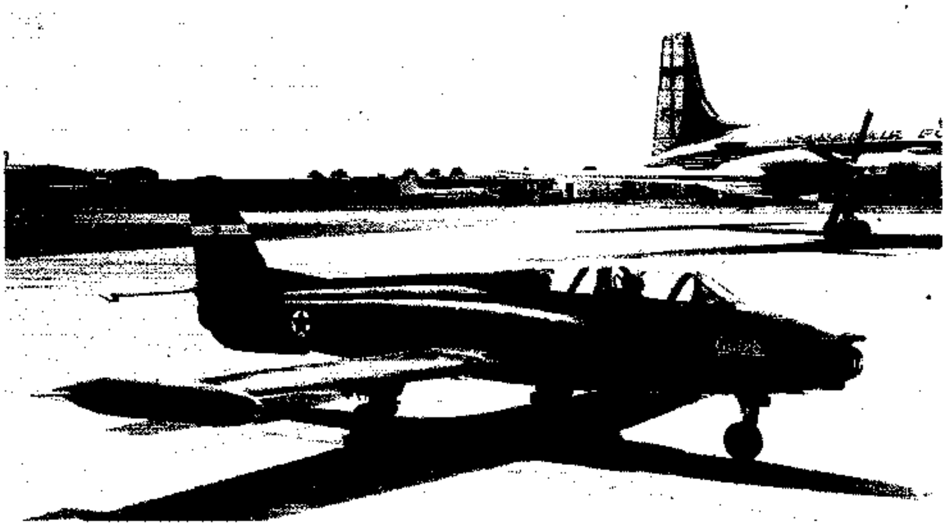
1579.302
HS 1182 HAWK
HAWKER SIDDELEY (UK)

Role(s): Two-seat multi-purpose strike/trainer aircraft. Designed for both basic and advanced training, with high subsonic performance and good low-speed handling characteristics. A close-support version can carry external stores on five pylons, the centre one of which (beneath the fuselage) may be replaced by a 30 mm gun
Power Plant: 1 × Rolls-Royce/Turbomeca RT 172-06 Adour un-reheated turbo-fan
Wing Span: 30 ft 10 in (9.40 m)
Length Overall: 33 ft 9½ in (11.96 m)
Max Take-Off Weight: 15,610 lb (7,080 kg)
Weapons: Centre-line attachment for 30 mm Aden gun and ammunition pack; two underwing points, each of 1,000 lb (454 kg) capacity; provision for two outer wing pylons of 1,000 lb (454 kg) capacity
Max Level Speed: 516 knots (1,102 km/h) at height
Typical Range: Ferry range approx 1,500 nm (2,780 km)
Under Development for: Royal Air Force. 175 ordered to enter service late 1976

Hawker Siddeley HS 1182 Hawk

8076.302
JASTREB
SOKO (YUGOSLAVIA)

Role(s): Single-seat light attack aircraft
Power Plant: 1 × 3,000 lb (1,360 kg) st, Rolls-Royce Bristol Viper 531 turbojet
Wing Span: 34 ft 8 in (10.56 m), 38 ft 4 in (11.68 m) with tip-tanks
Length Overall: 35 ft 1½ in (10.71 m)
Max Take-Off Weight: 10,010 lb (4,541 kg)
Installed Weapons: 3 × 0.50 in Colt-Browning machine-gun in nose (with 135 rpg)
Other Weapons: Has a total of 8 underwing weapons attachments.
2 inboard attachments can carry either:
2 × 550 lb (250 kg) bombs each.
2 × clusters of small bombs.
2 × 100 lb (45 kg) photo flares.
Other attachments can each carry:
1 × 57 mm or 127 mm rocket
Max Level Speed: 510 mph (820 kmh) at 19,680 (6,000 m) at AUW of 8,748 lb (3,968 kg)
Typical Range: 945 miles (1,520 km) at 29,520 ft (9,000 m) with tip-tanks full
In Service with: Yugoslav Air Force, Zambian Air Force



Two-seat Galeb trainer version of Soko Jastreb single-seat attack aircraft

1586.302
MFI-17
SAAB-SCANIA (SWEDEN)

Role(s): Two/three-seat light aircraft for forward area roles such as control (FAC), support, reconnaissance, observation, ground attack and training
Power Plant: 1 × Lycoming IO-360-AIB6, 200 hp fuel injection engine driving Hartzell constant-speed propeller
Wing span: 28 ft 6½ in (8.7 m)
Length Overall: 23 ft (7.0 m)
Max Take-Off Weight:
Normal – 2,095 lb (950 kg)
Restricted – 2,423 lb (1,100 kg)
Weapons: Up to 660 lbs (300 kg) of external loads can be carried on six underwing attachment points. Weapon options include:
4 × rocket launchers, each with 7 NATO 2.75 in HVA rockets.
4 × Bofors Bantam wire-guided anti-tank missiles.

Saab-MFI 17 army co-operation and trainer aircraft

2 × GE mini-gun pods, 5.56 mm
6 × Bofors 135 mm rockets.
18 × Bofors 75 mm rockets.
4 × TOW anti-tank missiles
Max Level Speed: 141 knots (262 km/h)
Typical Range: 450 to 850 miles (725 to 1,370 km) depending upon flight profile and load

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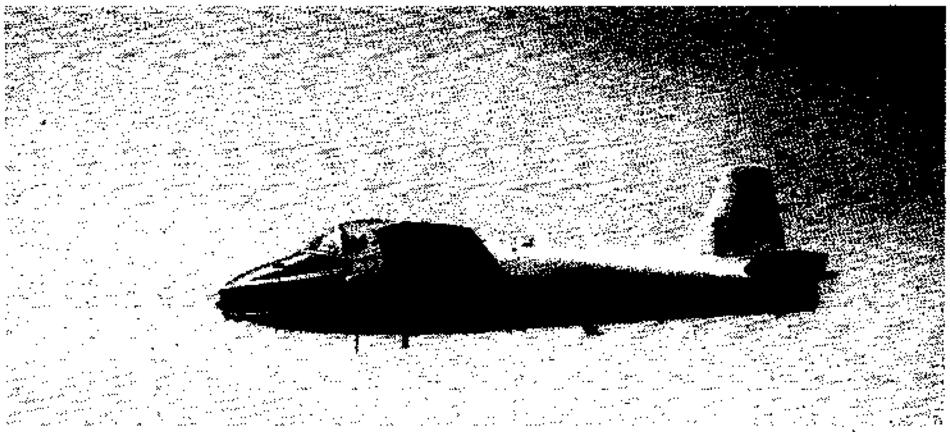
8077.302
P-2 KRAGUJ
SOKO (YUGOSLAVIA)
Role(s): Single-seat lightweight close-support aircraft
Power Plant: 1 × 340 hp Lycoming GSO-480-BIA6 piston-engine
Wing Span: 34 ft 11 in (10.64 m)
Length Overall: 26 ft 0¼ in (7.93 m)
Max Take-Off Weight: 3,580 lb (1,624 kg)
Installed Weapons: 1 × 7.7 mm machine-gun with 650 rpg in each wing
Other Weapons: 6 underwing attachments. 2 inner attachments each carry either:
1 × 220 lb (100 kg) bomb
Cluster of small bombs.
33 imp gal (150 litre) napalm tank.
12-round rocket pack.
The remaining 4 can each carry:
1 × 57 mm or 127 mm rocket.
Max Level Speed:
171 mph (275 kmh) at Sea Level
183 mph (295 kmh) at 5,000 ft (1,500 m)
Typical Range: 500 miles (800 km) with max fuel

8094.302
JET PROVOST T Mk 52
BAC (UK)
Role(s): 2-seat basic trainer and light attack aircraft
Power Plant: 1 × 2,500 lb (1,134 kg) st Rolls-Royce Bristol Viper 202 turbojet
Wing Span: 36 ft 11 in (11.25 m)
Length Overall: 32 ft 5 in (9.88 m)
Max Take-Off Weight: 7,400 lb (3,356 kg)
Installed Weapons: 2 × 0.303 in machine-guns in air intakes with 600 rounds per gun
Other Weapons: Wing attachments for:
24 × Sura Mk 3 rockets.
6 × 60 lb (27.2 kg) or 12 × 25 lb (11.3 kg) rockets.
8 × 25 lb (11.3 kg) or 2 × 100 lb (45.3 kg) bombs.
12 × 8 cm Oerlikon rockets.
Under fuselage pack of 2 × 0.50 in guns with 100 rounds per gun can also be carried
Max Level Speed: 410 mph (660 kmh) at 20,000 ft (6,096 m)
Typical Range: 700 miles (1,126 km)
In Service in: Iraq, Kuwait, South Yemen, Sri Lanka, Sudan, UK, and Venezuela

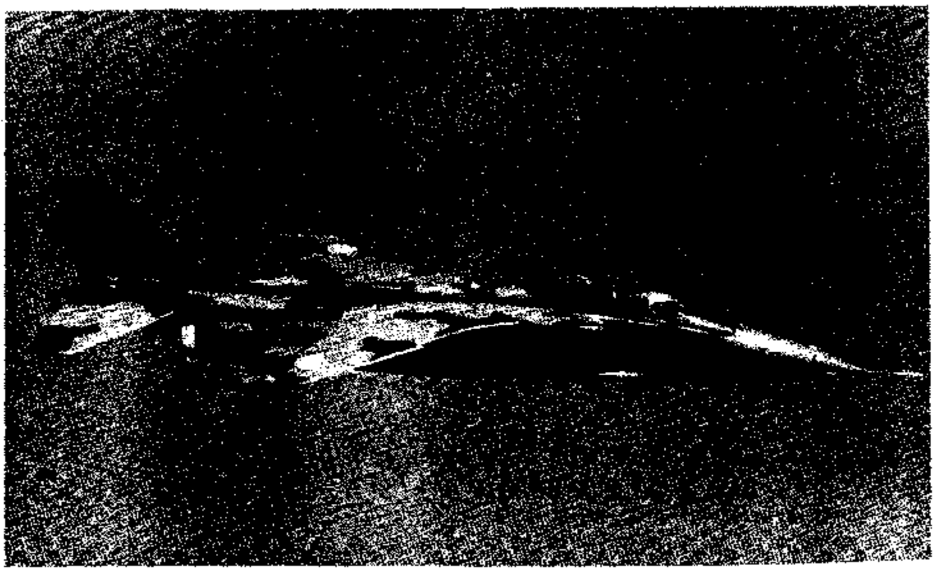


Provost Mk 5 of Royal Air Force

FIGHTER BOMBERS

1671.302
PUCARÁ IA-58
Argentine Military Aircraft Factory
Role(s): Multi-purpose, two-seat attack aircraft
Power Plant: 2 × 1021 ESHP Astazou XVIG turboprops
Wing Span: 47 ft 6 in (14.48 m)
Length Overall: 45 ft 7 in (13.90 m)
Max Take-Off Weight: 14,300 lb (6,846 kg)
Installed Armament:
4 × 7.62 mm machine guns
2 × 20 mm cannon
Other Weapons: Provision is made for a wide range of stores to a maximum combined load of 3,307 lbs (1,500 kg)
Max Level Speed: 281 knots (520 km/h) at 9,843 ft (3,000 m)
In Production for: Argentine Air Force

8006.302
JAGUAR
BAC/BREGUET (ANGLO-FRENCH)
Role(s): Single-seat tactical support aircraft
Power Plant: 2 × 6,950 lb (3,150 kg) st (with afterburning) Rolls-Royce/Turbomeca Adour turbofans
Wing Span: 27 ft 10¼ in (8.49 m)
Length Overall: 50 ft 11 in (15.52 m)
Max Take-Off Weight: 29,762 lb (13,500 kg)
Max Weapon Load: External weapons and stores 10,000 lb (4,500 kg)
Installed Weapons: 2 × 30 mm Aden cannon in lower fuselage aft of cockpit
Other Weapons:
5 weapon stations, 1 under fuselage and 4 under wings plus provision for 2 × Sidewinder AAM on wing tips.
Max loads are 2,000 lb (900 kg) on centre and inboard wing stations.
1,000 lb (450 kg) on outboard stations up to max total load of 10,000 lb (4,500 kg).
Typical Loads:
8 × 1,000 lb (450 kg) HE bombs.
3 × AS 37 ASM.
3 × 1,200 litre drop tanks.
6 × 1,000 lb (450 kg) HE bombs plus 4 × Matra type 155 68 mm rockets launchers.
2 × 1,000 lb (450 kg) bombs on centre station plus 2 × 1,200 litre drop tanks
Max Level Speed:
In initial form:
Mach 1.1 at sea level
Mach 1.7 at 36,000 ft (11,000 m)
Typical Range:
Attack radius, with external fuel:
Hi-lo-hi 1,025 miles (1,650 km).
Low altitude throughout 530 miles (850 km).
Attack radius, internal fuel only:
Hi-lo-hi 775 miles (1,250 km).
Low altitude throughout 405 miles (650 km)
In Service with: French and British Air Forces. Ordered for Ecuador and Oman

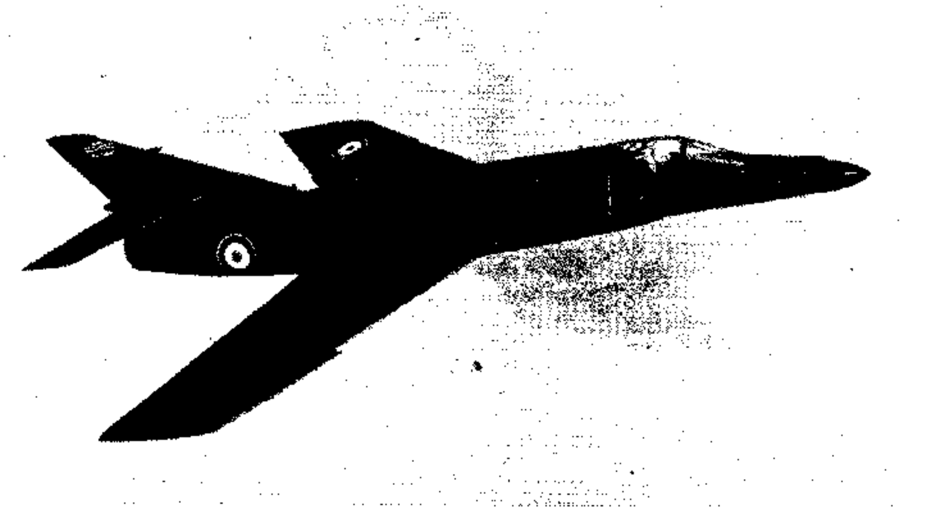


Anglo-French Jaguar

8018.302
ETENDARD IV-M
DASSAULT (FRANCE)
Role(s): Single-seat carrier-based interceptor and fighter-bomber
Power Plant: 1 × 9,700 lb (4,400 kg) st SNECMA Atar 8 turbojet
Wing Span: 31 ft 6 in (9.60 m)
Length Overall: 47 ft 3 in (14.40 m)
Max Take-Off Weight: 22,650 lb (10,273 kg)
Max Weapon Load: 3,000 lb (1,360 kg)
Installed Weapons: 1 or 2 × 30 mm cannon

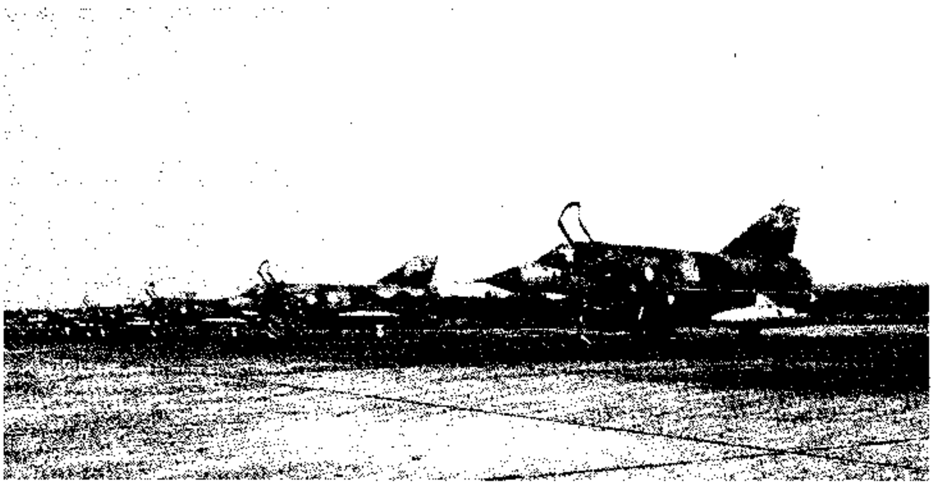
Other Weapons: Four under-wing attachments for up to 3,000 lb (1,360 kg) of rockets, bombs, Sidewinder air-to-air or Nord AS 30 air-to-surface missiles (or drop tanks)
Max Level Speed: Mach 1.02 at 36,000 ft (11,000 m)
Typical Range: 1,750 miles (2,816 km) with external tanks, at 510 mph (820 kmh)
In Service with: French Navy

Super Etendard
Dassault is developing for the French Fleet Air Arm an improved model of the Etendard IV, known as the Super Etendard. Similar in appearance to its predecessor, the new version will have a more powerful SNECMA 8K50 engine and a more sophisticated weapon system. The latter will include the Agave nose radar (**1672.353**) being developed by Thomson-CSF and Electronique Marcel Dassault, an inertial navigation system, and the use of new generation air-to-air missiles. Prototypes are planned for 1976 with deliveries to the French Navy starting in the Summer of 1977.



Super-Etendard being developed for French Fleet Air Arm

8020.302
MIRAGE IIIE
DASSAULT (FRANCE)
Role(s): Single-seat long-range fighter-bomber
Power Plant: 1 × 13,670 lb (6,200 kg) st (with reheat) SNECMA Atar 9C turbojet and, 1 × 3,307 lb (1,500 kg) st SEPR 844 rocket-engine
Wing Span: 27 ft 0 in (8.22 m)
Length Overall: 49 ft 3½ in (15.03 m)
Max Take-Off Weight: 29,760 lb (13,500 kg)
Installed Weapons: Provision for 2 × 30 mm DEFA cannon in fuselage, each with 125 rounds of ammunition
Other weapons: Normal interceptor armament comprises:
1 × MATRA R 530 air-to-air missile under fuselage.
2 × Sidewinder air-to-air missiles.
Ground attack armament consists normally of:
The 30 mm guns and 2 × 1,000 lb (453 kg) bombs or 1 × AS 30 air-to-surface missile under the fuselage and 1,000 lb (453 kg) bombs under the wings
Alternative underwing stores include:
JL-100 pods, each with 18 rockets, and 55 imp gallon (250 litre) fuel tanks
Max Level Speed: 870 mph (1,400 kmh) at max take-off weight and low altitude
Typical Range:
Combat radius at max take-off weight:
Low level throughout 305 miles (490 km).
High-low-high 398 miles (640 km).
High level throughout 472 miles (760 km)
In Service in: Argentine, Australia, Brazil, France, Lebanon, Libya, Pakistan, Saudi Arabia, South Africa, Spain, Switzerland, Venezuela, (in various versions)



Mirage IIIE

8022.302
MIRAGE 5
DASSAULT (FRANCE)
Role(s): Single-seat fighter-bomber
Power Plant: 1 × 13,670 lb (6,200 kg) st (with reheat) SNECMA Atar 9C turbojet
Wing Span: 27 ft 0 in (8.22 m)
Length Overall: 50 ft 10¼ in (15.50 m)
Max Take-Off Weight: 29,760 lb (13,500 kg)
Max Weapon Load: 8,820 lb (4,000 kg)
Installed Weapons: 2 × 30 mm cannon in fuselage
Other Weapons:
7 wing and fuselage attachment points can carry as a typical external weapon load:
2 × 1,000 lb (453 kg) bombs.
10 × 500 lb (226 kg) bombs.
2 × 250 lb (113 kg) bombs.
(As well as 2 external fuel tanks).
The Mirage 5 can also be flown as an interceptor with 2 × Sidewinder air-to-air missiles and also with external fuel
Max Level Speed: Mach 2.1 at 40,000 ft (12,192 m)
Ordered for: Belgian Air Force, Iraqi Air Force
In Service in: Abu Dhabi, Belgium, Colombia, France, Libya, Pakistan, Peru, Venezuela

Mirage 5 with a load of 14 bombs, and two external fuel tanks

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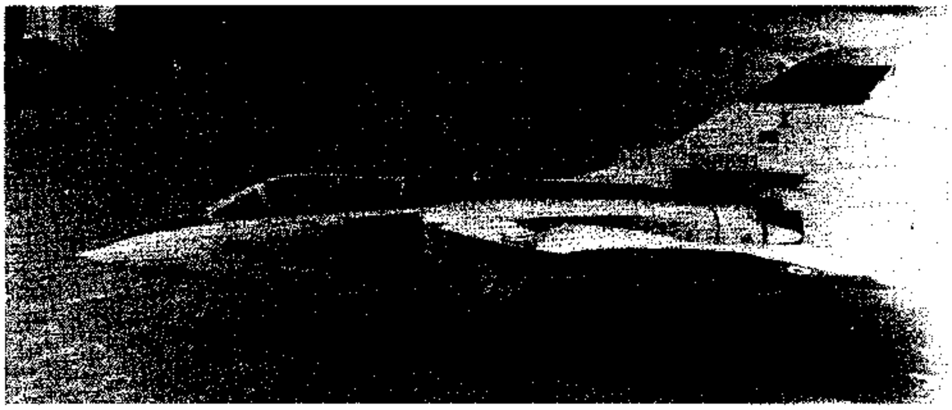
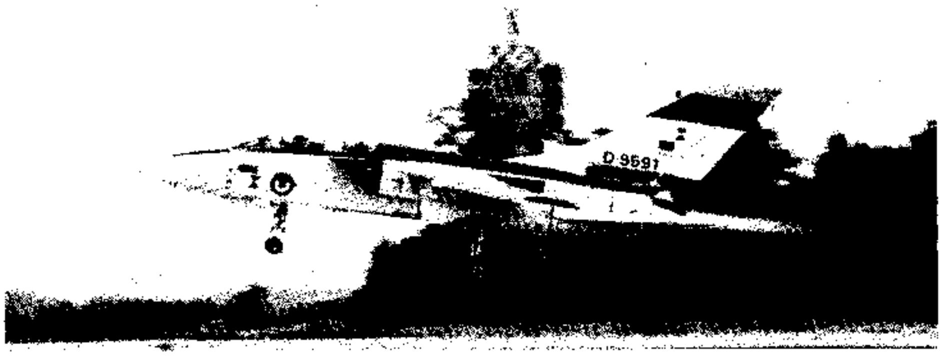
1581.302
PANAVIA 200 MRCA –
MULTI-ROLE COMBAT AIRCRAFT
PANAVIA (INTERNATIONAL – W. GERMANY, ITALY, UK)
Role(s): Two-seat multi-role aircraft for: close air support/battlefield interdictor; interdictor/strike; air superiority; naval role, reconnaissance
Wing Span: 28 ft 2½ in (8.6 m) swept
45 ft 7 in (13.9 m) maximum
Overall Length: 54 ft 10 in (16.7 m)
Max Take-Off Weight: 30,000 lb (13,607 kg) to 50,000 lb (22,680 kg) according to mission
Under Development for: British, German and Italian Air Forces
Systems Description: Although maximum commonality of systems and equipment has been a major design objective throughout the MRCA programme, there will be considerable variations as between roles and the three user

nations. Major systems common to aircraft for all three countries, which have been decided upon are a forward radar to be developed by Texas Instruments; Litef central digital computer; Ferranti inertial navigation system; Decca doppler radar; Marconi-Elliott autopilot; Smiths Industries Head-Up Display; Ferranti radar/map display; Marconi-Elliott TV/tabular data display; Honeywell air data computer. The nose radar is likely to appear in several versions to meet the requirements of specific missions and Marconi-Elliott Avionic Systems and Ferranti are collaborating in the development of a new radar for the British MRCA air defence role. There will be extensive co-production arrangements between concerns in the member countries. Much of the remaining avionics equipment will be selected largely on national considerations. Communications equipment will include UHF/VHF, and possibly HF in reconnaissance or longer range versions of MRCA. These requirements are likely to be met from home industries. Navigational equipment will include Tacan, which will be supplied by SEL for the German aircraft, and Marconi for British machines. The latter will have Cossor CILS 75/76 ILS receivers. The tactical landing aid for German and UK aircraft, respectively, is expected to be Setac and MADGE. IFF transponders are also likely to be provided by each nation's traditional supplier of this type of equipment.



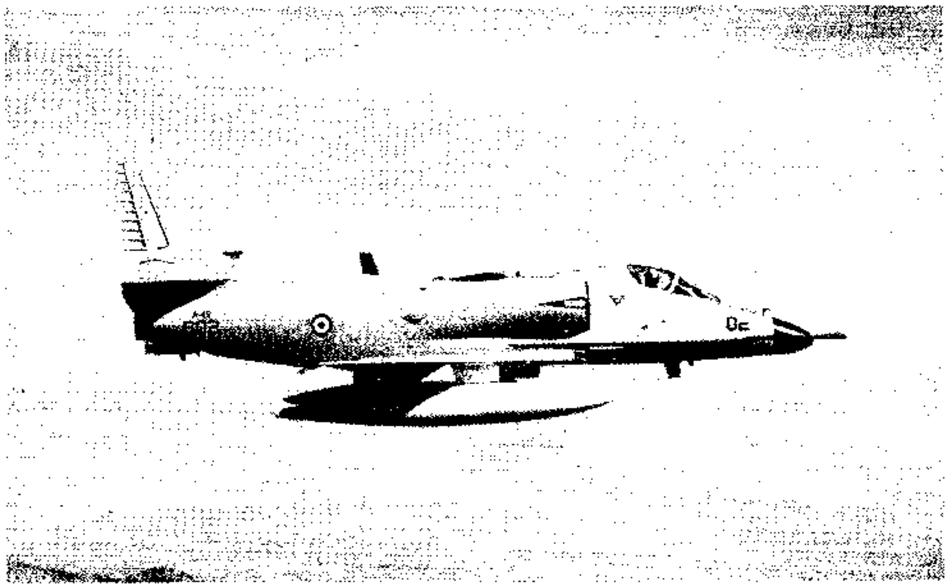
First prototype of MRCA



Panavia 200 Multi-Role Combat Aircraft

1414.302
SKYHAWK A-4M
McDONNELL-DOUGLAS (USA)
Role(s): Single-seat lightweight attack aircraft for land-based or carrier operations
Power Plant: 1 × Pratt & Whitney J52-P-408 11,200 lb (5,080 kg) turbojet engine
Wing Span: 27 ft 6 in (8.38 m)
Length Overall: 40 ft 3 in (12.27 m)
Max Take-Off Weight: 24,500 lb (10,206 kg)
Installed Weapons: 2 × 20 mm Mk 12 guns
Other Weapons:
Carried externally on five stations:
centre: max load 3,500 lb (1,588 kg).
inboard (2): max load 2,250 lb (1,020 kg).
outboard (2): max load 1,000 lb (450 kg).
External load can be made up of:
- HE bombs
- Rockets
- Flares
- ASM
- Sidewinder AAM
- Torpedoes
- Gun pods
- ECM equipment

Max Level Speed: 585 kt (1,085 km/hr)
Typical Range: 1,000 nm (1,853 km)
In Service with: (in different marks) US Navy, USMC, Royal Australian Navy, RNZAF, Israel AF, Argentine Navy, and Singapore



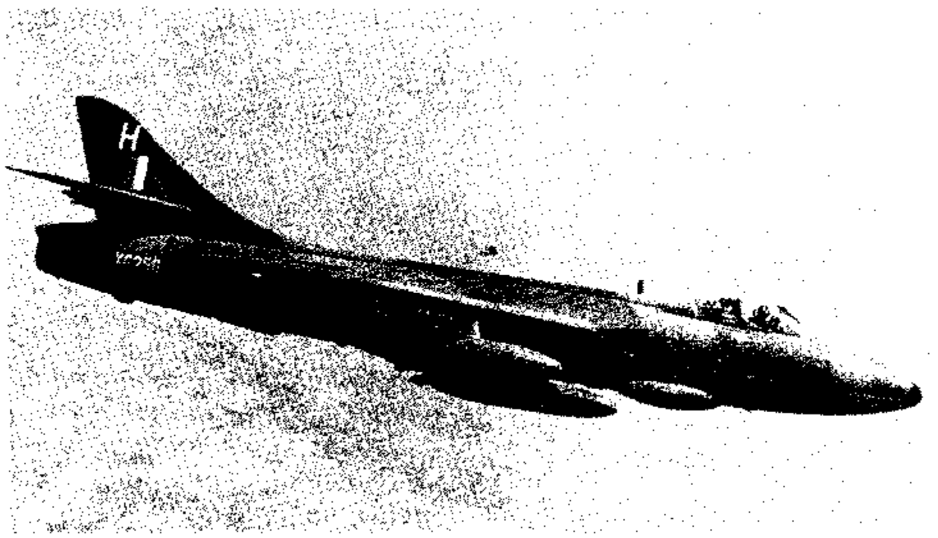
A-4B Skyhawk of the Singapore Air Defence Force

1670.302
A-10A
FAIRCHILD INDUSTRIES (USA)
Role(s): Single-seat close-support aircraft
Power Plant: 2 × 9,000 lb (4,080 kg) st General Electric TF34 turbofans
Wing Span: 54 ft 8 in (16.66 m)
Length Overall: 54 ft 8 in (16.66 m)
Max Take-Off Weight: 45,825 lb (20,786 kg)
Installed Weapons: 1 × GAU-8 multi-barrel forward-firing 30 mm gun in fuselage
Other Weapons: 10 underwing weapon pylons for the carriage of a wide range of stores including, bombs, gun-pods, AGM-65 Maverick missiles, flare or chaff dispensing pods
Max Level Speed: About 400 knots (740 km/h)
Under Development for: US Air Force

8029.302
G91R/3
FIAT (ITALY)
Role(s): Single-seat light tactical strike-reconnaissance fighter
Power Plant: 1 × 5,000 lb (2,270 kg) st Rolls-Royce Bristol Orpheus 803 turbojet
Wing Span: 28 ft 1 in (8.56 m)
Length Overall: 33 ft 9½ in (10.30 m)
Max Take-Off Weight: 12,125 lb (5,500 kg)
Installed Weapons: 2 × 30 mm cannon in sides of front fuselage
Other Weapons: 4 underwing attachments for up to 1,500 lb (860 kg) of bombs, Nord AS 20 missiles, air-to-ground rockets or 0.50 in machine gun pods
Max Level Speed: 650 mph (1,045 kmh) at 5,000 ft (1,500 m)
Typical Range: 400 miles (643 km) on internal fuel at 403 mph (649 kmh)
In Service with: German Air Force

8030.302
G91Y
FIAT (ITALY)
Role(s): Single-seat lightweight reconnaissance fighter-bomber
Power Plant: 2 × General Electric J85-GE-13A turbojet engines each 2,720 lb (1,235 kg) st dry, 4,080 lb (1,850 kg) st with afterburning
Wing Span: 29 ft 6½ in (9.01 m)
Length Overall: 38 ft 3½ in (11.67 m)
Max Take-Off Weight: 19,180 lb (8,700 kg)
Installed Weapons: 2 × 30 mm guns in nose

Other Weapons: 4 underwing attachments for 1,000 lb (453 kg) bombs, 750 lb (340 kg) napalm tanks, 7 × 2 in rocket packs, 28 × 2 in rocket packs or 4 × 5 in rocket containers
Max Level Speed: Mach 0.93 at sea-level
Typical Range: Combat radius 460 miles (740 km)
In Service with: Italian Air Force

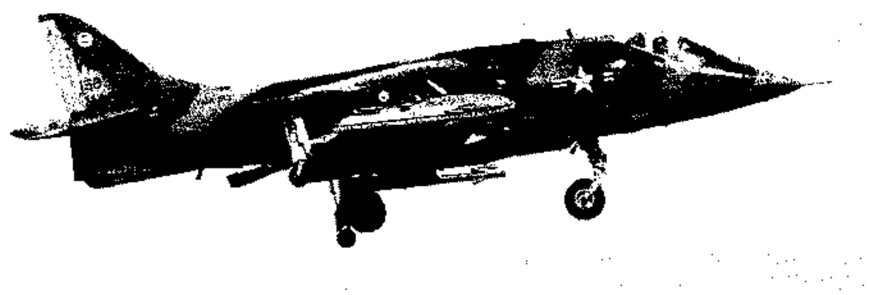


Hunter fighter-bomber with bombs and external fuel tanks

8037.302
HUNTER F (GA) Mk 9
HAWKER (UK)
Role(s): Single-seat fighter and 2 seat trainer
Power Plant: 1 × 10,000 lb (4,540 kg) st Rolls-Royce Avon 207 turbojet
Wing Span: 33 ft 8 in (10.26 m)
Length Overall: 45 ft 10½ in (13.98 m)
Max Take-Off Weight: 24,000 lb (10,885 kg)
Max Weapon Load: 7,400 lb (3,357 kg)
Installed Weapons: 4 × 30 mm Aden guns (150 rpg) in self-contained removable package in underside of fuselage nose
Other Weapons:
External stores that can be carried are.
On inboard wing pylons:
2 × 1,000 lb (454 kg) bombs.
2 × 500 lb (227 kg) bombs.
2 × carriers each with 2 25 lb (11 4 kg) practice bombs.
2 × clusters of 6 3 in rockets.
2 × containers, each with either 24 or 37 2 in folding-fin rockets.
(2 × drop tanks).
On outboard wing pylons:
(2 × drop tanks) or up to 24 × 3 in No. 1 Mk 5 RP's with 12 lb warheads.
The 100 gal drop tanks may be used as napalm bombs. Combinations of the above loads may be carried
Max Level Speed: Mach 0.92
Typical Range: 1,840 miles (2,965 km) with external tanks
In Service in: Abu Dhabi, Chile, India, Iraq, Jordan, Kuwait, Qatar, Lebanon, Oman, Peru, Rhodesia, Saudi Arabia, Singapore, Switzerland, UK. (Various versions)

8039.302
GNAT F Mk 1
HAWKER SIDDELEY (UK)
Role(s): Single-seat lightweight fighter or fighter-bomber
Power Plant: 1 × Bristol Siddeley Orpheus 701 (BOr2) turbojet engine 4,520 lb (2,050 kg) st
Wing Span: 22 ft 2 in (6.75 m)
Length Overall: 29 ft 9 in (9.06 m)
Max Take-Off Weight: Tactical version, max take-off weight with external tanks and armament 8,885 lb (4,020 kg)
Installed Weapons: 2 × 30 mm Aden cannon in the air intake fairings, 1 on each side of fuselage, with 115 rounds per gun
Other Weapons: Provision for underwing mounting of 2 × 500 lb (227 kg) bombs or 12 × 3 in (7.6 cm) rocket projectiles, etc
Max Level Speed: Mach 0 98
Typical Range: Radius of action 500 miles (805 km)
In Service with: Indian Air Force, Finnish Air Force

8040.302
HARRIER GR Mk 1
HAWKER SIDDELEY (UK)
Role(s): Single-seat V/STOL strike and reconnaissance aircraft
Power Plant: 1 × 19,200 lb (8,710 kg) st Rolls-Royce Bristol Pegasus 101 vectored-thrust turbofan
Wing Span: 25 ft 3 in (7.70 m)
Length Overall: 46 ft 4 in (14.12 m)
Max Take-Off Weight: VTOL approximately 16,000 lb (7,257 kg). STOL approximately 23,000 lb (10,433 kg)
Max Weapon Load: Max external load of 5,000 lb (2,270 kg)
Other Weapons: Combat load is carried on 4 underwing and 3 under-fuselage hard-points. The inboard wing points and the centre fuselage point are stressed for loads of up to 1,200 lb (544 kg) each, and the outboard underwing pair of loads of up to 650 lb (295 kg) each; the 2 outboard points under the fuselage can each carry a 30 mm gun pod and ammunition.
A typical combat load is:
2 × 30 mm Aden gun pods (interchangeable with under-fuselage strakes).
2 × Matra launchers each with 57 × 68 mm SNEB rockets.
2 × pairs of Lepus flares or two 100 imp gal (455 litre) drop-tanks under the wings.
1 × 1,000 lb (454 kg) bomb can be carried on central fuselage pylon in combination with gun pods
Max Level Speed: Mach 0.95 without combat load
Typical Range: Typical radius of action 500 miles (805 km)
In Service with: Royal Air Force, US Marine Corps. Ordered for Spanish Navy



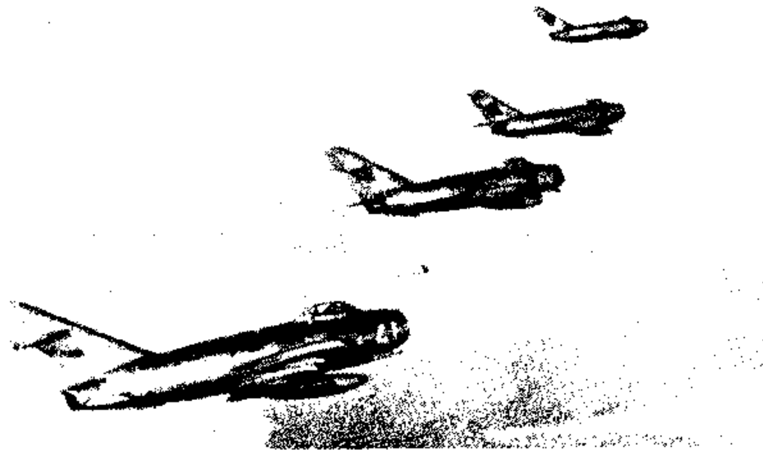
Harrier AV-8A of US Marine Corps

8044.302
HF-24 MARUT
HINDUSTAN (INDIA)
Role(s): Single-seat fighter
Power Plant: 2 × 4,850 lb (2,200 kg) st Bristol Siddeley Orpheus 703 turbojets (Mk I) or 6,600 lb (2,993 kg) st (with afterburning) Orpheus 703R (Mk IR)
Wing Span: 29 ft 6¼ in (9.00 m)
Length Overall: 52 ft 0¾ in (15 87 m)
Max Take-Off Weight: 24,250 lb (11,000 kg)
Installed Weapons: 4 × 30 mm Aden guns in nose, with about 120 rounds per gun, and retractable pack of 48 air-to-air rockets in lower fuselage aft of nose-wheel unit
Other Weapons: Attachments for 4 × 1,000 lb (453 kg) bombs, drop tanks and other stores under wings
Max Level Speed: Mach 1.02 attained at 40,000 ft (12,200 m)
In Service with: Indian Air Force

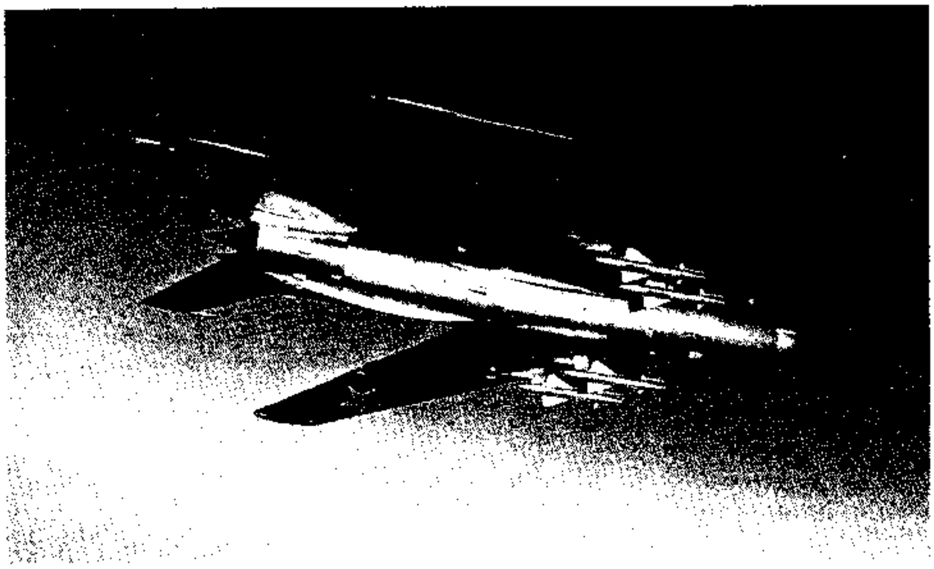
8055.302
MiG-15bis (NATO "FAGOT")
MIKOYAN/GUREVICH (USSR)
Role(s): Single-seat fighter bomber and 2-seat trainer
Power Plant: 1 × 5,950 lb (2,698 kg) st Klimov VK-1 turbojet
Wing Span: 33 ft 1¼ in (10.1 m)
Length Overall: 36 ft 4 in (11 1 m)
Max Take-Off Weight: 14,238 lb (6,464 kg)
Installed Weapons: 1 × 37 mm cannon with 40 rounds on starboard side of lower front fuselage. 2 × 23 mm NR 23 cannon on port side. Attachments for 1 100 lb (500 kg) of bombs
Max Level Speed: 668 mph (1,075 km/h) at sea

level
In Service with: Air Forces of Russia, Bulgaria, China, Czechoslovakia, East Germany, Egypt, Hungary, North Korea, Poland, Romania and Syria

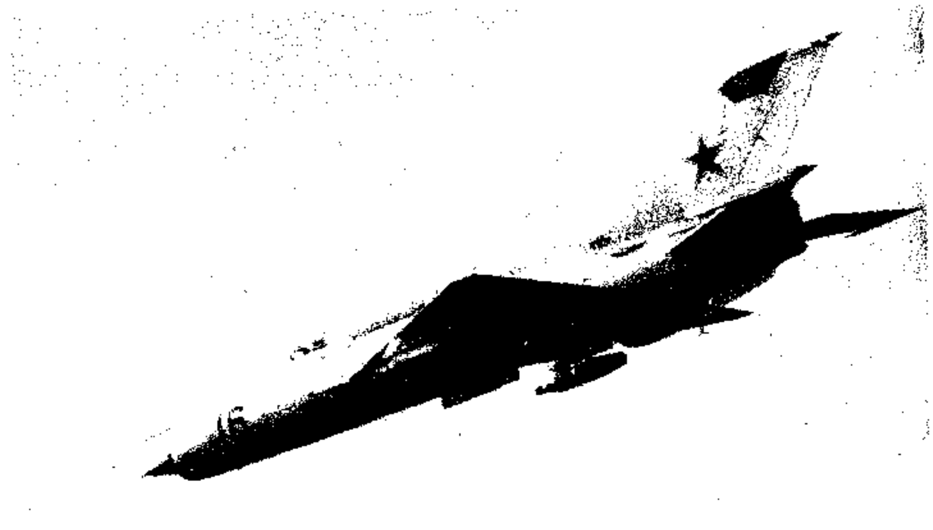
8056.302
MiG-17 (NATO "FRESCO-C")
MIKOYAN/GUREVICH (USSR)
Role(s): Single-seat fighter
Power Plant: 1 × 6,990 lb (3,170 kg) st (with afterburning) Klimov VK-1A turbojet
Wing Span: 31 ft 0 in (9.45 m)
Length Overall: 36 ft 4 in (11.07 m)
Max Take-Off Weight: 12,500 lb (5,669 kg) (clean)
Installed Weapons: 3 × 23 mm NR-23 cannon
Other Weapons: 4 × 8-rocket pods or 2 × 550 lb (250 kg) bombs
Max Level Speed: Mach 0.975 at sea level
Typical Range: With external tanks and bombs 750 miles (1,207 km)
In Service with: Soviet Air Force, plus the Air Forces of Poland, Czechoslovakia, China, Afghanistan, Albania, Bulgaria, Cuba, Egypt, Hungary, Indonesia, Iraq, Morocco, North Korea, Romania and Syria


MiG-17 fighter with external fuel tanks

8057.302
MiG-19 (NATO "FARMER C")
MIKOYAN (USSR)
Role(s): Single-seat fighter
Power Plant: 2 × 8,820 lb (4,000 kg) st (with afterburning) Klimov VK-5 turbojets
Wing Span: 32 ft 0 in (9.75 m)
Length Overall: 37 ft 6 in (11.43 m)
Max Take-Off Weight: 19,840 lb (9,000 kg)
Installed Weapons: 3 × 30 mm cannon
Other Weapons: Underwing rocket pods, missiles etc
Max Level Speed: 850 mph (1,368 kmh) at 36,000 ft (11,000 m)
In Service with: Soviet Air Force, Chinese Air Force, Pakistan Air Force and several East European Air Forces


MiG-19 fighter armed with four Alkali missiles

8058.302
MiG-21 (NATO "FISHBED-C")
MIKOYAN (USSR)
Role(s): Single-seat fighter and 2-seat trainer
Power Plant: 1 × 12,500 lb (5,669 kg) st (with afterburning) TDR Mk R37F turbojet
Wing Span: 25 ft 0 in (7.60 m)
Length Overall: 55 ft 0 in (16.75 m)
Max Take-Off Weight: 16,700 lb (7,575 kg)
Installed Weapons: 1 or 2 × 30 mm cannon with 600 rpg
Other Weapons: Underwing attachments carry 2 × Atoll air-to-air missiles
Max Level Speed: Mach 2 (clean) at 36,000 ft (11,000 m). Mach 1.5 at 36,000 ft (11,000 m) with missiles and under-fuselage fuel tank
Typical Range: Combat radius (clean) 375 miles (600 m)
In Service in: Afghanistan, Bangladesh, Cuba, Czechoslovakia, Egypt, Finland, Germany (Dem Rep), Hungary, India, Indonesia, Iraq, Jugoslavia, Korea (N), Poland, Romania, Sudan, Syria, USSR, Vietnam (N)


MiG-21 fighter fitted with rocket pods

1851.302
MiG-23 (NATO "FLOGGER")
MIKOYAN (USSR)
Role(s): Air-superiority fighter. Two-seat tactical/trainer version also, probably with ground attack capability
Power Plant: 1 × turbojet with reheat giving estimated 20,000 lb (9,070 kg) st
Wing Span:
Maximum: 50 ft (15.25 m)
Swept 29 ft 6 in (9.00 m)
Length Overall: 57 ft (17.4 m)
Take-Off Weight: 28,000 lb (12,700 kg) estimated, single-seat version
Weapons:
1 × 23 mm cannon
4 × stores pylons for missiles or other weapons
Max Level Speed: Mach 2.3 at height
Typical Range: 600 miles (960 km)
In Service with: Soviet Air Force

8062.302
F-86F SABRE
NORTH AMERICAN (USA)
Role(s): Single-seat tactical fighter and fighter-bomber
Power Plant: 1 × 5,910 lb (2,680 kg) st General Electric J47-GE-27 turbojet
Wing Span: 39 ft 1 in (11.91 m)
Length Overall: 37 ft 6½ in (11.44 m)

Max Take-Off Weight: 20,610 lb (9,348 kg)
Installed Weapons: 6 × 0.50 in machine-guns
Other Weapons:
2 × Sidewinder missiles
2 × 1,000 lb (453 kg) bombs or 8 × rockets
Max Level Speed: 687 mph (1,105 kmh) at sea level
Typical Range: 925 miles (1,488 km) at 530 mph (853 kmh)
In Service with: Air Forces of Argentine, Burma, Nationalist China, Colombia, Ethiopia, Greece, Iran, Japan, South Korea, Norway, Pakistan, Peru, Philippines, Portugal, Saudi Arabia, Spain, Thailand, Turkey and Venezuela

8063.302
F-100D SUPER SABRE
NORTH AMERICAN (USA)
Role(s): Interceptor and fighter-bomber
Power Plant: 1 × 11,700 lb (5,307 kg) st (17,000 lb (7,711 kg) with afterburner) Pratt and Whitney J57-P-21A turbojet
Wing Span: 38 ft 9 in (11.81 m)
Length Overall: 54 ft 3 in (16.54 m)
Max Take-Off Weight: 34,832 lb (15,799 kg)
Installed Weapons: 4 × 20 mm cannon in fuselage
Other Weapons: 6 underwing pick-up points for bombs, rockets, air-to-air or air-to-surface missiles etc
Max Level Speed: Mach 1.3 at 36,000 ft (11,000 m)
Typical Range: With 2 external tanks 1,500 miles (2,414 km)
In Service with: US Air Force and NATO nations such as Denmark, Turkey and France, and with Nationalist China

8065.302
F-5E TIGER II
NORTHROP (USA)
Role(s): Single-seat lightweight fighter
Power Plant: 2 × 5,000 lb (2,268 kg) st (with afterburning) General Electric J85-GE-21 turbojets
Wing Span: 26 ft 8 in (8.12 m)
Length Overall: 48 ft 2 in (14.8 m)
Max Take-Off Weight: 24,083 lb (10,923 kg)
Installed Weapons: 2 × 20 mm guns in nose of fuselage
Other Weapons:
2 × Sidewinder missiles on wing-tip launchers.
5 pylons, 1 under fuselage and 2 under each wing, permit the carriage of a wide variety of other operational warloads.
1 × 2,000 lb (910 kg) or more bomb or high-rate-of-fire gunpack can be suspended from centre pylon.
Underwing loads can include.
4 × air-to-air missiles
Bombs
Air-to-surface rockets
Gun packs
Max Level Speed: Mach 1.6 at 36,000 ft (11,000 m)
Typical Range: Combat air patrol mission radius 780 miles (1,255 km); interdiction mission radius 620 miles (1,000 km), both with 3 × 275 gallon auxiliary tanks

F-5E Tiger II armed with Sidewinder

In Service with: Various models of the F-5 are used by the Forces of: Brazil, Canada, Ethiopia, Greece, Iran, Jordan, Korea (S), Libya, Morocco, Netherlands, Norway, Philippines, Saudi Arabia, Taiwan, Thailand, Turkey, USA, Vietnam (S)

8081.302
Su-7B (NATO "FITTER")
SUKHOI (USSR)
Role(s): Single-seat ground-attack fighter
Power Plant: 1 × 22,050 lb (10,001 kg) st (with afterburning) turbojet, believed to be TRD-31
Wing Span: 30 ft 0 in (9.15 m)
Length Overall: 56 ft 0 in (17.0 m)
Installed Weapons: 1 × 30 mm cannon in each wing-root leading edge
Other Weapons: Attachments for external stores, including rocket packs and bombs, under each wing
Max Level Speed: Mach 1.6 at 36,000 ft (11,000 m)
In Service in: Afghanistan, Czechoslovakia, Egypt, Germany (Dem Rep), Iraq, Korea (N), Poland, Syria, USSR

1406.302
MIRAGE 'MILAN'
DASSAULT (FRANCE)
Role(s): Single-seat tactical support aircraft
Power Plant: 1 × SNECMA Atar 9K50 15,875 lb (7,200 kg)
Wing Span: 26 ft 11 in (8.22 m)
Length Overall: 49 ft 3 in (15.03 m)
Max Take-Off Weight: 30,860 lb (14,000 kg)
Installed Weapons: 2 × 30 mm DEFA guns with 125 rpg
Other Weapons: 5 external weapon pylons for max load 9,240 lb (4,200 kg) made up of 250 kg, 450 kg and 1,000 kg bombs, Sidewinder AAM; 1,700 litre fuel tanks; rockets; AS 30 ASM
Max Level Speed: Mach 2
Typical Range: 250 nm (463 km)
Under Development: As a replacement for Mirage 5

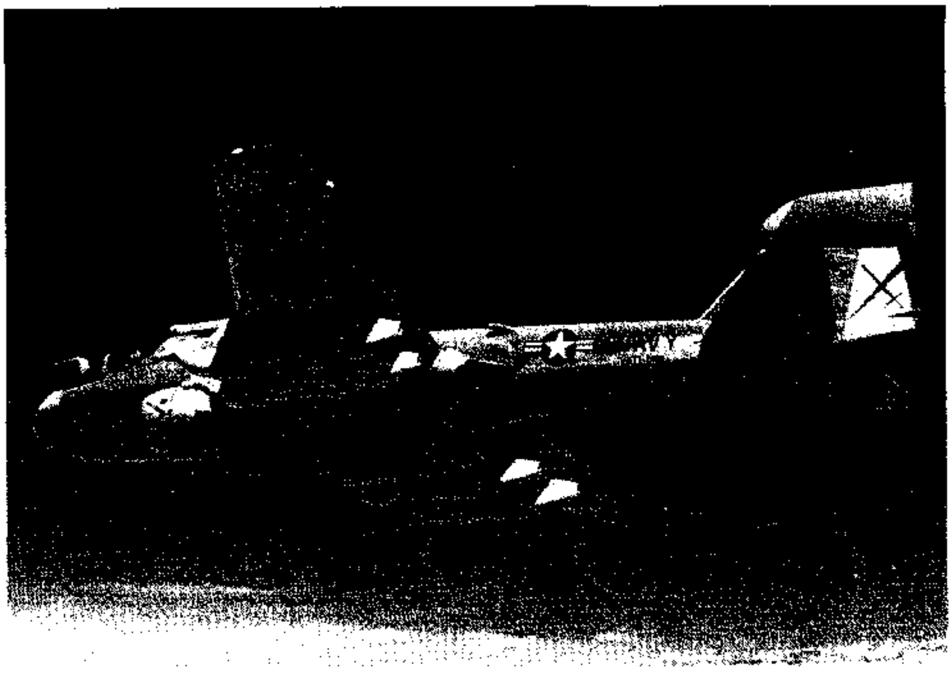
MEDIUM RANGE STRIKE/ INTERDICTION AIRCRAFT

8021.302
MIRAGE IV-A
DASSAULT (FRANCE)
Role(s): 2-seat supersonic strategic bomber
Power Plant: 2 × 15,400 lb (7,000 kg) st (with reheat) SNECMA Atar 9K turbojets
Wing Span: 38 ft 10½ in (11.85 m)
Length Overall: 77 ft 1 in (23.50 m)
Max Take-Off Weight: 69,665 lb (31,600 kg)
Other Weapons: 1 × nuclear weapon recessed into bottom of fuselage, or 16 × 1,000 lb (453 kg) bomb or Martel air-to-surface missiles under fuselage and wings
Max Level Speed: Mach 2.2 at 36,000 ft (11,000 m)
Typical Range: Operational radius of more than 1,000 miles (1,600 km)
In Service with: French Air Force

8028.302
CANBERRA B(I) Mk 8
ENGLISH ELECTRIC (UK)
Role(s): 2-seat night intruder and tactical bomber
Power Plant: 2 × 7,400 lb (3,357 kg) st Rolls-Royce Avon 109 turbojets
Wing Span: 63 ft 11½ in (19.50 m)
Length Overall: 65 ft 6 in (19.96 m)
Max Take-Off Weight: 54,950 lb (24,925 kg)
Other Weapons:
In bomber role can carry.
6 × 1,000 lb (453 kg) or 1 × 4,000 lb (1,814 kg) and
2 × 1,000 lb (453 kg) or 8 × 500 lb (226 kg) bombs internally, plus up to 2,000 lb of stores on underwing pylons.
In interdictor role.
A pack of 4 × 20 mm Hispano cannon is installed in rear of weapon bay, leaving room in forward part for 16 × 4.5 in flares or 3 × 1,000 lb (453 kg) bombs.
Can also carry Nord AS 30 air-to-surface missiles or nuclear weapons
Max Level Speed:
Mach 0.68 at sea level.
541 mph (871 kmh) at 40,000 ft (12,200 m) at 44,000 lb (19,760 kg) AUW
Typical Range: With max load, no reserves at 2,000 ft (600 m) with 10 min over target at full power 805 miles (1,295 km)
In Service with: (in various versions) the Air Forces of Argentina, Ecuador, Ethiopia, India, Peru, Rhodesia, South Africa, UK, Venezuela

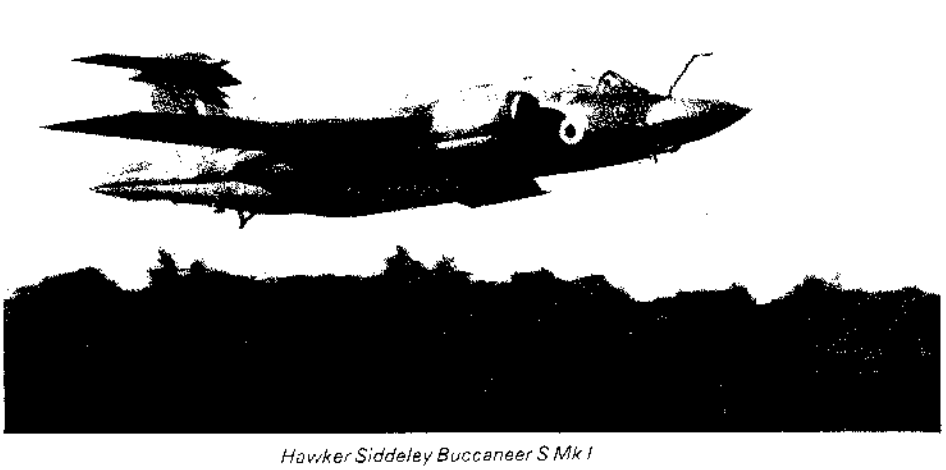
8032.302
F 111A
GENERAL DYNAMICS (USA)
Role(s): 2-seat tactical fighter
Power Plant: 2 × 12,500 lb (5,669 kg) st (21,000 lb (9,525 kg) with reheat) Pratt and Whitney TF30-P-3 turbofans
Wing Span: 63 ft 0 in (19.20 m) (spread) 31 ft 11½ in (9.74 m) (swept)
Length Overall: 72 ft 1⅓ in (21.98 m)
Max Take-Off Weight: 81,400 lb (36,922 kg)
Weapons: One M 61A1 20 mm gun or two 750 lb (340 kg) bombs in internal weapons bay; four fixed and four swivelling wing pylons for total external stores load of up to 25,000 lb (11,340 kg)
Max Level Speed: Mach 2.2 at 36,000 ft (11,000 m)
Typical Range: Tactical radius 1,600 miles (2,574 km) with 16,000 lb (7,257 kg) combat load
In Service with: US Air Force

8034.302
A-6A/E INTRUDER
GRUMMAN (USA)
Role(s): 2-seat carrier-based strike and reconnaissance aircraft
Power Plant: 2 × 9,300 lb (4,218 kg) st Pratt and Whitney J52-P-8A turbojets
Wing Span: 53 ft 0 in (16.15 m)
Length Overall: 54 ft 7 in (16.64 m)
Max Take-Off Weight: 60,626 lb (27,500 kg)
Max Weapon Load: 18,000 lb (8,165 kg)
Other Weapons: 5 weapon attachment points each have a 3,600 lb (1,633 kg) capacity. Typical weapon loads are:
30 × 500 lb (225 kg) bombs in clusters of three or
2 × Martin Bullpup missiles and
3 × 2,000 lb (907 kg) general purpose bombs
Max Level Speed: Mach 0.95 at sea level
Typical Range: Ferry range 3,225 miles (5,190 km)
In Service with: US Navy, US Marine Corps
Systems Description: The A-6E version of the Intruder is essentially the A-6A airframe and power plant with a completely new avionics installation. In early 1972 the USN awarded Grumman a contract to carry out a major retrofit programme to update A-6As now in service by fitting the A-6E avionics. The new avionics fit confers operational improvements and enhanced reliability. The principal differences between the A and E avionic specifications relate to the attack systems equipment. The E model has the Norden APQ-148 forward radar (Entry No. **1567.353**) which combines the functions of the APQ-92 and APQ-112 (Entries No. **1489.353** and **1490.353**) fitted in the A model. The new attack and navigation radar is associated with an IBM ASQ-133 digital computer which co-ordinates data to and from other aircraft systems, including inertial and doppler navigation systems, the automatic flight control system, electronic and other sensors, and weapon delivery sub-systems. A specially-developed interface unit supplied by Fairchild Camera and Instrument Corporation performs analogue-to-digital and digital-to-analogue conversions. A Conrac Armament Control Unit provides a single box system for management of the Intruder's weapons, and replaces several units needed on the A-6A. Conrac also provides the A-6E air data computer. The primary flight aid for navigation, approach and landing, and weapons delivery is a new multi-mode display system, AVA-1.
In addition to the basic A-6A and A-6E versions of the Intruder a number of specialised models have been produced. The A-6B was developed for surface-to-air missile suppression, using the USN Standard ARM; the A-6C carries electro-optical sensors to augment radar for target detection and recognition; and the KA-6D is a tanker version. More than 12 A-6Cs are to be equipped with improved Forward Looking Infra-Red Systems, AAS-28A



EA-6B intruder-attack aircraft with ECM payload

8038.302
BUCCANEER S Mk 2
HAWKER SIDDELEY (UK)
Role(s): 2-seat carrier-based low-level strike aircraft
Power Plant: 2 × 11,255 lb (5,105 kg) st Rolls-Royce RB 168 Spey Mk 101 turbofans
Wing Span: 42 ft 4 in (12.90 m)
Length Overall: 63 ft 5 in (19.33 m)
Weapons: Internal bomb-bay with rotating door accommodates a variety of weapons including:
4 × 1,000 lb (453 kg) nuclear bombs or 4 × 1,000 lb (453 kg) conventional bombs.
Four underwing pylons for Bullpup or Martel missiles.
4 × 1,000 lb (453 kg) bombs or packs of 2 in or 3 in rockets
Max Level Speed: Transonic at sea level
In Service with: Royal Navy, Royal Air Force, South African Air Force (similar version with rocket boost)

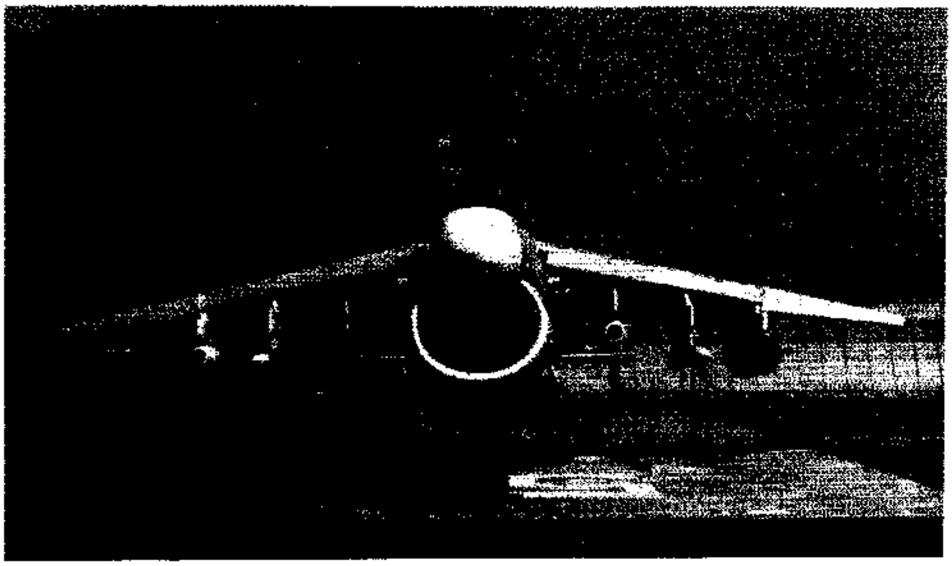


Hawker Siddeley Buccaneer S Mk I

8045.302
IL-28 (NATO "BEAGLE")
ILYUSHIN (USSR)
Role(s): 4-seat tactical bomber
Power Plant: 2 × 5,950 lb (2,698 kg) st Klimov VK-I turbojets
Wing Span: 64 ft 0 in (19.51 m)
Length Overall: 58 ft 0 in (17.68 m)
Max Take-Off Weight: 43,000 lb (19,504 kg)
Max Weapon Load: 4,500 lb (2,041 kg)
Installed Weapons: 2 × 30 mm cannon in nose; 2 × 23 mm cannon in tail turret
Other Weapons: A total of 4,500 lb (2,041 kg) of bombs
Max Level Speed: 580 mph (933 kmh) at 15,000 ft (4,572 m)
Typical Range: 1,500 miles (2,414 km) with max bomb load
In Service in: Algeria, China, Czechoslovakia, Egypt, Germany (Dem Rep), Hungary, Indonesia, Korea (N), Nigeria, Poland, Romania, Somalia, Syria, USSR, Vietnam (N), Yemen (N)

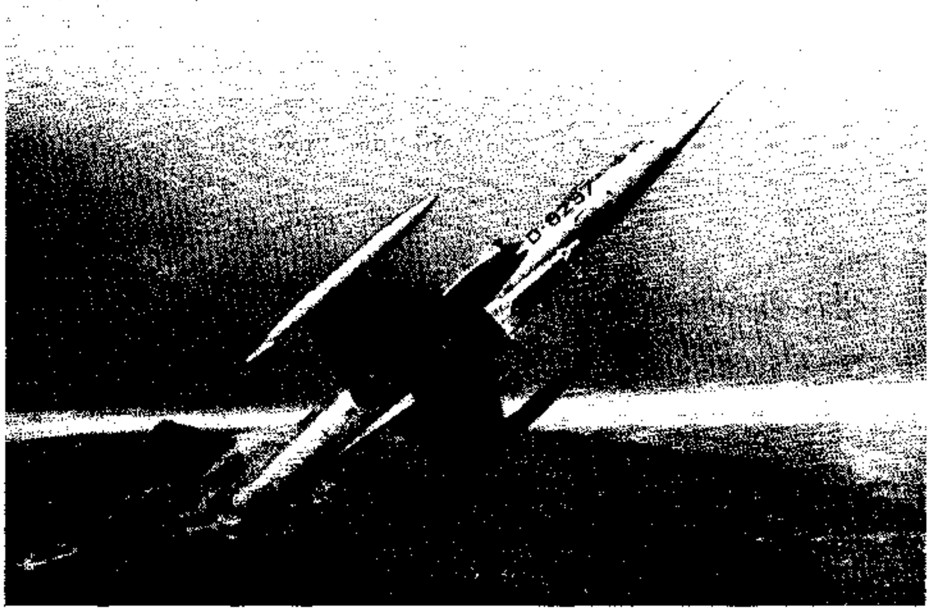
8049.302
A-7 CORSAIR II
LING-TEMCO-VOUGHT (USA)
Role(s): Single seat attack aircraft
Power Plant: 1 × 11,350 lb (5,150 kg) st Pratt and Whitney TF-30-P-6 turbofan
Wing Span: 38 ft 8¾ in (11.80 m)
Length Overall: 46 ft 1½ in (14.06 m)
Max Take-Off Weight: 32,500 lb (14,750 kg)
Max Weapon Load: 15,000 lb (6,800 kg)
Installed Weapons: 2 × 20 mm Mk 12 cannon in nose

Other Weapons: Typical weapon loads include:
24 × Mk 81 250 lb (113 kg) general-purpose bombs.
4 × Zuni rocket pods, 4 pods each containing 7 × 2.75 in rockets, and 4 pods each containing 19 × 2.75 in rockets.
1 × Shrike air-to-surface missile and 1 × Walleye glide bomb.
12 × Snakeye bombs.
4 × Bullpup A missiles and 2 × Shrike missiles.
2 × 2,000 lb (907 kg) bombs
Max Level Speed: 578 mph (930 kmh) at sea level
Typical Range: Radius of action 715 miles (1,150 km)
In Service with: US Navy, USAF



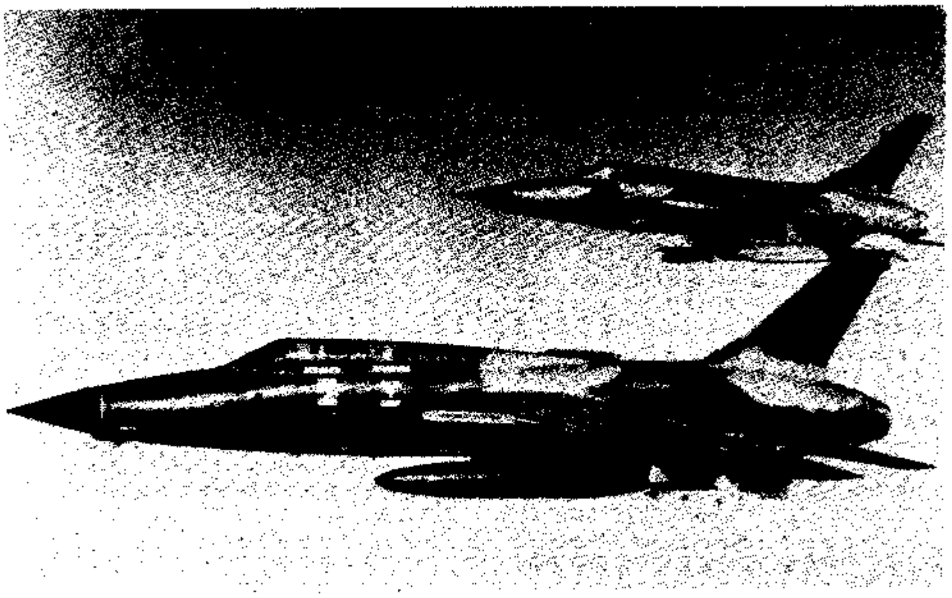
Corsair II with trials load which includes an instrumentation pod, Shrike anti-radar missiles, and camera pods

8051.302
F-104G STARFIGHTER
LOCKHEED (USA)
Role(s): Single-seat all-weather tactical strike and reconnaissance fighter
Power Plant: 1 × 15,800 lb (7,165 kg) st (with afterburning) General Electric J79-GE-11A turbojet
Wing Span: 21 ft 11 in (6.68 m)
Length Overall: 54 ft 9 in (16.69 m)
Max Take-Off Weight: 28,780 lb (13,054 kg)
Max Weapon Load: 4,800 lb (2,177 kg)
Other Weapons:
Bomb rack under fuselage for store weighing up to 2,000 lb (907 kg).
Underwing pylons can each carry a 1,000 lb (453 kg) store, fire bomb rocket pod, Sidewinder air-to-air missile, AGM-12B Bullpup air-to-surface missile or fuel tank.
Provision for 2 Sidewinders under fuselage and either a Sidewinder or fuel tank on each wingtip
Max Level Speed: Mach 2.2 at 36,000 ft (11,000 m)
Typical Range: Radius with max fuel 745 miles (1,200 km)
In Service with: Many NATO Air Forces, JASDF (similar version)



Royal Netherlands Air Force F-104 Starfighter with Sidewinders and wing tanks

8069.302
F-105D THUNDERCHIEF
REPUBLIC(USA)
Role(s): Single-seat long-range tactical fighter-bomber
Power Plant: 1 × 26,500 lb (12,030 kg) st (with afterburning) Pratt and Whitney J75-P-19W turbojet
Wing Span: 34 ft 11¼ in (10.65 m)
Length Overall: 67 ft 0¼ in (20.43 m)
Max Take-Off Weight: 52,546 lb (23,832 kg)
Installed Weapons: 1 × General Electric M-61 20 mm Vulcan automatic multi-barrel gun with 1,029 rounds
Other Weapons: Typical alternative loads are:
Nuclear store (plus 2 tanks of 650 and 450 gal).
4 × AGM-12 Bullpup missiles (plus 650 gal tank).
4 × Shrike + ECM pod.
2 × Standard ARM + ECM pod.
Nuclear weapon in bomb bay (plus 450 gal tanks).
2 × 3,000 lb (1,360 kg) bombs (plus 650 gal tank).
4 × Sidewinder missiles (plus 650 and 2,450 gal tanks).
9 × rocket packs.
9 × BLU-1/B fire-bombs or 9 × MLU-10/B mines or 16 × leaflet bombs, 750 lb (340 kg) bombs, or MC-1 toxic bombs

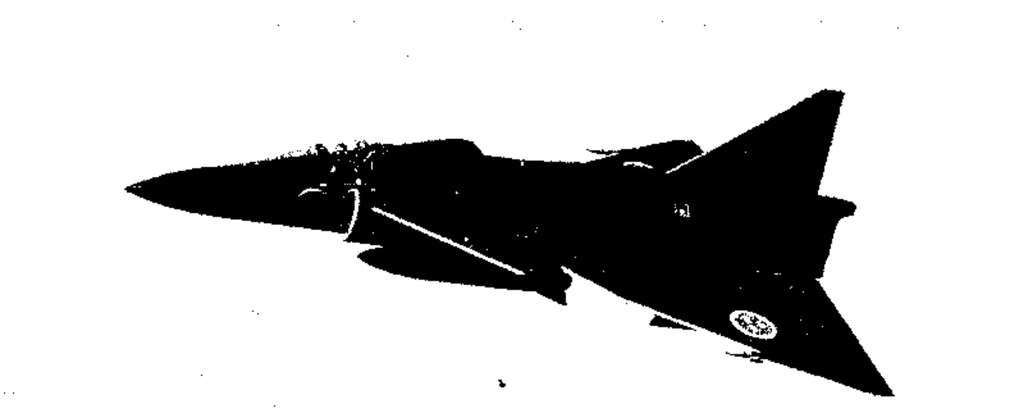


F-105F and F-105D Thunderchief aircraft

Max Level Speed:
Mach 1.11 at sea level.
Mach 2.1 above 36,000 ft (11,000 m)
Typical Range: With max fuel 2,070 miles (3,330 km)
In Service with: US Air Force

8072.302
AJ37 VIGGEN
SAAB (SWEDEN)
Role(s): Single-seat multi-mission combat aircraft
Power Plant: 1 × 26,450 lb (12,000 kg) st (with afterburning) Svenska Flygmotor RM8 (P and W JT8D-22) turbofan
Wing Span: 34 ft 9¼ in (10.60 m)
Length Overall: 53 ft 5¾ in (16.30 m)
Max Take-Off Weight: 35,275 lb (approx) (16,000 kg) with normal armament
Other Weapons: 3 attachments under fuselage

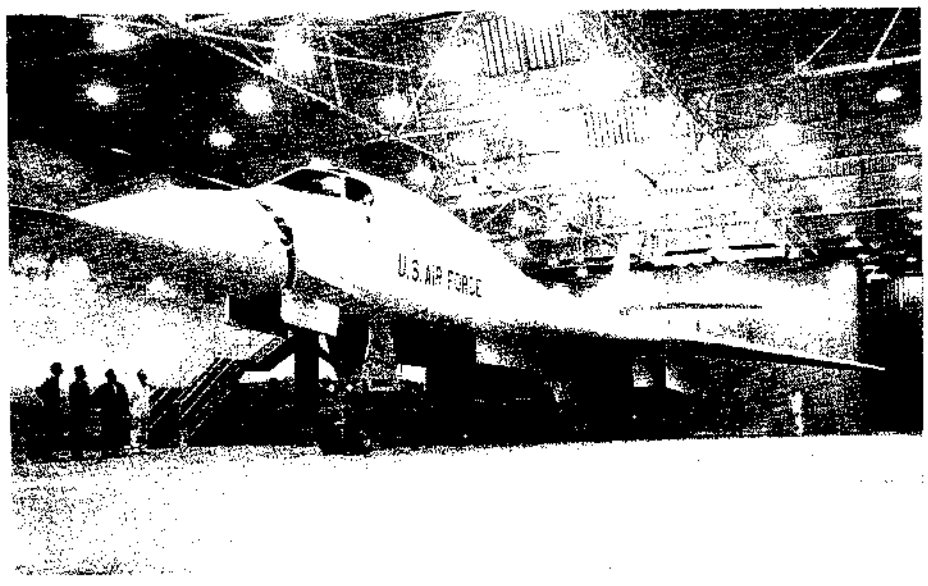
and 1 under each wing, for Rb 04 or Rb 05 air-to-surface missiles, plus alternative 30 mm gun packs, bombs, rockets or mines
Max Level Speed: (Above) Mach 2 at 36,000 ft (11,000 m)
In Service with: Swedish Air Force
Other Versions: The all-weather attack version (AJ37) went into service in 1971 and there are several operational squadrons. The two-seat trainer version (SK37) also is in service. Also in quantity production are two reconnaissance versions, the SH37 for combined maritime reconnaissance and attack and the SF37 for all-weather photo-reconnaissance. The latest version is the JA37 all weather fighter which is now in advanced development and test. Production of this version has been authorised and at least eight squadrons will be equipped, to replace Draken units from 1978 onward



Saab AJ37 Viggen

8095.302
B-57B CANBERRA
MARTIN (USA)
Role(s): 2 seat light tactical bomber
Power Plant: 2 × 7,200 lb (3,266 kg) st Wright J65-W 5 turbojets
Wing Span: 64 ft 0 in (19.5 m)
Length Overall: 65 ft 6 in (19.9 m)
Max Take-Off Weight: 55,000 lb (24,947 kg)
Installed Weapons: 8 × fixed forward-firing 0.50 in guns in nose
Other Weapons:
6,000 lb (2,721 kg) bomb load in rotary bomb-bay.
16 underwing points for rockets
Max Level Speed: 582 mph (937 kmh) at 40,000 ft (12,190 m)
Typical Range: 2,300 miles (3,700 m)
In Service in: USA, Pakistan, Taiwan.

STRATEGIC BOMBERS



Full-size B-1 bomber mock-up

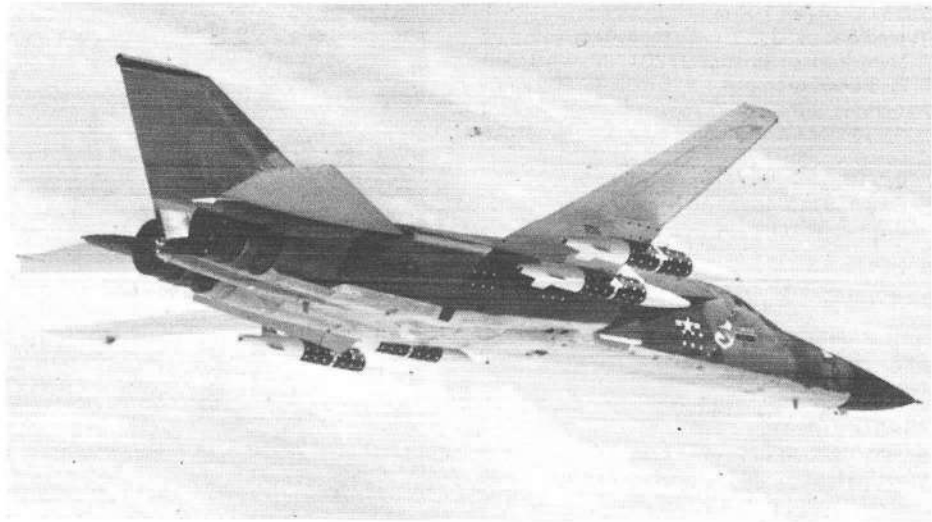
1582.302
B-1
NORTH AMERICAN ROCKWELL (USA)

Role(s): Long-range, low altitude penetrator strategic bomber
Crew: Normal – 4 (Pilot, Co-Pilot, two Systems Operators). Provisions for two instructors
Power Plant: 4 × 30,000 lb (13,600 kg) st class General Electric YF101-GE-100 turbofans with afterburner
Wing Span:
Wings forward 136.7 ft (41.6 m)
Wings swept 78.2 ft (23.8 m)
Length Overall: 150.2 ft (45.7 m)
Max Take-Off Weight: 398,800 lb (176,815 kg)
Weapons: 75,000 lb (34,000 kg) in three bays. Interchangeable mountings permit weapons mix: 24 SRAM (Short Range Attack Missiles), nuclear stores, conventional bombs
Max Level Speed:
Low-level penetration – high subsonic.
High altitude – above Mach 2.2
Typical Range: 6,100 miles (9,817 km) without refuelling
Under Development for: USAF as B-52 replacement
Systems Description:

In February 1972 Collins received contracts for almost $1.4 million for the development and production of the flight director computer, and an accident data recorder. The former will process data from navigation and approach radio systems, gyroscopes and other onboard sensors, and will display landing information to the flight crew. Displays will incorporate electronic display systems and vertical tape instruments.
A $62.4 million contract awarded to Boeing in April 1972 gives this concern responsibility for integration of all avionics hardware on the B-1.
In May, 1972 Boeing invited proposals from seven companies for the digital computer required – Singer General Precision Kearfott Division, Control Data Corporation, Univac, IBM, Texas Instruments, Honeywell, and General Electric. The Department of the Air Force, Headquarters Aeronautical Systems Division, has awarded an initial $2.5 million contract to Cutler-Hammer's AIL Division for Phase 1 of a two phase programme to develop the Radio Frequency Surveillance/Electronic Countermeasures subsystem (RFS/ECMS) for the B-1. The RFS/ECMS will provide the B-1 with the latest state-of-the-art electronic defences against hostile enemy radars. The objectives of the initial Phase 1 Programme are two fold: the completion of trade-off analysis to arrive at an optimum cost-effective subsystem configuration, and feasibility demonstrations of potentially high risk components prior to their selection for inclusion in the subsystem. The results of these efforts will reduce the cost risk and technical risk of the B-1 RFS/ECMS to acceptable levels prior to the initiation of the Phase 2 development and test programme.
AIL heads a team which includes Hallicrafters Company, and Sedco Systems, Inc, and will be responsible to the US Air Force for programme management and the overall technical configuration and performance of the RFS/ECMS. Hallicrafters, a major supplier of radar-jamming transmitters to the USAF, was selected by AIL for the new transmitter design. Sedco Systems, who will be responsible for the necessary antennas, has pioneered the development of sophisticated electronic countermeasures antennas for both the US Air Force and Navy. In addition to the overall technical and management responsibilities, AIL will be responsible for receiver and data processing design as well as for RFS/ECMS subsystem integration and test. The Phase 1 programme is a 10 month programme with the initiation of Phase 2 scheduled to commence about 45 days thereafter.
A Texas Instruments terrain following radar had been selected

8010.302
B-52H STRATOFORTRESS
BOEING(USA)
Role(s): Strategic heavy jet bomber
Power Plant: 8 × 17,000 (7,718 kg) st Pratt and Whitney TF33-P-3 turbofans
Wing Span: 185 ft 0 in (56.42 m)
Length Overall: 156 ft 0 in (47.55 m)
Max Take-Off Weight: 488,000 lb (221,350 kg)
Installed Weapons: 1 × M-61 20 mm gun in General Electric rear turret
Other Weapons: Normal offensive load comprises of 2 × AGM-29 Hound Dog missiles under wings and bombs in internal weapon-bay, or 20 × SRAM missiles. Provision for carrying ADM-20 Quail diversionary missiles
Max level speed: 660 mph (1,062 kmh) at 20,000 ft (6,096 m)
Typical Range: 12,500 miles (20,120 km)
In Service with: US Air Force

8033.302
FB-111A
GENERAL DYNAMICS (USA)
Role(s): 2-seat strategic bomber
Power Plant: 2 × Pratt and Whitney TF30-P-7 engines
Wing Span: Spread 70 ft 0 in (21.34 m), fully swept 33 ft 11 in (10.34 m)
Length Overall: 73 ft 6 in (22.40 m)
Other Weapons: Max load 50 × 750 lb (340 kg) bombs, of which two are carried in internal weapons bay and 48 in twin clusters of 3 on 8 underwing attachments. Full load carried with wings swept at 26°, reducing to 38 bombs (6 underwing attachments) at 54° of sweep, or 20 bombs at full sweep, or 4 × SRAM externally or plus 2 × SRAM in weapons bay
In Service with: US Air Force



FB-111 armed with SRAM

8043.302
VULCAN B Mk 2
HAWKER SIDDELEY (UK)
Role(s): 5-seat medium bomber
Power Plant: 4 × 20,000 lb (9,072 kg) st Rolls-Royce Bristol Olympus 301 turbojets
Wing Span: 111 ft 0 in (33.83 m)
Length Overall: 99 ft 11 in (30.45 m)
Max Take-Off Weight: Over 180,000 lb (81,646 kg)
Other Weapons:
Weapon load can include:
Hawker Siddeley Blue Steel air-to-surface missile.
Free fall nuclear weapons, or
21 × 1,000 lb (453 kg) high explosive bombs.
ECM and other defensive equipment in bulged tail-cone
Typical Tange: Combat radius:
At high and low altitude 1,725 miles (2,780 km).
At high altitude 2,300 miles (3,700 km).
With flight refuelling 2,875 miles (4,630 km)
In Service with: Royal Air Force

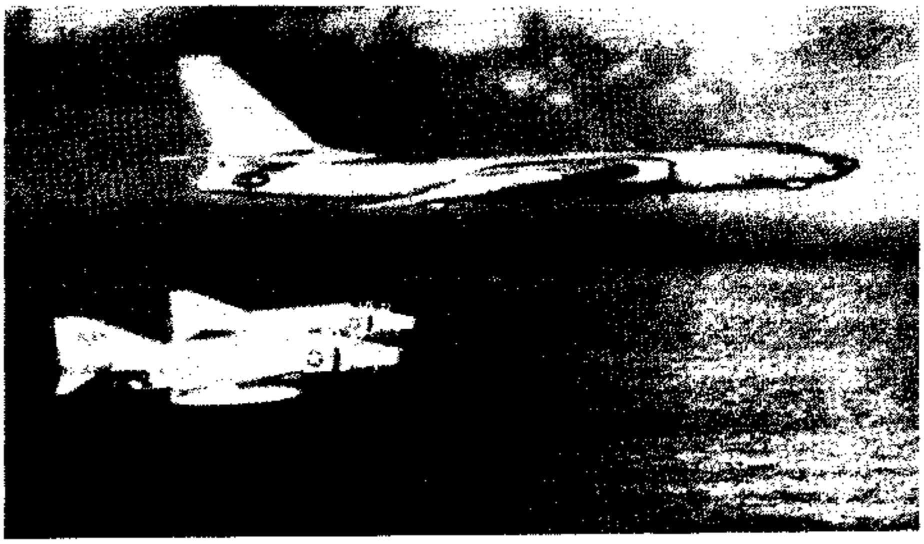
Vulcan B Mk 2

8060.302
Mya-4 (NATO "BISON")
MYASISHCHEV (USSR)
Role(s): 4-jet long-range reconnaissance bomber
Power Plant: 4 × 19,180 lb (8,700 kg) st Mikulin AM-3D turbojets
Wing Span: 170 ft 0 in (51.81 m)
Length Overall: 162 ft 0 in (49.37 m)
Max Take-Off Weight: 350,000 lb (158,757 kg)
Installed Weapons: Gun turrets in tail, above fuselage fore and aft of wing, and under fuselage fore and aft landing gear bays. (Thought to be equipped with 23 mm guns, 2 in each)
Other Weapons: Bomb load (normal) estimated at 9,000 lb (4,500 kg). Maximum load may be 19,800 lb (9,000 kg). Believed to be adapted to carry rocket-powered "stand off" type bomb with range of 50 miles (80 km)
Max Level Speed: 560 mph (900 kmh) at 36,000 ft (11,000 m)
Typical Range: 7,000 miles (11,265 km) at 520 mph (837 kmh) with 10,000 lb (4,535 kg) of bombs
In Service with: Soviet Air Force and Naval Air Force

1852.302
TUPOLEV V-g BOMBER (NATO "BACKFIRE")
TUPOLEV (USSR)
Role(s): Supersonic variable-gemoetry strategic bomber
Power Plant: Probably 2 × Kuznetsov NK-144 turbofans rated at 44,090 lb (20,000 kg) st (with reheat)
Max Take-Off Weight: 272,000 lb (123,350 kg) estimated
Max Level Speed: Mach 2.25 to 2.5 at height
Max Range: 6,000 miles (9,650 km) unrefuelled, at altitude
In Service with: Soviet Air Force

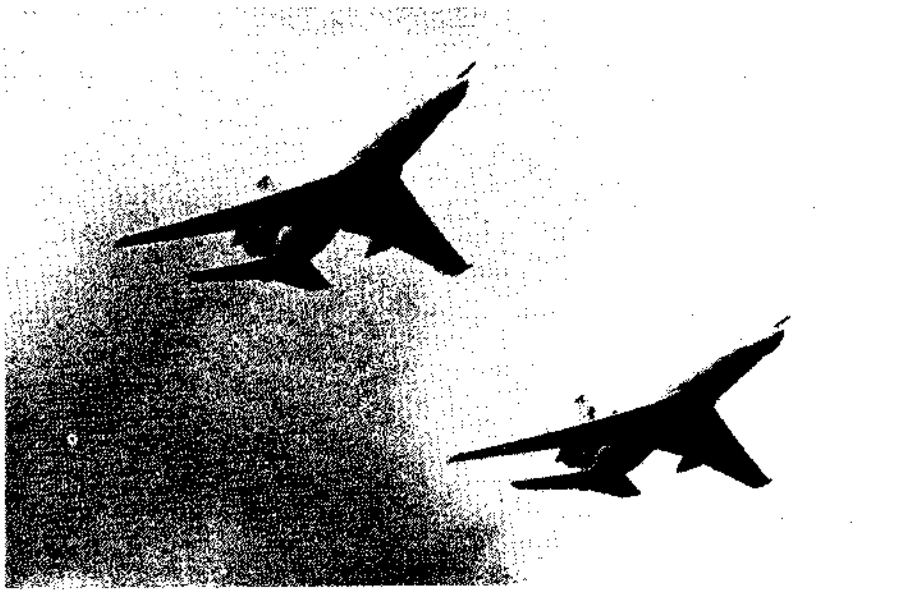
8084.302
Tu-16 (NATO "BADGER")
TUPOLEV (USSR)
Role(s): Medium bomber
Power Plant: 2 × 20,950 lb (9,500 kg) st Mikulin AM-3M turbojets
Wing Span: 110 ft 0 in (33.5 m) (estimated)
Length Overall: 120 ft 0 in (36.5 m) (estimated)
Max Take-Off Weight: 150,000 lb (68,000 kg) (estimated)
Max Weapon Load: Bomb-load up to 19,800 lb (9,000 kg) from bomb-bay
Installed Weapons:
Badger-A has 7 × 23 mm cannon in pairs in dorsal, ventral and tail turret and singly on starboard side of nose.
Badger-B is similar.
Badger-C has no nose cannon

Other Weapons:
Badger-A can carry up to 9 tons of bombs in bomb-bay.
Badger-B carries 2 × "Kennel" air-to-surface anti-shipping missiles under wing, instead of bombs.
Badger-C carries 1 × "Kipper" air-to-surface missile under the fuselage
Max Level Speed: 587 mph (945 kmh) at 35,000 ft (10,700 m)
Typical Range: 3,000 miles (4,800 km) with max bomb load. At 480 mph (770 kmh) with 6,000 lb (3,000 kg) bombs 3,975 miles (6,400 km)
In Service with:
All versions Soviet Air Force and Naval Air Force.
Badger-A Iraqi and Egyptian Air Forces.
Badger-B Indonesian Air Force.
Chinese Air Force



Tu-16 Badger escorted by USN F-4s

8086.302
Tu-22 (NATO "BLINDER")
TUPOLEV (USSR)
Role(s): Twin-jet supersonic bomber
Power Plant: 2 × unspecified turbojets with afterburners, dry rated at about 20,000 lb (9,071 kg) each
Wing Span: 80 ft 0 in (24.4 m)
Length Overall: 130 ft 0 in (39.6 m)
Mak Take-Off Weight: About 185,000 lb (83,914 kg)
Installed Weapons: 1 × gun in the radar-directed tail turret
Other Weapons: 1 × air-to-surface missile (NATO "Kitchen") carried internally by Blinder-A, and semi-submerged in underside of fuselage of Blinder-B
Max Level Speed: Mach 1.5 at 36,000 ft (11,000 m)
In Service with: Soviet Air Force and Naval Air Force



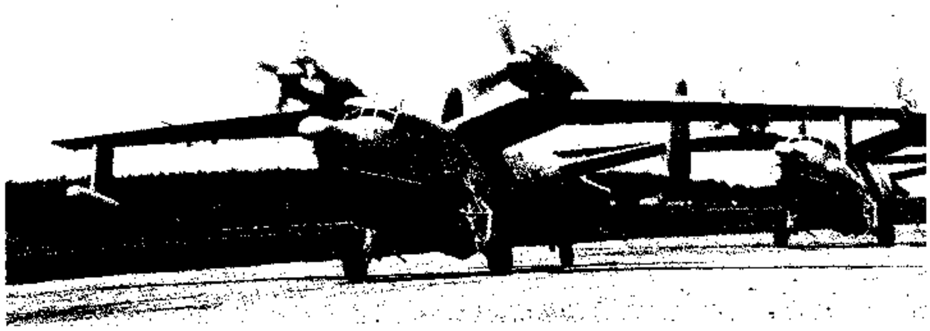
Tu-22 Blinder bombers

MARITIME AND ASW AIRCRAFT

8002.302
SHACKLETON MR Mk 3 PHASE 3
AVRO (UK)
Role(s): Long-range maritime-reconnaissance and ASR aircraft
Power Plant: 4 × 2,455 hp Rolls-Royce Griffon 57A piston-engines, and (RAF aircraft only) 2 × 2,500 lb (1,133 kg) st Rolls-Royce Bristol Viper 203 auxiliary turbojets
Wing Span: 119 ft 10 in (36.52 m)
Length Overall: 92 ft 6 in (28.19 m)
Max Take-Off Weight: 100,000 lb (45,360 kg)
Installed Weapons: 2 × 20 mm cannon in nose
Other Weapons: Bomb-bay carries a variety of anti-shipping weapons which include bombs, mines, depth charges, torpedoes, etc
Max Level Speed: 300 mph (483 kmh) at 12,000 ft (3,660 m)
Typical Range: At 200 mph (320 kmh) at 1,500 ft (460 m) 3,660 miles (5,890 km)
In Service with: South African Air Force

8008.302
Be-6 (NATO "MADGE")
BERIEV (USSR)
Role(s): Twin-engined reconnaissance and transport flying-boat
Power Plant: 2 × 2,000 hp ASh-73 radial engines
Wing Span: 108 ft 3¼ in (33 m)
Length Overall: 84 ft 0 in (25.6 m)
Max Take-Off Weight: 51,588 lb (23,400 kg)
Installed Weapons: Nose, dorsal and remotely-controlled tail gun-turrets containing 23 mm cannon
Other Weapons: Racks for bombs, mines, depth charges, torpedoes, etc, under wings, outboard of engines
Max Level Speed: 258 mph (415 kmh) at 7,875 ft (2,400 m)
Typical Range: 3,045 miles (4,900 km)
In Service with: Soviet Naval Air Force, Chinese Air Force

8009.302
Be-12 (NATO "MAIL")
BERIEV (USSR)
Role(s): Maritime reconnaissance amphibian
Power Plant: 2 × 4,000 ship Ivchenko AL-20D turboprops
Wing Span: 100 ft 0 in (30.5 m)
Length Overall: 100 ft 0 in (30.5 m)
Max Take-Off Weight: 65,000 lb (29,483 kg)
Other Weapons: In addition to the internal bomb-bay aft of the step, there is provision for one large or two small external stores pylons under each outer wing panel
In Service with: Soviet Naval Air Force

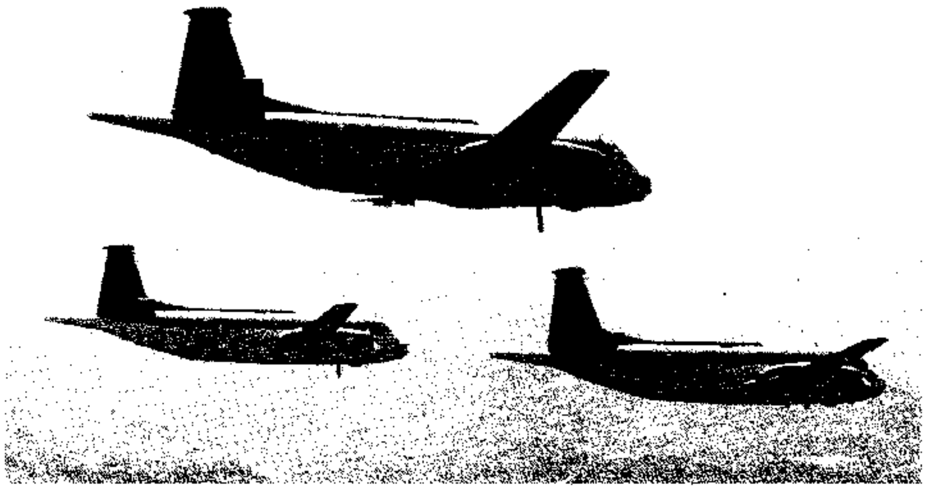


Be-12 Mail, maritime amphibian

1855.302
IL-38 (NATO "MAY")
ILYUSHIN (USSR)
Role(s): Anti-submarine/maritime patrol aircraft
Power Plant: 4 × Ivchenko A -20 turboprops of approx 4,250 ehp each
Wing Span: 122 ft 8½ in (37.4 m)
Length Overall: 129 ft 10 in (39.6 m)
Take-Off Weight: Approx 140,000 lb (63,500 kg) estimated
Max Cruising Speed: 347 knots (645 km/h) estimated
Max Range: 4,500 miles (7,250 km) estimated
In Service with: Soviet and Egyptian naval air forces

8011.302
Br 1050 ALIZE
BREGUET (FRANCE)
Role(s): 3-seat carrier-borne anti-submarine aircraft
Power Plant: 1 × 2,100 eshp Rolls-Royce Dart R Da 21 turbop
Wing Span: 51 ft 2 in (15.6 m)
Length Overall: 45 ft 6 in (13.86 m)
Max Take-Off Weight: 18,078 lb (8,200 kg)
Other Weapons:
Internal weapon bay for 3 × 353 lb (160 kg) depth charges or 1 × torpedo.
Racks under inner wings for 2 × 353 lb (160 kg) or 385 lb (175 kg) depth charges.
Racks under outer wings for 6 × 5 in rockets or 2 × Nord AS-12 air-to-surface missiles.
Sonobuoys in front of wheel housing
Max Level Speed: 292 mph (470 kmh) at 10,000 ft (3,048 m)
In Service with: French Navy, Indian Navy

8012.302
Br 1150 ATLANTIC
BREGUET (FRANCE)
Role(s): Long-range maritime reconnaissance aircraft
Power Plant: 2 × 6,105 eshp Hispano/Rolls-Royce Tyne R Ty 20 Mk 21 turboprops
Wing Span: 119 ft 1 in (36.30 m)
Length Overall: 104 ft 2 in (31.75 m)
Max Take-Off Weight: 95,900 lb (43,500 kg)
Other Weapons:: Main weapons carried in 30 ft (9 m) long bomb-bay in unpressurised lower fuselage. Weapons include:
All NATO standard bombs.
385 lb (157 kg) US or French depth charges.
HVAR rockets.
Homing torpedoes, including types such as the Mk 44 Brush or LX 4 with acoustic heads, or 4 × underwing air-to-surface missiles with nuclear or high explosive warheads
Max Level Speed: 380 mph (610 kmh) at high altitudes
Typical Range: 4,150 miles (7,700 km)
In Service with: French Navy, German Navy, Italian Navy and the Royal Netherlands Navy
Systems Description: Navigation of the Atlantic is performed in two modes, routine and tactical, the latter being concerned with 'on station' operations (ASW attack etc). Navigational aids include ADF, Tacan, VOR, Loran, doppler, air data computer and periscopic sextant. A Crouzet Type 61 navigation computer co-ordinates sensor inputs. Altitude and heading reference data are provided by a Sagem platform. There are two plotting tables with data projection facilities.



Br 1150 Atlantic ASW and maritime aircraft

Sensors fitted include a DRAA-2B search radar, APX-7 IFF interrogator, DHAX-1 MAD, ARAR-10B and ARAX-10B ECM, Mk 3B *Autolycus*, and *Julie* sonar equipment.
A more detailed description (Entry No. **1016.341**) appeared on pp 155-7 of JANE'S WEAPON SYSTEMS 1970-71

ATLANTIC Mk II
Development of an improved Mk II version of the Atlantic has been authorised for the French Navy, provisionally planned to enter service in 1982. In addition to enhanced ASW capability due to the use of a central digital computer to co-ordinate data from improved sonobuoys, new radar, MAD and an inertial navigation system, the Mk II version will provide wider facilities for the detection and engagement of surface targets. These include a new electronic warfare direction finder system, the new radar, and carriage of AS.12 wire-guided missiles, AS.37 anti-radiation Martel, and AM.39 air-to-surface Exocet anti-ship missile

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8013.202
CP-107 (CL-28) ARGUS
CANADAIR (CANADA)
Role(s): Maritime reconnaissance aircraft
Power Plant: 4 × 3,700 hp Wright R-3350-EA-I Turbo-Compound piston-engines
Wing Span: 142 ft 3½ in (43.37 m)
Length Overall: 128 ft 9½ in (39.26 m)
Max Take-Off Weight: 148,000 lb (67,130 kg)
Other Weapons: 2 bomb bays, each capable of accommodating 4,000 lb (1,815 kg) of stores, including homing torpedoes. Provision for carrying 2 3,800 lb (1,725 kg) missiles under outer wings
Max Level Speed: 315 mph (507 kmh) at 20,000 ft (6,096 m)
Typical Range: 5,900 miles (9,495 km) at 223 mph (359 kmh)
In Service with: Canadian Armed Forces

8035.202
HU-16B ALBATROSS
GRUMMAN (USA)
Role(s): Anti-submarine amphibian
Power Plant: 2 × 1,425 hp Wright R-1820-76A engines
Wing Span: 96 ft 8 in (29.46 m)
Length Overall: 62 ft 10 in (19.18 m)
Max Take-Off Weight: 37,500 lb (17,010 kg)
Other Weapons: Provision for carrying depth charges
Max Level Speed: 236 mph (379 kmh) at sea level
Typical Range: With max fuel, 5% reserve, 30 min hold off 2,850 miles (4,587 km)
In Service in: Argentine, Brazil, Chine, Greece, Italy, Norway, Peru, Spain, Thailand and USA

8036.202
S-2E TRACKER
GRUMMAN (USA)
Role(s): 4-seat carrier-based anti-submarine attack aircraft
Power Plant: 2 × 1,525 hp Wright R-1820-82WA piston-engines
Wing Span: 72 ft 7 in (22.13 m)
Length Overall: 43 ft 6 in (13.26 m)
Max Take-Off Weight: 29,150 lb (13,222 kg)
Max Weapon Load: 4,810 lb (2,182 kg)
Weapons:
25 × echo-sounding depth charges in fuselage.
1 × Mk 101 or Mk 57 nuclear depth bomb or similar store in bomb bay.
32 × sonobuoys in nacelles.

Royal Australian Navy S-2 Tracker

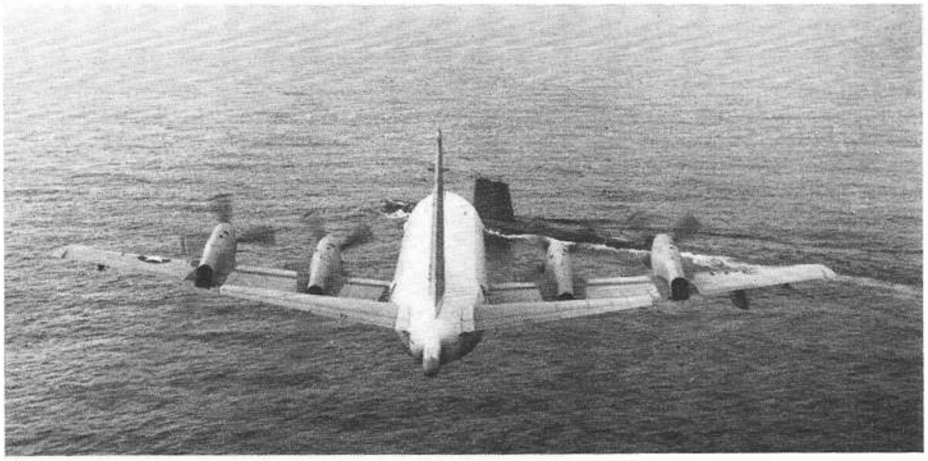
4 × float lights.
6 underwing pylons for 5 in rockets
Max Level Speed: Over 265 mph (426 kmh) at sea level with max take-off weight
Typical Range: Ferry range 1,300 miles (2,095 km)
In Service with: Argentine, Brazil, Chile, Canada, Italy, Japan, Netherlands, Taiwan, Uruguay, USA
Differing versions and designations apply to the aircraft used by the various countries
Systems Description: Navigation equipment carried includes the ASM-30 navigation computer display set, ASQ-80 co-ordinate data set, MF-1 compass system, APN-153 doppler, ADF, and Tacan, Search and detection equipment includes the APS-88A ASV search radar, ASR-3 condensation nuclei detector, ASQ-10A MAD, ARR-52A sonobuoy receiver, AQA-4 (System 2) *Jezebel* indicator, ASA-26B, *Julie* recorder, and UNH-6 tape recorder

8041.302
NIMROD MR Mk 1
HAWKER SIDDELEY (UK)
Role(s): Long-range anti-submarine aircraft
Power Plant: 4 × 11,500 lb (5,217 kg) st Rolls-Royce Spey Mk 250 turbofan
Wing Span: 114 ft 9½ in (35.00 m)
Length Overall: 126 ft 9 in (38.63 m)
Other Weapons: Ventral weapons bay, approximately 50 ft (15 m) long can accommodate full range of ASW weapons including bombs, mines, depth charges and torpedoes. Pylon beneath each wing can carry an 'AS 12' or 'Martel' air-to-surface missile
In Service with: Royal Air Force
Systems Description: Separate navigation systems are provided for routine and tactical navigation, but there are extensive interface arrangements between the two systems and each can serve as a back-up to the other. The two crew positions for navigation are located side-by-side, the tactical navigator acting as the attack co-ordinator during tactical operations.
Navigational equipment includes an Elliott E.3 inertial navigation system, Sperry gyrocompass, Decca doppler, Computing Devices Company wind computing and spherical data systems, AEI Mk I automatic variation computer, Tacan, ADF, Honeywell radio altimeter, air data computer, and Elliott and Ferranti display equipment. Special versions of the Smiths Industries SEP.6 autopilot and SFS.6 flight instrument systems are fitted.
Thomson-CSF ECM, MAD, *Autolycus*, sonar data receiving and processing equipment. Sensor data and navigation information are co-ordinated and processed by an Elliott MCS 920B digital computer.

Hawker Siddeley Nimrod MR Mk 1

It was announced in June 1971 that EMI is to develop an improved ASV radar for the Nimrod, and it was subsequently revealed that this was part of a major programme to provide a still more sophisticated avionics fit for the Nimrod. Other items include a new sono-buoy and complete aircraft sonics system, enhanced digital processing facilities, signal processing, and other improvements.
A more detailed description (Entry No. **1013.341**) appeared on pp 157-160 of JANE'S WEAPON SYSTEMS 1970-71.
Three special versions, designated R.Mk.1, are in use by the RAF for electronic reconnaissance

1402.302
ORION P-3
LOCKHEED (USA)
Role(s): Maritime Reconnaissance/anti-submarine aircraft, 12-man crew
Power Plant: 4 × Allison T56-A-14 4 910 eshp turboprop engines
Wing Span: 99 ft 8 in (30.37 m)
Length Overall: 116 ft 10 in (35.61 kg)
Max Take-Off Weight: 133,000 lb (60,325 kg)
Weapons: Carried internally and externally to max load 19,250 lb (8,730 kg) made up of
6 × 2,000 lb (907 kg- mines)
8 × Mk 57 depth bombs
8 × torpedoes
2 × Mk 101 nuclear depth bombs
plus sonobuoys, marine markets, etc
Max Level Speed: 413 kt (765 km/hr)
Typical Range: 3,000 nm (5,560 km)
In Service in: (in different marks) Australia, Iran, New Zealand, Norway, Spain, USA
System Description: Latest version of the Orion is the P-3C, in which the most significant difference from its predecessors (P-3A and B) was the development of a greatly improved electronics installation. This was described in detail on pages 162-4 of JANE'S WEAPON SYSTEMS 1970-71

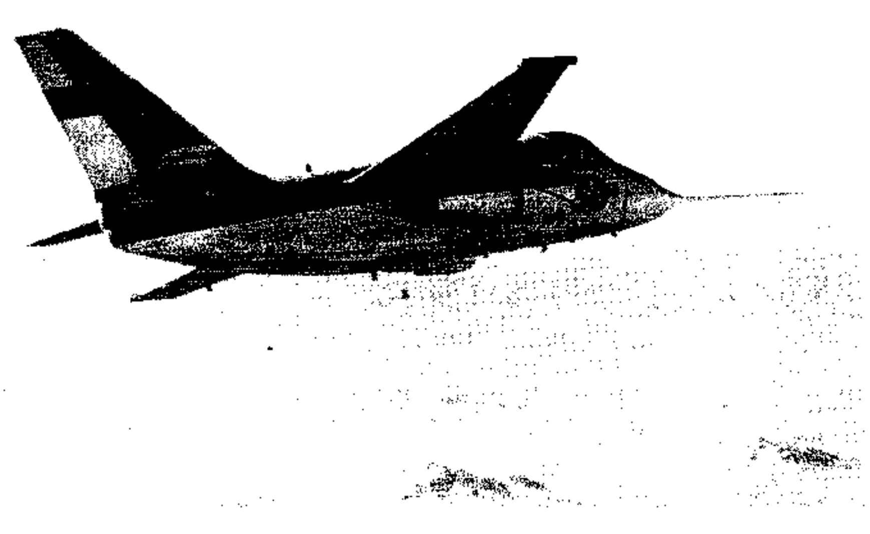


Lockheed P-3 Orion

8075.302
PS-1
SHIN MEIWA (JAPAN)
Role(s): 4-turboprop STOL maritime reconnaissance flying-boat
Power Plant: 4 × 2,850 shp General Electric T64-IHI-10 turboprops
Wing Span: 107 ft 7½ in (32.80 m)
Length Overall: 109 ft 11 in (39,400 kg)
Max Take-Off Weight: 86,862 lb (39,400 kg)
Max Weapon Load: 5,578 lb (2,530 kg)
Other Weapons:
2 underwing pods, between each pair of engine nacelles, each contain 2 × homing torpedoes.
6 × 5 in rockets on attachments under wing-tips.
4 × 330 lb (149 kg) anti-submarine bombs
Max Level Speed: 340 mph (547 kmh) at 5,000 ft (1,500 m)
Typical Range:
Normal range 1,347 miles (2,168 km)
Max range 2,948 miles (4,744 km)
In Service with: Japanese Maritime Self-Defence Force

1403.302
VIKING S-3A
LOCKHEED (USA)

Role(s): Carrier-based anti-submarine aircraft. Four-man crew
Power Plant: 2 × 9,000+ lb (4,080 kg) st General Electric TF-34-2 turbojets
Wing Span: 68 ft 8 in (20.92 m)
Length Overall: 53 ft 4 in (16.25 m)
Max Take-Off Weight: 41,000 lb (18,597 kg)
Other Weapons: Will include torpedoes, depth bombs, missiles, rockets, and mines
Max Level Speed: 495 mph (800 kmh)
Typical Range: 3,500 miles (5,630 km) – ferry range
In Production for: US Navy
Systems: The S 3A is the most recent American ASW aircraft programme to be undertaken, and this carrier-borne aircraft is equipped with the latest sensor and signal data processing systems and equipment. A full description appeared on pages 374 and 375 of JANE'S WEAPON SYSTEMS 1973-74. Projected introduction to operational service with the USN over the next few years will run at an annual rate of 45 aircraft per year



Lockheed S-3A Viking

EARLY WARNING AIRCRAFT

1304.302
E-3A AWACS – AIRBORNE WARNING AND CONTROL SYSTEM
BOEING (USA)

DESCRIPTION:
Originally planned and designed to fulfil both strategic and tactical airborne early warning and control functions for air defence and air superiority missions, the AWACS programme was changed in August 1973 to make it predominantly concerned with tactical roles only. At that time the US Secretary of Defence removed AWACS from the STRATEGIC CONUS Air Defence Forces and assigned it to the General Purpose Forces. Based on assessments made following prototype demonstrations in Europe in April 1973, and USN and US Army statements calling for the mutual support offered by AWACS in joint operations, it was considered that a more comprehensive and capable configuration of AWACS was needed to support General Purpose Forces. In November 1973 the USAF was authorised to continue the engineering development programme while accommodating the need to expand from the previously approved configuration. Procurement was planned on the basis of 12 AWACS per year from Fiscal Year 1975, successive annual batches incorporating enhancements as required and as available. The first batch has been defined as the basic AWACS plus a self-defence subsystem and a USAF satellite communications terminal. Funds were included to preserve options for the installation of additional improvement items in the second and third batches of aircraft for enhancement of Command, Control and Communications and survivability, a special IFF system and increased support to the other US Services. The final production decision on the first batch of 12 AWACS aircraft will be taken in December 1974. The tentative total procurement is 34 aircraft.
The aircraft employed is an adapted Boeing 707 and the systems were described on Page 375 of JANE'S WEAPON SYSTEMS 1973-74. Further details of the radar appear in this edition in Entry No. **1585.353**, in Section Three

AWACS evaluation and engineering development aircraft

1404.302
HAWKEYE E-2
GRUMMAN (USA)

Role(s): Naval airborne early warning aircraft
Power Plant: 2 × Allison T56 A 8 4,050 eshp turboprop engines
Wing Span: 80 ft 7 in (24.56 m)
Length Overall: 56 ft 4 in (17.17 m)
Maximum Take-Off Weight: 49,638 lb (22,515 kg)
Maximum Level Speed: 368 mph (953 kmh)
Typical Range: 1,905 miles (3,065 km) – ferry range
Systems Description: The E-2 Hawkeye series of aircraft exists in three versions, A, B and C. The E 2A has been in service for a number of years, and the E 2B differs principally in having more modern data processing facilities based on a Litton L-304 digital computer. US Navy E-2As are progressively being updated to E-2B standard. The E-2C, which is now in production, differs principally from the earlier versions in having an improved search radar. That in the E-2A and E 2B is the APS 96, and the E-2C has an APS 120 radar in improved form.
Operational functions of Hawkeye aircraft in support of naval forces are to patrol the extremes of land or fleet defence perimeters to detect air, sea or land threats, and those of strike and air traffic control, area surveillance, search and rescue guidance, and communications relay. To fulfil these roles the aircraft is equipped with ATDS, Airborne Tactical Data System, which consists of four basic elements the search radar, search computer, a larger digital computer for tracking and intercept control, and data links for the control of aircraft and communication with the overall Naval Tactical Data System (NTDS).
The search radar is housed in a 7.3 metre diameter radome mounted above the fuselage. The E 2B radome also has on its upper surface a small IFF antenna.
In the E-2C the APS-120 primary (search) and secondary (IFF) radars each have their own data extraction and signal processors, interfacing with the central processor. These are provided by the radar suppliers, General Electric and Hazeltine, respectively. Radar data and other information received via the data links is fed to the central processor, together with navigational data from the doppler/inertial, attitude and heading reference systems, and air data computer. Three display consoles are provided for the operators. The main display shows targets in PPI form or as synthetic video, with alpha-numeric and symbol labels. An auxiliary CRT unit is used for the presentation of tabular information selected by the operator.
The APS-96 radar used in the E-2A and E-2B versions operates in the P-band, with a coherent matched filter system and low PRF. To improve detection performance and MTI in the presence of clutter and ground returns overland, Grumman produced an improved version using the same transmitter chain but with a new receiver which incorporates clutter cancellation facilities.
This system was designated APS 111 and underwent a two-year test flight programme which ended in 1969. An improved version of this radar, the APS-120, is used in the E 2C, and it is used with an updated version of the APA-143 Rotodome antenna system provided by Dalmo Victor for other E-2 versions.
Present procurement plans call for the production of 23 E-2C aircraft over the next three years

1305.302
MOSS EARLY WARNING AIRCRAFT
TUPOLEV (USSR)

DESCRIPTION Moss is the NATO designation given to a version of the Tu 114 long-range passenger aircraft which has been converted for AWACS (Airborne Warning And Control System) operations.

The basic aircraft is a four-engined turboprop transport with a maximum take-off weight in that role of 171,000 kg. The service ceiling is 12,000 metres, and range 6,000 to 9,000 km, depending upon fuel and payloads. To adapt the Tu 114 for early warning roles, a configuration similar to that of the American E-2 Hawkeye has been employed, where a large circular radome is mounted above the rear part of the fuselage.

From the limited information available, little concerning the equipment or operation of Moss can be said with any certainty. The existence of the system was made public in 1968 in an official Soviet documentary film shown in the West

Airborne Early Warning aircraft "Moss"

1854.302
SHACKLETON AEW Mk 2
HAWKER SIDDELEY (UK)
Role(s): Airborne early warning aircraft
Power Plant: 4 × 2,455 hp Rolls-Royce Griffon 57A piston-engines
Wing Span: 119 ft 10 in (36.52 m)
Length Overall: 92 ft 6 in (28.19 m)
Max Take-Off Weight: 100,000 lb (45,360 kg)
Max Level Speed: 300 mph (483 km/h) at 12,000 ft (3,660 m)
Typical Range: 4,000 miles (6,440 km)
In Service with: Royal Air Force
Systems: Equipped with modernised and improved version of APS-20 search radar to provide Airborne Early Warning system facilities

RECONNAISSANCE AIRCRAFT

1667.302
SF37 and SH37 VIGGEN
SAAB-SCANIA (SWEDEN)

DESCRIPTION In the early part of 1973 it was announced that Saab-Scania had been awarded contracts by the Swedish Government for the development and production of reconnaissance versions of the Viggen (Entry No. **8072.302**) to replace the existing Saab S35E Draken and S32C Lansen aircraft currently used by the RSAF.

The reconnaissance aircraft now under development for future service consists of two Viggen versions:

(a) *SH37* for photo reconnaissance
(b) *SH37* for sea surveillance

Both versions will be equipped for all-weather operation, and both versions are developed from the same standard platform used for the AJ37 attack and SK37 trainer versions now in full production and service.

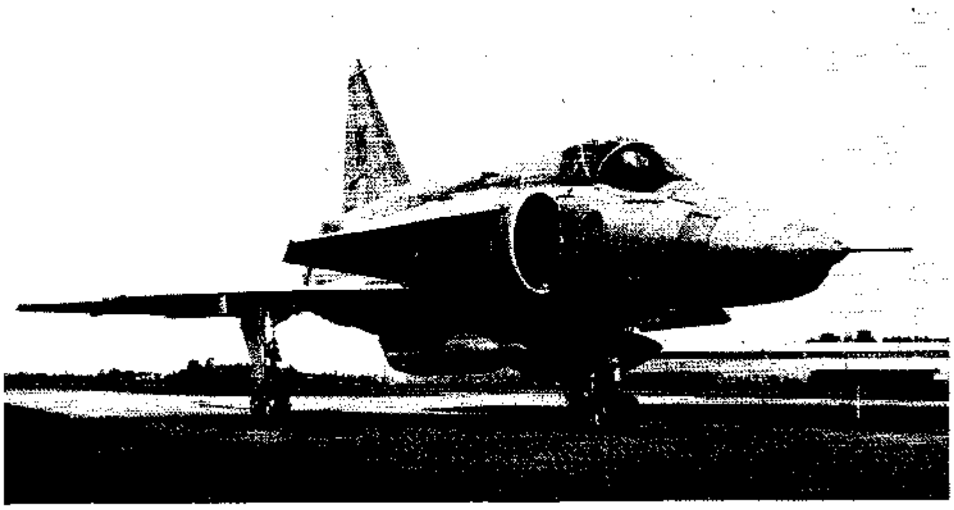
SH37

The primary mission of the SH37 is to survey, register and report activities in the neighbourhood of Sweden's territory, and it can also be used for attack missions. The reconnaissance equipment consists of surveillance radar, a camera for photographing the radar display, a long-distance camera, night photography equipment and various other registration systems including a data camera and a tape recorder.

SF37

The SF37 version is intended solely for reconnaissance missions. Its normal operational use will be over land. In the equipment are included cameras and other equipment permitting reconnaissance during daylight, dusk, darkness, at low and high altitudes and at long distances from the target. The systems configuration also makes possible detection of camouflaged targets and horizon-to-horizon (180°) photo coverage. To enable the pilot to aim the cameras correctly for high altitude and long-distance reconnaissance, the aircraft is equipped with a special optical sight. As in the SH37, the SF37 is fitted with data camera, tape recorder and other registration equipment. The data camera is an important aid in collecting and storing all information during the mission, and on the film are registered co-ordination figures, aircraft position, course, altitude, target location and other important data.

In contrast to earlier types of reconnaissance aircraft used in the Swedish Air Force (S29C, S32C and S35E), both Viggen reconnaissance versions will carry air-to-air missiles for self-defence. To reduce effectiveness of enemy action further, the aircraft will be equipped with active as well as passive counter-measures



The SF37 model of the two reconnaissance versions of the Saab Viggen

1405.302
MOHAWK OV-1
GRUMMAN (USA)
Role(s): Battlefield suveillance and reconnaissance aircraft
Power Plant: 2 × Lycoming T53-L-15, 1,100 eshp turboprops
Wing Span:
42 ft 0 in (12.80 m) OV-1A, C D.
48 ft 0 in (14.63 m) OV-1B
Length Overall: 41 ft 0 in (12.50 m)
Max Take-Off Weight:
15,031 lb (6,818 kg) OV-1A.
19,230 lb (8,722 kg) OV-1B, C
Max Level Speed:
308 mph (496 kmh) OV-1A, C
297 mph (478 kmh) OV-1B
Max Range (with external tanks):
1,410 miles (2,270 km) OV-1A
1,230 miles (1,980 km) OV-1B

1,155 miles (2,140 km) OV-1C
In Service with: US Army
Systems Description: The Mohawk is a multiple sensor aircraft for battlefield reconnaissance by both overflight and parallel surveillance. For the latter type of mission, a variety of sideways-looking sensors are employed. Both on-board recording of data, and real-time relay of information by data link to base stations are used. A detailed description of the Mohawk's sensor equipment appeared on page 377 of JANE'S WEAPON SYSTEMS 1973-74

US Army OV-1 Mohawk with Sideways Looking Radar

1409.302
RB-57F
GENERAL DYNAMICS (USA)
Role(s): High altitude reconnaissance – strategic and tactical
Power Plant: 2 × Pratt & Whitney 18,000 lb (8,165 kg) TF33-P-11 turbofan plus 2 × Pratt & Whitney 3,300 lb (1,500 kg) turbojets in underwing pods
Wing Span: 122 ft 5 in (37.32 m)
Length Overall: 69 ft 0 in (21.03 m)
Max Take-Off Weight: 50,000 lb (22,680 kg) estimated
Other Weapons: Active and passive reconnaissance sensors for intelligence gathering at the optical, infra-red and microwave frequencies
Max Level Speed: 450 kt (934 km/hr) class
In Service with: USAF

Special night reconnaissance and interdiction version of RB-57 used in Vietnam

1410.302
RA-5C
NORTH AMERICAN (USA)
Role(s): Two-seat, tactical reconnaissance from aircraft carriers
Power Plant: 2 × 17,900 lb (8,120 kg) GE J79-10 turbojet engine
Wing Span: 53 ft 0 in (16.15 m)
Length Overall: 76 ft 10 in (23.11 m)
Max Take-Off Weight: 80,000 lb (36,285 kg) approx
Other Weapons: Normal load multi-sensor reconnaissance pack. Attack capability retained. 4 × underwing weapon stations stressed for 3,000 lb (1,361 kg) each
Max Level Speed: Mach 2 approx
Typical Range: 1,500 nm (2,780 km)
In Service with: US Navy

1411.302
SR-71
LOCKHEED (USA)
Role(s): High altitude high speed strategic reconnaissance. Crew of 2
Power Plant: 2 × 32,500 lb (14,740 kg) Pratt & Whitney J58 turbojet engines
Wing Span: 55 ft 7 in (16.95 m)
Length Overall: 107 ft 5 in (32.74 m)
Other Weapons: Multi-sensor reconnaissance equipment with recorders for missions at high and low altitude and for tactical as well as strategic purposes. No offensive capability
Max Level Speed: Mach 3+ at 100,000 ft (30,500 m)
In Service with: Strategic Air Command 9th Strategic Reconnaissance Wing, USAF

Lockheed SR-71 high altitude reconnaissance aircraft

HELICOPTERS

8007.302
AH-1G HUEYCOBRA
BELL (USA)
Role(s): Armed helicopter
Power Plant: 1 × 1,100 shp (de-rated) Lycoming T53-L-13 shaft-turbine engine
Wing Span: 44 ft 0 in (13.41 m)
Length Overall: 53 ft 1¼ in (16.18 m)
Max Take-Off Weight: 9,500 lb (4,309 kg)
Installed Weapons: TAT 102 turret faired into the front fuselage undersurface houses a GAU2B/A Minigun 6-barrel 7.62 mm machine-gun, with 8,000 rounds. This will be fitted initially, but will be superseded later by the Emerson TAT-141 (XM28), mounting both the minigun (with 4,000 rounds) and an XM 120 40 mm grenade launcher with 300 rounds. Provision is made for alternative turret weapons including the M-61 (modified) 3-barrel version of the M-61 20 mm Vulcan gun, with 750 rounds
Other Weapons: 4 external stores attachments under the stub-wings will accommodate various loads including:
76 × 2.75 in rockets in 4 XM-159 packs.
2 × XM 18 minigun pods or
2 × pods each containing 3 TOW wire-guided missiles
Typical Range: A: 8,624 lb (3,912 kg) AUW 425 miles (684 km)
In Service with: US Army, US Marine Corps. Ordered for Iran and Spain
Development: Bell is engaged on a US Army contract calling for the modification of 101 AH-1G models to the AH-1Q TOW/Cobra configuration, in which the helicopter is equipped to

carry and launch 8 TOW anti-tank missiles. The XM-28 turret with a 7.62 mm minigun and a 40 mm grenade launcher is retained. Helmet sights will allow the crew to control the turret directly or provide target acquisition for the stabilised optics. The AH-1Q Hueycobra will carry 4,000 rounds of 7.62 mm, 300 rounds of 40 mm, eight TOW missiles, and fuel for over two hours. Another version is the AH-1J Sea Cobra used by the US Marines, and which in modified form is being supplied to Iran

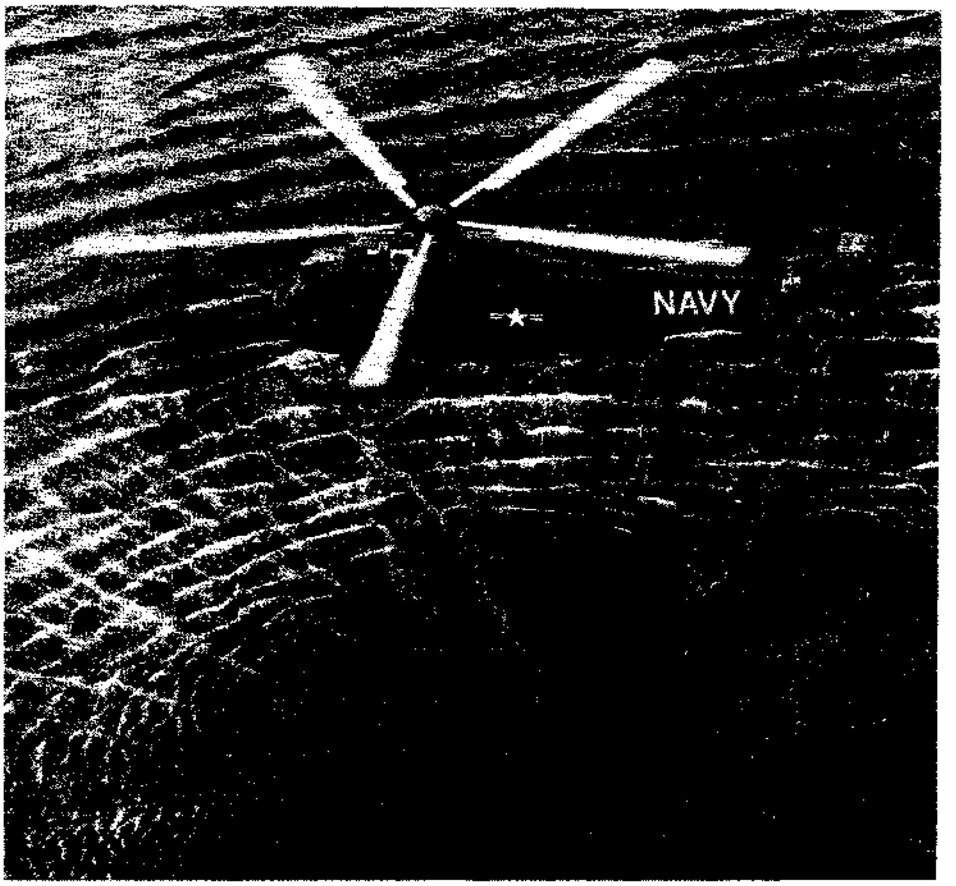
The AH-1Q TOW/Cobra. Bell is modifying over 100 existing AH-IG HueyCobras to the TOW/Cobra configuration

8046.302
HH-2C SEASPRITE
KAMAN (USA)
Role(s): Armed search and rescue helicopter
Power Plant: 2 × 1,250 shp General Electric T58-GE-8B shaft-turbines
Rotor Diameter: 44 ft 0 in (13.41 m)
Length Overall: 52 ft 2 in (15.90 m)
Max Take-Off Weight: 12,840 lb (5,824 kg)
Installed Weapons: Chin-mounted Minigun turret, waist-mounted machine-guns
Max Level Speed: 156 mph (251 kmh) at sea level
Typical Range: 340 miles (545 km)
In Service with: US Navy

eg21853.302
Mi-24 (NATO "HIND")
MIL (USSR)
Role(s): Anti-tank and assault helicopter
Power Plant: 2 × Isotov TV2-117A turbo-shaft engines of 1500 shp
Rotor Diameter: 70 ft 3 in (22.0 m)
Length Overall:
83 ft 8 in (25.5 m) rotor turning
65 ft 6 in (19.96 m) fuselage
Max Weight: 26,500 lb (12,000 kg) estimated
Weapons: Total of four or six weapon stations on stub wings, including two launchers for Sagger A/T missile. Chin turret gun. 8-12 troops carried
Max Speed: 140 knots (260 km/h) estimated
Max Range: 260 nm (480 km) estimated

8047.302
Ka-25 (NATO "HORMONE")
KAMOV (USSR)
Role(s): Twin-turbine flying-crane helicopter
Power Plant: 2 × 900 shp Glushenkov shaft-turbine engines
Rotor Diameter: (Each) 51 ft 8 in (15.74 m)
Length Overall: 32 ft 3 in (9.83 m)
Max Take-Off Weight: 16,100 lb (7,300 kg)
Max Level Speed: 137 mph (220 kmh)
Typical Range: With standard fuel, with reserves, 250 miles (400 km). With max fuel, with reserves, 405 miles (650 km)
In Service with: Soviet Naval Air Force

8074.302
S-61B (H-3 SEA KING)
SIKORSKY (USA)
Role(s): Anti-submarine and transport helicopter
Power Plant: 2 × 1,400 shp General Electric T58-GE-10 shaft-turbine
Rotor Diameter: 62 ft 0 in (18.90 m)
Length Overall: 72 ft 8 in (22.15 m)
Max Take-Off Weight: 20,500 lb (9,300 kg)
Max Weapon Load: 840 lb (381 kg)
Other Weapons: 840 lb (381 kg) of homing torpedoes, depth charges, etc
Max Level Speed: 166 mph (267 kmh) at 20,500 (9,300 kg) AUW
Typical Range: With max fuel, 10% reserve, 625 miles (1,005 km)
In Service with: US Navy, Spanish Navy, Brazilian Navy, Royal Canadian Navy, Italian Navy and the Japanese Maritime Self-Defence Force



US Navy SH-3D, Sikorsky S-61 helicopter

1588.302
SA.330 PUMA
SNIAS / WESTLAND (FRANCE / UK)
Role(s): Tactical utility helicopter
Power Plant: 2 × Turbomeca Turmo III C4 turbines of 1,320 hp each
Rotor Diameter: 49 ft 3 in (15.00 m)
Length Overall: 59 ft 7 in (18.18 m)
Max Take-Off Weight: 14,110 lb (6,400 kg)
Max Level Speed: 151 knots (278 km / h)
Max Range: 340 nm (625 km)
In Service in: France, Portugal, South Africa, UK, Zaire

SA.330 Puma helicopter in RAF service

1668.302
SA.341 GAZELLE
WESTLAND / AÉROSPATIALE (UK / FRANCE)
Role(s): Light tactical utility helicopter
Power Plant: 1 × Turbomeca Astazou 3 gas turbine of 530 shp
Rotor Diameter: 34 ft 6 in (10.5 m)
Length Overall: 39 ft 2 in (11.9 m)
Max Take-Off Weight: 3,750 lb (1,700 kg)
Max Speed: 167 knots (310 km / h)
In Service or Ordered for: French Army, British Army, RN, RAF, and Yugoslavian Air Force

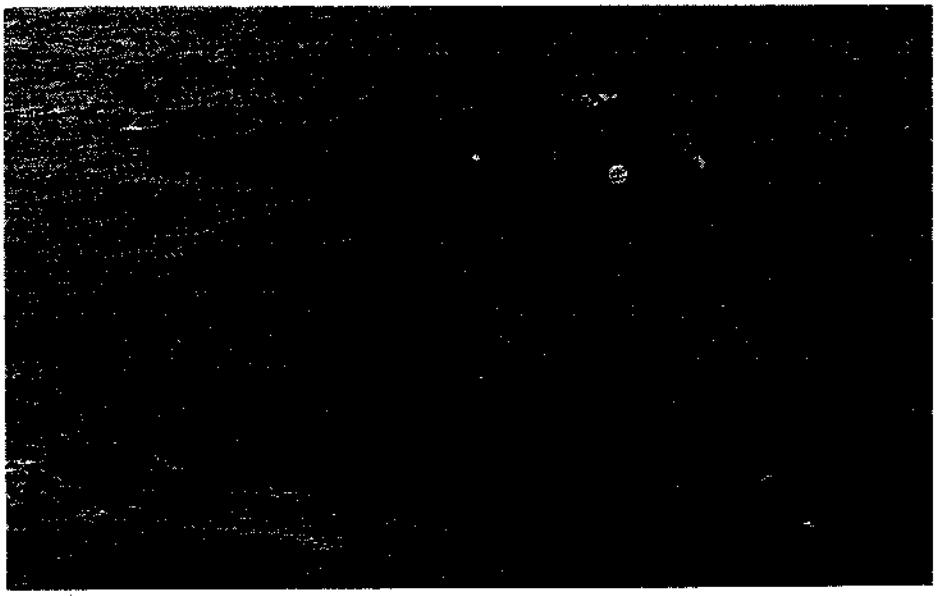
SA.341 Gazelle helicopter in British Army colours

8078.302
SE 3160 ALOUETTE III
SUD-AVIATION (FRANCE)
Role(s): General-purpose, armed reconnaissance and anti-tank helicopter
Power Plant: 1 × 870 shp (derated to 550 shp) Turbomeca Artouste IIIB shaft-turbine engine
Rotor Diameter: 36 ft 1 in (11.0 m)
Lenfth Overall:
42 ft 0¾ in (12.82 m) rotor turning
33 ft 4½ in (10.17 m) blades folded
Max Take-Off Weight: 4,630 lb (2,100 kg)
Other Weapons: Wide range of alternative armament includes:
AS 11 and AS 12 wire-guided missiles with gyro-stabilised sight.
Quick-firing 20 mm cannon.
Side mounted 7.62 mm machine gun.
2 × pods each containing 18 or 36 rockets.
An ASW version of the Alouette III fitted with MAD and carrying a Mk 44 homing torpedo is under development
Max Level Speed: 131 mph (210 kmh) at sea level
Typical Range:
Range with 1,800 lb (820 kg) payload at Sea Level 62 miles (100 km).
Range with 1,400 lb (635 kg) payload at Sea Level 186 miles (300 km).
Range with max fuel at Sea Level 342 miles (550 km).
Range at best altitude 385 miles (620 km)

8079.302
SA 321G SUPER FRELON
SUD-AVIATION (FRANCE)
Role(s): Naval anti-submarine helicopter
Power Plant: 3 × 1,500 shp Turbomeca Turmo IIIC3 shaft-turbines
Rotor Diameter: 62 ft 0 in (18.90 m)
Length Overall:
75 ft 6⅞ in (23.02 m) rotor turning.
65 ft 10¾ in (20.08 m) fuselage length including tail rotor.
56 ft 0 in (17.07 m) naval version blades and tail folded
Max Take-Off Weight: 26,455 lb (12,000 kg)
Other Weapons: Anti-submarine attack weapons in naval version
Max Level Speed: 158 mph (255 kmh) at sea level
Typical Range: At Sea Level 572 miles (920 kmh)
In Service with: French Navy

8088.302
SEA KING
WESTLAND (UK)
Role(s): Anti-submarine and general-purpose helicopter
Power Plant: 2 × 1,500 shp Rolls-Royce Gnome H 1400 shaft-turbines
Rotor Diameter: 62 ft 0 in (18.90 m)
Length Overall: 47 ft 3 in (14.40 m) rotors and tail pylon folded
Max Take-Off Weight: 20,500 lb (9,300 kg)
Other Weapons: Up to 4 torpedoes or bombs and / or depth charges
Max Level Speed: 161 mph (259 kmh)
Typical Range: With standard fuel 690 miles (1,110 km)
In Service with: The Royal Navy, Belgian Air Force, West German Navy, Indian Navy, Norwegian Air Force, Pakistan Air Force, Royal Australian Air Force
Systems Description: The Westland Sea King helicopter performs a variety of naval operational roles. The principal functions are ASW, SAR (search and rescue), air to surface strike, cargo, casualty evacuation and personnel carrying. The Westland version of the Sea King is claimed to be unique in that its standard of

equipment enables it to be used as a platform for tactical control and co-ordination of submarine search and attack operation involving both surface and airborne units. A full description of the Sea King's systems appeared on page 380 of JANE'S WEAPONS SYSTEMS 1973-74

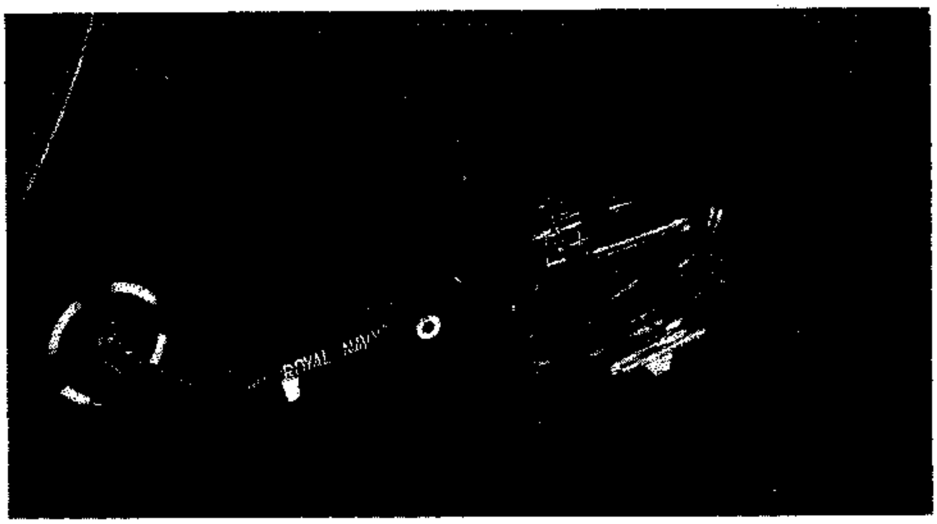


Westland Sea King of the German Navy during SAR trials

8089.302
WESSEX HAS Mk 3
WESTLAND (UK)
Role(s): 4-seat anti-submarine helicopter
Power Plant: 1 × 1,600 shp flat-rated Gazelle NGa 22 Mk 165 shaft-turbine engine
Rotor Diameter: 56 ft 0 in (17.07 m)
Length Overall: 65 ft 9 in (20.03 m)
Other Weapons: Anti-submarine strike weapons
In Service with: Royal Navy, Royal Australian Navy (similar version)

1587.302
WG-13 LYNX
WESTLAND (UK)
Role(s): Anti-submarine, surface strike, training, general purpose
Power Plant: 2 × Rolls-Royce BS 360-07-26 three-shaft, free turbine engines, of 900 shp rating
Rotor Diameter: 42 ft (12.80 m)
Length Overall:
49 ft 9 in (15.16 m) rotor turning
41 ft 10¾ in (12.77 m) rotor folded
Max Take-Off Weight:
8,000 lb (3,630 kg) general purpose version.
8,550 lb (3,879 kg) naval version
Weapons: A variety of weapon options are possible, depending upon role:
2 × Mk 44 torpedoes.
Internal and external fixed weapons.
AS 12 or SS 11 missiles.
CL.834 anti-ship missile (under development)
Max Level Speed: 160 knots (294 km/h) – general purpose version
Typical Range: 440 nm (810 km) – general purpose version
In Production for: French and British Services
Army Variant: The fuselage of the Army variant has been designed for maximum weapon system flexibility whilst still retaining high speed and performance. Radio, navigational and auto-pilot facilities are available to meet particular operational requirements. These include UHF/VHF radio, IFF equipment, doppler navigation system, tactical map display, Decca Mk 19 and radio altimeter. The duplex flight stabiliser and auto-pilot are designed on a modular basis to give optional auto-pilot capabilities ranging from datum holding, indicated airspeed, barometric height and heading to automatic turns on to preselected headings, automatic transition to the hover and hover control.
Role equipment is available to meet troop transport (10 troops), freight carriage, rescue and casualty evacuation (3 stretchers) roles. A full weapon load can be carried for a highly flexible weapon response. Armament installations can include 2 × 7.62 mm G.P.N.G.s, 2 × 7.62 mini-guns and a pintal mounted 20 mm cannon which can be mounted in the doorways on quick release fasteners allowing rapid interchange of armament.
For anti-tank missions either SS11 or Hawkswing missiles can be carried. Avimo Ferranti or APX stabilised sighting systems are available for use in conjunction with the missiles. The Hawkswing missile can be fired and controlled while the helicopter is undertaking evasive manoeuvres. Facilities are available for carrying

WG-13 Lynx helicopter in the British Army configuration



WG-13 Naval Lynx carrying AS.12 air-to-surface missiles two bomb racks with a total complement of up to eight light stores.

Naval Variant: With a similar fuselage assembly to the army variant, and employing the same dynamic components, the naval variant has been designed as a powerful extension of small ships' weapon systems. The naval variant has a high energy absorption tricycle undercarriage designed specially to enable it to operate from small ships in rough conditions. The same wide range of radio, navigational and auto-pilot facilities are available as on the army version but with further augmentation by a Ferranti Sea Spray nose radar installation. The Lynx helicopter will form an integral part of small ship armament and is so designed to provide a complete weapon system in ASW or ASV roles and also provide the other miscellaneous requirements such as SAR and ship to ship communication.

An integrated weapon system is provided for anti-submarine warfare. Two homing torpedoes or two depth charges as alternative weapons can be carried, mounted one on each side of the cabin. Two light series bomb racks are also carried, one under each wheel sponson with a total complement of six light series stores. Provisions are made for the carriage and dropping of sonar buoys and MAD classification system can be deployed. Dunking sonar can be installed as an alternative fit.

The Lynx is also designed as a search and strike system against surface targets. The new BAC CL 834, Skua, light-weight missile will be installed on the Royal Navy Lynx helicopters to provide long-range defence for frigates against missile carrying fast patrol boats, hydrofoils and hovercraft. The operational range will enable CL 834 to strike long before any defensive missile on the parent ship itself could successfully engage the target, and the general performance of this important new defensive system will far outstrip that of existing missile equipped naval helicopters. For the French naval version of the Lynx four AS 12 wire guided missiles will be fitted. With these missiles a stabilised APX B34 sight will be provided for surveillance and missile control

1412.302
KIOWA OH-58A
BELL (USA)

Role(s): 2-seat light tactical armed observation helicopter
Power Plant: 1 × Allison T63-A-700 270 shp shaft turbine engine
Rotor Diameter: 33 ft 4 in (10.14 m)
Length Overall: 41 ft (12.5 m)
Max Take-Off Weight: 3,000 lb (1,361 kg)
Other Weapons: XM134 7.62 mm minigun or XM 8,440 mm grenade launcher or 2.75 in rocket pod; XM170E1 sighting system
Max Level Speed: 115 kt (213 km/h)
Typical Range: 300 nm (556 km)
In Service with: (in different marks) US Navy, US Army, Brazil AF, Israeli AF

1398.302
LAMPS HELICOPTER

DESCRIPTION LAMPS (Light Airborne Multi-Purpose System) is the designation of a US Navy programme calling for a ship-borne helicopter system to perform anti-submarine and missile defence functions with search and rescue, and a wide variety of other missions as secondary roles.

Three Marks of LAMPS have been nominated, as follows: Mk I is the current operational system which originated in 1970 with the Kaman Aerospace Corporation response to a $2-million contract for the conversion of a number of Kaman H-2 Seasprite helicopters for the new role. These aircraft were designated SH-2D and during 1972 twelve of these helicopters were deployed aboard USN Belknap Class guided missile frigates and escorts of the DE 1052 Knox class. A similar quantity followed in 1973. In the same year a further improved version, the SH-2F entered service and this version now represents the standard LAMPS Mk I configuration. Virtually all H-2 and SH-2D helicopters will be brought up to this standard and more than 50 have already been converted.

The Mk II was to have differed principally in the use of advanced electronics and sensor equipment, and two YSH-2E helicopters were assigned as test vehicles for this programme. Non-availability of the advanced equipment in production quantities led to the cancellation of the Mk II effort as a production programme and the data and experience acquired was transferred to the Mk III programme.

The Mk III programme is geared to a much slower pace and at the time of closing for press

Kaman SH-2D LAMPS helicopter

neither a systems integration contractor nor an airframe prime contractor had been selected. The Mk I LAMPS thus represents the definitive system for the foreseeable future.

A modified Canadian Marconi Company small boat radar is fitted in a 'chin' radome to provide ASV facilities, and this is based on the solid state LN 66 set. This is a 10 kW, X-band radar, designed for good sub-clutter visibility. 25 cm or 18 cm diameter displays are available. The ASQ-10 magnetic anomally detector used on the Orion P-3C maritime aircraft is fitted to the LAMPS helicopter in a cable-towed form and designated ASQ-81. Fifteen sonobuoys, SSQ-41 or SSQ-47 types, can be carried internally and an ARR-52 sonobuoy receiver is installed for the retrieval of data from them after they have been dropped.

Other avionics include the APN-182 doppler navigator, ASN-50 attitude and heading reference system, APN-171 radio altimeter, two ARC-159 UHF radios, and an AYK-2 navigation computer, AKT-22 data link set, ALR-54 countermeasures receiver, Tacan, IFF, and ADF

SUBMARINES

SUBMARINES CARRYING STRATEGIC MISSILES (6601.402)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
CHINA (PEOPLE'S REPUBLIC OF)					
G class: Ballistic missile type submarine	1964	1	2,350 surface 2,800 submerged	3 x *Sark* launching tubes (no evidence of missiles)	Torpedo tubes: 6 x 21 in (533 mm)
FRANCE					
Le Redoutable class: Nuclear powered ballistic missile submarines	1971–78	5	7,500 surface 9,000 submerged	16 x tubes for MSBS Type ICBMs	Torpedo tubes: 4 (18 torpedoes)
Gymnote: Experimental missile submarine	1966	1	3,000 surface 3,250 submerged	4 x tubes for MSBS Type ICBMs	
UNITED KINGDOM					
Renown, Repulse, Resolution, Revenge: Resolution class: Nuclear powered ballistic missile submarines	1967–69	4	7,500 surface 8,400 submerged	16 x tubes for *Polaris* A-3 IRBMs	Torpedo tubes: 6 x 21 in (533 mm)
UNITED STATES					
Lafayette class: Ballistic missile submarines	1963–67	31	7,320 standard surface 8,250 submerged	16 x tubes for *Polaris* A-3 except for those converting to *Poseidon* missiles	Torpedo tubes: 4 x 21 in (533 mm)
Ethan Allen class: Ballistic missile submarines	1961–63	5	6,900 standard surface 7,900 submerged	16 x tubes for *Polaris* A-2 (All 5 are being modified to fire the A-3 missile)	Torpedo tubes: 4 x 21 in (533 mm)
George Washington class: Ballistic missile submarines	1959–61	5	5,900 standard surface 6,700 submerged	16 x tubes for *Polaris*-A3	Torpedo tubes: 6 x 21 in (533 mm)
USSR					
Hotel II class: Nuclear powered ballistic missile submarines	1958–62	8	3,700 surface 4,100 submerged	3 x tubes for SS-N-5 missile system	Torpedo tubes: 6 x 21 in (533 mm); (bow) 4 x 16 in (aft), AS
Hotel III class	1962	1	3,700 surface 4,100 submerged	SS-N-8	Torpedo tubes: 6 x 21 in (533 mm) (bow) 4 x 16 in (stern)
Golf class: Ballistic missile submarines	1963–65	22	2,350 surface 2,800 submerged	3 x SS-N-4 (G-*1*) 3 x SS-N-5 (G-*11*)	Torpedo tubes: 10 x 21 in (533 mm)
Yankee class: Nuclear powered ballistic missile submarines	1968–72	33	8,000 surface 9,000 submerged	16 x tubes for SS-N-6 missile system	Torpedo tubes: 8 x 21 in (533 mm)
Delta and *Delta II* class: Nuclear powered ballistic missile submarines	1972+	6	8,000 surface 9,000 submerged	12 x tubes for SS-N-8 missile system (? 16 in *Delta II*)	Torpedo tubes: 8 x 21 in (533 mm)

SUBMARINES CARRYING TACTICAL SUB-SURFACE TO SUB-SURFACE MISSILES (6603.402)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
UNITED STATES					
SSN 688–710: Nuclear powered fleet submarines	1974–78	23	6,900 submerged	AS: *SUBROC*	AS: MK 48 AS torpedoes Torpedo tubes: 4 x 21 in (533 mm)
Glenard P. Lipscomb: Nuclear powered fleet submarine	1974	1	5,000 submerged	AS: *SUBROC*	AS: AS torpedoes Torpedo tubes: 4 x 21 in (533 mm)
Narwhal: Narwhal class: Nuclear powered fleet submarine	1969	1	4,450 standard 5,350 submerged	AS: *SUBROC*	AS: AS torpedoes Torpedo tubes: 4 x 21 in (533 mm)
Sturgeon class: Nuclear powered fleet submarines	1967–74	37	3,860 standard 4,630 submerged	AS: *SUBROC*	AS: AS torpedoes Torpedo tubes: 4 x 21 in (533 mm)
Permit class: Nuclear powered fleet submarines	1962–67	13	3,750 standard (except *Flasher, Greenling* and *Gato:* 3,800.) 4,300 submerged (except *Jack:* 4,500. submerged). *(Flasher, Greenling* and *Gato:* 4,600 submerged).	AS: *SUBROC*	AS: AS torpedoes Torpedo tubes: 4 x 21 in (533 mm)

SUBMARINES CARRYING TACTICAL SURFACE-TO-SURFACE MISSILES (6602.402)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Missiles	Other Weapons
USSR					
Charlie class: Nuclear powered cruise missile submarines		11	4,300 surface 5,100 submerged	8 x launching tubes for SS-N-7	Torpedo tubes: 8 x 21 in (533 mm)
Echo II class: Nuclear powered cruise missile submarines	1962–67	27	5,000 surface 5,600 submerged	8 x SS-N-3 launching tubes	Torpedo tubes: 6 x 21 in (533 mm) (bow); 4 x 16 in (aft), AS
Echo I class: Nuclear powered cruise missile submarine	1961–62	1	4,600 surface 5,000 submerged	6 x SS-N-3 launching tubes	Torpedo tubes: 6 x 21 in (533 mm) (bow); 4 x 16 in (aft), AS
Juliet class: Cruise missile submarines	1963	16	2,200 surface 2,500 submerged	4 x 22-N-3 launching tubes	Torpedo tubes: 6 x 21 in (533 mm) (bow); 2/4 x 16 in (aft), AS
Whisky class: Long bin Type: Twin cylinder Type: Cruise missile submarines	1959–63 (rebuild)	7 5	"long bin" type 1,300 surface 1,800 submerged	4 x SS-N-3 launching tubes (long bin type)	Torpedo tubes: 4 x 21 in (533 mm) (Long bin)
			"twin cylinder" type 1,100 surface 1,600 submerged	2 x cylinders for SS-N-3	6 x 21 in (533 mm) (twin cylinder)

SUBMARINES CARRYING TORPEDOES (6604.402)

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Torpedo tubes	Other Weapons
ALBANIA					
Ex-USSR *Whisky:* Submarines		4	1,030 surface 1,180 submerged	6 x 21 in (533 mm)	
ARGENTINA					
Ex-US *Guppy IA* and *II:* Submarines	1945	2	1,870 surface 2,430 submerged	10 x 21 in (533 mm)	
Type 209: Submarines	1974	2	980 surface 1,230 submerged	8 x 21 in (533 mm)	
AUSTRALIA					
Oxley class: Submarines	1969–75	4 + 2	1,975 surface 2,450 submerged	8 x 21 in (533 mm)	
BRAZIL					
2 Ex-US *Guppy III:* Submarines	1945–46	1	1,816 surface 2,400 submerged	10 x 21 in (533 mm)	
Ex-US Guppy II Type: Submarines	1945–49	3	1,870 surface 2,420 submerged	10 x 21 in (533 mm)	
Humaita, Tonelero, Riachuelo: British *Oberon* class: Submarines	1972–73	3	2,060 surface 2,420 submerged	8 x 21 in (533 mm)	
BULGARIA					
Pobeda, Slava: USSR Whisky Type: Submarines		2	1,050 surface 1,350 submerged	6 x 21 in (533 mm)	
CANADA					
Ojibwa, Okanagan, Onondago: British-built *Oberon* class: Submarines	1965–68	3	1,975 normal surface 2,420 submerged	8 x 21 in (533 mm)	
Rainbow: Ex-US *Tench:* Submarine	1945	1	1,800 surface 2,500 submerged	10 x 21 in (533 mm)	
CHILE					
Hyatt, O'Brien: British *Oberon* class: New construction submarines		2	2,030 surface 2,410 submerged	8 x 21 in (533 mm)	
Simpson: Ex-US *Balao:* Submarine	1944	1	1,816 surface 2,425 submerged	10 x 21 in (533 mm)	
CHINA (PEOPLE'S REPUBLIC)					
Ex-Soviet S-1 class: Submarine	1937–40	3	840 surface 1,050 submerged	6 x 21 in (533 mm)	
Ex-Soviet M-V class: Submarines		1	350 surface 420 submerged	2 x 21 in (533 mm)	Guns, AA: 1 x 45 mm 1 x MG

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Torpedo tubes	Other Weapons
Whisky class: Submarines	1956–64	21	1,030 surface 1,180 submerged	6 x 21 in (533 mm) (20 torpedoes or 40 mines)	
Romeo class: Submarines		24	1,100 surface 1,600 submerged	6 x 21 in (533 mm) (18 torpedoes)	
DENMARK					
Narhvalen, Nordkaperen: Narhvalen class: Submarines	1970	2	370 surface 450 submerged	8 x 21 in (533 mm)	
Delfinen, Spaekhuggeren, Springeren, Tumleren: Delfinen class: Submarines	1958–64	4	595 surface 643 submerged	4 x 21 in (533 mm)	
EGYPT					
Ex-USSR *Romeo* class: Submarines		6	1,100 surface 1,600 submerged	6 x 21 in (533 mm)	
Ex-USSR *Whisky* class: Submarines		6	1,030 surface 1,180 submerged	6 x 21 in (533 mm)	Guns: 4 x 25 mm AA
FRANCE					
Daphné class: Submarines	1964–70	9	869 surface 1,043 submerged	12 x 21.7 in (550 mm)	
Agosta class: Submarines		4	1,450 surface 1,725 submerged	4 x 21.7 in (550 mm) (14 torpedoes)	
Arethuse class: Submarines	1958–60	4	543 surface 669 submerged	4 x 21.7 in (550 mm)	
Narval class: Submarines	1957–60	6	1,640 surface 1,910 submerged	6 x 21.7 in (550 mm) (20 torpedoes)	
GERMANY (FEDERAL REPUBLIC)					
U 13–30: Type 206: Submarines		18	500 nominal 600 submerged	8 x torpedo tubes	
U 1–U 12, (no *U 3*): Type 205: Submarines	1961–68	11	370 surface 450 submerged	8 x torpedo tubes	
Wilhelm Bauer: Converted Type XXI: Submarine	1959 (rebuilt)	1	1,620 surface 1,820 submerged	4 x 21 in (533 mm)	
GREECE					
Ex-US *Guppy II A* class	1945	1	1,840 standard 2,445 dived	10 x 21 in	
Ex-US *Guppy III* class	1945	1	1,975 standard 2,450 dived	10 x 21 in	
Triaina: Ex-US *Balao:* Submarine	1944	1	1,816 surface 2,425 submerged	10 x 21 in (533 mm)	
Glavkos, Proteus, Nereus, Triton: Submarines	1972–73	4	990 surface 1,290 submerged	8 x 21 in (533 mm)	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Torpedo tubes	Other Weapons
INDIA					
Kalvari, Karanj, Kursura, Kanderi: +2 ex-Soviet *Foxtrot* class: Submarines		4 + 2	2,000 surface 2,300 submerged	10 x 21 in (533 mm) (20 torpedoes carried)	
INDONESIA					
Ex-USSR *Whisky* class: Submarines		10	1,030 surface 1,180 submerged	6 x 21 in (533 mm) (18 torpedoes carried)	Guns AA: 2 x 2.4 in (57 mm) 2 x 25 mm Mines: 40 in lieu of torpedoes
ISRAEL					
Leviathan, Dolphin: Ex-British T class: Submarines	1944–45	2	*Dolphin,* Surface 1,535 submerged, 1,740 *Leviathan,* surface 1,505 submerged, 1,700	6 x 21 in (533 mm)	
Vickers 500 ton Type:	1975 ?	3	420 surface 600 submerged	8 x 21 in (533 mm)	
Sauro class	1975 ?	2	1,300 surface 1,450 submerged	6 x 21 in (533 mm)	
ITALY					
Alfredo Cappellini, Evangelista Torricelli, Francesco Morosini: Ex-US *Balao* class: Submarines	1944–45	3	1,855 surface 2,455 submerged	10 x 21 in (533 mm)	
Bagnolini, Dandolo, Mocenigo, Toti: Toti class: Submarines	1968–69	4	524 surface 582 submerged	4 x 21 in (533 mm)	
Gianfranco Gazzana Priaroggia, Primo Longobardo: Ex-US *Guppy III* class: Submarines	1948–49	2	1,975 surface 2,450 submerged	10 x 21 in (533 mm)	
JAPAN					
Arashio, Asashio, Harushio, Michishio, Ooshio: Ooshio class: Submarines	1965–69	5	1,650 standard 1,600 (*Oshio* standard)	8 x 21 in (533 mm)	
Uzushio, Isoshio, Makishio, Narushio, Kuroshio, Takashio: New construction: Submarines		4 + 4	1,850 (standard)	6 x 21 in (533 mm)	
Fuyushio, Hayashio, Natsushio, Wakashio: Hayashio class: Submarines	1962–63	4	750 (standard) SS 521 SS 522 780 (standard) SS 523 SS 524	3 x 21 in (533 mm)	
Oyashio: Submarine	1960	1	1,130 surface 1,420 submerged	4 x 21 in (533 mm) (10 torpedoes)	
KOREA (NORTH)					
Ex-USSR *Whisky* class: Submarines		4	1,300 surface 1,600 submerged	6 x 21 in 18 torpedoes carried normally (or up to 40 mines)	
NETHERLANDS					
Potvis, Tonijn, Dolfijn, Zeehond: Potvis class, *Dolfijn* class: Submarines	1960–65	2 2	1,494 surface 1,826 submerged	8 x 21 in (533 mm)	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Torpedo tubes	Other Weapons
Tigerhaai, Zwaardvis: Submarines	1972	2	2,350 surface 2,640 submerged	6 x 21 in (533 mm)	
NORWAY					
Kobben class: Submarines	1964–67	15	350 standard 472 submerged	8 x 21 in (533 mm)	
PAKISTAN					
Hangor, Mangro, Shushuk: Hangor class: Submarines	1970	3	869 surface 1,043 submerged	12 x 21 in (533 mm)	
PERU					
Abtao, Angamos, Dos De Mayo, Iquique: Abtao class: Submarines	1954–57	4	825 standard 1,400 submerged	6 x 21 in (533 mm)	Guns: Surface, 1 x 5 in (127 mm) *(Abtao* and *Dos De Mayo)*
Type 209	1974–75	2	990 surface 1,290 submerged	8 x 21 in (533 mm)	
POLAND					
Bielik, Kondor, Orzel, Sokol: Ex-USSR *Whisky* class: Submarines		4	1,030 surface 1,160 submerged	6 x 21 in (533 mm)	Mines: 40 or Torpedoes: 18
PORTUGAL					
Albacora, Barracuda, Cachalote, Delfim: Albacora class: Submarines	1967–69	4	869 surface 1,043 submerged	12 x 21.7 in (550 mm)	
SOUTH AFRICA					
French *Daphne* class: Submarines	1970–71	3	850 surface 1,040 submerged	12 x 21.7 in (550 mm)	
SPAIN					
Daphne class: Submarines	1973–74	4	850 surface 1,040 submerged	12 x 21.7 in (550 mm)	
Almirante Garcia De Los Reyes: Ex-US Balao Type: Submarine	1944	1	1,880 surface 2,060 submerged	10 x 21 in (533 mm)	
Ex-US Balao Guppy IIA Type: Submarines		3	1,840 surface 2,445 submerged	10 x 21 in (533 mm)	
SA 51, SA 52: Tiburon class: Submarines	1958	2	78 surface 81 submerged	2 x 21 in (533 mm)	
SWEDEN					
Sjoormen class: Submarines	1967–69	5	1,100 standard 1,400 submerged	6 x 21 in (533 mm)	
A14 class: New construction: Submarines	1977–78	5	980 surface 1,125 submerged	21 in (533 mm)	
Draken class: Submarines	1961–62	6	835 surface 1,110 submerged	4 x 21 in (533 mm)	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Torpedo tubes	Other Weapons
Abborren class: Submarines	1960–64 (reconstruction)	5	430 surface 460 submerged	4 x 21 in (533 mm)	
Hajen class: Submarines	1957–60	6	785 surface 1,000 submerged	4 x 21 in (533 mm) (8 torpedoes)	Guns: 1 x 20 mm AA
TURKEY					
Type 209: Submarines	1974–75	2	990 surface 1,290 submerged	8 x 21 in (533 mm)	
Guppy III class: Submarines	1945	2	1,975 surface 2,540 submerged	10 x 21 in (533 mm) (24 torpedoes)	
Guppy IIA, Guppy IA class	1944–45	7 + 1	1,840 surface 2,445 submerged	10 x 21 in (533 mm)	
Ex-*Balao* class:	1944–45		1,829 surface 2,424 submerged	10 x 21 in (533 mm)	
UNITED KINGDOM					
Valiant class, *Swiftsure* class, *Churchill* class: Nuclear powered fleet submarines	1966 +	10 (2 + 3 + 5)	3,500 standard 4,500 submerged	6 x 21 in (533 mm) for homing torpedoes 5 x 21 in (533 mm) in *Swiftsure*	
Dreadnought: Nuclear powered submarine	1963	1	3,500 surface 4,000 submerged	6 x 21 in (533 mm)	
Oberon class: Patrol submarines	1960–67	13	2,030 surface 2,410 submerged	8 x 21 in (533 mm) for homing torpedoes	
Porpoise class: Patrol submarines	1958–61	8	2,030 surface 2,405 submerged	8 x 21 in (533 mm) (30 x torpedoes carried)	
Aeneas: A class: Patrol submarines	1946–48	1	1,385 surface 1,620 submerged	6 x 21 in (533 mm) (16 x torpedoes carried)	
UNITED STATES					
Tullibee: Nuclear powered attack submarine	1960	1	2,317 standard 2,640 submerged	4 x 21 in (533 mm)	AS: AS torpedoes
Skipjack class: Nuclear powered attack submarines	1959–61	5	3,075 standard 3,500 submerged	6 x 21 in (533 mm)	AS: AS torpedoes
Halibut: Nuclear powered attack submarine	1960	1	3,850 standard 5,000 submerged	6 x 21 in (533 mm)	
Triton: Nuclear powered attack submarine	1959	1	5,940 standard 7,780 submerged	6 x 21 in (533 mm)	
Skate, Swordfish, Sargo, Seadragon: *Skate* class: Nuclear powered attack submarines	1957–59	4	2,570 standard 2,861 submerged	8 x 21 in (533 mm)	

Category (JWS) Name/Class/Type	Years Completed	No. in Class	Displacement (Full Load) tons	Type and No. of Torpedo tubes	Other Weapons
Nautilus: Nuclear powered attack submarine	1954	1	3,530 standard 4,040 submerged	6 x 21 in (533 mm)	
Barbel, Blueback, Bonefish: Barbel class: Attack submarines	1959	3	2,145 surface 2,895 submerged	6 x 21 in (533 mm)	
Darter: Attack submarine	1956	1	1,720 surface 2,388 submerged	8 x 21 in (533 mm)	
Growler: Attack submarine	1958	1	2,540 standard 3,515 submerged	6 x 21 in (533 mm)	
Sailfish, Salmon: Sailfish class: Attack submarines	1956	2	2,625 surface 3,168 submerged	6 x 21 in (533 mm)	
Tang class: Attack submarines	1951–52	4	2,100 surface 2,700 submerged	8 x 21 in (533 mm)	
Guppy III Type: Attack submarines	1944–49	2	1,975 standard 2,450 submerged	10 x 21 in (533 mm)	
Guppy II Type: Attack submarines	1945–51	1	1,870 standard 2,420 submerged	10 x 21 in (533 mm)	
Guppy IIA Type: Attack submarines	1943–45	3	1,840 standard 2,445 submerged	10 x 21 in (533 mm)	
Guppy IA Type: Attack submarines (in reserve)	1944	1	1,870 standard 2,440 submerged	10 x 21 in (533 mm)	
USSR					
November class: Nuclear-powered fleet submarines	1958–65	14	3,500 surface 4,000 submerged	6 x 21 in (533 mm) (bow); 4 x 16 in (aft), AS	
Bravo class: Patrol submarines		4	2,500 surface 2,800 submerged	6 x 21 in (533 mm)	
Foxtrot class: Anti-submarine Type: Submarines	1958–67	56	2,000 surface 2,300 submerged	10 x 21 in (533 mm) (20 torpedoes carried)	
Zulu class: Large ocean going Type: Fleet submarines	1951–57	20	1,900 surface 2,200 submerged	10 x 21 in (533 mm) (24 torpedoes or 40 mines carried)	
Romeo class: Medium range patrol Type: Submarines	1958–61	14	1,100 surface 1,600 submerged	6 x 21 in (533 mm)	
Quebec class: Short range Type: Fleet submarines	1954–58	22	650 surface 740 submerged	4 x 21 in (533 mm)	
Victor class: Anti-submarine Type: Submarines	1969	14	3,600 surface 4,200 submerged	8 x 21 in (533 mm)	

Category (JWS) Name/Class/Type	Years Completed	No. in Class tons	Displacement (Full Load)	Type and No. of Torpedo tubes	Other Weapons
Whisky class, CB Type: Submarines		3	1,100 surface 1,200 submerged	6 x 21 in (533 mm)	
Whisky class: Patrol Type: Submarines	1950–57	110	1,030 surface 1,160 submerged	6 x 21 in (533 mm) (18 torpedoes carried or 40 mines)	
VENEZUELA					
Carite, Tiberon: Ex-Grenadier: Ex-US *Guppy II* class: Submarines	1943	3	1,816 surface 2,425 submerged	10 x 21 in (533 mm)	
Type 209	1974–75	2	920 surface 1,290 submerged	8 x 21 in tubes	
YUGOSLAVIA					
Sutjeska, Neretva: Submarines	1960	2	820 surface 945 submerged	6 x 21 in (533 mm)	
Heroj, Junak, Uskok: Submarines	1968+	3	905 surface 1,068 submerged	6 x 21 in (533 mm)	

SECTION THREE – EQUIPMENT

ORDNANCE

ELECTRONIC AND OPTICAL EQUIPMENT

ARMY ORDNANCE

INTRODUCTION

This section of the book is devoted to descriptions of those heavier weapons with which the land forces are equipped, and which have not already been described in Section One under the various weapon system headings.

There is such a wide variety of these weapons and so many overlapping uses to which they can be put that the selection of entries for this section presents many problems. A further complication is that most of the heavier guns are highly durable pieces of equipment, and many of them continue in service – often in countries other than those in which they were manufactured – for many years after the cessation of manufacture. To present anything like a reasonable picture of the range of weapons in service, therefore, it is necessary to go far beyond the list of weapons regarded as current by those who are developing and making such weapons. Moreover, it is not always easy to be sure whether or not a particular weapon should still be regarded as current; and sufficient detail to warrant an entry is more easily obtained from some sources than it is from others. It is important for the reader to understand, therefore, that the list of weapons in this section is not exhaustive on the one hand, and that on the other hand, some of the weapons included in it may no longer be in service anywhere.

Subject to these reservations, the following notes indicate the scope of the section.

1. *Classes of weapons (not necessarily mutually exclusive)*
   Field Guns
   Howitzers
   Tank Guns
   Anti-tank guns
   Anti-aircraft guns
   Recoilless weapons
   Cannon
   Unguided artillery rockets (in separate sub-section)
   Mortars (in separate sub-section)
   Man-portable anti tank weapons (in separate sub-section)
2. *Sizes of weapons*
   Generally only weapons of calibre 20 mm and above are included. An exception is made in favour of including some smaller weapons when used in multiple mountings.
3. *Other criteria and methods of arrangement*
   To be included a weapon must be (a) believed to be in service with active or reserve formations of at least one country – not necessarily its country of origin – or (b) in development and expected to enter service at some future date; or (c) in current development or production and on offer for sale to suitable customers; or (d) no longer in service but convenient as a reference for its derivatives.

A weapon satisfying these criteria and in service – even if only in reserve – in its country of origin is listed under that country.

A weapon no longer in service in its country of origin but satisfying the criteria for two or more other countries is entered under its country of origin.

A weapon which is in service in only one country but satisfying the criteria is entered under that country even though it may not be the country of origin. The same treatment is given to a weapon which is put to a special use in only one country.

A weapon or weapon variant being *developed* in only one country but not yet in service is listed under that country.

A weapon *developed* by more than one country as a collaborative venture is entered under the "International" heading. Weapons manufactured under licence or copied in a country other than the country of origin are generally entered under both country headings.

ALBANIA

2012.103
ALBANIAN ORDNANCE

Albania has no indigenous armaments industry of any consequence, and thus relies on imported weapons for the equipment of her armed forces. Within the confines of a small national budget, even though defence expenditure takes a larger share of the GNP than it does in most countries, there is little money available for weapon imports.

Much of the equipment and almost all the heavy weapons of the Albanian Army therefore date from before Albania's withdrawal from the Warsaw Pact group of countries. Little has been received from the Chinese People's Republic, with which Albania is now aligned; and, so far as is known, all artillery and related weapons are of Russian origin.

Most of these weapons are of Second World War or very early post-war date, because they are no longer in service with active formations in their country of origin, some brief details are given in the following entries. Weapons in service with the Albanian forces and described elsewhere in this book are listed below.

152 mm gun-howitzer M-37 (**2886.103**)
152 mm field howitzer M-43 (**2885.103**)
122 mm howitzer M-38 (**5520.103**)
85 mm AA gun M-44 (**5580.103**)
76 mm anti-tank gun M-42 (**5516.103**)
57 mm AA gun M-50 (**5514.103**)
37 mm AA gun M-38/39 (**2887.103**)
14.5 mm (quad-mounted) AA MG (**5582.103**)
160 mm mortar M-43 (**5568.103**)
120 mm mortar M-43 (**5567.103**)
82 mm mortar M-37 (**5566.103**)

2014.103
76 mm SP ANTI-TANK GUN SU-76

DESCRIPTION:

This self-propelled anti-tank gun equips the infantry brigades of the Albanian Army. Designed in Russia at the end of the Second World War, it is believed to be no longer in service in that country. It comprises a high-velocity 76.2 mm gun mounted on a lengthened T70 light tank chassis.

CHARACTERISTICS:
Gun:
Calibre: 76.2 mm
Barrel length: 42 calibres
MV: 662 m/sec (ATk)
Vehicle:
Crew: 4
Weight: 11.2 t
Engines: 2 × 85 bhp Otto
Road speed/range: 45 km/h/230 km
Length: 5.1 m
Width: 2.73 m
Height: 2.3 m
Ground pressure: 0.6 kg/cm²

STATUS:
In service.

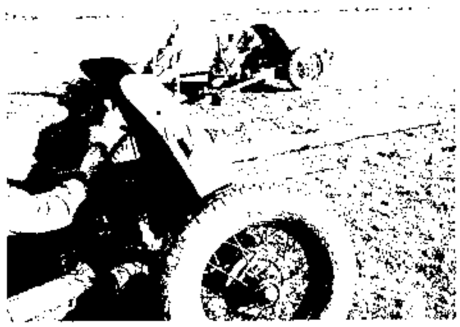
2013.103
45 mm ANTI-TANK GUN M-37

DESCRIPTION:

Deployed in active formations of the Albanian defence forces, this is a Second World War weapon of the Russian Army which is no longer used in its country of origin.

CHARACTERISTICS:
Calibre: 45 mm
Barrel length: 46 calibres
Elevation: −8° to +25°
Traverse: 60°
Weight in firing order: 510 kg
Shell weight: 1.43 kg
MV: 760 m/sec
Range: 8,900 m
Rate of fire: 30 rounds/min
Penetration: 60 mm at 500 m and 90°

STATUS:
In service, but presumably obsolescent.



M-37 45 mm anti-tank Gun

AUSTRIA

2015.103
AUSTRIAN ORDNANCE

Austria's central European location and slow disengagement from the post-war occupying powers are among the reasons why the Austrian Army is equipped with weapons obtained from Czechoslovakia as well as from NATO and neutral countries. The Czechoslovakian link is also an historical one: much of the artillery of the Austro-Hungarian Empire was made at the Skoda works.

Most current Austrian weapons appropriate to this section are described elsewhere in this book. They are:

Czechoslovakia
85 mm anti tank gun M 52 (**5588.103**)
130 mm Praga multiple RL (**2024.103**)
Sweden
40 mm L/70 AA gun (**5528.103**)
Switzerland
35 mm AA cannon system M-65 (**2374.131**)
20 mm AA cannon M-58 (**5587.103**)
UK (made under licence in Austria)
81 mm mortar L16A1 (**5563.103**)

USA
155 mm field gun M-2 (**5506.103**)
155 mm field howitzer M-1 (**5510.103**)
105 mm field howitzer M-2 (**5511.103**)
105 mm SP howitzer M-109 (**5570.103**)
Twin 40 mm L/60 SP AA gun M-42 (**5526.103**)
106 mm recoilless rifle M40A1 (**5584.103** but see also **2023.103** below)
107 mm mortar M-30 (**5565.103**)
81 mm mortar M-1/M-29 (**5564.103**)
USSR (made in Austria)
120 mm mortar M-43 (Austrian designation M 60) (**5567.103**)

2022.103
102 mm FIELD HOWITZER 18/40
DESCRIPTION:
Now relegated to reserve formations only this is a Second World War weapon of German origin. It is a hybrid construction comprising the Rheinmetall/Krupp gun from the earlier M18M field howitzer mounted on the carriage of the Rheinmetall 75 mm M40 anti-tank gun.
CHARACTERISTICS:
Calibre: 104.9 mm
Barrel length: 28 calibres
Elevation: $-5°$ to $+45°$
Traverse: 60°
Weight in firing order: 1,800 kg
Shell weight: 14.8 kg
MV: 540 m/sec
Maximum range: 12,325 m
STATUS:
Used in Austrian and German Armies during the Second World War. Now found only in Austrian Army reserve units.
MANUFACTURER:
Rheinmetall GmbH, 4 Düsseldorf 1, Germany

2023.103
106 mm RECOILLESS RIFLE M40A1 (TOWED)
DESCRIPTION:
The M40A1 recoilless rifle is in service with the Austrian Army in two forms. One of these is as a vehicle mounted weapon – as it is in its US Army applications (**5584.103**), the other is as a towed weapon on an Austrian-designed two-wheeled carriage. This carriage is notable for having two stable firing positions, the barrel being 0.26 m higher in one position than it is in the other.
CHARACTERISTICS
Rifle:
Calibre: 106 mm
Barrel length: 3.4 m
Elevation: $-17°$ to $+65°$
Traverse: 360°
Weight in firing order: 113.9 kg (rifle only)
Weight of shell: 7.71 kg
MV: 503 m/sec
Maximum range: 6,900 m
Rate of fire: 5 rounds/min
Carriage:
Weight: 170 kg
Breadth: 1.41 m
Height: 0.93 m or 0.67 m
STATUS:
In service with the Austrian Army

BELGIUM

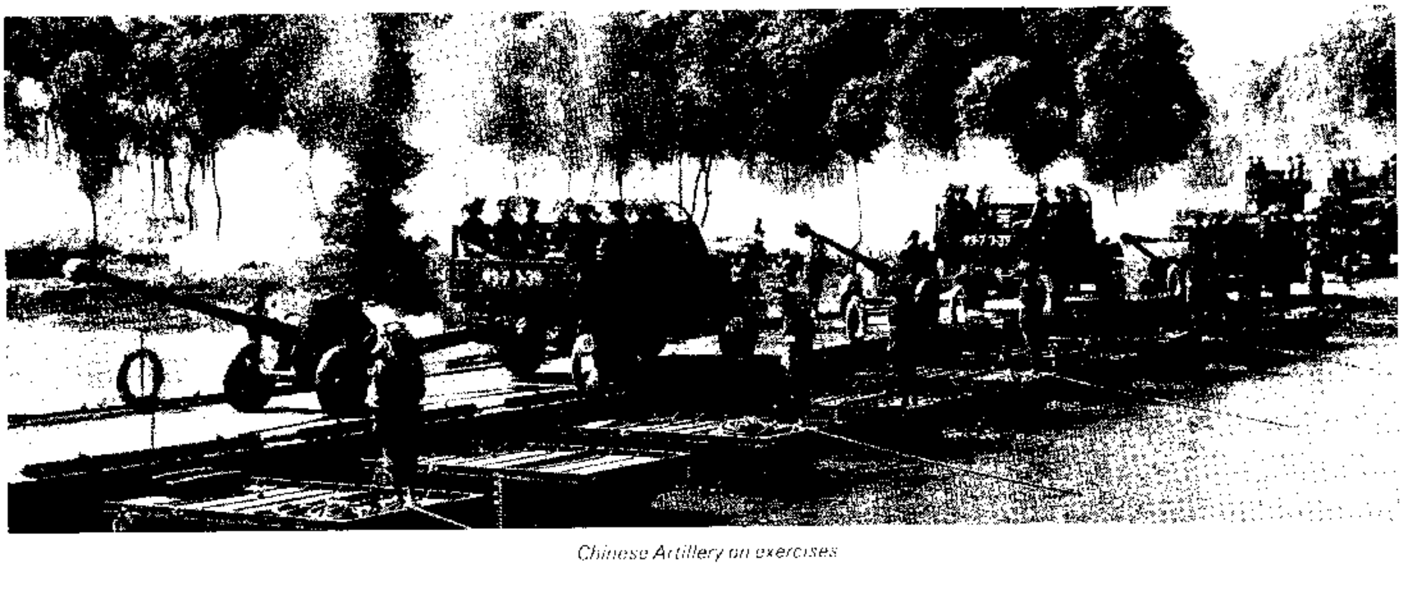
2491.103
90 mm MECAR LIGHT GUN
DESCRIPTION
The Mecar 90 mm light gun system is designed primarily for anti-tank defence and has been developed over a number of years. It can fire various types of ammunition including HEAT, canister, fragmentation and smoke; in addition there is a training round. It is of light construction and can be fitted to a variety of vehicles (e.g. the Commando armoured car **5066.102**), on its own wheels, or in a fixed position. If required a muzzle brake can be fitted. Characteristics of two versions are given below.

CHARACTERISTICS:	CAN-90L	CAN-90H
Overall length:	3.13 m	3.25 m
Overall height:	.35 m	.40 m
Overall width:	.29 m	.45 m
Barrel length:	.29 m	.29 m
Weight:	285 kg	416 kg
Calibre:	90 mm	90 mm
Length of gas chamber:	368 mm	368 mm
Chamber volume:	2,560 cc	2,560 cc
Maximum gas pressure:	1,200 kg/cm²	1,200 kg/cm²
Working pressure:	700/800 kg/cm²	700/800 kg/cm²
Minimum recoil:	400 mm	400 mm
Recoil speed:	10.2 m/sec	7.8 m/sec

AMMUNITION:
Tracer Projectile 90 mm (HEAT-CAN-90): Length 635 mm, projectile weight 2.28 kg, complete round weight 3.54 kg, fuse – impact point-detonating, maximum operational range 1,000 m, maximum range at 12° elevation 3,500 m, armour penetration 350 mm, concrete penetration 1.2 m, launch velocity 633 m/sec, arming distance 18 m.
Tracer Projectile 90 mm (Fragmentation): Length 528 mm, weight of complete round 5.21 kg, projectile weight 4.10 kg, fuse – point-detonating, max range when launched at 20° 4,200 m, maximum effective radius 50 m, launch velocity 338 m/sec, arming distance 40 m.
Tracer Projectile 90 mm (Smoke): Length 528 mm, projectile weight 4.10 kg, max range when launched at 20° 4,200 m, width of smoke screen 40 m, launch velocity 338 m/sec. Arming distance 40 m. **Canister Projectile**: Length 373 mm, weight complete 5.95 kg, operational range 300 m, contains 1,120 spheres weighing 3.6 gm.
MANUFACTURER:
Mecar SA, 6522 Petit-Roeulx-lez-Nivelles, Belgium.

CHINA (PEOPLE'S REPUBLIC)

5529.103
CHINESE ORDNANCE
DESCRIPTION:
Most Chinese Army ordnance is of Russian design. Some was supplied by the USSR before the two countries became estranged, but substantial quantities of various Russian-designed weapons have been manufactured in China. Among the entries below are all those weapons which are known to be, or to have been, manufactured in this way, but there may well be others.
Also in service with the Chinese forces are some



Chinese Artillery on exercises

ex-Japanese guns of World War II vintage. One which is known to be in service and to have been made in China is entered below – but again there may be others.

Finally there are two recoilless rifles in service with the Chinese Army which are based on an American design.

The Chinese have no long history or experience of gunnery, except what they have learned from the Russians, and it may be expected that their tactical use and methods of fire control will be very similar to those of the Soviet Army.

2168.103
130 mm FIELD GUN

DESCRIPTION:

It has been reported that the Russian M-1946 130 mm field gun (**5554.103**) is being built in China. The Russian design of this weapon was based on the 130 mm naval gun and two slightly different versions are in service with the Red Army and elsewhere. Available details of the Russian weapons are given in the entries for that country; no differences between the Russian and Chinese versions are known.

STATUS:

Uncertain. It has been reported that some Chinese-built weapons have been supplied to Pakistan.

2169.103
76 mm LIGHT FIELD GUN TYPE 54

DESCRIPTION:

The Type 54 76 mm light field gun is the Chinese version of the Russian M.1942 (ZIS-3) weapon (**5516.103**). In the USSR this weapon is probably obsolescent although it is still widely deployed in other countries. No differences between the Russian and Chinese version are known; and available details will be found among the entries for the USSR.

STATUS:

In service with Chinese forces. Supplied by China to several countries including Cambodia, Tanzania and North Vietnam.

5531.103
Ex-JAPANESE 75 mm MOUNTAIN GUN TYPE 94

DESCRIPTION:

This gun continues in service as it is the only true mountain gun possessed by the Chinese. It breaks into eight pack loads for transport and is meant to be carried by mules. It has a much better performance than the 70 mm howitzer, and is in pack gun.

CHARACTERISTICS:

Overall weight: 544 kg
Barrel length: 20.8 calibres
Maximum range: 8,320 m
Elevation: $+45°$ to $-10°$
Traverse: 40° (on carriage)
Ammunition: Semi-fixed QF. Complete round weighs 7.2 kg
Shell: HE, Shrapnel, APHE, HE/AT, Smoke WP
MV: 385 m/s
Penetration: APHE 58 mm/1,000 m/0°
HE/AT, 85 mm/0°

STATUS:

In service. The gun has been seen in North Vietnam.

2170.103
75 mm RECOILLESS RIFLES TYPES 52 & 56

DESCRIPTION:

Two 75 mm recoilless rifles are known to be in service with the Chinese forces. Both are based on the American M-20 weapon of the same calibre (**2561.103**), details of which will be found among the entries for the USA.

It is understood that the Chinese Type 52 weapon is a modified version of the M-20, and that the Type 56 incorporates additional modifications, but no details of these changes are known.

STATUS:

In service. Some are reported to have been supplied to North Vietnam.

2171.103
57 mm ANTI-TANK GUN TYPE 55

DESCRIPTION:

The Type 55 57 mm anti-tank gun is a Chinese copy of the Russian M.1943 (ZIS-2) gun (**5515.103**). Although still widely deployed in Warsaw Pact countries, the weapon should probably be regarded as obsolescent so far as USSR forces are concerned. No differences between the Russian and Chinese versions are known: available data will be found among the entries for the USSR.

STATUS:

In service.

2172.103
37 mm LIGHT ANTI-AIRCRAFT GUN TYPE 55

DESCRIPTION:

The Type 55 37 mm LAA gun is a copy of the Russian M.1939 weapon (**2887.103**) made in China. Now allocated only to reserve formations in the USSR the gun is still in service with active formations elsewhere. All available details will be found among the USSR entries.

STATUS:

In service with Chinese forces. Some have been supplied to Cambodia, Laos, North Vietnam, Pakistan and Tanzania.

CZECHOSLOVAKIA

2306.103
152 mm HOWITZER M-18/46

DESCRIPTION:

The Czech M-18/46 152 mm howitzer is a modification of the German 150 mm M-18 medium howitzer of which a large number remained in Czechoslovakia at the end of the Second World War. The modifications carried out involved reboring the guns, to accept the Russian 152 mm howitzer round, and fitting a double-baffle muzzle brake and a new shield.

CHARACTERISTICS:

Calibre: 152 mm
Barrel Length: 4.875 m
Elevation: 0° to $+45°$
Traverse: 60° (total)
Firing Weight: 5,512 kg
Shell Weights: HE 39.9 kg, Semi-AP 51.1 kg
MV: HE 508 m/s, Semi-AP 432 m/s
Maximum Range: 12.4 km (HE)
Armour Penetration: 82 mm at 1 km (Semi-AP)
Crew: 7

STATUS:

Reserve forces only.

MANUFACTURER:

Modified by Skoda Works, Pilsen.

2307.103
105 mm HOWITZER M-18/49

DESCRIPTION:

One of several variants of the Rheinmetall/Krupp 105 mm light field howitzer designed in the 1920s (see entry **2190.103** for variants still in service in Norway and Yugoslavia) the Czech M-18/49 is a modification of the M-18/40 (which itself was the M-18 mounted on the German PAK.40 carriage), the modification involving replacing the spoked wheels and solid tyres of the carriage by more modern solid wheels with rubber tyres.

CHARACTERISTICS:

Calibre: 105 mm
Barrel Length: 3,308 mm (including muzzle brake)
Elevation: $-5°$ to $+42°$
Traverse: 60° (total)
Firing Weight: 1,750 kg
Shell Weight: (HE) 14.8 kg
MV: 540 m/s
Maximum Range: 12.32 km
Rate of Fire: 6-8 rounds/min
Crew: 8

STATUS:

Reserve forces only.

2308.103
100 mm FIELD ANTI-TANK GUN M-1955

DESCRIPTION:

The Czech 100 mm Field Anti-Tank Gun M-1955 is also known as the 100 mm Field Gun M-53 and is the equivalent of the Russian 100 mm field gun (**5518.103**) – firing the same ammunition and having similar performance.

CHARACTERISTICS:

Calibre: 100 mm
Barrel Length: 6,431 mm (including muzzle brake)
Elevation: $-5°$ to $+40°$
Traverse: 60° (total)
Firing Weight: 3,400 kg
Shell Weight: APHE 15.9 kg; HE 15.7 kg; HEAT not known
MV: APHE 1,000 m/s; HE 900 m/s; HEAT 800 m/s
Maximum Range: 21 km (HE)
Rate of Fire: 8 rounds/min

Armour Penetration: 185 mm at 1,000 m (APHE)
Crew: 8

STATUS:
Service.

MANUFACTURER:
Skoda Works, Pilsen.

2309.103
85 mm FIELD GUN M-52
DESCRIPTION:
Similar in appearance and performance to the Russian D-44 gun (**5517.103**) and firing the same ammunition, the Czech 85 mm M-52 weapon was designed and manufactured entirely in Czechoslovakia.
CHARACTERISTICS:
Calibre: 85 mm
Barrel Length: 5,070 mm (including muzzle brake)
Elevation: $-6°$ to $+38°$
Traverse: 60° (total)
Firing Weight: 2,095 kg
Shell Weight: HE 9.5 kg; APHE 9.3 kg; HVAP 5.0 kg
MV: HE 805 m/s; APHE 820 m/s; HVAP 1,070 m/s
Maximum Range: 16.16 km (HE)
Rate of Fire: 20 rounds/min
Armour Penetration: 123 mm at 1,000 m
Crew: 7

STATUS:
In service in Czechoslovakia and East Germany.
MANUFACTURER:
Škoda Works, Pilsen.

2310.103
82 mm RECOILLESS ANTI-TANK RIFLES
DESCRIPTION:
Two 82 mm recoilless rifles are in service with Czech forces, one being a much more powerful weapon than the other. The lighter one, the T-21, fires a 3-5 kg projectile with a muzzle velocity of 250 m/sec and has an effective range of only 450 m. Characteristics of the larger M-59 weapon (which has a minor variant known as the M-59A) are given below: it should be noted that this weapon (but not the T-21) is fitted with a 12.7 mm spotting rifle.
CHARACTERISTICS (M-59/59A):
Calibre: 82 mm
Elevation: $-13°$ to $+25°$
Traverse: 360° at 0° elevation; 60° at 25° elevation
Firing Weight: 366 kg
Shell Weight: 6 kg (HE or HEAT projectile)
MV: HE 565 m/s; HEAT 745 m/s
Maximum Range: 7.6 km
Rate of Fire: 6 rounds/min
Armour Penetration: 250 mm (HEAT)
Crew: 5

M-59A Recoilless anti-tank rifle

STATUS:
In service in Czechoslovakia and Egypt.

MANUFACTURER:
Skoda Works, Pilsen.

2311.103
57 mm ANTI-AIRCRAFT GUN
DESCRIPTION:
A 57 mm anti-aircraft gun was developed in Czechoslovakia and put into production. The Russian S-60 57 mm weapon (**5514.103**) was, however, preferred to it because it was lighter and had a higher muzzle velocity. As a result only a small quantity of the Czechoslovakian weapon was produced, most of which appear to have been exported – either directly or indirectly.

STATUS:
Believed not to be used in Warsaw Pact forces. Supplied to Cuba, Guinea and Mali.

2312.103
QUAD-MOUNTED 12.7 mm AA MACHINE GUN M-53
DESCRIPTION:
No longer in service with Warsaw Pact forces but still in use elsewhere, the M-53 quad-mounting comprises four Russian-designed M1938/46 DSLK 12.7 mm heavy machine-guns on a mounting designed and built in Czechoslovakia but generally similar to that used, for example, for 14.5 mm machine-guns in the Russian ZPU-4 weapon (**5582.103**).
CHARACTERISTICS:
Calibre: 4 × 12.7 mm
Barrel length: 1,069 mm
Elevation: $-7°$ to $+90°$
Traverse: 360°
Firing Weight: 628 kg
Projectile Weight: 49.5 kg
MV: 840 m/s
Maximum Range: 6,500 m horizontal; 5,500 m vertical
Rate of Fire: (per barrel) 550-600 rounds/min cyclic; 80 rounds/min practical
Armour Penetration: 20 mm at 500 m (API round)
Crew: 6
STATUS:
No longer in Warsaw Pact service, but known to be used in Cuba and believed to have been supplied to North Vietnam.

2029.103
TWIN 30 mm ANTI-AIRCRAFT CANNON M-53/59
DESCRIPTION:
Two versions of this twin AA mounting are in service in Czechoslovakia. The M-53 is an open mounting on a light four-wheel trailer; the other, M-59, is a partially-enclosed mounting (giving some protection to the gunner's body) installed on an armoured version of the Praga 6 × 6 V3S truck.
CHARACTERISTICS (M-53):
Calibre: 2 × 30 mm
Barrel Length: 2,429 mm
Elevation: $-10°$ to 90°
Traverse: 360°
Firing Weight: 2,000 kg
Shell Weight: HE or API projectile 0.45 kg; Complete round 0.9 kg
MV: 1,000 m/s
Maximum Range: 10,000 m horizontal; 7,000 m vertical but effective only 2,000 m
Rate of Fire: 450-500 rounds/min (cyclic); 100 rounds/min
Armour Penetration: 60 mm at 500 m
Crew: 4
STATUS:
Both versions are in service with divisional anti-aircraft regiments of the Czechoslovakian Army. The SP version is also used by the anti-aircraft companies of the armoured regiments.

FINLAND

2037.103
122 mm FIELD GUN M-60
DESCRIPTION:
This is a powerful weapon of Finnish design. It is mounted on a four-wheel carriage, the wheels of which are driven by an hydraulic motor.
CHARACTERISTICS:
Calibre: 122 mm
Barrel length: Apparently about 50 calibres
Elevation: $-5°$ to $+50°$
Traverse: 90° or 360° with supplementary equipment.
Weight in firing order: 9,500 kg
Weight of shell: 25 kg
MV: 950 m/sec
Range: 25 km
Trail: split

STATUS:
In service in the Finnish Army. Principal employment of this weapon is in the artillery battalion of the armoured brigade.
MANUFACTURER:
Tampella Ab, Finland.

2039.103
105 mm LIGHT FIELD HOWITZERS M-61/37 AND M-37/10
DESCRIPTION:
These are two hybrid howitzers in service with the Finnish Army. The M-61/37 has been constructed by mounting a new 105 mm Tampella gun on the carriage of the earlier 105 mm Tampella LFH. A similar hybrid was constructed at the same time by mounting the gun of the Tampella LFH on the carriage of the Russian 122 mm LFH M-10 to make the LFH M-37/10.
The 122 mm LFH M-10/50 together with several others of similar age, is now used only in a static role in forts or coast defences. Details of the more modern hybrid howitzer are given below.
CHARACTERISTICS:
Calibre: 105 mm
Elevation: 6° to 45°
Traverse: 53°
Weight in firing order: 1,800 kg
Weight of shell: 14.9 kg
MV: 600 m/sec
Range: 13.4 km
Rate of fire: 7 rounds/min
Trail: split
STATUS:
In service as brigade artillery in Finnish infantry brigades.
MANUFACTURERS
Tampella Ab, Finland.

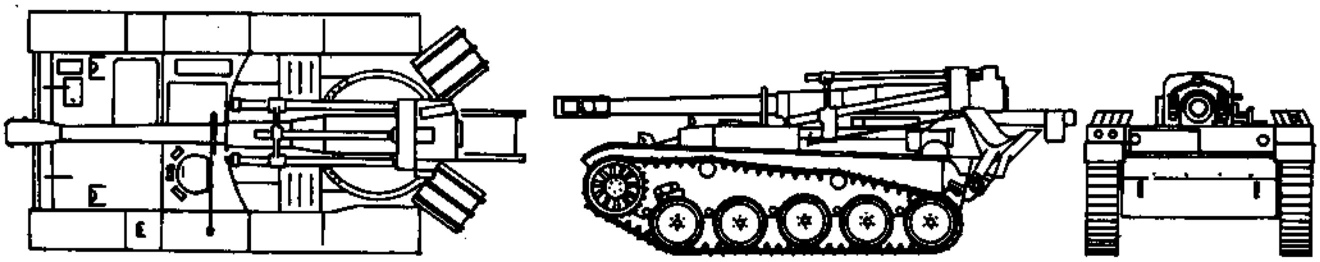
2041.103
95 mm RECOILLESS ANTI-TANK GUN M-58
DESCRIPTION:
This is the only heavy recoilless weapon known to be in service in the Finnish Army. It is mounted on a two-wheel trailer for towing and the wheels remain in position for firing. Reported characteristics make it appear superior in performance to the American 106 mm weapon (**5584.103**) and not far short of that of the British 120 mm Wombat (**2476.103**).
CHARACTERISTICS:
Calibre: 95 mm
Barrel length: 3.2 m
Weight in firing order: 140 kg
Weight of shell: 10.1 kg
MV: 615 m/sec
Anti-tank range: 1,000 m
Penetration: 300 mm
Rate of fire: 6-8 rounds/min
STATUS:
In service in heavy weapon companies of infantry battalions.

2571.103
ROCKET-ASSISTED PROJECTILES
It has been reported that rocket-assisted projectile developments are in hand in Finland.
So far as is known, these projectiles have not been put into service in Finland: but it is believed that some have been supplied to other countries.
No details are known.

FRANCE

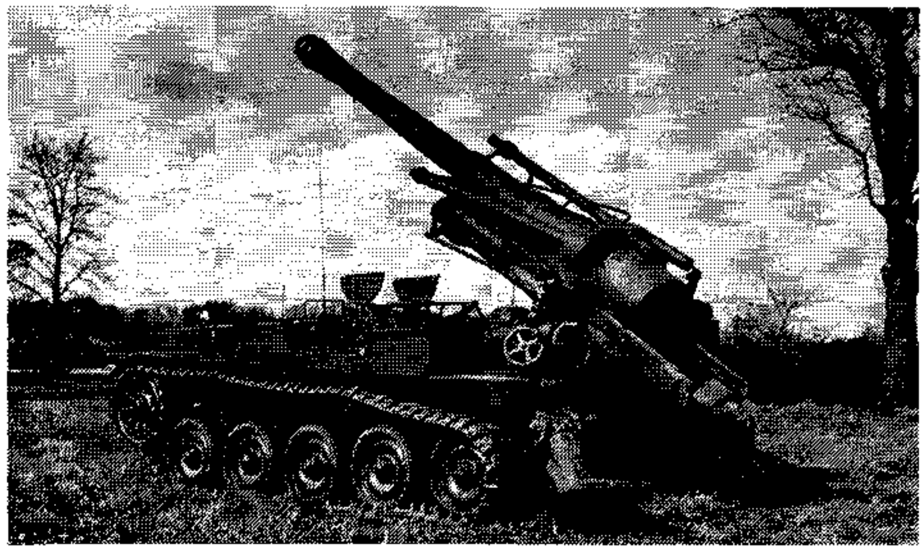
5536.103
155 mm SP HOWITZER Mk F3
DESCRIPTION:
This howitzer provides the general fire support for the mechanised divisions of the French Army, and uses one more variant of the AMX 13 tank chassis. The gun is of French design and manufacture, but will accept both US and French ammunition. The driver and one gunner ride with the gun, the remainder of the 8 man crew being transported in a second vehicle, lorry or APC/AMX 13.
Ammunition is carried in the second vehicle which also transports the crew.

CHARACTERISTICS:
Overall length: 6.22 m
Width: 2.75 m
Height: 2.20 m
All-up weight: 17,000 kg
Barrel length: 33 calibres
Maximum range: 20 km
Elevation: 0° to +67°
Horsepower: 270
Speeds: max 60 km/h (average 40 km/h)
Ammunition: BL about 10 charges
Shell: HE, smoke, illuminating, hollow base shell. Average weight 43 kg
MV: 647 m/s
Rate of fire: max 4 rounds/min (average 1 round/min)
Crew: 8



155 mm SP

STATUS:
In service in French Army. Supplied also to Argentina, Venezuela and two other countries.
MANUFACTURER:
Creusot-Loire, (Groupes Marine Schneider), 15, rue Pasquier, 75383-Paris, France.



155 mm SP Howitzer Mk F.3

5541.103
AMX 13 VCA TRACKED ACCOMPANYING VEHICLE FOR THE 155 mm SP GUN

DESCRIPTION:
The tracked accompanying vehicle (VCA) is part of the team for the 155 mm Mk F3 SP gun. It is an AMX 13 chassis with the APC superstructure and carries the gun team or ammunition. It also tows the ARE trailer with extra ammunition. It carries a 12.7 mm machine gun in a cupola.
CHARACTERISTICS:
Overall length: 5.80 m
Width: 2.80 m
Height: 2.40 m
Overall weight (laden): 15,700 kg. 8 men and 25-155 mm rounds

2 Tons ARE Ammunition Trailer
This small vehicle is towed behind the accompanying vehicle of the 155-mm SP Gun. It is a two-wheeled trailer without suspension and with a hand-brake on each wheel.
CHARACTERISTICS:
Trailer weight (laden): 2,200 kg
length: 3.85 m
width: 2.18 m
height: 1.48 m
wheel base: 1.87 m
Vehicle plus trailer:
overall length: 9.55 m
max road speed: 60 km/h
cross country: 15-20 km/h
STATUS:
In service with the French Army.
MANUFACTURER:
Creusot-Loire (Groupes Marine Schneider) 15, rue Pasquier 75383-Paris, France.

5574.103
155 GCT SP GUN

DESCRIPTION:
The 155 mm self-propelled gun mounted on an AMX 30 chassis is designed to give indirect fire support to units of the battle corps. The main operational requirements forming the basis of the specification for equipment were:

- mobility similar to that of a battle tank,
- quick reaction time to engage targets in all directions, at short or long range in conditions of very mobile warfare,
- instantaneous high fire power, in range as well as in rate of fire with up-to-date ammunition,
- protection of crew and ammunition in unsafe area or NBC environment.

The resulting weapon system is a self-propelled gun with a weight and a mobility similar to those of the AMX 30 battle tank. Its main armament is a 155 mm/40 calibre gun, with a range of approximately 24 km with 155 mm hollow base shells. Gun loading is automatic and allows for a high rate of fire.
The gun's fire control system establishes firing parameters quickly and with a very low risk of error. The hydraulically controlled turret permits full weapon traverse and elevation from −5° to +66°.
Secondary armament is a 7.62 mm MG.
Four men make up the crew, their functions being:

- 1 gun commander: responsible for outside communications and co-ordination of the crew work,
- 1 gunner: in charge of fire control and turret traverse and elevation
- 1 loader: prepares charges and selects types of shells
- 1 driver: not in action during firing sequences.

The gun commander and the gunner can exchange their functions in the turret and the driver can replace the loader. Also the gun can fight with only a 2 men crew, without noticeable decrease of its capability.
Ammunition reloading of the 155 GCT/AMX 30 takes 2 or 3 men.

155 GCT

CHARACTERISTICS:
Weights and dimensions:
- **total weight in running order:** 37 t
- **total weight in combat order:** 41 t
  of which ammunition represents: 2.5 t
- **overall length, gun forward:** 10.4 m
- **gun to the rear:** 9.5 m
- **overall width:** 3.1 m
- **height to turret roof:** 3.0 m
- **overall height (without machine-gun):** 3.17 m
- **ground clearance:** 0.43 m

Mobility:
- **maximum road speed:** 60 km/h
- **cross country mobility:** identical to that of AMX 30 tank
- **fording:** 2.20 m
- **range of action on road at 40 km/h average speed:** 450 km

Main Gun Performance:
The gun is a 155 mm/40 calibre weapon with a vertical wedge breech block, hydraulically operated but with provision for emergency manual operation. The gun is equipped with a gas exhaust device.
Muzzle velocity: 155 mm M1e ammunition 760 m/sec; 155 mm hollow base shell
Range: M/e ammunition 21,300 m; hollow base ammunition 23,500 m
Loading: Automatic, hydraulically operated
Rate of fire: Up to 8 rounds/min automatic. Emergency manual rate 1-2 rounds/min
Recoil: 950 mm
Train: +360°: 0.01° to 10°/sec
Elevation: −5° to +66°: 0.01° to 5°/sec
Shell weight: 43.2 kg, for hollow base shell, of which 8.355 kg is RDX – tolite explosive. Other types of 155 mm shell can be fired.
Ammunition in the turret is 42 shells and 42 slow bags arranged in 7 racks of 6 shells and 7

racks of 6 bags. In addition, 40 quick charges 1 are housed in a fixed container in the turret basket.

Re-supplying involves loading shells and bags into the cells which are visible when the rear door is opened. Firing can go on during re-supplying operations.

The time required for re-supplying the gun completely is one half-hour with 3 men or 20 minutes with 4 men.

STATUS:

Pre-production and trials. Series production of the 155 GCT/AMX 30 is planned for 1976.

In association with Krauss-Maffei AG, Munich, GIAT have also developed the 155 GCT/LEOPARD – comprising a specially-adapted Leopard tank chassis and the 155 GCT gun and turret assembly. See entry **2572.103.**

MANUFACTURER:

Groupement Industriel des Armements Terrestres (GIAT) 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.

5542.103

105-mm TANK GUN CN-105-F1

DESCRIPTION:

This gun is the main armament of the AMX-30 tank (**5018.102**). It is a conventional high performance AFV gun. A semi-combustible cartridge case is under development.

CHARACTERISTICS:

Barrel length: 56 calibres with no muzzle brake.
Recoil length: 480 mm
Recoil stress: 20/25 tons
Ammunition: QF fixed
Shell: HEAT, HE, Smoke (weights 11-12 kg)
MV: 1,000 m/s
Accuracy: Better than 1.5 mil
Penetration: 360 mm/0°, 150 mm/65°

STATUS:

In service with the French Army. This gun is also being used as the basis of a modernisation of the American M47 (Patton) tank (**5046.102**) now under development in France.

MANUFACTURER:

Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.

2148.103

TANK TURRET TYPE F1-12

DESCRIPTION:

Generally similar to the earlier FL-10 turret (**2149.103** which, with its 75 mm gun has been supplied for use in AFVs in France and many other countries, the FL-12 turret mounts a 105 mm rifled gun (**2147.103**) and is suitable for tank installation either in new production or retrospectively.

Main features of the turret are stable and accurate positioning resulting from the use of a large diameter ball-bearing ring; hydraulic laying (360° in 12-13 seconds) controlled by commander or gunner; emergency hand laying; eight observation periscopes for commander and gunner; dual magnification sight for commander and X7-5 sight for the gunner. Most standard tank communication equipment can be fitted and there is provision for mounting smoke-pot launchers, searchlights or a laser rangefinder.

The main gun features semi-automatic loading with external case ejection (see **2149.103**). Rate of fire is about 12 rounds/min: there are 12 ready rounds and 5-7 other rounds stored in the turret. Secondary armament of a 7.5 mm or 7.62 mm MG can be mounted.

Turret crew is two men (commander and gunner) and weight without crew or ammunition 4,300 kg.

STATUS:

Production. Some hundreds of turrets have been produced and are in service in several countries.

MANUFACTURER:

Fives Lille-Cail, Départment Armement, 7, rue Montalivet, 75-Paris 8e, France.

2147.103

105 mm TANK GUN D1504

DESCRIPTION:

This gun is the main armament of the AMX-13 tank (**5020.102**) in the version fitted with the FL-12 turret (**2148.103**) but it can also be used in the same turret for retrospective fitting to other AFVs.

CHARACTERISTICS:

Barrel length: 44 calibres
Recoil length: 368 mm
Recoil force: 800 m/s
MV: HEAT shell: 800 m/s HEAP shell: 700 m/s
Penetration: HEAT shell: 360 mm/0°

STATUS:

In production and in service with the armies of several countries outside France.

MANUFACTURER:

Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.

2149.103

TANK TURRET TYPE FL-10

DESCRIPTION:

This turret was the standard fitment to the AMX-13 tank (**5020.102**) when this was armed with the 75 mm 61.5 calibre gun type 50. Although no longer in production, this variant of the AMX-13 with its FL-10 turret is still in service in many parts of the world.

The design of the FL-10 is essentially the same as that of the FL-12 (**2148.103**) which was derived from it by replacing the 75 mm gun by a 105 mm weapon and altering the ammunition storage arrangements. Both are 'oscillating' turrets – which means that the complete gun turret and basket assemblies remain in a fixed relationship to each other, being supported on two trunnions by a support structure which is attached to the turret ring. The whole oscillating structure can thus be elevated or depressed relative to the support structure, and the combined structures can be rotated in azimuth.

The fixed position of the gun makes it possible to incorporate a recoil-operated automatic loader while still retaining a reasonably low profile and with the gun mounted relatively high in the turret. The incorporation of the automatic loader, in turn, means that the turret crew need only comprise commander and gunner. The reloader is mounted in the turret bustle and contains two revolving cylinders, each containing six rounds of ammunition, mounted on either side of the recoil path of the breech. Spent cases are ejected through a hole in the back of the bustle. The loader arrangement makes it possible to achieve a high rate of fire for twelve rounds: the cylinders must then be replenished through hatches in the turret roof; one crew member must dismount to do this.

STATUS:

In service outside France. No longer in production.

MANUFACTURER:

Fives Lille-Cail, Départment Armement, 7, rue Montalivet, 75-Paris 8e, France.

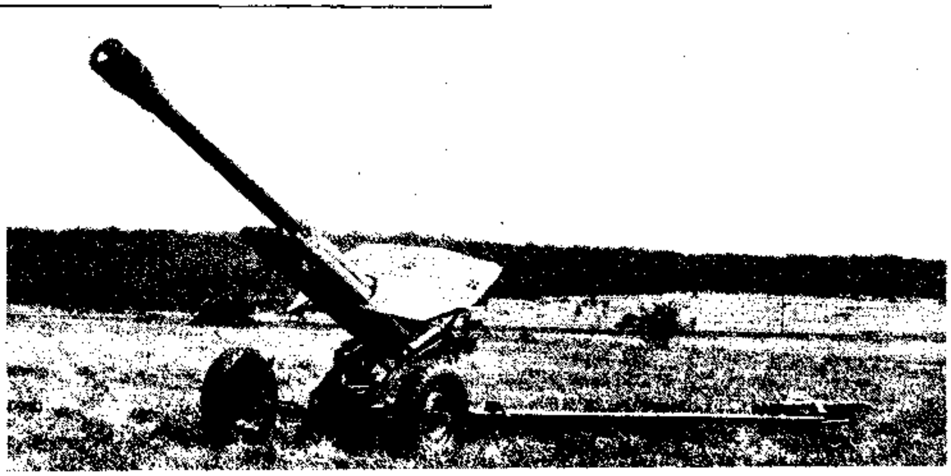
5552.103

105 mm LIGHT GUN

DESCRIPTION:

This gun is a rugged and light weapon for general-purpose use on the battlefield. Suitable for direct and indirect support and for use against tanks it can be air-dropped or transported by helicopter. French or American 105 mm ammunition can be used.

The gun can be towed either folded, for transport in L. of C. zone, or unfolded when travelling in an advanced combat zone. Opening the trails automatically positions the gun on the firing platform.



105 mm Light Gun

CHARACTERISTICS:

Total weight: 1,200 kg
Barrel length: 30 calibres
Vertical field: —5° to +70°
Traverse: 45°
Height of line of fire: 0.8 m
Length (folded): 5.12 m
Width (folded): 1.77 m
Height: (folded): 1.18 m
Max range: 15,000 m (French 105 mm Mk 63 hollow base shell). 11,000 m (American 105 mm HEM 1 shell)

STATUS:

Demonstration prototype.

MANUFACTURER:

Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.

2582.103
105 mm HOWITZER M-50

DESCRIPTION:

One of the older weapons still in service with the French Army and with the armies of some former French colonies, the M-50 howitzer was developed between 1946 and 1952 and went into service in 1955. Production ceased in 1960.

CHARACTERISTICS:
Calibre: 105 mm
Weight travelling: 2,922 kg
Length travelling: 6,004 mm
Width travelling: 1,981 mm
Height travelling: 1,706 mm
Elevation: $-5°$ to $+70°$
Traverse: 360°
MV: 580 m/sec
Range: 14,500 m
Rate of Fire: 6 rounds/min

STATUS:

In service in France, Cameroun, Guinea, Israel, Ivory Coast, Morocco

5538.103
105 mm SP HOWITZER AMX 105B

DESCRIPTION:

The B model of the 105 mm howitzer is a more modern version of the A model (**5537.103**). The obvious difference is in the turret, which not only provides all-round traverse but also lowers the silhouette. Less obvious is the improved gun with longer barrel.

CHARACTERISTICS:
Overall length: 5.20 m
Height: 2.7 m
Width: 2.5 m
Laden weight: 17,000 kg
Ammunition: 80 rounds
Range: 15,000 m

Characteristics are otherwise similar to those of the AMX 105A howitzer (**5537.103**) described below.

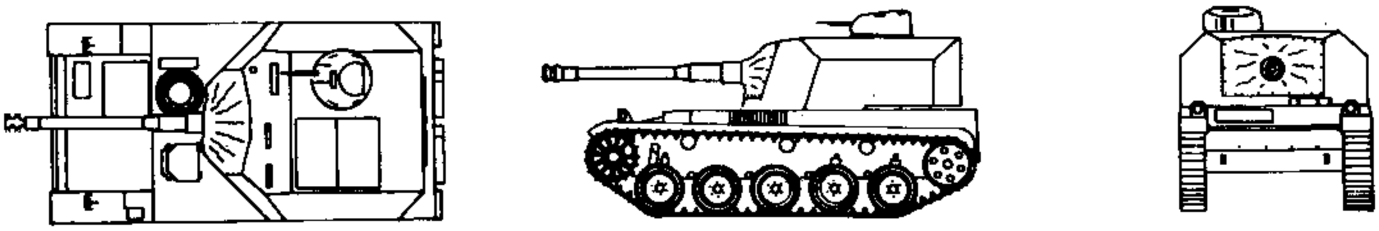
105 mm SP Howitzer AMX 105 A

STATUS:

So far this SP howitzer is not yet in service but a pre-production quantity has been made and some are believed to have been sold to Switzerland.

MANUFACTURER:

Creusot-Loire (Groupes Marine Schneider), 15, rue Pasquier, 75383-Paris, France.



105 mm SP AMX 105B

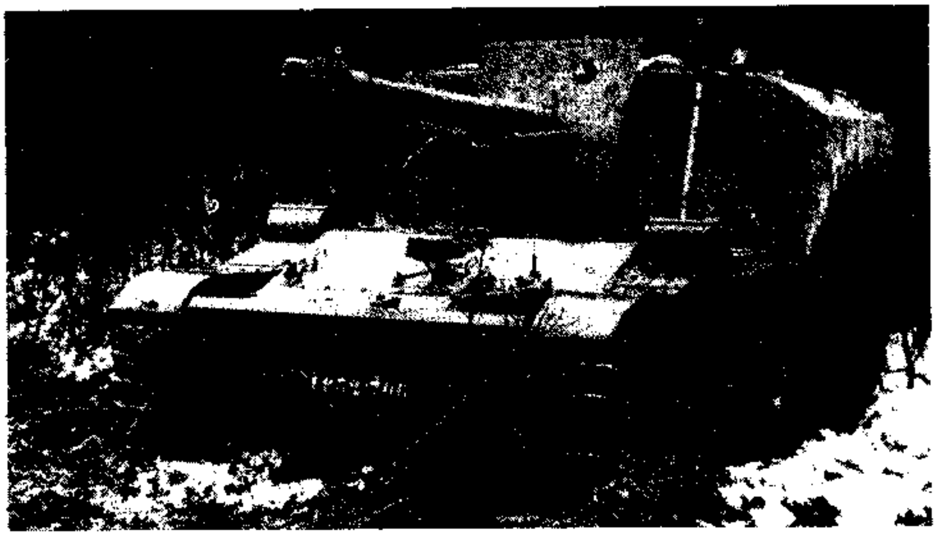
5537.103
105 mm SP Howitzer AMX 105 A

DESCRIPTION:

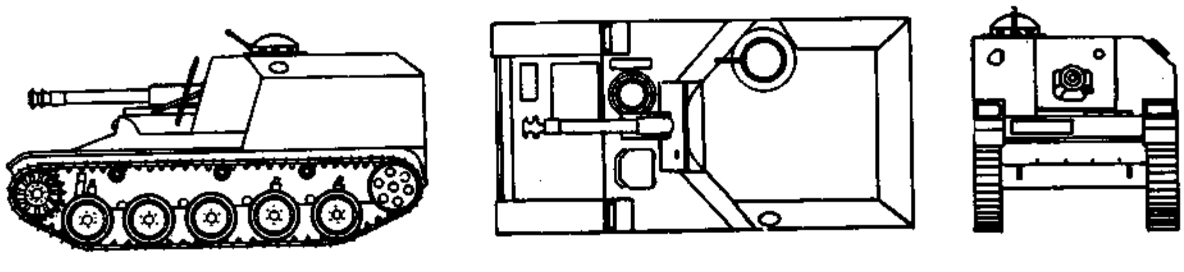
The SP 105 mm is the basic artillery weapon for close fire support in the French Army. There is now very little towed artillery in service, and the AMX 105 A is the equipment of most field regiments. This model is now fairly old having been in service since 1952. Its chief drawback is, of course, the fixed gun casemate which limits traverse. The amount of ammunition which can be carried is also fairly restricted, though better than some more modern designs. and it is destined to be steadily replaced by the model B.

The gun fires both US and French ammunition, and there are two lengths of barrel. The French Army uses a barrel 23 calibres long, but the Netherlands army has a 30 calibre length. It is not known what precise difference this makes to the performance of the gun.

CHARACTERISTICS
Overall length: 6.40 m
Height: 2.70 m
Width: 2.65 m
Overall weight: 16,500 kg
Barrel length: 30 or 23 calibres



105 mm SP Howitzer AMX 105A



Maximum range: 11,500 m with US M1 ammunition. 15,000 m with French Mk 63 ammunition
Elevation: −4°30′ to +70°
Traverse: 20°
Horsepower: 270
Speeds: Max 60 km/h (average 40 km/h)

Ammunition: US M1 or French Mk 63 105 mm 56 rounds carried in vehicle
Shell: Semi fixed cartridge HE, Smoke, Illuminating
MV: 230 m/s to 586 m/s (8 charges)
STATUS:
In service with the French Army.

COUNTRIES SUPPLIED:
Netherlands.

MANUFACTURERS:
Groupement Industriel des Armements Terrestres (GIAT) 10, Place Georges Clémenceau, 92211-Saint Cloud, France

5543.103
90-mm AFV GUN CN-90-FI

This gun is widely used in the small AFVs in the French army, particularly those in the weight range up to 10 tons. It is also installed in the modernised M 24 Chaffee tank, and in this mount great accuracy is claimed for it. Its most interesting feature is that it is unusual in firing fin-stabilised ammunition. This is necessary in order to retain the best penetration for the HEAT rounds.

A modernised version of the gun (F3) is fitted to the AMX-13 tank (**5020.102**), and fires at a higher MV.

CHARACTERISTICS:

Barrel length	**F1:**	33 calibres less muzzle brake
	F3:	51 calibres
Recoil length	**F1:**	580 mm
	F2:	300 mm
	F3:	340 mm
Recoil stress	**F1:**	3.5 tons
	F2:	9 tons
	F3:	4.5 tons
MV	**F1:**	750 m/s
	F3:	950 m/s

Ammunition: OF fixed HEAT HE, Smoke. All fin stabilised
Shell weights: HEAT 3.65 kg, HE 5.27 kg, Smoke 5.40 kg
Penetration: 320 mm/0°, 120 mm/65°
Accuracy: Better than 2 m.

STATUS:
Operational in French Army. F1 gun is operational in 6 other armies. F3 in one other army.

MANUFACTURER:
Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau 92211-Saint-Cloud, France.

5539.103
SP TWIN 30 mm AA GUNS (AMX D.C.A. 30)

This SP AA vehicle is fairly typical of the type which appears in many of the NATO armies for defence against low flying aircraft. The 30 mm guns are the Hispano-Suiza type 831 L which are also mounted on ships for the same purpose: the turret is the SAMM S401A.

This vehicle carries its own fire control radar ("Oeil Noir") mounted on the back of the turret on a retractable mounting. The vehicle is therefore a completely self-contained fire unit, although it would obviously be connected to an early warning system operated from some distance away. The radar "locks-on" to a target, and the guns follow it, the necessary lead angles being calculated by the on-board computer. There are optical sights for emergency use.

The design was developed in 1960, and the first production model appeared in 1964. Mounted on a lightweight version of the AMX chassis it has been in service with the French Army since 1965.

An improved version has now been developed using the AMX 30 chassis thus giving the weapon system wider operational scope and greater mobility. In particular the AMX-30 mounting has the advantages of a larger supply of ammunition and – thanks to the AMX-30 power supply arrangements – the ability to function when the vehicle is at rest without running the main engine or making special power supply arrangements.

CHARACTERISTICS:

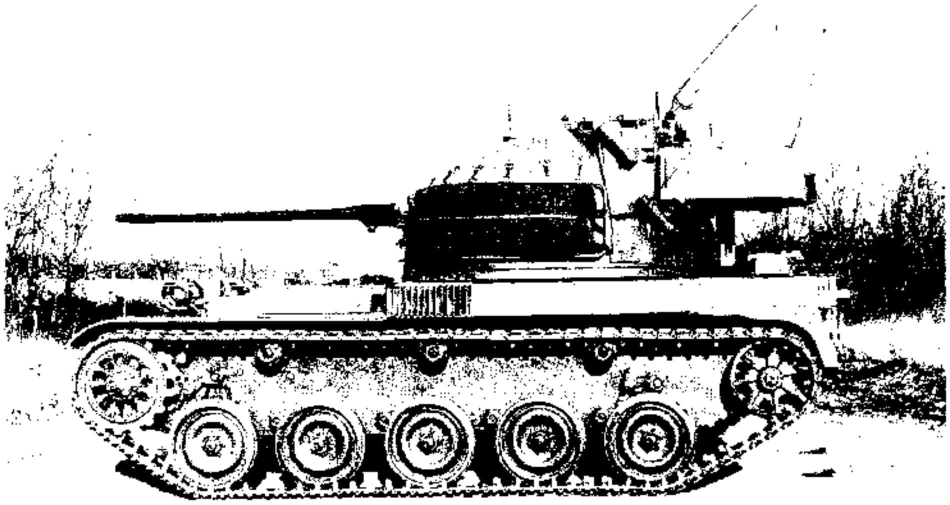
	AMX 13 Version	AMX 30 Version
Overall length:	5.40 m	6.80 m
Width:	2.50 m	3.10 m
Height:	3.00 m	3.00 m
Horsepower:	270	680
Speed-max:	60 km/h	65 km/h
Ammunition:	HS 831 L	HS 831 L

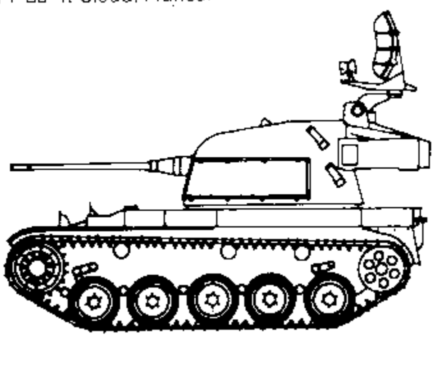
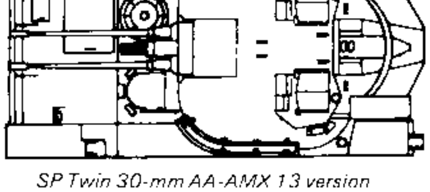
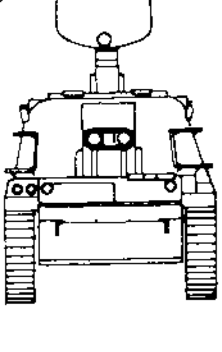
See the entry for Rarden cannon for full details of HS 831 L rounds (**5504.103**)

STATUS:
In service.

MANUFACTURER:
Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.


SP Twin 30-mm AA – AMX-13 version with radar


SP Twin 30 mm AA on AMX 30 chassis




SP Twin 30-mm AA-AMX 13 version

5544.103
SAMM 8.530 AA TURRET

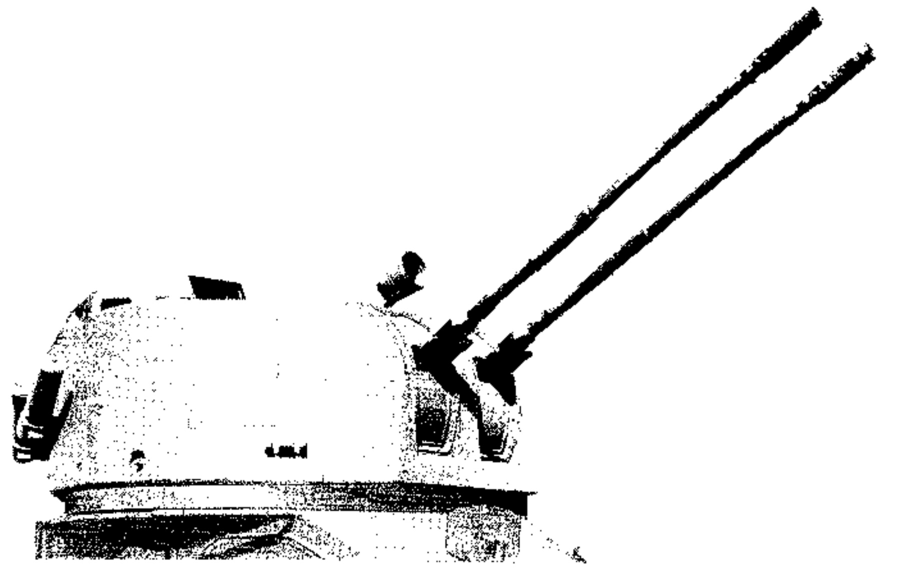
The SAMM S.530 turret is a light, simple equipment intended to be fitted to any small AFV to provide a special purpose gun mounting. It carries two 20 mm guns and the primary role of these is attacking low flying aircraft. A secondary role is for ground targets, particularly those encountered in guerrilla warfare.

The turret and turret basket carry most of the mechanical, hydraulic and electrical equipments for laying and firing the guns. The main ammunition stowage is also in the basket. The elevating mass of the guns carries the ammunition feed.

Sighting is optical, and there are two systems: the first is the AA sight which is carried in an armoured cupola on top of the turret roof. The second is an APX episcope used for ground targets.

The crew consists of a commander and gunner. The commander acquires the targets through his episcopes, controls the gunner, and operates the radio. The gunner lays and fires the guns in both roles.

In the photograph the turret is mounted on an AML Panhard chassis (**5021.102**) but can be adapted to any other chassis of similar type or used as an AA turret in a static installation.



SAMM S.530 Turret

CHARACTERISTICS
Total weight of turret (including crew): 1.720 kg
Armour: 7 mm
Elevation: $-10°$ to $+70°$
Elevation speed: 40°/s
Traverse: 360°
Traversing speed: 80°/s
Guns: AME 621 20 mm (**5589.103**)
Ammunition: The standard for each type of gun
Ammunition stowage: 300 rounds for each gun in the turret basket

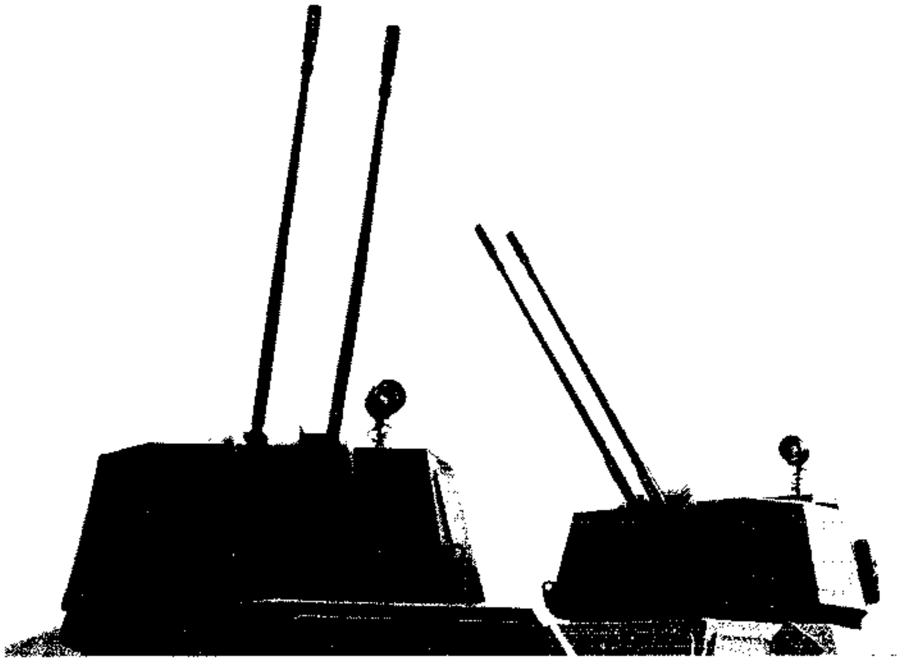
STATUS
Series production.
MANUFACTURER:
Société D'Applications des Machines Motrices (SAMM), 224, Quai de Stalingrad, 92130-Issy Les Moulineaux.

2150.103
20 mm AA TURRET TG 522 F1

DESCRIPTION:
This is a twin-gun anti-aircraft turret suitable for mounting on light or medium armoured vehicles. The gun can also be brought to bear on surface targets.

The turret is of the rotating casemate type and is operated by two men. It is equipped with a hydraulic "speed" aiming control system, optical gunsights and shell feed systems which together permit smooth tracking and continuous engagement of moving targets. Provision is made for the installation of radio and any one of a variety of fire control systems.

CHARACTERISTICS:
Weight: 1.800 kg in firing order
Armament: Two 20 mm guns CN-MIT-20F1 (**5599.103**)
Rate of fire: 700 rounds/min per gun
MV: 1 040 m/sec (HE)
Effective range: 1.300 m (HE)
Ammunition capacity: HE: 240 rounds per gun. AP: (Optional) 40 rounds per gun
Training limits: 360°
Elevation limits: $-8°$ to $+75°$
Training speed: Min 80°/sec
Max 0.8°/sec
Observation devices: Episcope/sight-tube and episcopes



TG 522 FI AA turrets

FIRE CONTROL OPTIONS:
1. AA firing: sight/gunsight M348. Surface: episcope/sight-tube M250/1
2. AA and surface firing: episcope/sight-tube M411.
3. AA firing: CSEE sight correction unit Uranus. Emergency AA and surface firing: episcope/sight-tube M411.
4. AA firing: TV tracking and correction system. Emergency AA and surface firing: episcope/sight-tube M411

STATUS:
Prototype stage
MANUFACTURER:
Société D'Applications des Machines Motrices (SAMM), 224, Quai de Stalingrad, 92130-Issy Les Moulineaux.

5589.103
20 mm GUN M621

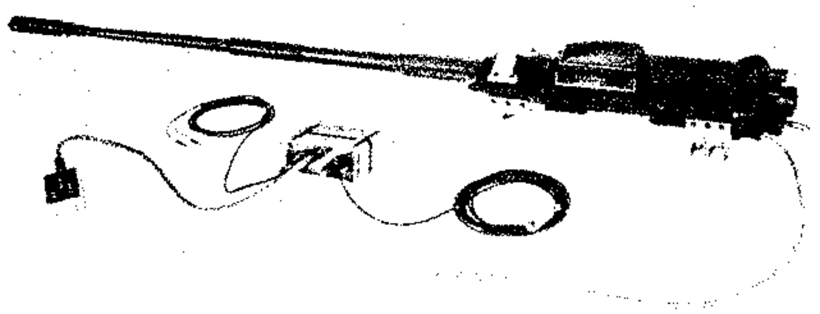
DESCRIPTION:
This is an electrically operated rapid fire gun designed for use with electrically-primed US and French ammunition. A variety of ammunition feed systems are available: and these, together with the light compact construction of the weapon and low recoil stresses make it suitable for installation in helicopters and light aircraft as well as in a variety of military vehicles. For airborne applications see entry **1275.303**.

Single shots or bursts can be fired and the rate of fire can be selected from the alternatives of 300 or 740 rounds per minute. An optional burst-limiting device is also available.

Three feed systems are available. The standard flat feed mechanism is of simple construction and takes up little room. Left hand or right hand versions are available, the links being ejected from the side opposite to the feed. A rather more elaborate mechanism using, for the most part, the same components as the flat feed mechanism, provides for the ejection of links on the same side as the feed. Finally there is a selective feed mechanism which accepts two ammunition feed belts and enables the gunner to choose from two different types of ammunition. The first two systems can be used with a built-in generator which supplies the power required to operate the weapon, thus making it independent of external power supplies.

CHARACTERISTICS:
Weight: (Gun plus cradle) 58 kg
Length: (Gun plus cradle) 2,207 mm
Width: (Gun plus cradle) 202 mm
Height: (Gun plus cradle) 245 mm

Rate of fire: 300 or 740 rounds/min
Muzzle velocity: 980 to 1,030 m/sec
MANUFACTURER:
Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.



M621 gun

2583.103
20 mm M621 CANNON FOR TRUCK MOUNTING
DESCRIPTION:
This weapon arrangement consists basically of the 20 mm M621 cannon (**5589.103**) associated with a new type of combined mounting and feed system which enables it to be mounted as an independent self-contained system on unarmoured vehicles or small naval craft.

In this arrangement the gun is fed from the left with ammunition which is drawn from a cylindrical ammunition container surrounding the vertical shaft which carries the trunnions on which the gun is mounted. The ammunition box thus pivots with the gun in azimuth and the feed does not interfere with the field of fire.

CHARACTERISTICS:
Generally as in Entry **5589.103**

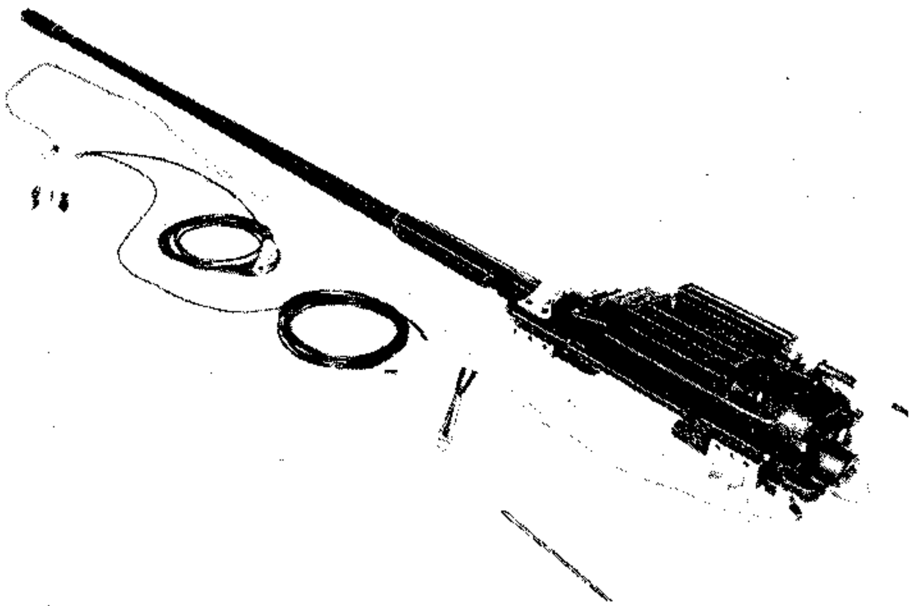
Elevation: —10° to +50°
Traverse: 360°
Rounds in magazine: 150
Total weight: 220 kg with 150 rounds

MANUFACTURERS:
The mounting was designed by Etablissements d'Etudes et de Fabrication de Bourges (EFBA) and is made by the Manufacture National d'Armes de Tulle (MAT) under the auspices of GIAT.

5599.103
20 mm GUN MODEL F2 (M693)
DESCRIPTION:
Derived from the M621 20 mm gun (**5589.103**) the M693 is an electrically operated weapon that is designed to fire all cartridges with the mechanical priming of the Hispano HS820 family – whereas the M621 is designed to fire electrically-primed ammunition.

A dual feed ammunition supply system is standard for the weapon, giving the gunner a choice of two types of ammunition. For example, the choice could be between the HS820 HE ammunition and the type 693 sub-calibre high-velocity AP ammunition. This choice, coupled with the range of HS ammunition available makes the weapon extremely versatile in this sense without impairing the versatility that it inherits from the M621.

CHARACTERISTICS:
Calibre: 20 mm
Muzzle velocity: HS820 ammunition about 1,030 m/sec. 693 sub-calibre ammunition about 1,300 m/sec.
Rate of fire: 740 rounds/min.
Type of fire: Single round; limited burst; continuous burst.
Power requirement: 24 V dc 6-7 A.
Dimensions: With cradle:
Length 2,695 mm
Height 266 mm
Width 205 mm
Cradle adds 30 mm to height.
Weight: Basic gun 70.5 kg. Cradle 10.5 kg. Control box 1.25 kg



M693 gun

STATUS:
Using so much of the technology and so many of the components of the M621 gun, the M693 was developed and put into production quickly.

The gun is installed on the T20-13 cupola of the AMX 13 VTT vehicle (**5010.102**) and on the TH 20 turret of the AMX 10P vehicle (**5009.102**). It is also being considered for installation on the T20-13 cupola of the AML/VTT vehicle (**5022.102**) for two types of anti-aircraft installation and for installation in helicopters.

MANUFACTURER:
Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.

GERMANY (FEDERAL REPUBLIC)

5575.103
GERMAN ARTILLERY—GENERAL
In addition to the weapons listed here, reference may be made to the following entries in other parts of this book.

Self-propelled Anti-tank Gun, Kanone JPZ 4-5 (**5019.102**). 90 mm gun in turretless mounting on essentially the same chassis as the Rakete GW launcher and the Marder APC. Rheinmetall high-velocity gun.

20 mm Twin-Gun Anti-Aircraft System (**2182.131**). One application of the Rheinmetall 20 mm gun

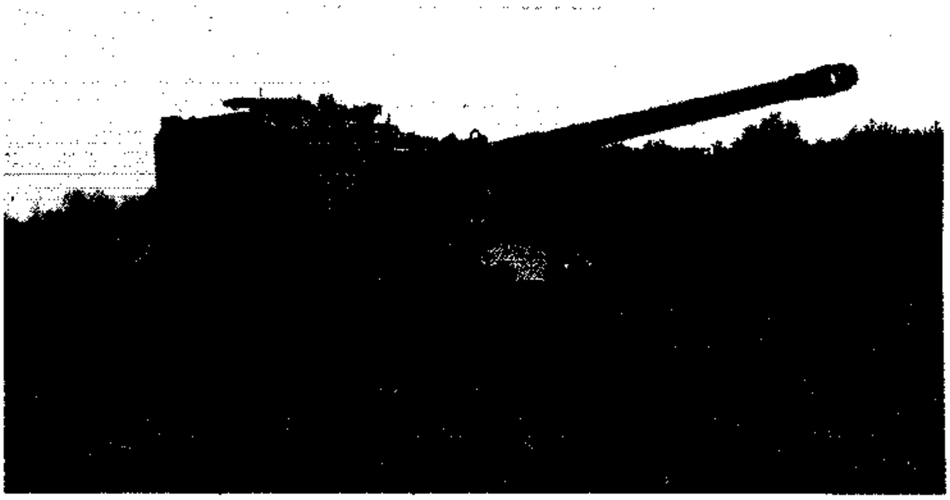
MANUFACTURER:
Rheinmetall GmbH, 4 Düsseldorf 1 Germany.

2572.103
155 mm GCT LEOPARD SP GUN
DESCRIPTION:
The 155 mm GCT Leopard is the German version of the SP weapon system, the French (and original) version of which is the 155 GCT mounted on the AMX-30 chassis (**5574.103**).

The German version is the result of a cooperative operation by GIAT – who have been responsible for the French weapon system – and Krauss-Maffei, designers and manufacturers of the Leopard tank.

In essence the weapon system consists of the turret of the French version mounted on a specially adapted Leopard tank chassis. Apart from the chassis difference there are believed to be no differences of consequence between the two weapon systems and the reader is invited to consult entry **5674.103**, earlier in this section, where he will find all available details of the weapon proper. The advantage of having a Leopard system, however, is that it will be a logistically more suitable weapon for the numerous armies which are already equipped with Leopard tanks.

MANUFACTURERS:
Gun and Turret: GIAT, 10 Place Georges Clémenceau, 92211 Saint-Cloud, France.
Leopard Chassis and System Integration: Krauss-Maffei AG, 8, München 50, Federal German Republic.



155 GCT Leopard SP Gun

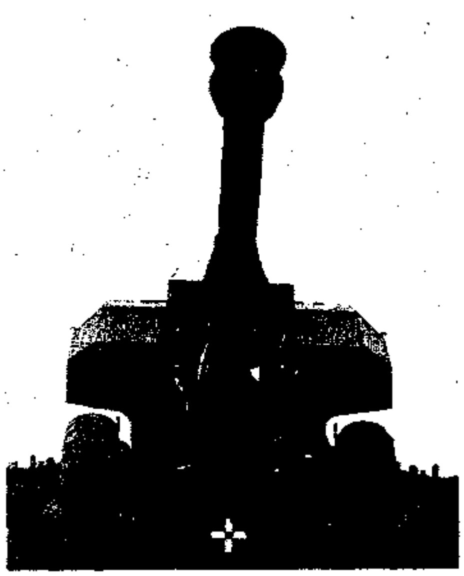
2192.103
155 mm SP HOWITZER M-109G
DESCRIPTION:
This weapon is a German modification of the American M-109 howitzer (**5508.103**). Significant modifications include a vertical sliding breech-block, semi-fixed ammunition and improved sights.
CHARACTERISTICS:
Calibre: 155 m
Barrel length: 23 calibres
Elevation: $-5°$ to $+75°$
Traverse: 360°
MV: 686 m/s
Weight of shell: (HE) 43.18 kg
Range: 18,100 m
Dimensions: Length 6.95 m; width 5.06 m; height 3.0 m
Total weight: 24.6 t
Engine: Otto 420 bhp (max)
Road speed: 56 km/h
Cruising range: 350 km
Crew: 6

STATUS:
In service in the Bundeswehr.

MANUFACTURER:
Rheinmetall GmbH, 4 Düsseldorf 1, Germany.

2179.103
155 mm FIELD HOWITZER FH155(L)
DESCRIPTION:
A modernisation programme on the American 155 mm and 105 mm field howitzers has been carried out by Rheinmetall. The updated version of the larger weapon, the FH155 (L) has been equipped with a new barrel with breech ring, breech and muzzle brake, and new sighting and fire control systems have been provided.

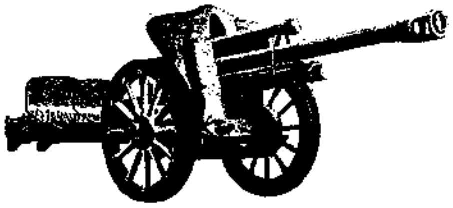
The general characteristics of the weapon can be found in the entry dealing with the original American version (**5510.103**). The introduction of the modifications referred to above is considered to have considerably extended the life of the gun.
STATUS:
In service.
MANUFACTURER:
Rheinmetall GmbH, 4 Düsseldorf 1, Germany.



155 mm Field Howitzer after modification

5576.103
105 mm LIGHT FIELD HOWITZER
DESCRIPTION:
A modified version of the American 105 mm M.101 Howitzer (**5511.103**) this gun has a longer barrel with a muzzle brake and a new type of sight.
CHARACTERISTICS:
Calibre: 105 mm
Barrel length: 35.5 calibres
Weight in firing order: 2.5 t
MV: 600 m/sec
Range: 14.1 km
Trail: Spread
Other characteristics believed similar to M.101.
MANUFACTURER:
Rheinmetall GmbH, 4 Düsseldorf 1, Germany.

2190.103
105 mm LIGHT FIELD HOWITZER M-18/18M/39
DESCRIPTION:
Designed in the late 1920s the M-18 105 mm light field howitzer first went into service with the German Army in 1935. In its original form it was made by Rheinmetall; subsequently Rheinmetall and Krupp jointly brought out an improved version, the 18M. The M39 was made by Krupp and a quantity was to have been delivered to the Netherlands; but the Second World War intervened and the guns were appropriated instead by the German Army and mounted on M-18 carriages to become the M18/39.
CHARACTERISTICS:
Calibre: 105 mm
Barrel length: 28 calibres
Elevation: $-5°$ to $+42°$
Traverse: 56°
Firing weight: M-18 and M-39: 1,915-1,985 kg; M-18M: 2,040 kg
Shell weight: 14.8 kg
MV: M-18 and M-39: 470 m/sec; M-18M 540 m/sec
Range: M-18 and M-39: 10,675 m; M-18M: 12,325 m.



105 mm Light Field Howitzer M-18

STATUS:
Apart from the German Army these weapons were supplied to Finland, Hungary, Norway, Spain and Sweden. Today, however, there are only a few M-18Ms in Yugoslavia and some M-39s in Norway.

MANUFACTURERS:
Rheinmetall and Krupp.

2191.103
NEW HIGH-PERFORMANCE GUNS

Rheinmetall GmbH is understood to be working on a range of new high-performance guns and ammunition.

Gun calibres are believed to be 105 mm, 110 mm, 120 mm and 155 mm. Some of these developments are joint projects; the 110 mm development (**2197.103**) for the Leopard II tank (**5015.102**) and the 155 mm FH 70 and SP 70 developments (**2195.103**) and (**2196.103**) being examples. In addition to these, however it is understood that there is a project for a 105 mm smooth bore gun firing fin-stabilised rounds with a very high muzzle velocity and a very high degree of accuracy. Another project, believed to be further advanced, concerns a high-pressure smooth bore 120 mm gun also firing fin-stabilised rounds.

Rheinmetall is certainly doing a lot of work on fin-stabilised rounds, some of which can be used over remarkably long ranges: one unconfirmed report has suggested that 70 km is feasible.

Finally, mention should be made of SPEAR—a gun-launched, fin stabilised, unguided anti tank rocket of about 60 mm calibre which can cover the first 1,000 metres in one second.

STATUS

Mainly development.

MANUFACTURER:

Rheinmetall GmbH, 4 Düsseldorf 1, Ulmenstrasse 125, Germany.

2180.103
90 mm ANTI-TANK GUN WITH AUXILIARY PROPULSION

DESCRIPTION:

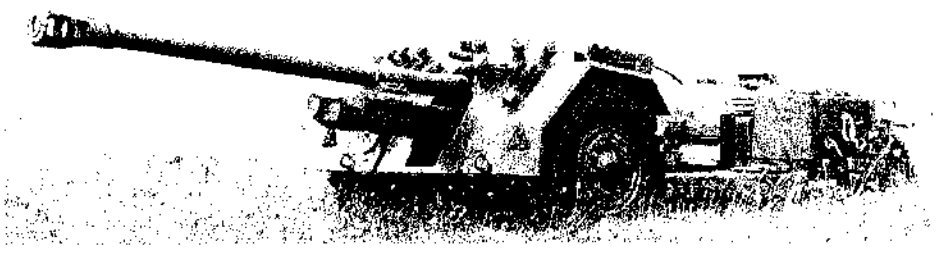
This weapon arrangement is designed to give a high-precision 90 mm anti-tank gun sufficient mobility to enable it to change its position under battlefield conditions without either the increase in silhouette that results from mounting the weapon on a tracked chassis or the cost of providing armoured protection for a commander, gunner and driver all with a clear view ahead.

STATUS:

Experimental.

MANUFACTURER:

Rheinmetall GmbH, 4 Düsseldorf 1, Germany.



90 mm SP Anti-tank gun with auxiliary propulsion unit

5600.103
20 mm RAPID-FIRE GUN Mk 20 Rh 202

DESCRIPTION

The Rheinmetall Mk 20 Rh 202 rapid-fire gun is designed for use with the 20 mm ammunition with disintegrating belt now in service with the army of the Federal German Republic.

The gun has a normal rate of fire of between 800 and 1,000 rounds per minute which can be reduced to about 600 rounds per minute if desired. The gun is gas operated and has a rigid breech block: a noteworthy feature is that the breech is locked symmetrically by two locking pieces so that the forces are absorbed centrally. Recoil forces are reduced by the use of a muzzle brake and by firing each round before the recoil travel from the previous round is complete. The ammunition feed is gas operated and does not depend on the movement of the belt and weapon.

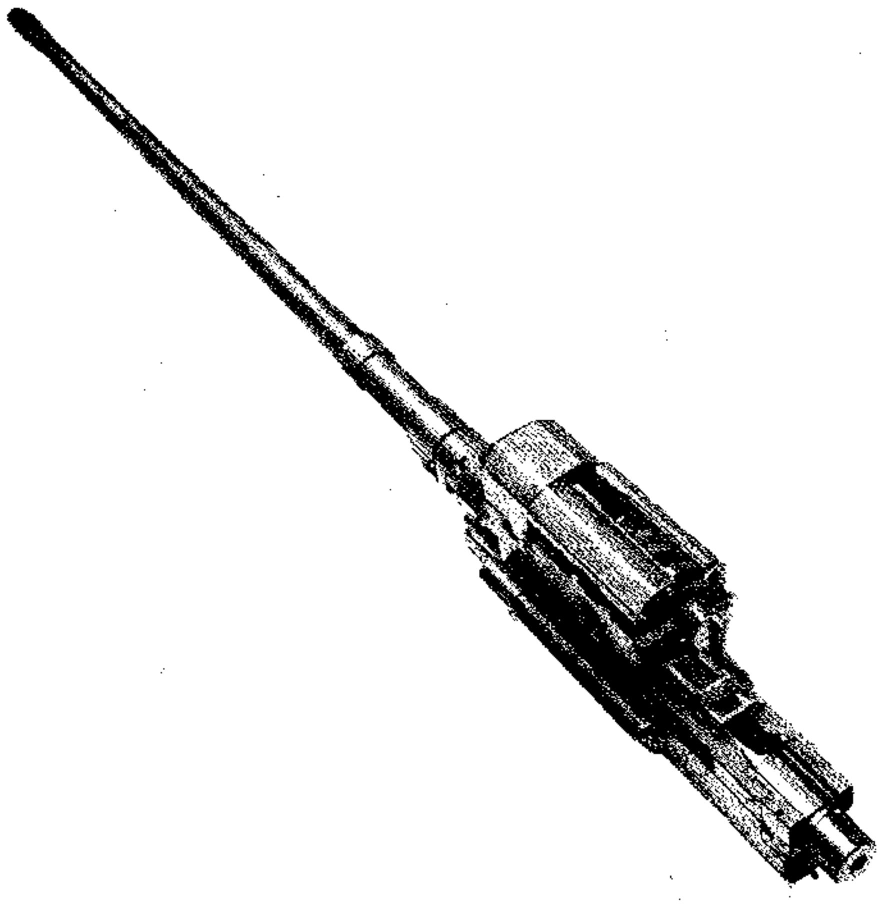
Two different belt feed mechanisms are available. In one (Type 2) two standard cartridge belts can be introduced in parallel simultaneously from above and the operational belt can be selected by a simple lever control. In the other (Type 3) a single standard cartridge belt is used but can be introduced from the left, from the right or from above without the necessity of making any mechanical changes.

The gun has been designed to operate satisfactorily under the most arduous physical conditions including temperatures below −54°C and exposure to water and heavy contamination.

All these characteristics make the gun suitable for use in a variety of different applications and several different mounts have been devised, including naval and airborne mounts. Particularly noteworthy here are the twin mountings that form the basis of the Twin-Gun Anti-Aircraft System (**2182.131**) and a one man turret system designed by Rheinmetall primarily for use on M113 armoured personnel carriers (**5016.102**).

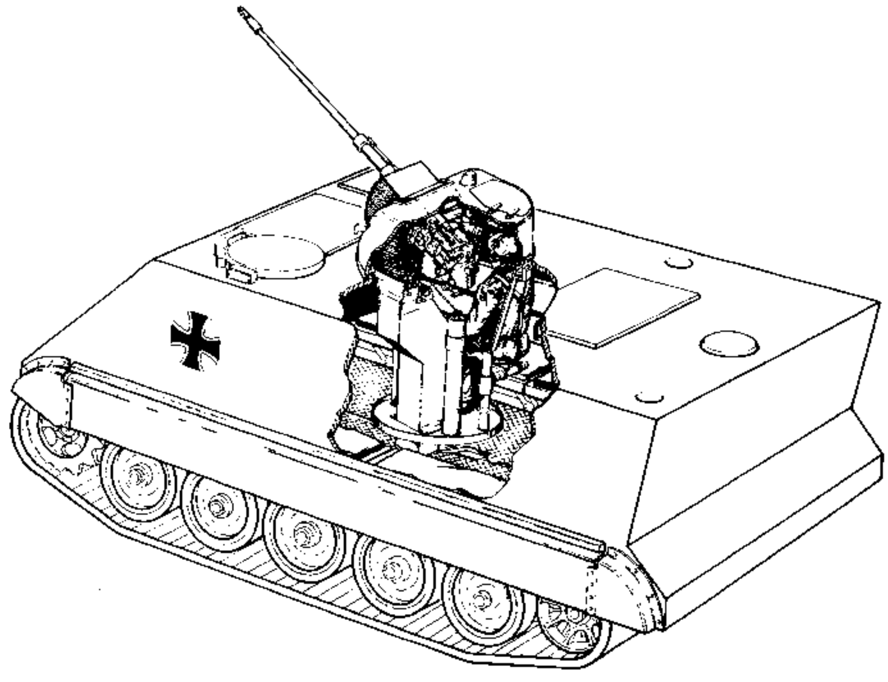
STATUS:

In service. The gun is the primary armament of the new Spähpanzer 8x8 ARV (**5115.102**) now in production for the German Army.



Rheinmetall Rh 202 gun

MANUFACTURER:
Rheinmetall GmbH, 4 Düsseldorf 1, Ulmenstrasse 125, Germany.



One-man turret for the Rh 202 gun

INTERNATIONAL

2195.103
155 mm TOWED HOWITZER FH70
DESCRIPTION:
FH70 – standing for "Field Howitzer of the Seventies" is one of two 155 mm artillery weapons which are being jointly developed by organisations in Britain, Germany and Italy.
An extremely versatile weapon, it is designed to fire all the standard 155 mm munitions in service in NATO and in addition it has to fire a special shell to a range in excess of 30 km – compared with some 24 km for a conventional shell. It is understood that the special shell chosen is a sub-calibre fin-stabilised round with a range capability in excess of 45 km.
The FH70, in addition to its ammunition versatility has several other interesting features. One is the inclusion of a detachable auxiliary power unit, mounted on the front of the carriage together with its fuel supply. This unit can be used for self-propulsion but also provides power for a multiplicity of operations in connecting and disconnecting the gun and its towing vehicle, for steering the small trail wheels and for raising the main wheels when the sole plate has been lowered. Provision is made for carrying out these tasks manually if the APU fails.
Another important feature is the assisted loading device which is actuated during the barrel run-out, and positions the shell in the mouth of the chamber for manual ramming. It is operable up to the maximum elevation angle of 70°.
CHARACTERISTICS:
Calibre: 155 mm
Barrel length: about 40 calibres
Elevation: –5.5° to +70°
Traverse: 55°
Weight: without shield and APU, 8.8t approx
Projectile weight: 43.5 kg (standard HE)
Ammunition: HE, smoke, illuminating, mine-dispensing, rocket-assisted
MV: 827 m/sec
Range: conventional round 24 km; sub-calibre and rocket-assisted projectiles at least 30 km
Rate of fire: normal 6 rounds/min; burst 3 rounds/15-20 sec
APU weight: 1.6 t approx
SP range: about 20 km
DEVELOPMENT AND MANUFACTURER:
Originally an Anglo-German project, the FH70 became a tri-nation operation when Italy joined as an equal partner in 1970 – by which time the first prototype firing trials had started. British and German government establishments have joint co-ordinating responsibilities at the government level; at the industrial level Vickers Ltd have overall co-ordination responsibility and particular responsibility for the carriage. Rheinmetall GmbH have particular responsibility for the elevating mass. Other German firms involved are Faun-Werke (APU), Leitz-Wetzler (sights) and Möller (telescope); in Britain the Royal Ordnance Factories and the Royal Armament Research and Development Establishment are involved in projectile and charge system work. Italian firms will enter at the production stage and are expected to include OTO Melara, SIGME and SNIA Viscosa.
Development is expected to be completed in 1975.

2196.103
155 mm SP HOWITZER SP70
DESCRIPTION:
SP70 is the second tri-nation ordnance project for the equipment of West European armies in the late 1970s. It is being developed on a programme which has a later time scale than the FH70 project and less information is available concerning its ultimate design and performance.
It is known, however, that while the new weapon will fire the same ammunition as the FH70 it will use a different gun which will be turret-mounted.
Probable work-sharing arrangements appear to be that Germany will undertake responsibility for the chassis and engine (Rheinmetall and Porsche) while the UK and Italy share the armament and turret and jointly produce the ammunition. The gun is likely to go to Italy where OTO Melara's upgunning of the M-109 (see **2193.103**) is probably relevant. The British contributor is understood to be ROF, Leeds.

2197.103
110 mm TANK GUN L10
DESCRIPTION:
This gun is being developed for the Leopard II tank (**5015.102**).
Very little information has so far been released concerning this project; but it is understood that the gun and ammunition are being developed jointly by the Royal Armament Research and Development Establishment (RARDE) in the UK and Rheinmetall GmbH, with a target specification which includes a muzzle velocity of around 1,800 m/sec with a terminal velocity at 2 km distance well in excess of 1,000 m/sec. It is believed that the gun will have a light steel barrel.
Ammunition development is understood to be shared between the two principals, the UK developing HEAP and HEAT spin-stabilised rounds while Rheinmetall develops a sub-calibre fin-stabilised discarded sabot round.
STATUS:
Development – as part of Leopard II development.

ISRAEL

2312.103
155 mm M-68 HOWITZER
DESCRIPTION:
This is built in Israel. It has a four-wheeled carriage with no shield. When travelling, the barrel is traversed 180° so that it is over the trails. The barrel has a single-baffle muzzle brake. The weapon is similar in appearance to the Finnish 122 mm gun M-60.
CHARACTERISTICS:
Calibre: 155 mm
Length of barrel: 33 calibres
Total Weight Travelling: 9,500 kg
Range: 20,000 m
Elevation: –3° to +52°
Traverse: 90°
Ammunition: HE wt 43.7 kg
STATUS:
In service.
SUPPLIER:
Soltam Limited, Israel

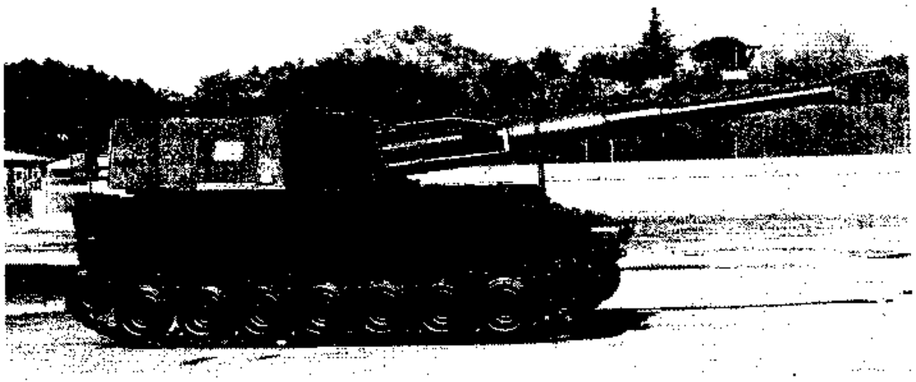
2319.103
155 mm M-68 SELF-PROPELLED GUN/HOWITZER (L-33)
DESCRIPTION:
This is basically a Sherman chassis rebuilt with a superstructure mounting the 155 mm M-68 gun/howitzer. The vehicle is fitted with a pneumatic lifting - loading system which, combined with the semi-automatic breech mechanism, enables the weapon to achieve a high rate of fire. The modifications to the Sherman chassis are quite extensive and include the fitting of a new engine. The L-33 was extensively used during the 1973 campaign.

CHARACTERISTICS:
Calibre: 155 mm
Length of Barrel: 33 calibres
Length Overall: 8.47 m
Width Overall: 3.50 m
Height Overall: 3.25 m
Total Weight: 41,500 kg (loaded)
Range: 21,500 m
Elevation: −3° to +52°
Traverse: 60° (total)
Speed: 36 km/h
Range: 260 km
Ammunition: HE wt 43.7 kg m/v 725 m/s

STATUS:
In service.
SUPPLIER:
Soltam Limited, Israel.

ITALY

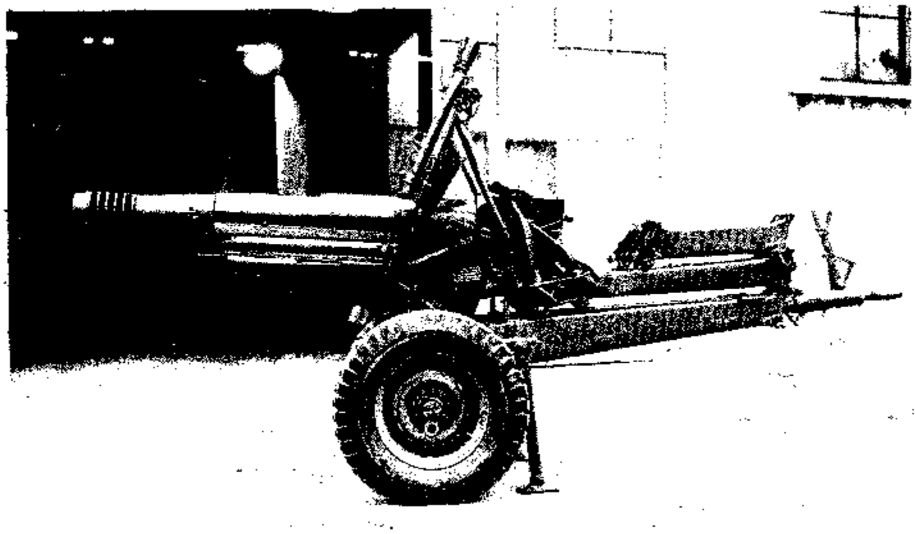
2193.103
155 mm SP HOWITZER (M-109) (MODIFIED)
DESCRIPTION:
OTO Melara have developed and successfully tested a modified version of the M-109 155 mm SP howitzer (**5508.103**). This howitzer already exists in two modified forms—one of which is little different from the original (the Swiss M-109U **2298.103**) while the other (German M-109G **2192.103**) is more heavily modified. The Italian modification would seem to be the most substantial of all: the gun is a higher-performance weapon with a longer barrel.
Among the characteristics of the new weapon are the ability to fire existing M101 and M107 ammunition to a range of some 22 km and the new FH70 ammunition (**2195.103**) to a range of some 24 km. The development indeed looks much like a preliminary stage in the development of the new SP70 self-propelled howitzer (**2196.103**).

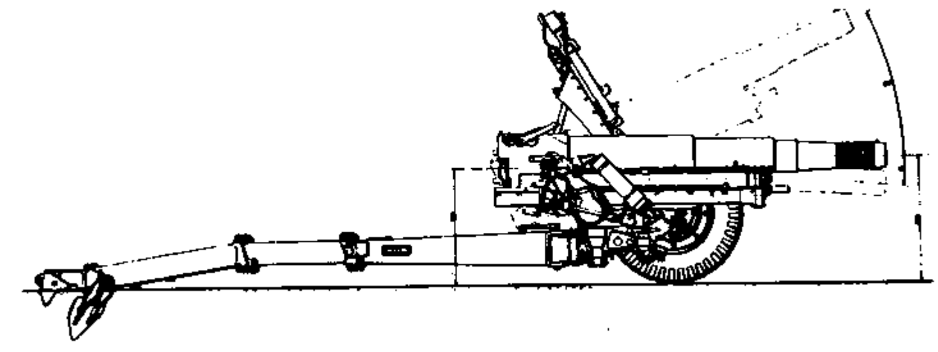

Italian modified version of M-109 SP howitzer

STATUS:
Demonstration prototype.

MANUFACTURER:
OTO Melara SpA, Via Valdilecchi 15 – 19100 La Spezia, Italy.

5501.103
105/14 MODEL 56 PACK HOWITZER
DESCRIPTION:
The Model 56 Pack Howitzer was designed with the intention of providing one weapon of sufficient versatility to cover the operational roles normally performed by several different types. At the same time the gun had to conform to the widest possible standardisation in materials and ammunition.
Design work started in 1950, the first prototype was produced in 1956, and the first gun was in service with the Italian Army in 1957. The gun has been outstandingly successful, and so far 1,417 have been ordered of which 1,365 have been delivered.
Essentially it is a light weight pack howitzer capable of rapid and easy dismantling into small parts, and equally rapid re-assembly. It is pre-eminently a highly portable equipment, and is unique in the modern world in that it can be man-packed, although only for short distances as the heaviest load is 122 kg
It can be transported in the following ways.
Mule train (breaks down into 11 mule loads)
Man pack
Parachute
Helicopter
Aircraft
In addition it can be, and usually is, towed by a vehicle or animal. In the British Army the towing vehicle is a ¾ ton long wheelbase Land Rover, but any similar sized vehicle is adequate.
It was not, however, designed for extensive high-speed towing over rough country; for this purpose a more robust weapon is desirable; and this is one reason why the Model 56 is to be replaced in British Army service by the new 105 mm Light Gun (**5505.103**). Another reason is the relatively short range of the Italian weapon – a necessary result of achieving the prime objective of high mobility in all kinds of difficult terrain.
The howitzer is widely used throughout the world, and one factor which has assisted in this is the ammunition. The ammunition is the US M1 system which is a NATO standard and is easily procured in practically all the western nations. Whilst this may not be the most advanced ammunition system which can now be manufactured, it is more than adequate for a light field piece such as this. Inevitably the range is slightly degraded by the short barrel, but the loss is very small and worth the price for the mobility achieved.
The howitzer has a secondary role as an anti-tank gun. For this the profile is lowered by moving the wheels forward, and laying the legs out flat. Not only is stability increased by this, but the gun is also easier to conceal; however, the howitzer is primarily intended as a close support weapon, and anti-tank actions would only be undertaken in emergencies.
The long, cranked legs of the split trail are unusual, and have to be folded for travel. A five-baffle muzzle brake is fitted to reduce the recoil as far as possible, and a small shield protects the crew.


105 mm Pack Howitzer with trail legs folded


105 mm Pack Howitzer in the Anti-Tank Role

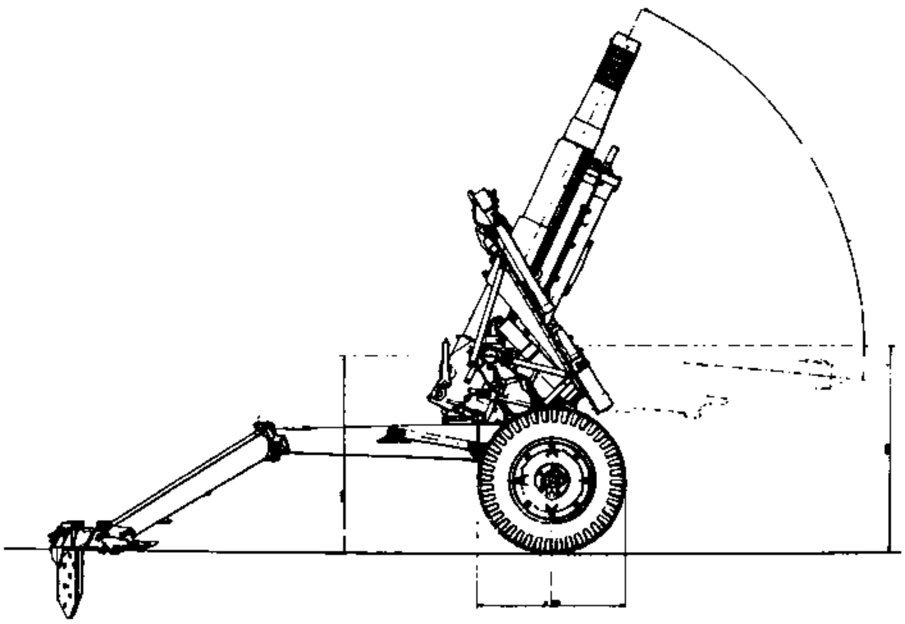
CHARACTERISTICS:
Overall length: 5 3 m
Width: 1.51 m
Height: 1.92 m (max), 1.55 m (min)
Barrel length: 14 calibres
Total weight: 1,290 kg. Breaks down into 11 loads, the heaviest being 122 kg
Range:– **Max**10.575 m
Elevation: −5° to +65°
Traverse: 36°
Ammunition: US M1 System. Shell weight 14.9 kg

COUNTRIES SUPPLIED:
Argentina, Australia, Belgium, Canada, Chile, France, Federal German Republic, India, Italy, Malaysia, Nigeria, New Zealand, Pakistan, Rhodesia, Spain, United Kingdom, Zambia.

PENDING:
Saudi Arabia.

STATUS:
In production.

MANUFACTURER:
OTO Melara SpA Via Valdilecchi 15 - 19100 La Spezia, Italy.



105 mm Pack Howitzer in the Field Role

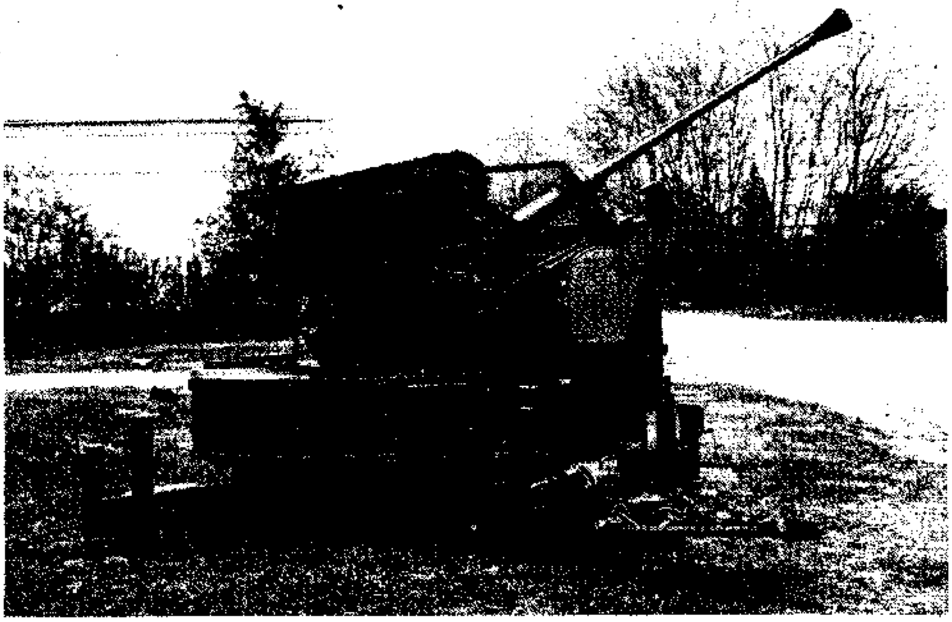
2603.103
40 mm BREDA/BOFORS LAA FIELD MOUNTINGS

DESCRIPTION:
Breda Meccanica Bresciana make a range of light anti-aircraft field gun-mountings, based on the Bofors 40 mm L/70 gun, which is similar to the range of single gun-mountings made for naval use (**2557.203**).

Illustrated here is the version with the 144-round Breda automatic feeder; others are that with the 32-round AL.100 feeder and the basic manually loaded version.

MANUFACTURER:
Breda Meccanica Bresciana, Via Lunga 2, 25100-Brescia, Italy.

Breda / Bofors LAA mobile field mounting



Bofors 40 mm L/ 70 AA gun in Breda mounting with 144-round feed

JAPAN

2585.103
106 mm SP RECOILLESS RIFLE TYPE 60

DESCRIPTION:
The type 60 SPRR was the first post-war Japanese armoured fighting vehicle and entered service in 1960/61. It is designed primarily for the anti-tank role, and is similar in concept to the M-50 Ontos (**2763.103** - 1973/74) which has recently been phased out of service with the United States Marine Corps. The 106 mm rifles fitted are known as the Type 60 and are basically the American 106 mm M-40A1 (**5584.103**) built in Japan. Production of this vehicle has been completed.

CHARACTERISTICS:
Crew: 3
Weight: 8.02 t
Size: Length 4 3m. Width 2.23m. Height 1.38m
Road speed/range: 48 km/hr/130 km
Main Armament: 2 × 106 mm recoilless rifles
Method of ranging: 1 × 12.7 mm ranging machine gun
Rate of fire: 6 rounds a minute
Max Effective anti-tank range: 1,100 m
Elevation/depression: −5° to +10° (normal)
−15° to +25° (when mount is raised)
Ammunition: Fixed HE and HEAT rounds
Turret rotation limits: 10° left and right (normal)
30° left and right (mount raised)
Engine: Komatsu 6 cylinder air-cooled diesel, 120 HP/2,400 rpm
Agility: Ground pressure .63 kg/cm^2. Max step 53 m. Max trench 1.78 m.
Max gradient: 67%. Ground clearance .35 m
Water crossing ability: Fords to a depth of .8 m
NBC system: nil
Night fighting aids: nil

STATUS:
In service with the JSDF.

SOUTH AFRICA

2586.103
SOUTH AFRICAN ORDNANCE
DESCRIPTION:

Full details of South African artillery developments are not available; but it is known that they have undertaken a considerable amount of work in refurbishing and modifying older weapons and it is believed that they have developed at least one major piece of ordnance – a 90 mm Field Gun.

Ammunition for South African artillery is believed now to be made entirely within the Union.

SP 25-pounder (Sexton) gun in service with the South African Army

SPAIN

2030.103
SPANISH ORDNANCE

Most of the heavy weapons used by the Spanish Army are of American origin and they include many of the American weapons which are currently operational in US and other NATO armies. For anti-aircraft operations there is possibly greater reliance on AA guns than is common elsewhere in Western European countries, although there is one battalion equipped with Hawk missiles. Guns, too, are relied upon heavily for anti-tank purposes.

Apart from these American weapons the only other imported gun is believed to be the Italian pack howitzer (**5501.103**); although, since the guns in service in Spain appear to have a modified muzzle brake, it may be that they have been either made or modified in Spain. Spain has its own armaments industry and has for many years made both field and naval guns for its armed forces. In the following entries there are descriptions of one old and one modern gun, both of which are in service in Spain and believed to be of Spanish design. There is also a description of a family of Spanish artillery rockets.

2031.103
105 mm LIGHT HOWITZER
DESCRIPTION:

This is a general-purpose field howitzer of robust and conventional construction. Date of entry into service is not known, but it seems likely that it was designed in the 1950s. Maker not known but almost certainly Spanish.

CHARACTERISTICS:
Calibre: 105 mm
Barrel length: 26 calibres
Elevation: $-5°$ to $+45°$
Traverse: 50°
Weight: in firing order 1,950 kg
MV: 443 m/sec
Range: 9,400 m
Trail: Spread

STATUS:
In service in Spain.

2032.103
75 mm LIGHT FIELD GUN
DESCRIPTION:

This is a horse-drawn weapon of unknown but probably Spanish, presumably pre-1939, design. It features a box trail, a simple gunshield and large spoked wheels. With a total weight of only a little over 750 kg it is evidently easily manoeuvred in difficult terrain and has a useful range – although its accuracy may not be very great.

CHARACTERISTICS:
Calibre: 75 mm
Barrel length: 22 calibres
Elevation: 0° to 40°
Traverse: 7°
Weight in firing order: 764 kg
MV: 480 m/sec
Range: 10,500 m
Trail: box

STATUS:
In service in Spain.

SWEDEN

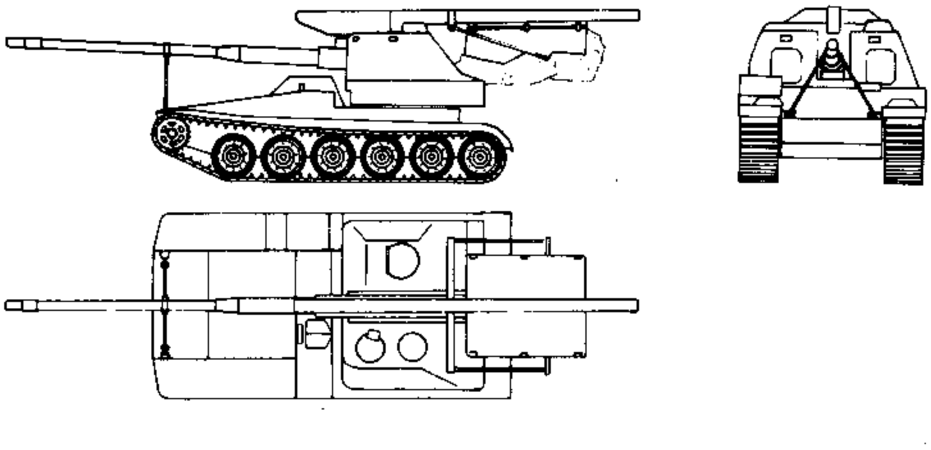
5527.103
155 mm SP AUTOMATIC GUN L/50 (VK 155 L/50)
DESCRIPTION:

The design of this very interesting gun began in the early 1950s prompted by the Swedish Army Staff. The intention was to produce a long range SP Gun with a high rate of fire. The first prototype was ready in 1960, production started in 1966, and was completed in 1968.

The L/50 is a fully automatic SP field gun on a tracked chassis. It is unique in that it loads each round automatically from a magazine, utilising the force of recoil to do so.

A four man crew is sufficient to operate the gun; the gun commander and gun layer being in the left cabin, the loader in the right hand one, and the driver in the hull.

The two cabins are protected from NBC attack, and contain enough room for three more men.



Normal elevating and traversing is by hand wheel, but an electric motor raises and lowers the gun to and from the loading position.

The loading arrangements consist of a tray beneath a magazine behind the breech. This tray carries the round to the breech, where it is then rammed. Both the tray and the rammer are activated by springs which are cocked by recoil. The loading tray is supplied by two feeding trays, again spring operated. The magazine holds 14 rounds in 7 drop compartments. The two rounds in each compartment drop onto the feed tray by gravity. The 14 rounds can be loaded in a clip in less than two minutes. Before loading, the type of fuse and the charge required for the action are chosen, thus avoiding having to change ammunition in the magazine.

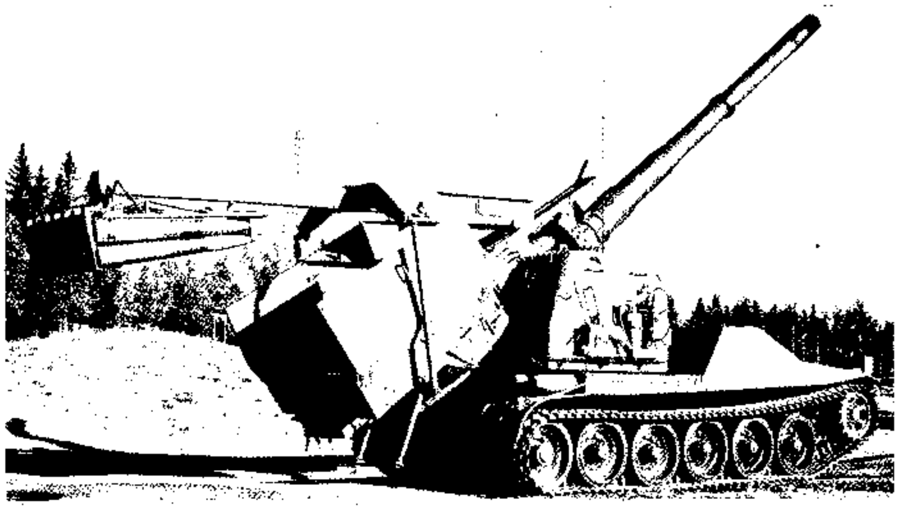
The rate of fire is very high, maximum being 15 rounds per minute.

The chassis is supported on six large road wheels, with the track returning along their top. The sprocket is at the front. Suspension is hydropneumatic and is locked for firing.

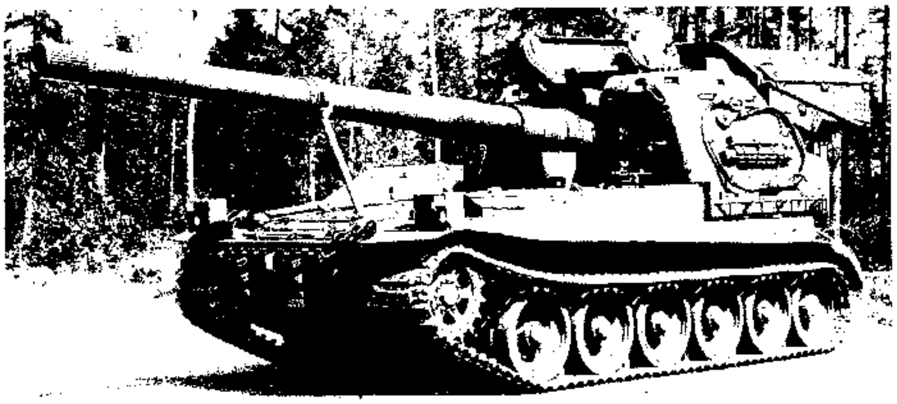
There are two engines, a diesel and a gas turbine. The diesel drives an hydraulic pump, and the sprockets are connected to an hydraulic motor whose output varies differentially to each sprocket for steering. When only the gas turbine is driving, steering is effected by clutches and brakes.

STATUS:
In service since 1966.

Width: 3.3 m
Height: 3.25 m
Total weight: 51,000 kg
Range—max: 25,000 m with conventional ammunition
Elevation: $-3°$ to $+40°$
Traverse: 30°
Ammunition: Fixed. Weight of complete round. 85 kg. The existence of an RAP round has been reported, but no details are known.
Shell: HE. Weight 48 kg
MV: 865 m/s to 600 m/s
Engines: C.I. engine RR K 60 2-stroke Gas Turbine: Boeing 502-10 MA
Horsepower: C.I. engine: 240 SAE. Gas turbine 300 SAE



Bofors L/50 showing a clip of 14 rounds being loaded into the magazine by the integral derrick



155-mm L/50 SP Automatic Gun in travelling position

COUNTRIES SUPPLIED:
Sweden

MANUFACTURER:
AB Bofors, S-690 20 Bofors, Sweden

2331.103
155 mm F MEDIUM HOWITZER

DESCRIPTION:
This weapon is a version of the French 155 mm howitzer (**5536.103**) made under licence in Sweden in a slightly modified form. So far as is known, these modifications relate only to speeding up the unlimbering drill and improving the traverse mechanism.

CHARACTERISTICS:
Calibre: 155 mm
Barrel length: 23 calibres
Elevation: $-4°$ to $+69°$
Traverse: 82°
Weight in combat order: 8-15 t
Weight of shell: 43.75 kg
MV: 650 m/sec
Range: 17,700 metres
Rate of fire: 4-6 rounds/min
Trail: split, 4 wheels

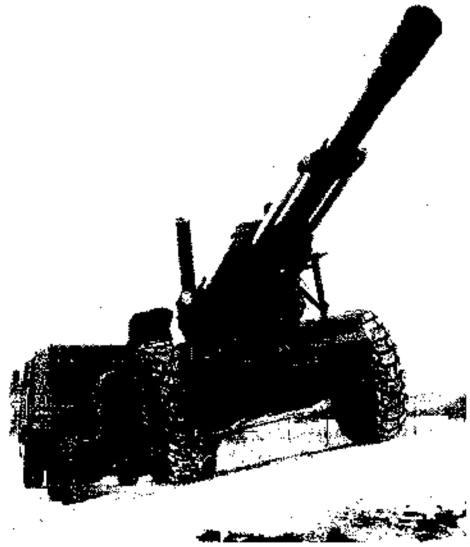
2332.103
155 mm FIELD HOWITZER 77

DESCRIPTION
The 155 mm Field Howitzer 77 is a new field artillery piece, with auxiliary engine, developed by AB Bofors on a contract from the Swedish Defence Authorities.

The Swedish Army – like many other armies – has a great number of guns from World War II days. FH 77 is intended to form the nucleus of the new generation of weapons in the Swedish field artillery. The nature of Swedish terrain and climate make good cross-country mobility an important consideration in the design of a new weapon; and the Swedish tactical philosophy demands that any such piece of ordnance have a high rate of fire. Financial consideration ruled out the development of a tracked weapon to meet the first requirement; instead, it was decided to develop a towed weapon with auxiliary propulsion. In doing this, and in meeting the rate of fire requirement Bofors have made extensive use of their experience of hydraulic systems and have produced (not for the first time – consider the S-tank) a system of considerable interest and ingenuity – the most noteworthy feature in this instance being perhaps the use of the auxiliary engine as a source of power for the various hydraulic systems.

The auxiliary engine drives the gun's two big wheels via an hydraulic transmission. When driving in rough terrain this drive is utilised to increase the cross country mobility of the equipment: the auxiliary engine is started and the tractive force of the wheels is controlled by the driver of the towing vehicle, with the aid of a special co-ordinating system. Trials hitherto carried out show that the gun driver in co-ordination with the towing vehicle gives the combination very good cross-country mobility. The howitzer can also move

FH 77 in firing position



FH 77 under its own power

FH 77 on tow

separately, by means of the auxiliary drive. It is steered with two control levers, one for each driving wheel.

In order to attain the high rate of fire stipulated – 3 rounds in 10 seconds – hydraulics are utilized for ramming the ammunition.

Hydraulics are also utilized for aiming the weapon in elevation and traverse, and to raise and lower the supporting wheels on the carriage trails.

For the deployment of the howitzer, the auxiliary drive and the hydraulics for the supporting wheels are used to disengage the howitzer from the towing vehicle, spread the trails and seat the trail spades in the ground. They are also used in the opposite way when leaving a position. The weapon can thus be made ready for firing and moved out of its firing position very rapidly; at the same time the work for the gun crew becomes very easy. This, in turn, increases the ability of the weapon to maintain combat activities for long periods of time.

The auxiliary drive is also used to turn the weapon – to direct the fire to different zones. This too can be accomplished very rapidly, with little effort on the part of the gun crew.

Extensive studies and trials relating to ammunition supply for the weapon have also been carried out. On one of its carriage trails, the howitzer has an electrically operated hoisting crane, whereby the heavy shells can be moved from the ammunition store to a loading tray on the weapon. Manual handling of the shells is thereby avoided and a high rate of fire can be obtained even if the gun crew is reduced or the crew members are tired.

Having regard to existing supplies of ammunition in Sweden, the choice of calibre lay between 105 mm and 155 mm. Because it was thought necessary to use a highly effective individual round, the larger calibre was chosen; and in order to increase the effect extensive development work on a new shell has been carried out by Bofors. This shell will be made of a type of steel that has not been used previously, and which gives better fragmentation properties than earlier types. Furthermore, the shell will be filled with hexotol, a high explosive with a more powerful effect than TNT.

In addition to the high-explosive shell, development of which has now been completed, smoke and illuminating shells are being developed.

Characteristics:

Calibre: 155 mm
Range: 22 km
Weight of projectile: 43 kg (with fuze)
Rate of fire: 3 rounds in 10 seconds
Traverse: – 30°
Elevation: –3° to +50°
Weight: 11 tons
Engine: Type: Volvo B20B Output DIN 74 kw at 92 rps.
Max. speed when towed: 70 km/h
Max. speed when self-propelled: 8 km/h

Status:

FH 77 is in the prototype-testing stage. Three prototypes, with ammunition and sights, are with the Swedish Army, for user trials, approval tests etc.

The three prototypes have been provided with three different types of sight. One of them has a conventional mechanical sight, one has a newly developed mechanical sight and one has an automatic electronic sight.

Manufacturer:

AB Bofors, Bofors, Sweden.

2335.103

105 mm LIGHT FIELD HOWITZER 4140

Description:

Remarkable at the time of its introduction for the use of a four-part trail permitting unlimited traverse, this is the current modern 105 mm howitzer of the Swedish Army. It has replaced the older weapons (**2334.103** 1973-74).

Characteristics:

Calibre: 105 mm
Barrel length: 28 calibres
Elevation: –5° to +65°
Traverse: 360°
Weight in combat order: 2.6 t
Weight of shell: 14.5 kg
MV: 620 m/sec
Range: 14,600 m
Rate of fire: 25 rounds/min

Manufacturer:

AB Bofors, Bofors, Sweden.

2343.103

105 mm TANK GUN L74

Description:

Main armament of the Swedish (Bofors) Strv 103 tank (**5003.102**) this gun is similar to the Vickers L7A family of guns, used on the Centurion and many other tanks, but has a longer barrel. It is fitted with a bore evacuator but has no muzzle brake.

Characteristics

Full details of performance have not been disclosed and the following list summarises the available data.

Calibre: 105 mm
Barrel length: 62 calibres
Elevation: (as mounted) –11° to +11° with tank chassis
Traverse: (as mounted) nil relative to tank chassis
Ammunition: HEP, APDS or Smoke
Projectile weight: 6.5 kg
Recoil: 270 mm
Loading: automatic
Rate of fire: 15-20 rounds/min

Muzzle velocity is among the undisclosed characteristics but is more than 1,500 m/sec with APDS

Status:

In service in Sweden.

2587.103

90 mm TANK GUN – BOFORS KV 90 S 73

Description:

This 90 mm Bofors gun is of the low pressure type: the peak pressure is only 17,000 psi – thus offering the advantages of lower weight and smaller recoil loads over conventional guns. The gun fires fin-stabilised shells, also developed by Bofors. The HEAT round utilises a piezo-electric fuse in order to reach a full-calibre sensitivity and is capable of penetrating all NATO targets. The HE round has a mechanical impact fuse and is used for anti-personnel missions. Maximum effective range is 2,000 m. The gun is the primary armament of the Ikv 91 Tank Destroyer (**5063.102**).

Characteristics:

Calibre: 90 mm
Length of barrel: 54 calibres
Ammunition: HEAT round has a m/v of 825 m/sec, complete round weighs 10.7 kg and projectile weighs 4.5 kg.

HE round has a m/v of 600 m/sec; complete round weighs 12.2 kg and projectile weighs 6.7 kg.

Manufacturer:

AB Bofors, S-690 20 Bofors, Sweden.

2339.103

75 mm COASTAL DEFENCE GUN

Description:

These weapons are mounted in fortified emplacements on the Swedish coast. The coastal artillery system for the protection of Sweden's long coastline is in fact under the control of the Royal Swedish Navy; in addition to the 75 mm gun described below, the defence system includes static and mobile batteries with 105 mm, 120 mm, 152 mm and 210 mm guns and with Rb-08 (**2372.121**) and Rb-52 (SS-11 **2139.111**) missiles, there being 20 batteries in all.

Characteristics:

Calibre: 75 mm
Barrel length: 60 calibres
MV: 840 m/sec

Range: 12,000 m
Rate of fire: 25 rounds/min

STATUS:
In service.

MANUFACTURERS:
AB Bofors, Bofors, Sweden.

2336.103
57 mm ANTI-AIRCRAFT GUN M54

DESCRIPTION:
This is a quick-firing anti-aircraft gun which, like the 40 mm L/70 (**5528.103**) is in service with anti-aircraft artillery battalions of the Swedish Army.

CHARACTERISTICS:
Calibre: 57 mm
Barrel length: 60 calibres
Elevation: −5° to +90°
Traverse: 360°
Weight in combat order: 8.1 t
Weight of shell: 2.6 kg
MV: 920 m/sec
Range: maximum: 14.5 km. Effective against aircraft 4,000 m
Rate of fire: 120 rounds/min

STATUS:
In service.

2337.103
40 mm ANTI-AIRCRAFT GUN L/60

DESCRIPTION:
Forerunner of the widely used L/70 weapon (**5528.103**) the Bofors L/60 is still in service in Sweden and elsewhere – as indeed is its naval counterpart.

CHARACTERISTICS:
Calibre: 40 mm
Barrel length: 60 calibres
Elevation: −5° to +90°
Traverse: 360°
Weight in combat order: 1.73 t
Weight of shell: 0.96 kg
MV: 850 m/sec
Range: maximum: 8,700 m; effective against air targets: 1,200 m
Rate of fire: 120 rounds/min
Penetration: (in anti-tank role) 55 mm at 500 m and 90°

STATUS:
In service with territorial forces but obsolescent. No longer in production.

5528.103
40 mm AUTOMATIC GUN L/70

DESCRIPTION:
The Bofors 40 mm light anti-aircraft gun is one of the best known and most widely used pieces of ordnance in the world. In many languages the name of Bofors is automatically synonymous with the 40 mm gun. It has been in service since about 1937.

The L/70 is a later variant of the original design, and the first prototype appeared in 1947. The first production models were delivered in 1951 and the latest version is still being manufactured. Over 5,000 equipments have been made, of which 1,000 are in naval mountings.

The gun is self-loading, feeding from clips of ammunition placed by the crew into guideways above the breech. A cyclic rate of fire of 300 rounds per minute can be achieved, together with very high rates of traverse and elevation.

In the ground version the gun has its own power unit on the carriage, and can generate independently of any power supply. Fire control data is fed in by cable from an external radar set which can be up to 500 m away. Gun layers are not required when the weapon is being automatically controlled.

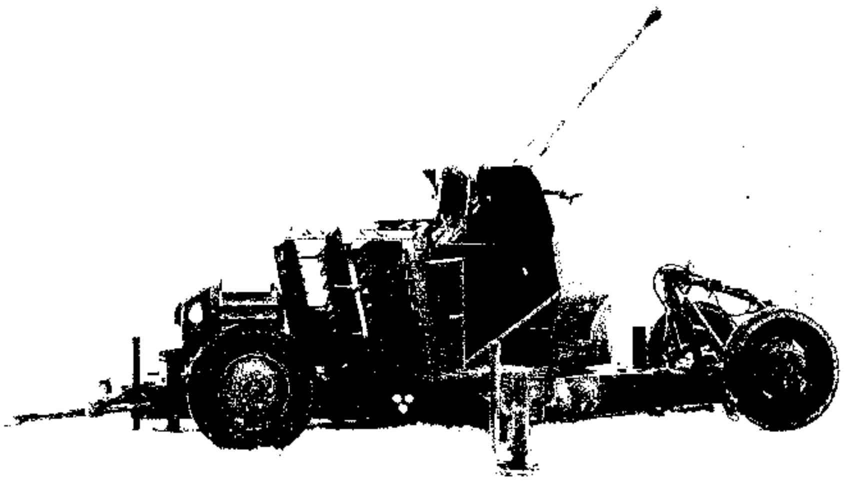
The gun can also be provided with an integrated optronic fire control equipment called BOFI (**2378.151**), the combination constituting a weapon system which can be rapidly deployed.

Mobility is good, the four wheeled carriage accepting cross country movement well. The entire equipment is air portable without extensive preparation, and can also be parachuted.

The crew is normally six, of which four are loaders and ammunition numbers.

The ammunition is normally HE, with a point detonating fuse of great reliability. The HE round also has a self destruction timer which operates at 8.5 sec (+2 sec) after firing. But since this gun is often used against surface targets a full-calibre armour piercing round and an APCBC-T round have been evolved.

A recent development is a pre-fragmented shell for use with a newly-developed proximity fuse. This ammunition is superior to the earlier types in its effects against aircraft and particularly missiles.



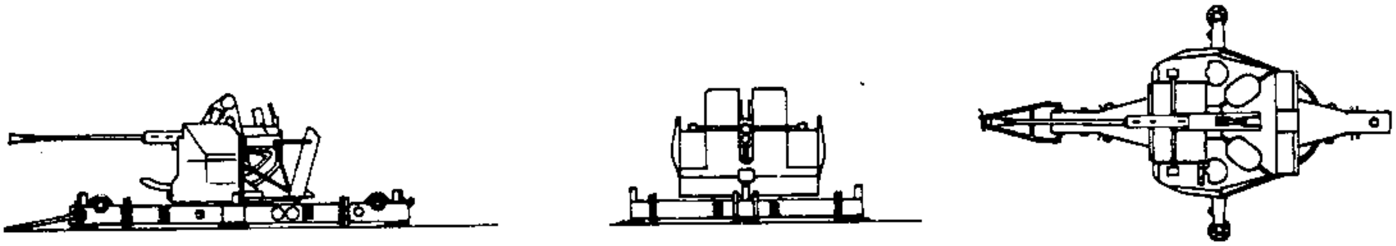
40-mm L/70 AA gun with integral power unit

STATUS:
In production.

COUNTRIES SUPPLIED:
Up to 20 different nations supplied so far. Typical users are NATO countries, India and Sweden.

CHARACTERISTICS:
Overall length: 6.32 m
Width: 2.25 m
Height: 2.35 m
Barrel length: 70 calibres
Total weight: 5,150 kg
Tactical range: 4,000 m
Elevation: −5° to +90°
Traverse: 360°
Ammunition: See text
MV: 1,000 m/s

MANUFACTURER:
AB Bofors Ordnance Division, Box 500, S-690 20, Bofors, Sweden.



40-mm L/70

2338.103
20 mm ANTI-AIRCRAFT CANNON M40-70

DESCRIPTION:
This light anti-aircraft weapon is used by brigade anti-aircraft units in the Swedish Army. It is mounted on a two wheel trailer for towing; but for firing it is supported on a three-part trail with the wheels raised.

CHARACTERISTICS:
Calibre: 20 mm
Barrel length: 70 calibres
Elevation: −5° to +35°
Traverse: 360°
Weight combat order: 500 kg
Weight of projectile: 0.145 kg
MV: 815 m/sec
Range: maximum: 7,500 m; effective against air targets: 1,600 m
Rate of fire: 360 rounds/min

STATUS:
The M40 70 weapon is the latest in a series of improvements on a basic weapon design extending back to before the Second World War and is the version which is currently in service.

2333.103
90 mm RECOILLESS ANTI-TANK RIFLE 1110
DESCRIPTION:
This weapon is employed either mounted on a light wheeled vehicle or on a two-wheel trailer towed by a tractor. In the latter version the weapon is mounted on a turntable to which the wheels are attached and which serves as an arm rest for the gunner who fires from a kneeling position. With this arrangement the available traverse, as measured in the horizontal plane, varies with the elevation angle since the turntable tilts when the weapon is elevated.
CHARACTERISTICS:
Calibre: 90 mm
Barrel length: 3.7 m
Elevation: −10° to +15°
Traverse: 75-115° according to elevation
Weight in combat order: 260 kg as a trailer
Weight of shell: 3.1 kg
MV: 715 m/sec
Effective range: 900 m
Penetration: 380 mm at 90°
Rate of fire: 6 rounds/min

STATUS:
In service.

SWITZERLAND

2998.103
155 mm SP MEDIUM HOWITZER M-109U
DESCRIPTION:
So far as is known this Swiss version of the American M-109 SP howitzer differs little from the original (see entry **5508.103**). It is believed that the differences are mainly electrical – necessitated by national practice
CHARACTERISTICS:
Designation: Panzerhaubitze 66 (PzHb 66)
All-up weight: 23.5 t
Crew: 8
Gun calibre: 155 mm
Barrel length: 23 calibres
Range: 15-18 km
Rate of fire: 5-6 rounds/min
Rounds carried: 28
Secondary armament: 12.7 mm AA MG
STATUS:
In service, replacing 105 mm LFH (**2387.103**) in mechanised divisions. 145-150 deployed.

2389.103
150 mm MEDIUM HOWITZER M-42

DESCRIPTION:
This is an early Bofors-designed weapon made under licence in Switzerland and still in service there in small numbers.
CHARACTERISTICS:
Calibre: 150 mm
Barrel length: 28 calibres
Elevation: −5° to +65°
Traverse: 45°
Weight in firing order: 6.5 t
Weight of shell: 42 kg
MV: 580 m/sec
Range: 15 km
Trail: spread
Rate of fire: 5 rounds/min
STATUS:
In service in artillery regiments and artillery battalions of mechanised divisions.

2387.103
105 mm LIGHT HOWITZER M-46
DESCRIPTION:
This is a Bofors-designed weapon manufactured under licence in Switzerland and believed now to be in service only in that country.
CHARACTERISTICS:
Calibre: 105 mm
Barrel length: 22 calibres
Elevation: −0° to +65°
Traverse: 60°
Weight in firing order: 1,850 kg
Weight of shell: 15.15 kg
MV: 490 m/sec
Range: 10 km
Trail: spread
STATUS:
In service in the divisional artillery of the Swiss Army. Some 800 of these howitzers and the M-35 medium guns (**2388.103**) are believed to be operational in Switzerland. It is being replaced in mechanised divisions by the M-109U 155 mm SP medium howitzer (**2998.103**).

2388.103
105 mm MEDIUM GUN M-35
DESCRIPTION:
This is an old weapon of Bofors design which was made under licence in Switzerland where a few are still in service.

CHARACTERISTICS:
Calibre: 105 mm
Barrel length: 42 calibres
Elevation: −3° to +45°
Traverse: 60°
Weight in firing order: 3,840 kg
Shell weight: about 15 kg
MV: 750-800 m/sec depending on ammunition used
Range: 17.5 - 21 km depending on ammunition used
Trail: spread
Rate of fire: 5 rounds/min

STATUS:
In service in the artillery battalions of mechanised divisions and in artillery support regiments. Some 800 of these guns and the M-35 howitzers (**2387.103**) are believed to be operational in Switzerland.

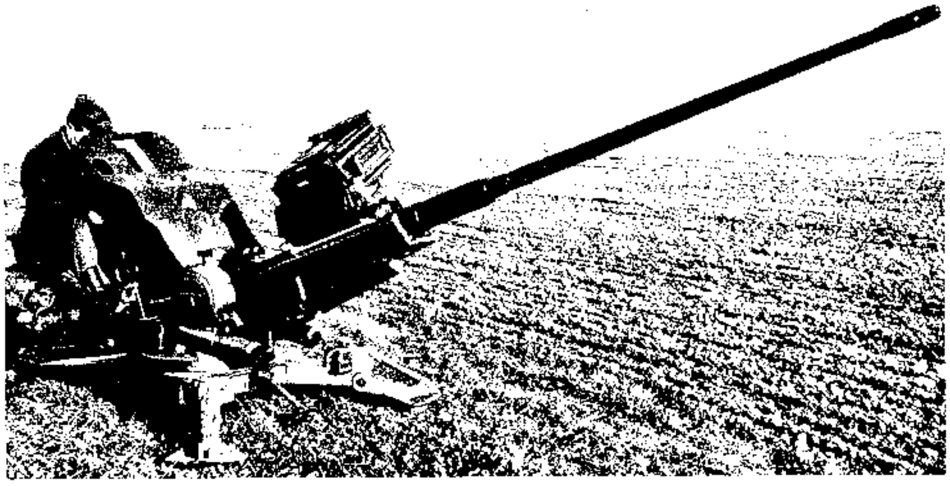
2393.103
90 mm ANTI-TANK GUNS M-50/57
DESCRIPTION:
Two 90 mm anti-tank guns are in service with the Swiss armed forces. Performances are not greatly different: but the M-57 has a longer effective range and is generally of more streamlined construction.

CHARACTERISTICS (M-57):
Calibre: 90 mm
Weight in firing order: 550 kg
Weight of shell: 3.15 kg (hollow charge)
MV: 600 m/sec
Effective anti-tank range: 800-1,000 m
Trail: spread
Penetration: 250 mm at 60° with hollow shell

STATUS:
Both weapons are in service with heavy companies of the fusilier battalions.

2380.103
30 mm ANTI-AIRCRAFT MOUNTING TYPE 661
DESCRIPTION:
This is a mobile anti-aircraft weapon system designed to be transported on a two-wheel trailer and capable of rapid deployment in the field.
The complete mounting comprises a type 831-SL M 30 mm Oerlikon cannon (**2379.103**), a type P36 Galileo mechanical fire control computer, sights for air and ground targets and hydraulic drives for elevation and traverse. The gun is arranged for feeding with linkless ammunition in clips.
Rate of fire is 650 rounds/min and the ammunition feed box contains 40 ready rounds. All-up weight is 1,500 kg.

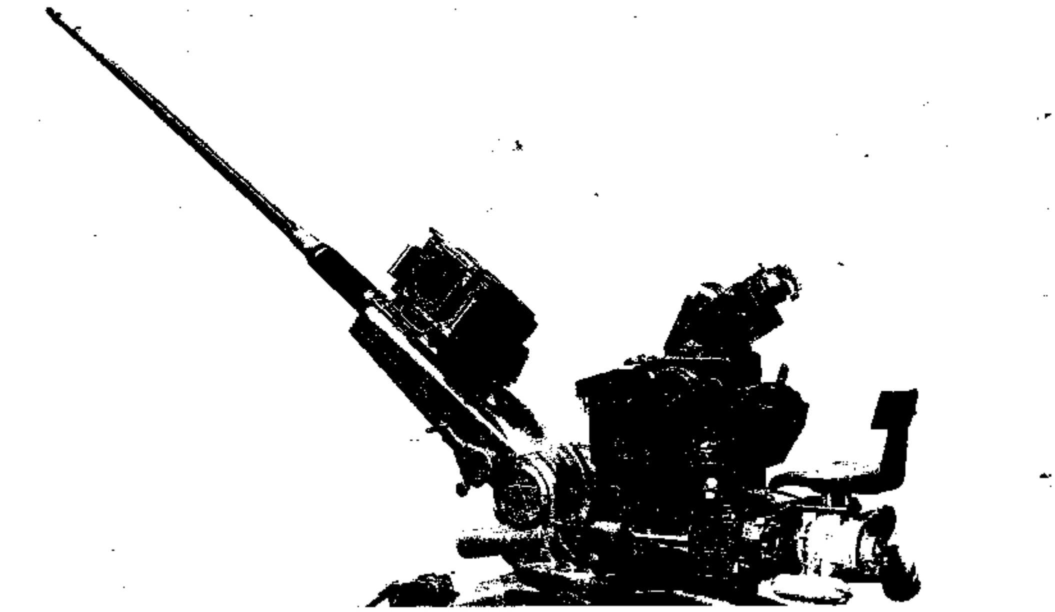
MANUFACTURER:
Machine Tool Works, Oerlikon Bührle Ltd, Birchstrasse 155, Zürich, Switzerland.


Type 661 30 mm Automatic Cannon

2342.103
34 mm ANTI-AIRCRAFT GUN M-38
DESCRIPTION:
This light and mobile gun is deployed together with smaller weapons, for the defence of airfields and hydro-electric installations against attack by low-flying aircraft. It is mounted on a four-wheel trailer and can be bought into action rapidly.

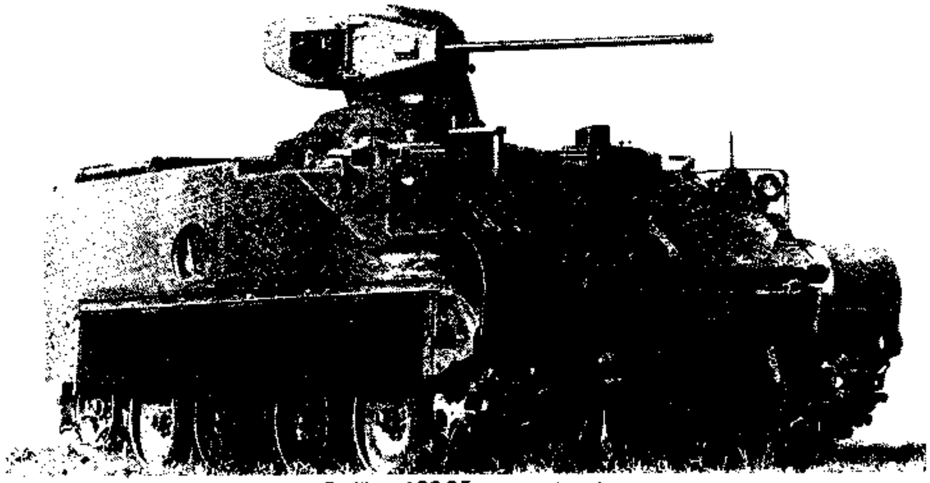
CHARACTERISTICS:
Calibre: 34 mm
Barrel length: about 60 calibres
Traverse: 360°
Weight in firing order: 2.8 t
Weight of shell: 720 gm
MV: 900 m/sec
Range: maximum 12 km
effective AA 3 km
Rate of fire: 250-270 rounds/min
STATUS:
In service as noted above.
MANUFACTURER:
Berner Waffenfabrik.

2379.103
30 mm AUTOMATIC CANNON TYPE 831 SLM
DESCRIPTION:
Cannon type 831 SLM is a derivative of the Hispano (now Oerlikon) type 831A; one major difference being that the latter fires a 420 g projectile whereas the 831 SLM fires a 360 g projectile. Other characteristics are:
Rate of fire: 650 rounds/min
MV: 1,080 m/sec
Ammunition feed: 1. linkless with clips (5 rounds per clip, 8 clips per box). 2. belt with either left-hand or right-hand feeders
MANUFACTURER:
Machine Tool Works Oerlikon Bührle Ltd, Birchstrasse 155, Zürich, Switzerland.



Type 831 30 mm Automatic Cannon

5586.103
OERLIKON 25 mm APC GUN TURRET
DESCRIPTION:
Oerlikon have developed a 25 mm gun turret which can be fitted into any type of armoured personnel carrier. The turret is equipped with an overhead mounting, is operated by one man and can be supplied either manually controlled or electrically controlled and stabilised, so that firing while on the move is possible. The turret characteristics are suitable for engaging aircraft, armoured vehicles or infantry, and versatility is increased by the possibility of a quick changeover from HE to AP ammunition. For night firing there is a built-in infra-red aiming periscope with 4-power magnification. The turret is equipped with the newly developed Oerlikon KBA 25 mm dual purpose automatic gun which has the following characteristics.
CHARACTERISTICS:
Calibre: 25 mm
Rate of fire: Selectable from single shot to 250 rds/min, max rate 750 rds/min
MV: 1,100 m/sec
Tactical range: 2,000 m
Weight of gun: 95 kg



Oerlikon APC 25 mm gun turret

Ammunition supply: 120 and 80 rds in two containers. Dual feed for AA/infantry and AP ammunition selectable without any delay in time
Weight of turret: Total, including 200 rds: manually controlled, 960 kg; electrical controlled and stabilised, 1,055 kg
MANUFACTURER:
Machine Tool Works, Oerlikon-Bührle Ltd, Zürich, Switzerland.

5587.103
20 mm AA GUN TYPE 10 ILa/5TG
DESCRIPTION:
The 10 ILa/5TG 20 mm anti-aircraft mounting is a high-performance weapon of modern design. Manually operated it is suitable not only for anti-aircraft engagements but also for ground-to-ground fire. By reducing all oscillating masses to a minimum and designing all parts as simply as possible, a very high rate of fire has been achieved. The mounting features high aiming speed, quick changeover from travel position to fire position (less than one minute) and low weight and ease of dismantling. Furthermore even the heaviest parts of the mounting can be carried by only two men.
CHARACTERISTICS:
Calibre: 20 mm
MV: 1,100-1,200 m/sec

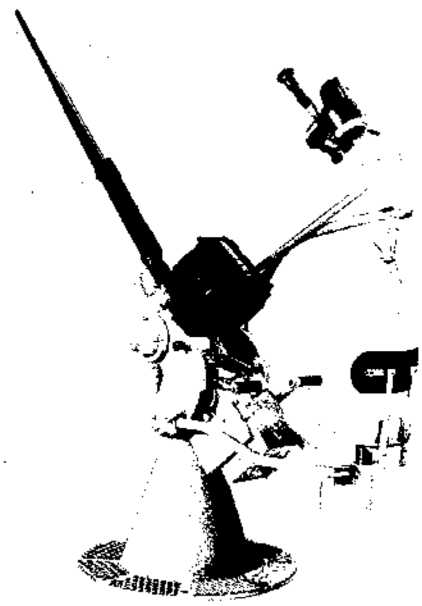
Oerlikon 20 mm AA gun

Rate of fire: 1,000 rds/min
Weight of mounting: 544 kg in travel position, 383 kg in firing position

Ammunition feed: Drum magazine containing 50 rounds
Tactical range: Up to 2,000 m

MANUFACTURER:
Machine Tool Works, Oerlikon Bührle Ltd, Zürich, Switzerland.

2381.103
20 mm AUTOMATIC CANNON TYPE 804
DESCRIPTION:
One of the most widely used 20 mm weapons, this Hispano cannon is no longer in production but is included here because it is still extensively used.
CHARACTERISTICS:
Calibre: 20 mm
Barrel length: 70 calibres
Weight: Gun without feed, 41.6 kg
Projectile weight: 120 gm
MV: 835 m/sec
Rate of fire: Up to 800 rounds/min
Recoil thrust: max 474 kg
Range: typically 1,500 m against aircraft
MANUFACTURER:
Formerly manufactured by Hispano-Suiza in Switzerland (and under licence in other countries).



20 mm Type 804 cannon on A41B mounting

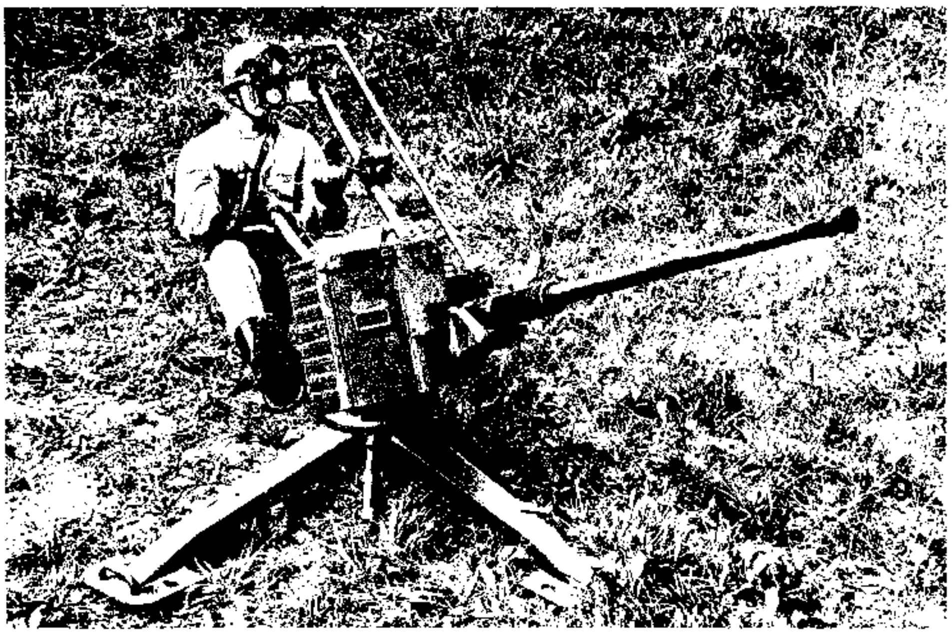
2382.103
20 mm AUTOMATIC CANNON TYPE HO 820 SL
DESCRIPTION:
This weapon is the successor to the Oerlikon 20 mm cannon type 804 (**2381.103**). Principal differences between the two weapons are the greater barrel length and the higher muzzle velocity of the later weapon.

CHARACTERISTICS:
Calibre: 20 mm
Barrel length: 105 calibres
Projectile weight: 120 g
MV: 1,050 m/sec
Rate of fire: 1,000 rounds/min
Range: typically 1,500 m against aircraft
Ammunition feed:
1. Drum magazines: 50 rounds per magazine
2. Stick magazines: 10 rounds per magazine
3. Belt feed: left-hand, right-hand or dual

STATUS:
In service – mainly in APC turrets.

MANUFACTURER:
Machine Tool Works, Oerlikon Bührle Ltd, Birchstrasse 155, Zürich, Switzerland.

2383.103
SINGLE 20 mm MOUNTING TYPE 639-B
DESCRIPTION:
This is the smallest and simplest of several mobile field mountings for the Oerlikon 20 mm cannon type HO 820 SL (**2382.103**). It is mounted on a two-wheel trailer for travelling but is quickly deployed.
CHARACTERISTICS
Gun: 20 mm type HO 820 SL
Elevation: manual
Traverse: by gunner's body
Sight: Delta-Reflex
Ammunition: 50 rounds in drum magazine or 75 rounds in belt
All-up weight: 495 kg on trailer
MANUFACTURER:
Machine Tool Works, Oerlikon Bührle Ltd, Birchstrasse 155, Zürich, Switzerland.



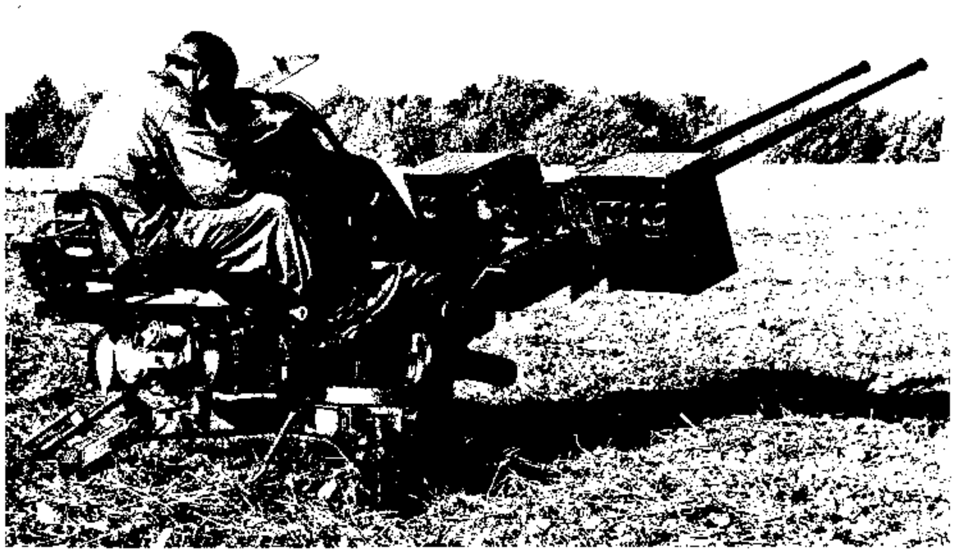
20 mm Type 639B single mounting

2384.103
TWIN MOUNTING 20 mm TYPE 666

DESCRIPTION:
Based on the Oerlikon 20 mm cannon type HO 820 SL (**2382.103**), this mounting is otherwise similar in many respects to the 30 mm cannon mounting type 661 (**2380.103**). Specifically, the mounting is equipped with the same sights, fire control computer and hydraulic drives. Like the other field mountings for this gun it travels on a two-wheel trailer.

CHARACTERISTICS:
Guns: 20 mm type HO 820 SL
Rate of fire: 2,000 rounds/min total
Ammunition feed: belt feed of 120 rounds per gun
All-up weight: 1,500 kg on trailer

MANUFACTURER:
Machine Tool Works, Oerlikon Bührle Ltd, Birchstrasse 155, Zürich, Switzerland.


20 mm Type 666 twin mounting

THE UNITED KINGDOM

5546.103
BL- 5.5 in GUN
DESCRIPTION:

The 5.5-in gun was a contemporary of the 25 pounder and was immensely popular with the Royal Artillery. It saw a great deal of service in the 1939-45 war and established a very good reputation for accuracy and lethality. It is now in service with reserve units but will shortly be phased out even from these.

It achieves a maximum range of 18,100 yards with an 80 lb shell and was used mainly in support of armoured regiments. It was also eminently suitable for counter-battery tasks. In its early days the gun had a 100 lb shell; however it was later decided to enlarge the cavity and reduce the amount of metal in the shell body: thus, the 80 lb shell was produced with a considerably higher explosive content and increased lethality.

The gun is towed by a 10-ton Leyland tractor which gives it a surprisingly good mobility. It has a very reasonable cross-country performance and can be brought into and out of action by its 10 man detachment in 3 to 5 minutes.

The split trail not only allows the detachment to load the heavy shell with ease, but also gives the gun an excellent top traverse of 30 degrees right and left. The gun also incorporates an ingenious quick loading device which enables the detachment to swing it down to a loading angle and return it to its original elevation after loading, with minimum effort and maximum speed.

The gun was not designed to have a high angle capability and is thus able to employ two compression type balancing gears mounted vertically on either side of the elevating mass.

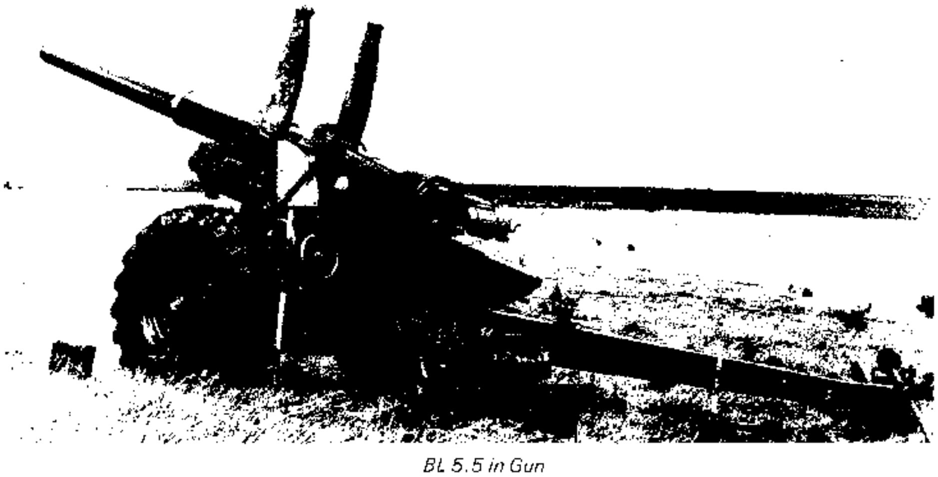
The breech of the gun combines a modified Welin breech screw with the famous Asbury mechanism. The latter was introduced in 1916. The system gives excellent strength and reliability, and although the ammunition is of the separate loading, bag charge variety, the gun has a fairly high rate of fire.

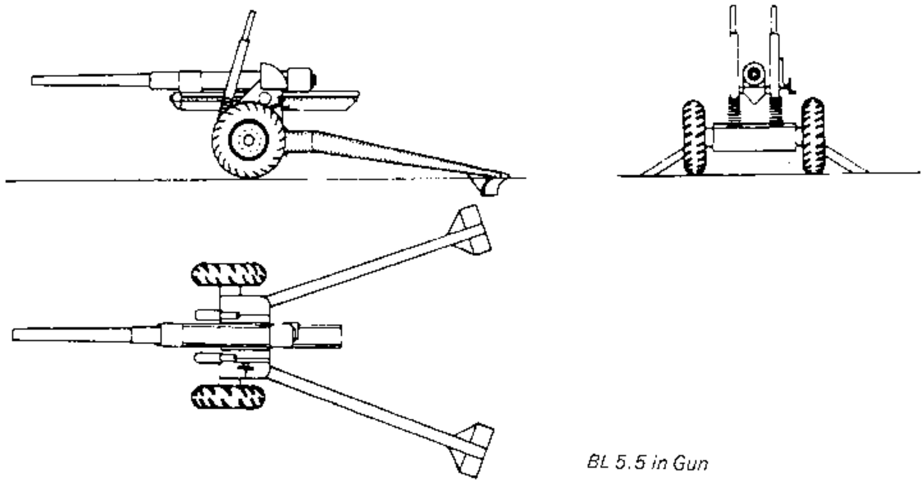
STATUS:

Reserve units of the British Army. Believed still to be in service in Burma, India, Malaysia, New Zealand, Oman, Pakistan and South Africa.

CHARACTERISTICS:

Overall length: 7.5 m
Width: 2.54 m
Height: 2.6 m
Barrel length: 4.17 m
Calibre: 5.5 in (140 mm)
Total weight: 6,184 kg
Range – max: 16,500 m
Elevation: 45°
Traverse: 60°
MV: Charge 1: 290 m/s. Charge 2: 594 m/s
Ammunition: Separate loading, bag charge
Shell: HE wt 36.4 kg, Smoke, Illuminating


BL 5.5 in Gun


BL 5.5 in Gun

2453.103
120 mm TANK GUN L11A3
DESCRIPTION:

Main armament of the Chieftain tank (**5006.102**), this gun is one of the most powerful tank weapons in current operational service and is said to be the only one capable of outranging the Russian 115 mm tank guns (but see entries **2191.103** and **2197.103**).

Separate ammunition is used, the bagged charges being fully combustible. The gun, as mounted in the Chieftain, is fully stabilised in azimuth and elevation so as to permit accurate firing while on the move; to prevent gunnery errors resulting from differential heating or cooling on opposite sides of the barrel a thermal jacket is fitted. A bore evacuator is also fitted.

CHARACTERISTICS:
Calibre: 120 mm
Barrel length: 55 calibres
Elevation: (in Chieftain) −10° to +20°
MV: APDS: 1,370 m/sec HESH: 670 m/sec
Range: (effective maximum) APDS: 3,000 m; HESH: 8,000 m
Rate of fire: 7 rounds/min
Projectile weight: 17 kg
Recoil distance: 356 mm

STATUS:
In service.

2451.103
105 mm TANK GUNS L7A1 and L7A2

DESCRIPTION:
These two guns were introduced sequentially into British Army service in the Centurion tank (**5004.102**) as successive replacements for the 20-pounder gun with which that tank was first equipped. The L7A1 gun is also used on the American M60A1 tank (**5024.102**) and a modified version built under licence in Switzerland is used on the Pz61 tank (**5031.102**). The 105 mm L74 gun used on the Swedish S-tank (**5003.102** and **2343.103**) is similar, but has a longer barrel and is modified for automatic loading.

CHARACTERISTICS:
Reliable detailed information is in short supply. The following data gives some indication of the capabilities of the two weapons.
Calibre: 105 mm
Barrel length: 51 calibres
Elevation: (on Centurion) −10° to +18°
Projectile weight: 11.3 kg
MV: about 1,470 m/sec with APDS
about 730 m/sec with MESH
Recoil: Approx 280 mm
Rate of fire: 9-10 rounds/min (Centurion)

STATUS:
L7A1 in service in Mk 10 Centurions and in some upgunned earlier marks. L7A2 is in service with Mk 13 Centurions.

2452.103
105 mm TANK GUN L7A3

DESCRIPTION:
Successor to the L7A1 and L7A2 guns (**2451.103**) this 105 mm gun is used on the Vickers Mark 3 tank (**5057.102**), the Leopard tank (**5015.102**) and the Japanese ST-B tank (**5073.102**).

CHARACTERISTICS.
Calibre: 105 mm
Barrel length: 51 calibres
Elevation: (in Vickers MBT) −7° to +20°
Weight of projectile: 11.3 kg
MV: 1,470-1,480 m/sec with APDS;
730 m/sec with HESH
Range: maximum: 36,750 m. Effective: 1,800 m APDS; 5,500 m HESH
Rate of fire: 9-10 rounds/min

STATUS:
In service.

5503.103
105 mm SP GUN ABBOT

DESCRIPTION:
Abbot is a compact and highly mobile SP gun. Its 218 bhp Rolls-Royce K60 engine gives it a speed of 48 km/h and an operating range of 370 km. It swims using its flotation screen, and can be prepared for the water in a very short time. Though smaller than its contemporaries its speed, mobility, high rate of fire and highly lethal ammunition make it highly effective. In spite of the comparatively small crew compartment 40 rounds of ammunition are carried on the gun and a further 200 can be carried in its accompanying Stalwart limber vehicle.

Firing the British-designed 15 kg alloy shel the gun is reported to have a range of 17 km. Barrel life is believed to be at least 10,000 rounds.

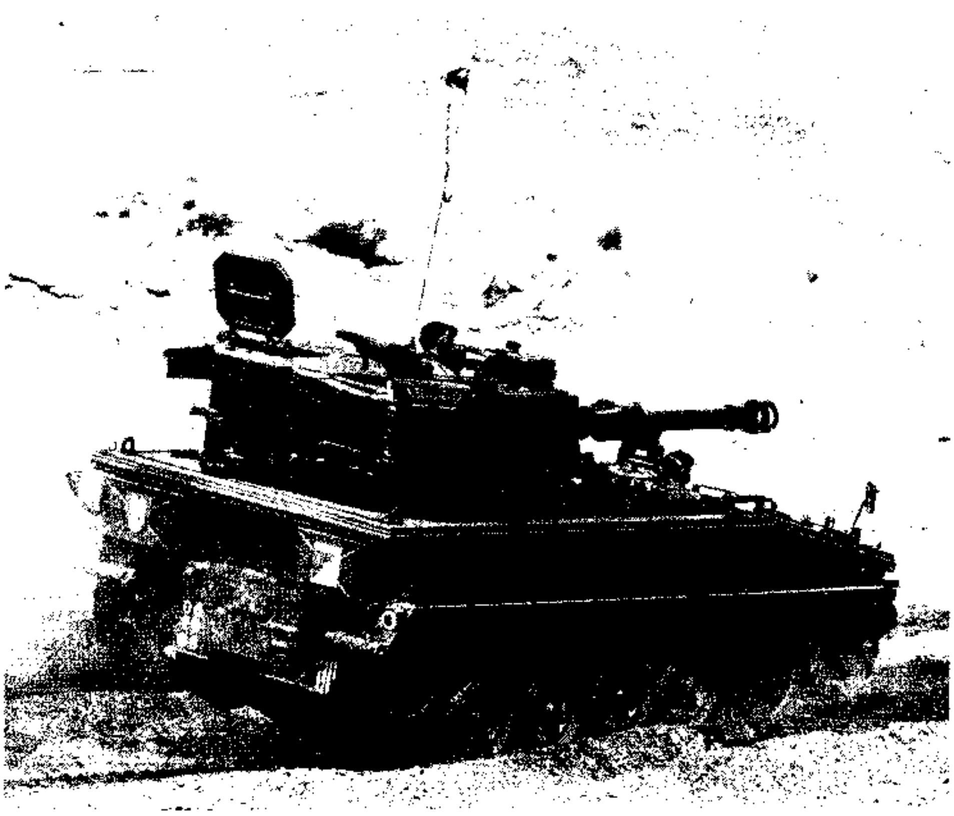
The gun detachment consists of 3 gun numbers and a driver on the gun and two ammunition numbers on the limber vehicle.

Optional equipment includes a 7.62 mm commander's machine gun which is mounted on a pintle on the turret.

STATUS:
The Abbot, FV.433 is currently in service with the British Army.

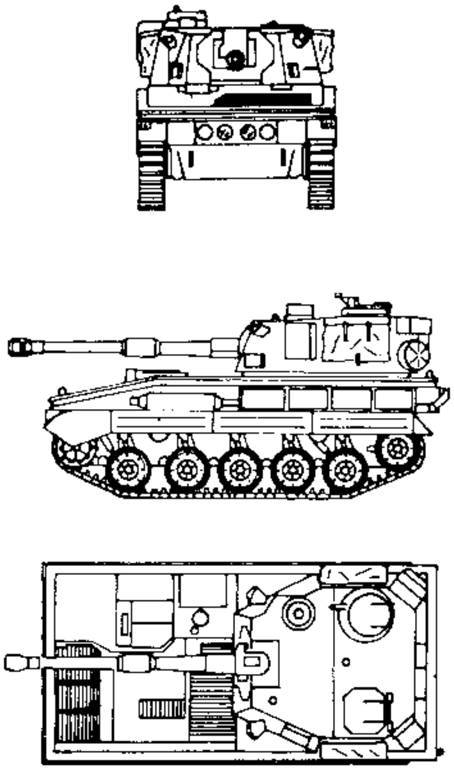
The sole manufacturers of the vehicle, Vickers Limited, have developed a less sophisticated version of the Abbot, FV.433, by removing some of the trimmings from it, e.g. power traverse and power ramming, and allied with value engineering have produced a less expensive basic vehicle named the Vickers Abbot which nevertheless has lost nothing in performance or battle-worthiness. At the option of the purchaser, any of the trimmings can be replaced at the manufacturing stage, and within limits, at a later stage.

MANUFACTURER
Vickers Ltd. Armament Division, Elswick Works, Newcastle-upon-Tyne, NE99 1CP. England



105 mm SP Abbot – 1973 picture (Christopher F. Foss)

Abbot swimming with flotation screen extended



Abbot

Characteristics:	British Army Abbot	Vickers Abbot
Crew:	4, commander, loader, gunner, driver	4, commander, loader, gunner, driver
Weight (Battle):	17.527 kg	16.800 kg
Height:	2.68 m	2.6 m
Length Overall:	5.77 m	5.7 m
Width:	2.67 m	2.6 m
Road speed:	48 km/h	48 km/h
Range:	370 km	370 km
Armament main:	105 mm	105 mm
Armament auxiliary:	7.62 mm machine gun	Optional equipment
Ammunition 105 mm:	40 rounds mixed HE, HESH	36 rounds mixed HE, HESH
Ammunition 7.62 mm	1,200 rounds	Optional equipment
Engine:	Rolls-Royce K60 multi-fuel 6-cylinder turbo charged 2 stroke	Rolls-Royce K60 diesel only 6 cylinder turbo charged 2 stroke
BHP:	211/213 at 3,750 rev/min	211/213 at 3,750 rev/min
Power weight:	12.5 bhp/ton	12.6 bhp/ton
Transmission:	Allison Torqmatic Gearbox Cletrac Steering unit	Allison Torqmatic Gearbox Cletrac Steering unit
Ground pressure:	0.86 kg/sq cm	0.84 kg/sq cm
Vertical Obstacle:	0.6 m	0.6 m
Maximum trench:	2.06 m	2.06 m
Maximum gradient:	30°	30°
Wading without preparation:	1.2 m	1.1 m
Flotation:	Collapsible Screen	Optical equipment
NBC protection:	Pressurised Air Conditioning and Filtration System	Optional equipment
Night vision:	IR filtered headlights IR driver's sight available in future	IR filtered headlights IR driver's sight available in future

5505.103
105 mm LIGHT GUN

Description:

The 105-mm Light Gun is a close support weapon which has been designed to provide the range, mobility and firepower required in limited war conditions from the Arctic to the Tropics.

The gun fires a 15 kg shell with a range of 17,500 metres. On its wheels it can be towed at a high speed, yet be in action within one minute of arriving at the gun position. The elevating mass can be removed to give two light helicopter loads, and the gun reassembled with simple tools in less than 30 minutes.

Its low silhouette and fast all round traverse give it an effective anti-tank performance using a HESH shell. Also, the gun can be linked to the FACE fire control system (**2415.153**).

The gun is fitted with an efficient muzzle brake which does not cause crew discomfort and for cleaning purposes is readily removable. The barrel is of totally new design, being of thin-walled auto-frettaged construction in high yield steel. Barrel wear is negligible so that muzzle velocity should vary very little during the life of the gun.

A vertical sliding block, hand operated breech mechanism of advanced design is actuated by a lever mounted at the top, affording smooth breech opening at all elevations and permitting easy removal of the breech block for cleaning.

The hydro pneumatic recoil system has a separate recuperator and the buffer is fitted with cut-off gear to reduce the recoil length from 45 in to 20 in at full elevation.

A recoil pit is not necessary.

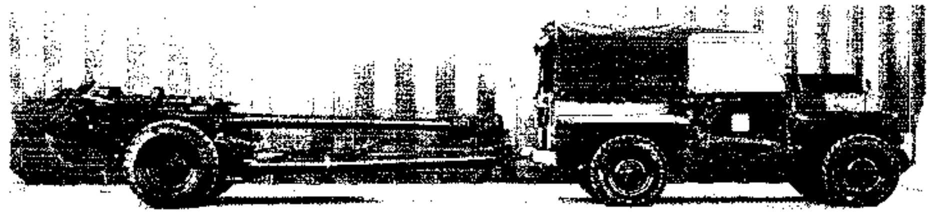
The recoil system is mounted in a light weight fabricated cradle, which carries the elevating arc and a simple helical compression spring balancing gear.

The saddle is a light weight fabrication, on which the elevating mass is carried. It provides a top traverse of 100 mils left and right.

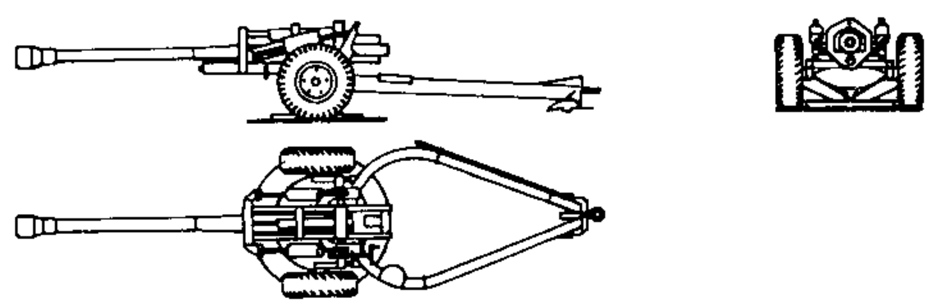
The direct and indirect sighting system and controls are operated by the layer whilst seated and all controls including the firing lever are immediately accessible to him from this position.

A direct fire telescopic sight, incorporating a moving illuminated graticule which is adjustable in both the X and Y axes to allow for target movement and range, is fitted.

105 mm Light Gun, firing attitude



105 mm Light Gun, towing attitude



105 mm Light Gun

Two knobs on the sight carrier set the angle of sight and tangent elevation for indirect fire and their values appear in two windows. The gun is then elevated until two pointers are matched in a third window.

This advanced sighting system is provided with Trilux nuclear light sources, illuminating all scales and graticules, therefore eliminating the use of any batteries on the equipment.

The trail is fabricated in high strength stainless steel and is bow shaped to enable the breech operator and loader to remain within the trail and maintain a high rate of fire at all elevations. The shape also allows the platform to be conveniently stowed within the trail during travelling.

The platform is a circular light weight fabrication with a toothed rim which gives a firm base and permanent gun stability even under the most adverse ground conditions.

The tyres run on the outer edge of the platform which is connected to the underside of the gun by two links. This arrangement ensures stability when firing and ease of traverse. The links are also used as front gun stays when the equipment is in the forward area towing attitude.

AMMUNITION:

Charge System.

The charge system is developed to give very long barrel life together with good accuracy. It consists of a five charge cartridge with range overlaps from the minimum range of 2,500 m to a maximum of 17,500 m.

HE Shell:

The standard HE shell is of forged steel, but to meet the requirements for increased lethality against troops in the open a shell with a body of spheroidal graphite cast iron is under development.

US 105 mm Ammunition:

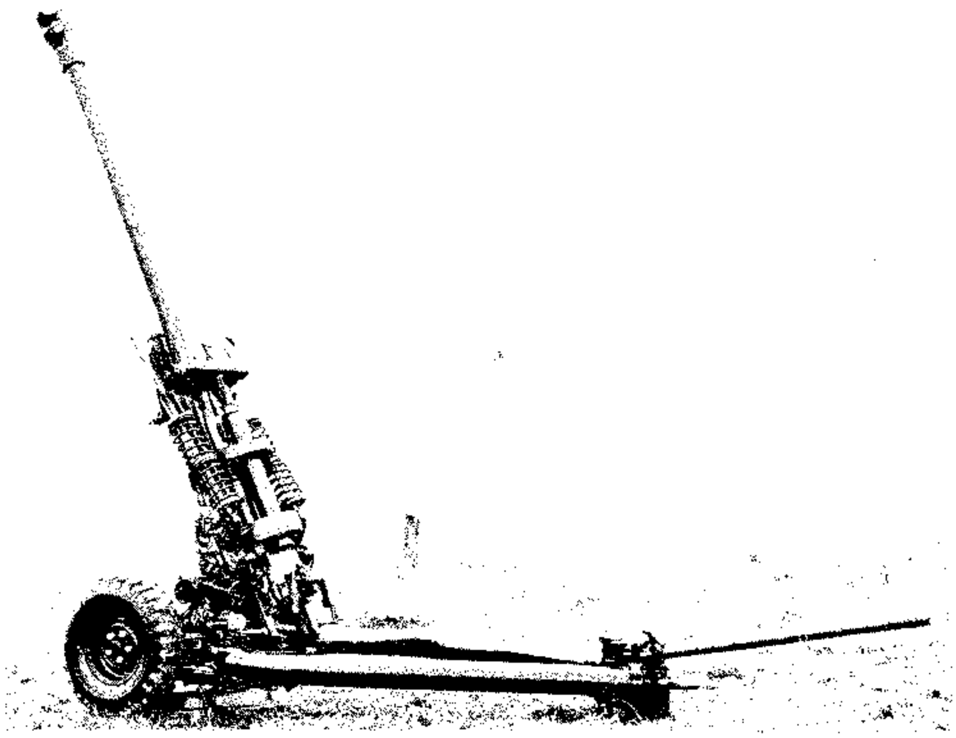
US 105 mm ammunition, including the pre-World War 2 Mk 1 ammunition can be fired by using a completely interchangeable percussion fired ordnance.

STATUS:

Now entering British Army service.

MANUFACTURER

Director of Sales (Army), Ministry of Defence, St. Christopher House, Southwark Street, London S.E.1.



105 mm Light Gun, firing attitude

2489.103
3.7-INCH AA GUN

DESCRIPTION:

Developed just before World War II this was the mainstay of the British HAA artillery during the major part of that war and was sometimes used, in its mobile versions, as an anti-tank weapon. Three marks of the gun were produced – varying mainly in the design of the tube jacket – and there were four mounts differing in the associated sighting, loading and running equipment. A substantial number of these guns were installed on fixed sites (or temporarily fixed "mattress" sites during the "Diver" operation against German V.1 weapons) for the air defence of Britain.

The highest mark of this gun in service was the Mark 3: the 3.7-inch Mark 6 was not basically a 3.7-inch weapon – it was a 4.5-inch HAA gun lined down to fire 3.7-inch shells in an attempt to deal with high-flying aircraft out of normal 3.7-inch range.

CHARACTERISTICS:

Calibre: 94 mm
Weight (travelling): 9,200 kg
Elevation: –5° to +90°
Traverse: 360°
Range: 18,800 m horizontal, 12,000 m vertical – but effective vertical range about 9,000 m
Rate of fire: 20 rounds/min with No 11 mechanical fuse-setter (MFS) and a good crew
Ammunition: HE, AP or shrapnel
MV: 792 m/s (HE)
Penetration: 117 mm at 30° and 914 m

STATUS:

No longer in British service. Believed still used by Burma, Egypt, India and Malaysia.

5502.103
25 POUNDER GUN

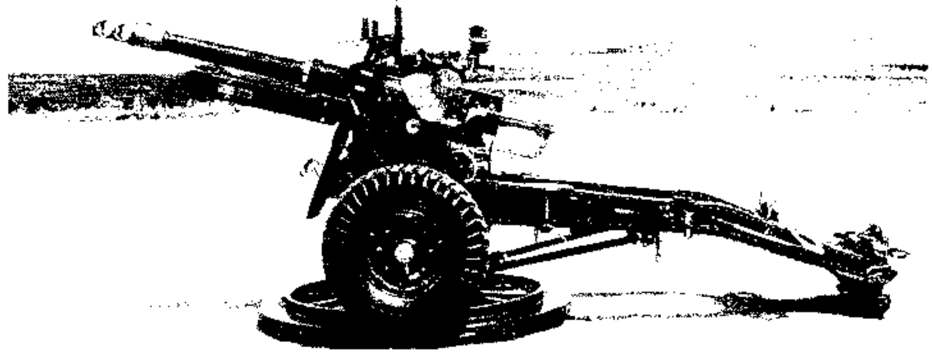
DESCRIPTION:

This well-known and well-used gun is no longer in service with the Field Force units of the Royal Artillery, but some survive in Reserve units and the weapon appears in the equipment schedules of armies all over the world. First designed in 1935, the 25-pounder was a development of the 18-pounder which had equipped the British Army of World War I, and by 1940 it had replaced its predecessor only to repeat history by fighting through another World War. The last significant modification was incorporated in 1943, since when the gun has been virtually unchanged.

It is a sturdy, simple and rather heavy equipment, with a reasonable range and the ability to fire in the upper register, although the higher angles of elevation require some preparation to the gun pit if they are to be achieved. A shield is fitted, although this was removed on some air-portable versions. One drawback throughout the life of the 25-pounder was its weight, and a satisfactory airborne version was never achieved. For the same reason a powerful towing vehicle is required. The cross country mobility of any towed gun is usually in doubt, and the 25-pounder was no better than most. Curiously, a satisfactory self-propelled version never emerged, probably because a special chassis was not produced and the pressures of war or the economies of post war could allow nothing other than a roughly modified tank as a carriage. The gun served nearly all its life as a towed equipment, in the British Army generally pulled by a 3 ton lorry.

The ammunition is semi-fixed, allowing a range of charges, and a wide variety of shell was produced. The North African campaign gave rise to an anti-tank round, and to reduce the recoil from this round a double baffle muzzle brake was fitted, and has remained on all subsequent production guns.

When the gun is brought into action a circular platform is lowered from its travelling position (suspended beneath the trail) and the wheels of the gun are pulled back onto it as shown in the photograph. The platform is secured to the trail by two tie-rods which are hinged for folding into the travelling position. The platform digs into the ground and takes much of the firing load off the spade which is fitted with a 'shoe' to prevent it digging into the ground. Thus the spade and box trail may easily be lifted by one man and the gun swung round on its platform to give very swift traverse through 360 degrees.



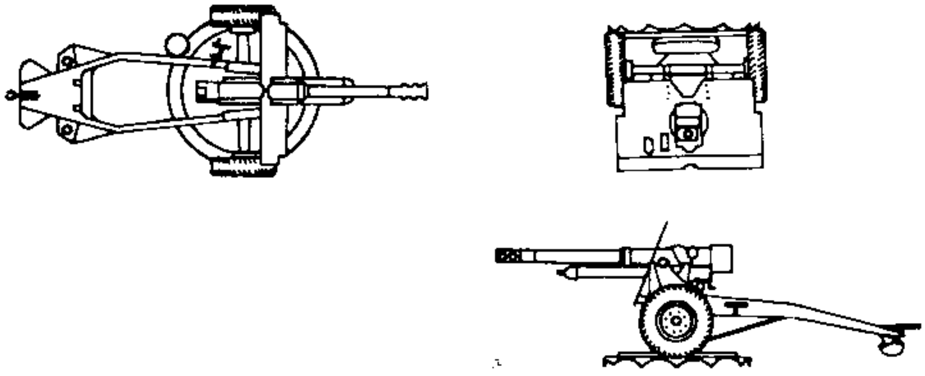
25 Pounder Gun on No. 9 Platform

CHARACTERISTICS:

Overall length: 4.65 m
Width: 2.13 m
Height: 1.69 m
Barrel length: 2.48 m
Calibre: 88 mm
Total weight: 1,741 kg
Range – max: 12,252 m
Elevation: 45°
Traverse: 45° on carriage
MV: Charge 1: 198 m/s, Charge 2: 533 m/s
Ammunition: Semi-fixed

Shell: HE weight for all shell, 11.3 kg, Smoke, Target Indication, Illuminating, APDS, Carrier (i.e. chemical, etc)
STATUS:
Reserve units.

COUNTRIES SUPPLIED:
Commonwealth, Portugal. Most countries of the Middle and Far East.



25-pdr

2486.103
17-POUNDER ANTI-TANK GUN

DESCRIPTION:
No longer in British Army service but still used in several countries, the 17-pounder (76 mm) anti-tank gun was developed in 1940/41 and entered service in 1942. Some early models were mounted on a 25-pounder (**5502.103**) carriage and there were various SP versions. Basic data of the Mark 1 version are given below: the weapon has a distinctive low-silhouette carriage and scalloped-top gunshield and is fitted with a double-baffle muzzle brake.

CHARACTERISTICS:
Calibre: 76.2 mm
Weight (travelling): 3,040 kg
Width (travelling): 2,255 mm
Length (travelling): 7,540 mm
Height (travelling): 1,676 mm
Elevation: $-6°$ to $+16.5°$
Traverse: 60° total
MV: 950 m/s standard
Range: 10,520 m
Rate of fire: 20 rounds/min
Penetration (APDS): 222 mm at 1,000 m

STATUS:
Believed still in service in Burma, Egypt, Israel, Pakistan and South Africa.

2487.103
6-POUNDER ANTI-TANK GUN

DESCRIPTION:
Developed around the outbreak of the Second World War as a replacement for the 2-pounder ant.-tank gun, the 6-pounder (57 mm) was used both as a tank gun and in an anti-tank role.
The design was also taken up by the USA where it was produced as the M-1 57 mm gun. Some vehicle mounted versions were also produced.
CHARACTERISTICS:
Calibre: 57 mm
Weight (travelling): 1,224 kg
Length (travelling): 4,724 mm
Width (travelling): 1,889 mm
Height (travelling): 1,280 mm
Elevation: $-5°$ to $+15°$
Traverse: 90° total
MV: 900 m/s standard
Range: 8,990 m
Rate of fire: 20 rounds/min
Penetration: 118 mm at 475 m

EMPLOYMENT:
No longer in British or US Army service but still in service in many countries, some of which have the American M-1 weapon.

2455.103
40 mm LIGHT ANTI-AIRCRAFT GUN

DESCRIPTION:
This British version of the L/70 Bofors 40 mm AA gun (**5528.103**) is, despite the introduction of light guided weapons, still extensively used in the British armed forces. Mounted on a high-speed four-wheel trailer it can be brought into action quickly and equally quickly taken out again. Mainly used for the protection of airfields and other military installations, it can also be used effectively against ground targets.
CHARACTERISTICS:
Calibre: 40 mm
Barrel length: 70 calibres
Elevation: $-5°$ to $+90°$
Traverse: 360°
Weight in combat order: 4.5 t
Weight of projectile: 0.96 kg
MV: 1,000 m/sec
Range: effective AA: 4,100 m; effective ground 4,600 m
Rate of fire: 250 rounds/min
Crew: 2 gun-layers; two ammunition numbers on the gun
Ammunition: HE tracer with percussion and self-destroying fuse
Ready rounds: 16 in magazine plus 48 in racks
STATUS:
In service. Currently being replaced in some places by the Rapier missile system (**2424.131**).

Men of the RAF regiment man a 40 mm LAA gun at Belize airport, British Honduras

5504.103
RARDEN 30 CANNON

DESCRIPTION:
The Rarden 30 mm automatic cannon has been developed to meet a need for a versatile weapon which, with suitable ammunition can perform a variety of roles.
For the British service it is mounted in the Fox armoured car (**5064.102**) and the Scimitar derivative of the Scorpion light tank (**5040.102**). It is also suitable for mounting as secondary armament in a main battle tank or in small naval craft or helicopters.
The cannon is primarily a compact single shot self-loading weapon, but it is also capable of firing automatically at a rate of approx 120 rounds per minute. The full load is 6 rounds, 5 in the feed way and 1 in the chamber. The clips of three rounds will fully load the weapon. Careful assessment indicates that this is more than enough for a successful engagement of typical light armour targets. Additional rounds could not be used in the short span of an air engagement. The gun is normally loaded by the gunner. If a loader is available, continuous aimed fire is possible.
Hand cocking, by rotating a small handle, is required only at the start of action. The breech is held open on firing the last round and closed by pressing a catch after reloading the magazine.
The gun fires with the breech locked by operating an electric switch. Only the solenoid and firing hammer move, giving immediate response, with minimum disturbance of the lay of the gun. Mechanical firing is also available.
All recoils and other operations take place within a closed casing. The spent cartridge cases are ejected forward out of the turret, reducing toxicity hazards to the minimum and dispensing with the need for bulky ventilation machinery an

important feature when considering a weapon to operate from armoured vehicles in radioactive areas.

As the rounds are fed in from the rear, the gun need protrude only nine inches into the turret. Access to the feeding and breech mechanism is nevertheless excellent. The top part of the casing can be removed completely in seconds without tools, conveniently carrying with it all the feed mechanism for maintenance and inspection. The breech mechanism is then fully revealed and the recoil system can be examined. A jammed round can be cleared by lifting open the top and reaching inside the casing.

As the whole mechanism is enclosed, there is no difficulty in operating in dirty and wet conditions.

AMMUNITION:

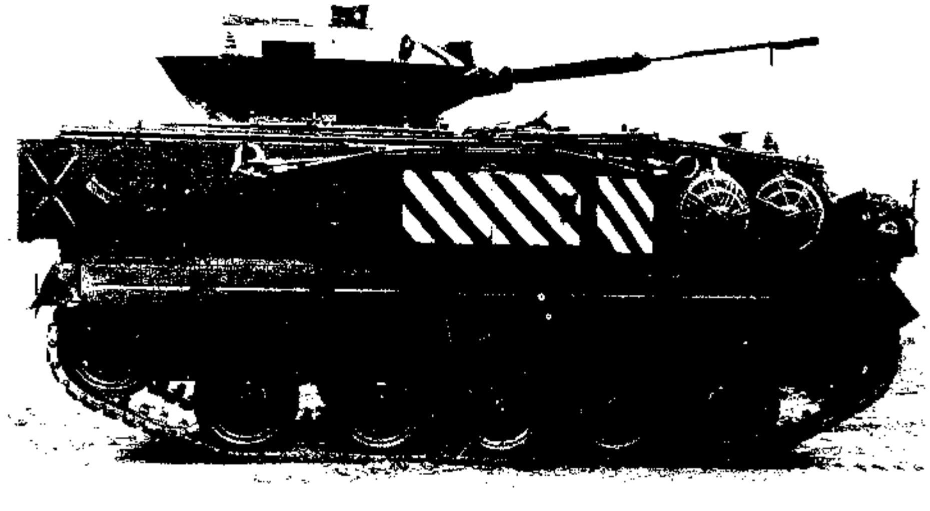
To achieve the outstanding performance of the Rarden 30 against armour an Armour Piercing Discarding Sabot (APDS) round has been developed by the Royal Armament Research and Development Establishment.

For other roles standard Hispano Suiza 831 L ammunition is available. The gun was deliberately designed to take this existing family to ensure that quick development of the system was not delayed by any problems of ammunition development.

For the Rarden 30, although all HS 831 L rounds can be fired, tracered ammunition is considered essential, to enable the aim of each round to be corrected.

CHARACTERISTICS

Overall length: 2.80 m
Inboard length when mounted: 230 mm
Weight: 100 kg
Trunnion loading: 1,360 kg
Ammunition: HS 831 L ammunition, HE, AP, Practice, RARDE APDS
Weight of complete round: 870 gm (HS 831) 780 gm (RARDE APDS)



Rarden 30 mounted in Fox turret on FV 432

Rarden 30 cannon

MV: 1,080 m/s, HE and Practice, 1,100 m/s, AP, 1,200 + m/s, RARDE APDS

STATUS:
In service.

SOURCE:
Director of Sales (Army), Ministry of Defence, St. Christopher House, Southwark Street, London S.E.1.

2454.103
SINGLE 20 mm PEDESTAL MOUNTING TYPE A41 B FOR LAND ROVER

DESCRIPTION:

Derived from the A41 naval mounting for the HS 804 20 mm cannon, the A41 B is the second of two single pedestal mountings developed for mobile operations in Land Rover vehicles. This model differs from the first, A41A, mainly in the provision of a seat for the gunner and in the control and sighting arrangements.

The gun is mounted on a conical pedestal and is controlled in elevation by two horizontal handgrips located above the rear of the gun cradle. The trigger rotates round the axis of the left handgrip. Traverse is achieved by leg action by the gunner: the seat is adjustable to enable him to traverse the gun comfortably. An unusual feature of the mounting is the displacement of the sight from the gun cradle: this is done to enable the gunner to use the sight comfortably at all elevation angles, the sight line being maintained parallel to the gun line by means of a mechanical linkage.

Although designed primarily for installation on a Land Rover, the weapon can obviously be installed readily on any larger open vehicle.

A41 B 20 mm pedestal mounting on Land Rover

CHARACTERISTICS (Type A41 B):
Cannon: HS 804/70 20 mm
MV: 835 m/sec
Rate of fire: max 800 rounds/min
Weight of cannon: 41.6 kg without feed mechanism
Feed mechanism: 60-round drum magazine. Empty weight 12.5 kg
Weight of mounting: 188 kg
Elevation arc: −10° to +50°
Traverse: unlimited

STATUS:
Production.

MANUFACTURER:
British Manufacture and Research Company Ltd, Springfield Road, Grantham, Lincs, England

2476.103
MOBAT RECOILLESS ANTI-TANK GUN

DESCRIPTION:

Now largely superseded by the Wombat (**2477.103**), this is a second generation battalion anti-tank gun. Of rugged construction, the gun can be towed on its two wheel trailer over rough country but is nevertheless readily manoeuvrable by its three-man crew. A 7.62 mm Bren LMG is mounted on the left-hand side of the barrel, the gunner's sight being mounted on the right. The gun fires off its wheels, being steadied by a short trail, and the mounting permits full 360 deg traverse.

CHARACTERISTICS:
Designation: 120 mm BAT L4
Calibre: 120 mm
Barrel length: Approx 3.2 m
Combat weight: 764 kg
Projectile weight: 12.84 kg
MV: 462 m/sec
Effective range: Approx 820 m
Crew: 3

STATUS:
Obsolescent.

2477.103
WOMBAT RECOILLESS ANTI-TANK GUN

DESCRIPTION:

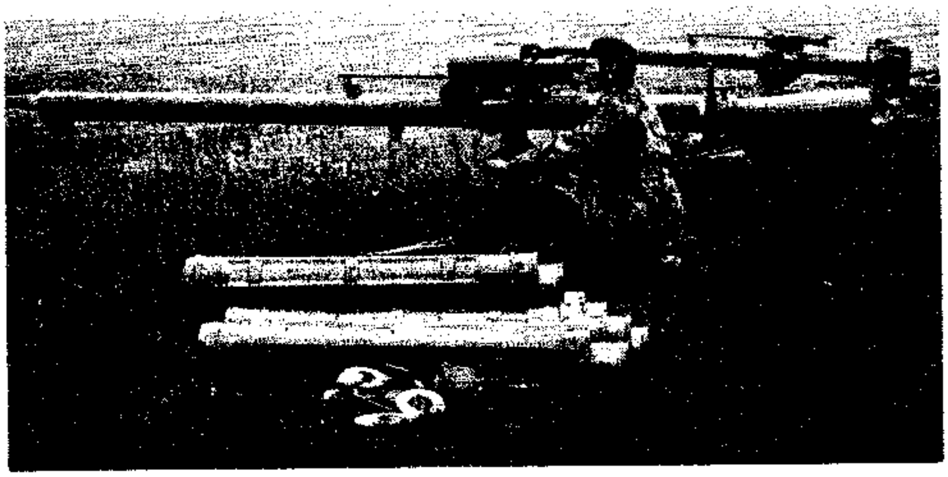
This 120 mm recoilless anti-tank weapon is the latest of its kind in service with the British Army. Significantly lighter than its predecessor, the Mobat (**2476.103**), it is designed to be fired from or transported by wheeled or tracked vehicles, the light two-wheel carriage of the portee version being intended solely for manoeuvring into or out of a firing position and not for cross-country towing. Other changes from Mobat include a new optical battle sight and a powerful 12.7 mm (Remington) spotting rifle which enables moving targets to be engaged up to 1,000 metres and stationary targets up to 1,450 metres.

CHARACTERISTICS:

Designation: 120 mm BAT L6
Calibre: 120 mm
Barrel length: 3.86 m
Combat weight: (Portee version) 295 kg
Projectile Weight: 12.84 kg
MV: 462 m/sec
Effective range: 1,000-1,500 m

STATUS:

In service.



Wombat. The weapon in the foreground is fitted with the S330 Crew-served Sight made by Rank Precision Industries

THE UNITED STATES OF AMERICA

5523.103
8 inch SP HOWITZER. M-110

DESCRIPTION:

The M-110 was introduced in 1962 as a replacement for the M.55. Design work was begun in 1957 by the Pacific Car and Foundry Company and the first models were delivered to units in 1962. The M-110 shares the same chassis as the M-107 175 mm gun, only the barrels being different. Both versions came into service together. The design was intended to improve the mobility of the M-55 and in particular, to reduce the weight.

The M110 chassis is comparatively small and very low. The flat deck is not much above the level of the road wheels. The track runs on five large road wheels with the drive sprocket in the front. There is no separate idler, the track returning around the rear road-wheel, and no return rollers.

The engine is in the front of the chassis, on the right, and the driver beside it. Ground clearance is good, and the whole design quite neat. It is a departure from the M-55 in that no attempt is made to armour the fighting compartment. The crew service the gun completely in the open on the flat top deck.

The suspension is novel as it involves a single hydraulic cylinder to each wheel which combines the functions of spring and shock-absorber. It can also be locked solid when the gun is firing. Hydraulic power is used to operate the other functions required, notably the traverse and elevation, loading and ramming, and lowering and raising the large spade. An hydraulic derrick hoists the shells from ground level to the breech.

Mobility is the same as with the 175 mm gun, but the M-110 has more range. The crew is also similar, a total of 13 men of whom 5 travel in the gun vehicle, the remainder in a separate load-carrier.

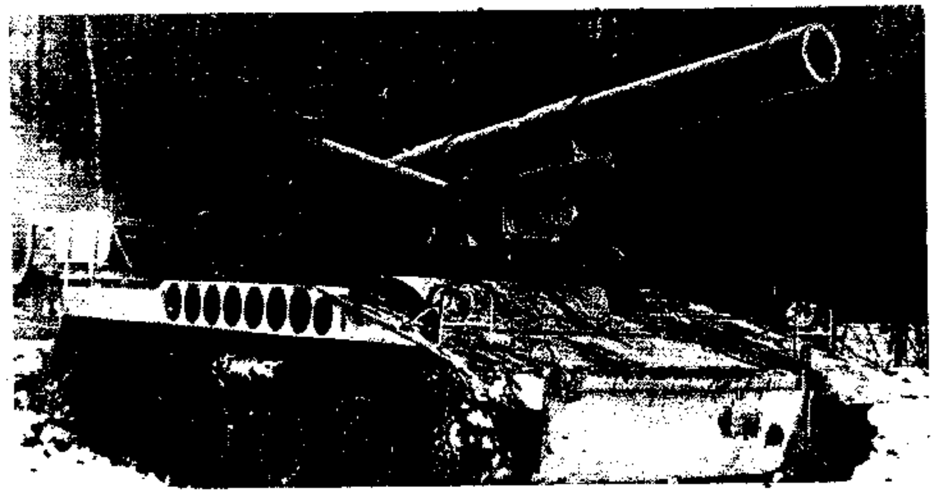
M-110 is employed as a general artillery support weapon, and is assigned down to divisions. In the divisional artillery it is found in single batteries of 4 guns. At Corps or above it is employed in battalions of three batteries, each of four howitzers.

CHARACTERISTICS:

Overall length: 7.48 m
Width: 3.14 m
Height (firing): 6.4 m
Height (travelling): 2.6 m
Total weight: 26,308 kg
Range – max: 16,800 m
Elevation: 2° to 65°
Traverse: 30°
Ammunition: Separate loading
Shell: HE, Nuclear
MV: 594 m/s
Sustained rate of fire: 1 round in 2 minutes
Speed (cross country): 14 km/h
Speed (roads): 54 km/h
Crew: 13

STATUS:

In service since 1962. Supplied also to Belgium, Iran, the Netherlands, South Korea, the United Kingdom and West Germany.



8 inch Howitzer M.110 moving through woods in Germany (US Army Photograph)

203 mm SP

5549.103
8-INCH TOWED HOWITZER M.115

DESCRIPTION:

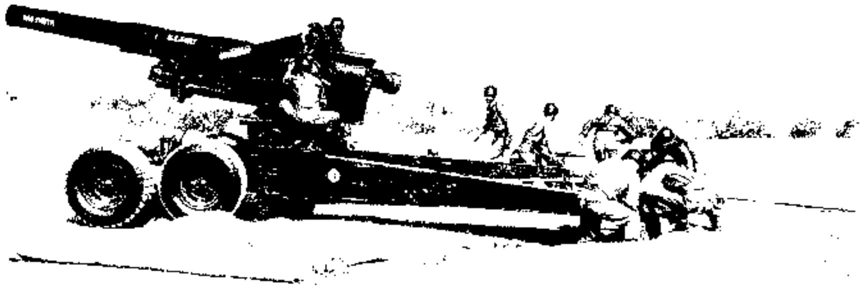
This howitzer is the towed counterpart to the M.110. The details of the performance of the howitzers are identical, and they are intended to be employed in the same manner. The M.115 is not in service in large numbers, although many are in reserve in the USA. The design is now fairly old, going back to the early 1950s.

CHARACTERISTICS:

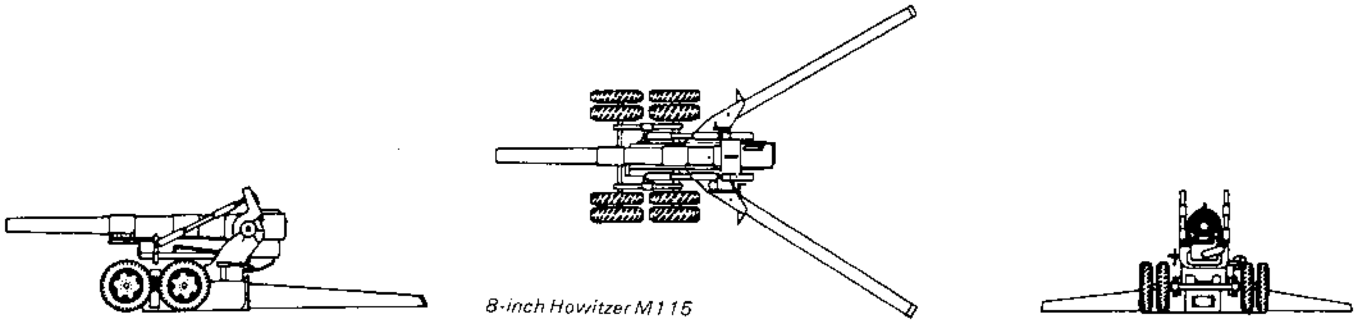
Total weight: 12,400 kg

Elevation: 2° to +65°
Traverse: 60°
All gun performance details as for M.110

STATUS:
Obsolescent. US reserve forces.
COUNTRIES SUPPLIED:
NATO countries plus India, Jordan and Spain.

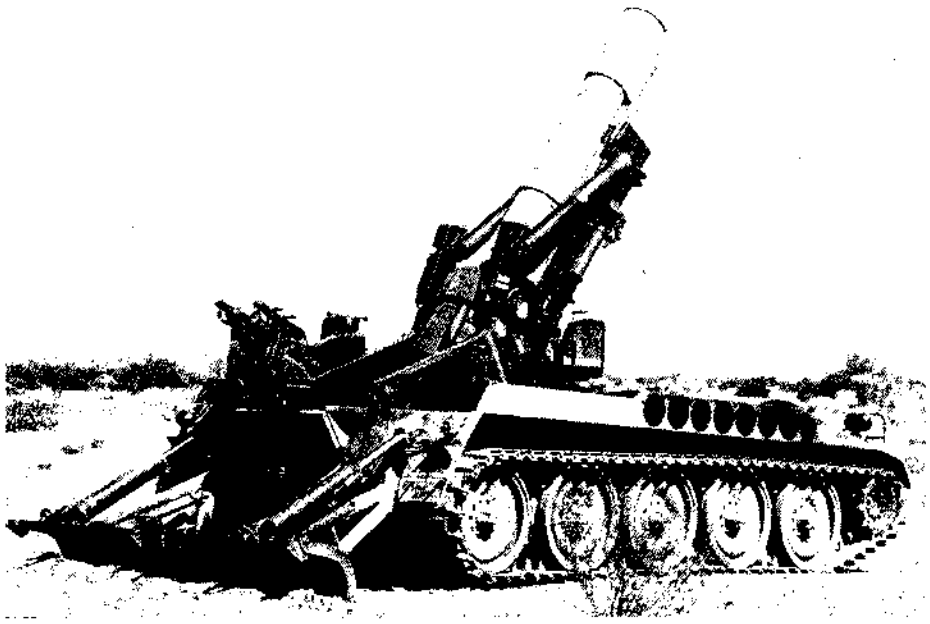


Emplacing an M.115 howitzer on a training range (US Army photograph)



8-inch Howitzer M115

5573.103
8-INCH SP HOWITZER M110E2
DESCRIPTION:
This howitzer is an improved version of the M110 (**5523.103**) and is currently being developed by the US Army Weapons Command as a follow-on system for the M110 8-inch howitzer (**5523.103**) and the M-107 175 mm gun (**5524.103**). Development began in December, 1919.
In most respects the weapon is believed to be similar to the M.110—the most obvious difference being the increase of some 2.4 metres in barrel length—and the weight has been given as something over 28,000 kg which is about 2,000 kg more than the earlier weapon. The carriage is understood to be the same as that of the M-107.
No performance details have been released, but evidently the range may be expected to be greater than the 16.8 km given for the M110. Ammunition will be HE, incendiary, nuclear, ICM (improved conventional munitions) and dual-purpose.
STATUS:
Engineering tests. It is believed that early deployment is intended.



M 110E2 8-inch SP Howitzer
(US Army photograph)

5524.103
175 mm SP GUN, M-107
DESCRIPTION:
The M-107 is one of the excellent and formidable family of heavy guns and howitzers which provide general artillery support to the field army. This particular gun was developed by Watervliet Arsenal, New York, and the general specification called for a weapon with a range and effect greater than that of the 155 mm gun. The resulting M107 has the same chassis, mounting and components

175 mm SPG Gun, in service with British Army, being driven into an action position as the 8 inch howitzer, the only difference being the very long barrel.

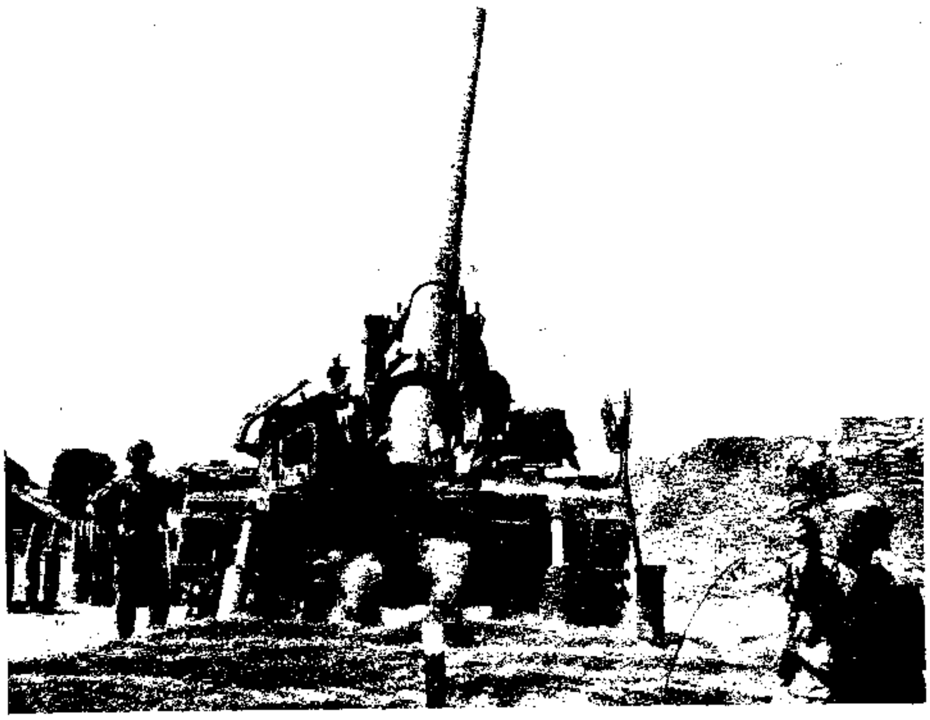
This long barrel, together with a fairly large propellant charge, gives the projectile a high muzzle velocity, and great range. The barrel life is probably quite short, but this is not known, and in any case guns of this size do not generally undertake prolonged shoots. For firing, the spades at the rear of the chassis are lowered hydraulically, and dug into the ground. The actual firing mechanism is actuated by a long lanyard.

M107 is surprisingly mobile for its size, although a ground pressure of 13.5 lb/in^2 (0.95 kg/cm^2) makes it essential for the route to be examined before the gun moves off a prepared surface. It can be dismantled and carried in large cargo aircraft, but obviously could not come into action as soon as it was landed. When travelling under its own power, it has a crew of five. The full section is thirteen men, and the remaining eight travel in a separate M 548 tracked vehicle.

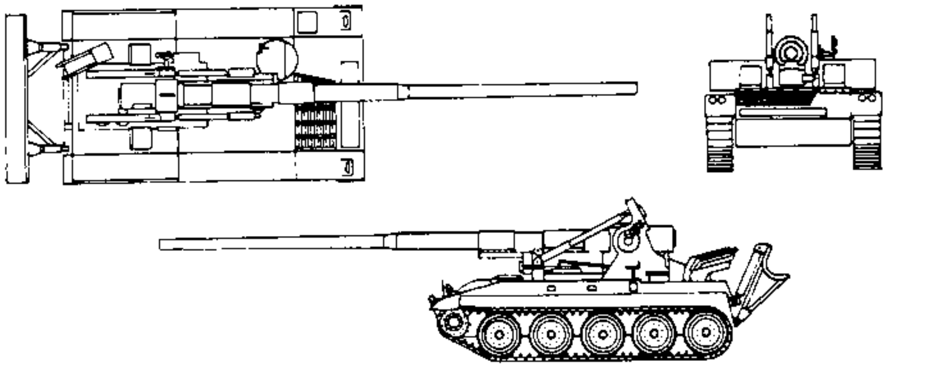
Only HE rounds are fired, and loading, ramming and breech closing are hydraulically performed, as are elevating and traversing.

CHARACTERISTICS:
Overall length: 11.30 m
Width: 3.14 m
Height: 3.47 m
Total weight: 28,165 kg
Range—max: 32,700 m
Elevation: +2° to +65°
Traverse: 30° left and right
Ammunition: Separate loading, bagged charge
Shell: HE only. Weight 66.6 kg
MV: 914 m/s
Crew: 13 (5 on the M.107 and 8 in an accompanying vehicle)
Cruising range: 725 km
Speed—max: 54 km/h

STATUS:
In service since 1962.
COUNTRIES SUPPLIED:
Federal German Republic, Greece, Iran, Israel, Italy, the Netherlands, Spain, South Vietnam and the United Kingdom.
MANUFACTURERS:
Gun: Watervliet Arsenal, New York.
Chassis: Bowen-McLaughlin-York, York, Pennsylvania



175 mm Gun, M-107 at the moment of firing. Note the spades and their hydraulic rams, the bombardier in the foreground holding the firing lanyard, and stacked shells on the left
(US Army Photograph)

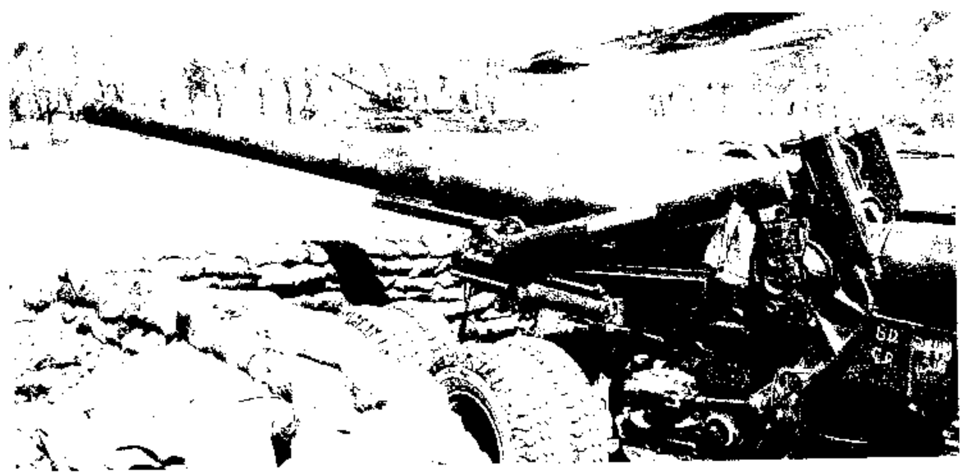


175-mm SP M.107

5506.103
155 mm GUN M2

The 155 mm Gun is an elderly weapon, having first been introduced in the late 1930s as a replacement for a 155 mm which the US Army had taken from the French in 1917. It is a good and sound design and virtually no major modification has ever been necessary to the original model.

The long range and heavy projectile make the 155 an extremely effective gun and it continues to serve in the inventory of many armies. The SP version has increased the life-span of the gun by many years, but battlefield mobility is not an outstanding virtue of the towed 155. The carriage is the same as for the 8 inch Howitzer. It is transported on four dual wheels on a bogie, and the trail is a wide-angled twin leg variety.



155 mm M.2 guns in action

CHARACTERISTICS:
Overall weight: 13,645 kg
Barrel length: 7.02 m
Elevation: −2° to +63°
Traverse: 60°
Ammunition: Separate loading. Not interchangeable with the 155 mm howitzer. Complete round weighs 56.6 kg
Shell: HE, weight 43.1 kg, Smoke WP, Chemical. There is also a two wheeled limber.

STATUS:
In service.

COUNTRIES SUPPLIED:
Austria, Argentina, Greece, Italy, Japan, Jordan, the Netherlands, Pakistan, South Korea, Spain, Turkey and Yugoslavia.
SOURCE:
Department of Defense, The Pentagon, Washington 25 DC.

5510.103
155 mm HOWITZER M.114A1

DESCRIPTION:

The M.114A1 Howitzer provides general supporting fire and it is normally assigned to the Divisional Artillery of Infantry Divisions and Corps artillery battalions. It is not a new design, but is robust and sturdy with a good performance for its size and weight. It was developed by the Rock Island Arsenal and so far about 6,000 have been made. Many have been transferred to NATO and other allies through the Military Assistance and Sales Programme.

For firing, the carriage is jacked up until the wheels clear the ground, and the jack shares the firing stresses with the trails and spades.

For moving, the howitzer is normally towed by a 5 ton truck or high-speed tractor.

There are several variations of this howitzer, all having the same general characteristics.

A version with auxiliary propulsion, known as the M-123A1 is illustrated here. The howitzer is driven by an internal combustion engine mounted on the trail. The drive is transmitted to the large dished plates on the outside of the wheel hubs. A speed of 4.5 mph (6 km/h) is claimed.

Similar attempts at low-speed self-propulsion have been tried by other armies, but generally the power output of the engine is insufficient to drive the gun on any but smooth level surfaces. The system shown in this photograph drives by hydraulics, and is said to give the howitzer good cross-country mobility. It is unique in that it drives the main wheels of the carriage.

COUNTRIES SUPPLIED:

NATO and others under the Military Assistance Programme.

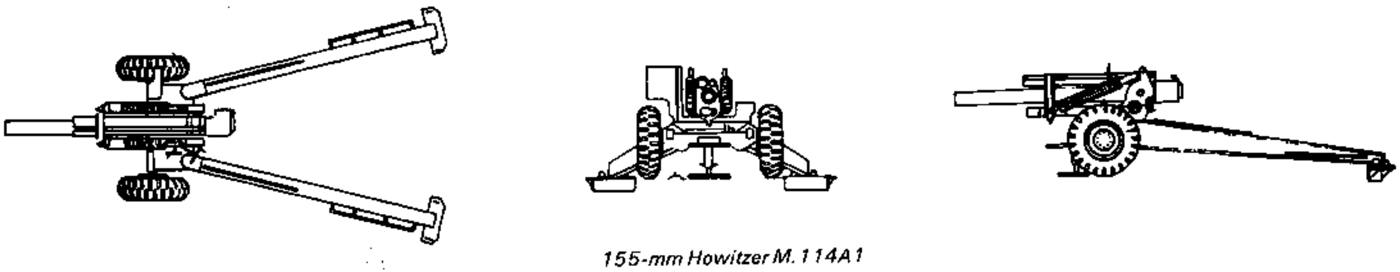
CHARACTERISTICS:

Overall length: 7.30 m
Width (trails spread): 5.7 m
Width (trails closed): 2.4 m
Height (firing): 4.5 m
Height (travelling): 1.8 m
Range—max: 14,600 m
Elevation: $-2°$ to $+63°$
Traverse: 48.7°
Ammunition: Separate loading
Shell: HE, weight 43 kg, Illuminating, Chemical, Nuclear
MV: 564 m/s
Maximum towed speed (cross country): 16 km/h
Maximum towed speded (roads): 48 km/h
Crew: 11

155-mm Howitzer M.114A1

155 mm Howitzer in a fortified firing position in Vietnam. The carriage has been raised on its jacks to permit rapid traversing through 360°. (US Army Photograph)

155 mm Howitzer fitted with integral self-propulsion unit (US Army Photograph)



155-mm Howitzer M.114A1

5571.103
155 mm LIGHTWEIGHT HOWITZER XM198

DESCRIPTION:

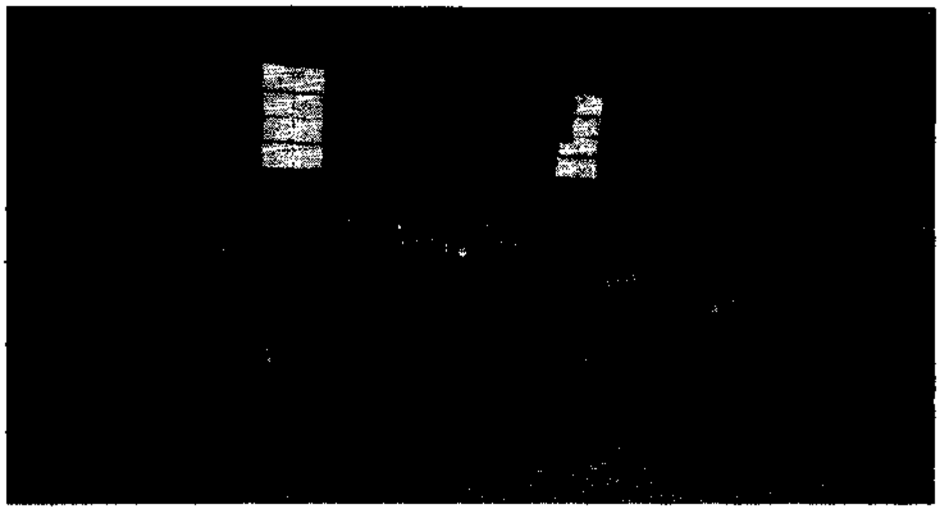
This howitzer is currently under development and is scheduled to replace the M.114A1 towed howitzer in the mid-1970s.

Lighter and with a greater range capability than the M114A1, the XM198 is said also to be more reliable. It will be employed to provide general support field artillery fire for infantry and airborne divisions during the post-1974 period, with both nuclear and non-nuclear munitions. It will also be employed in air-mobile operations using the CH-47C helicopter and the US Army light tactical transport systems as prime movers.

No performance details have yet been released for publication. It has been said that the gun will weigh not more than 6,600 kg – but since this appears to be rather more than the weight of the M114A1 it is either a deliberate exaggeration or a mistake. The main mechanical features can be seen in the accompanying illustrations.

STATUS:

Design work on the XM198 began in 1968 and engineering development started in 1970. As already noted, operational deployment is planned for the mid-1970s.



XM198 155 mm howitzer in stowed position. Note the platform secured by the trails
(US Army Photograph)

XM198 155 mm howitzer in firing position
(US Army Photograph)

5550.103
155 mm SP HOWITZER M.44

DESCRIPTION:

This howitzer is very similar to the M.52, the only real differences being in the gun and fighting compartment. The hull and chassis are identical to M.52, but the total weight has gone up, and so the automotive performance has decreased. The top of the fighting compartment is open, and normally covered by a canvas tilt, so that there is no overhead protection for the crew, nor any capability to keep out gas or nuclear attack.

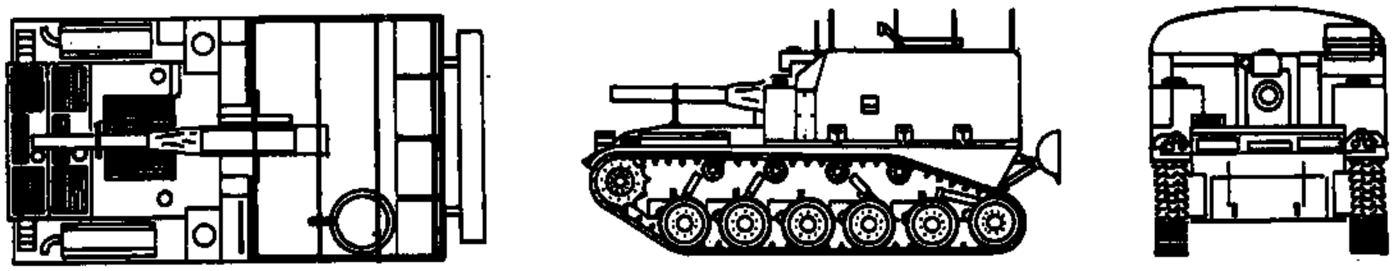
A large spade is carried at the rear. The cruising range is low, and few rounds of ammunition can be carried. The design is similar in age to the M.52, and like that gun it is now no longer in first line service in the US Army.

CHARACTERISTICS:

Overall length: 6.09 m
Width: 3.3 m
Height: 3.1 m
Total weight: 28,550 kg
Range—max: 14,600 m
Elevation: $-5°$ to $+60°$
Ammunition: US 155 mm Howitzer
Shell: HE, Smoke, Chemical
Ammunition stowage: 24 rounds
Cruising range: 120 km
Speed—max: 56 km/h

STATUS:

US Army Reserve. First line service in some NATO countries.



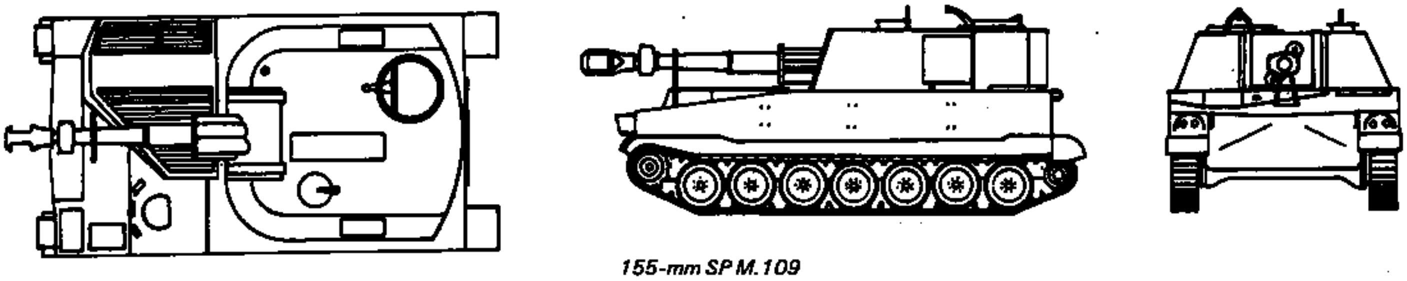
155-mm SP Howitzer M 44

5508.103
155 mm SP HOWITZER M.109

DESCRIPTION:

In all outward respects, apart from the size of the barrel, the M.109 is identical with the M.108. The chassis and power plant are the same and the only change to the hull lies in the gun mounting in the front of the turret. Naturally it is heavier than M.108. Despite its weight the gun is air-transportable in the C-124 and C-133 freight aircraft.

M.109 is used to provide general fire support and reinforcing fire to armoured and mechanised divisions, and is also available to other formations. It is the smallest gun in the US service to fire a nuclear shell. Ground mobility is roughly similar to M.108 although the cruising range is reduced somewhat. The vehicle floats in the same way.



155-mm SP M.109

Some 2,000 M.109s have been produced so far.

CHARACTERISTICS:
All leading dimensions are identical with M.108.
Total weight: 23,795 kg
Range: 14,600 m
Elevation and traverse as for M.108
Maximum speed: 55 km/h
Cruising range: 350 km
Ammunition: HE, Canister, Chemical, Nuclear. Typical shell weight 43 kg
Sustained rate of fire: 45 r.p.hr.

STATUS:
In service.

COUNTRIES SUPPLIED:
Austria, Belgium, Canada, Denmark, Federal German Republic, Iran, Israel, Italy, Libya, the Netherlands, Norway, Spain, Switzerland and the United Kingdom.

M 109. 155 mm SP Howitzer (US Army Photograph)

5570.103
155 mm SP HOWITZER M.109A1
DESCRIPTION:
The M109A1 is a retrofit modification to the basic M109 SP howitzer (**5508.103**). It was initiated by the US Army Material Command in 1966 who recommended testing modifications – including a longer barrel and a larger charge – which would extend the range of the weapon from 14,600 m to 18,000 m.

Development, by the Allison Division of General Motors Corporation, Cleveland, Ohio, began in 1967; and the modified weapon was classified Standard A in October, 1970. The barrel length increase is from 3.7 m to 6.1 m and the propellant has been improved. All M.109s are to be converted to the new M.109A1 standard.

Modifications began during Fiscal Year 1971 and the A1 version became operational in Fiscal Year 1972.

M109A1 155 mm SP Howitzer (US Army Photograph)

2833.103
152 mm TANK GUN XM162
DESCRIPTION:
Main armament of the M60A2 main battle tank (**5025.102**) and one of three gun-launchers capable of launching the Shillelagh anti-tank missile (**2809.111**) as well as being able to fire a conventional shell, this gun was caught up in the development troubles which afflicted both the missile and its incorporation in the M60 tank.

Although it seems that the gun-launcher, when ultimately deployed in the M60A2 tank, functioned satisfactorily within the limits of its specifications, the inability of such a gun to fire a kinetic energy round is a severe limitation in tank applications: it means that most anti-tank operations have to be conducted using the missile – which tends to defeat the object of having a dual-purpose weapon. In this connection it is interesting to note that the French ACRA gun-launched missile project (**2071.111**), although in many respects different from the Shillelagh project, has also been shelved.

The M60A2 tank is now in service in small numbers – and indeed it was never envisaged that the numbers would be large, since the tank was intended only as a stopgap pending the introduction of the ill-fated MBT-70 (**5029.102**). The bulk of the Shillelagh gun-launchers currently in service is made up of those mounted on the 1,662 Sheridan tanks (**5030.102**). The Sheridan gun-launcher is the XM-81 which is very much like the XM162 and suffers from the same drawbacks as a conventional gun – a short barrel, with consequent low MV suitable only for shaped-charge projectiles (and hence lack of variety because the Shillelagh warhead is similar), and an inconveniently large bore.

In the Sheridan vehicle the 152 mm round is unpopular with crews because the recoil forces are very large in relation to the size of the vehicle. This is less of a problem in the M60A2 tank; also it is said that the XM162 gun is easier to set up and maintain and more reliable than the earlier weapon.

For the MBT-70 a different gun-launcher, the XM150, was developed. This had a longer barrel and could fire both medium velocity HE projectiles and high-velocity APFSDS rounds. For the MBT-70 successor, however, a conventional tank gun has been specified.

5511.103
105 mm TOWED HOWITZER M.101A1
DESCRIPTION:
The M.101A1 is the standard general purpose close support light artillery weapon of the US Army. It is now obsolescent and being replaced by more modern SP equipments, or the lighter and improved M.102 towed howitzer. The design dates back to the years immediately after World War 2, and production ceased at Rock Island Arsenal in 1953. By that time 10,202 had been produced and issued. Since then the howitzer has been employed in many armies all over the world. It is simple, reliable and rather heavy.

The design follows conventional patterns, and there is little that is remarkable in it. It will probably remain in the reserve units of the US Army for some years, and continue in first line service elsewhere in the world. It was designed to fire the M.1 ammunition system, and very large stocks of this remain.

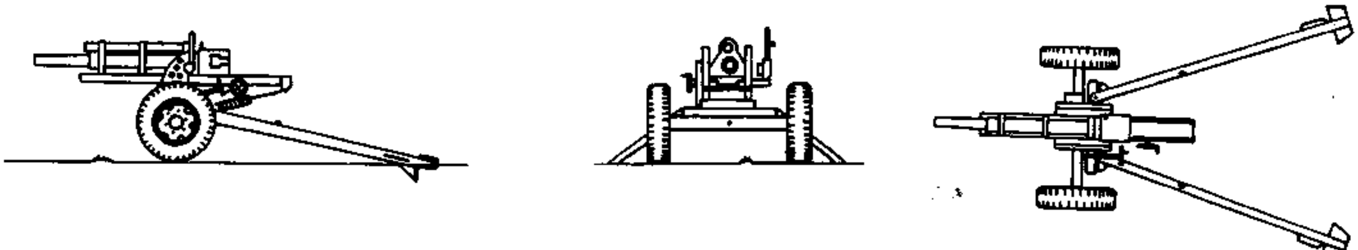
105 mm Howitzer M101A1 in action in South Vietnam (US Army Photograph)

CHARACTERISTICS:
Overall length: 6.00 m
Width: 2.1 m
Height: 1.65 m
Total weight: 2,220 kg
Range—max: 11,000 m
Elevation: −5° to +665°
Traverse: 45°
Ammunition: Semi-fixed, M.1 system
Shell: HE, HEAT, Illuminating, Chemical
MV: 473 m/s
Crew: 8

STATUS:
In service. Obsolescent.

COUNTRIES SUPPLIED.
More than 40 countries have been supplied with this weapon.

MANUFACTURER:
Department of Defense, The Pentagon, Washington 25, DC.



105-mm Howitzer M101A1

5556.103
105 mm HOWITZER WITH AUXILIARY PROPULSION (MAJOR-MINOR WHEELS)

DESCRIPTION:

This version of the 105 mm M101 howitzer has been designed on a US Army contract to establish the applicability of the "major-minor" wheel concept to artillery and other military apparatus.

The purpose of the major-minor wheel arrangement is to combine the advantages of tracked and wheeled transport mechanisms and produce a system that is suitable for all kinds of terrain. As can be seen from the accompanying illustration the major-minor wheel arrangement comprises three small wheels disposed symmetrically around a central axle. The drive to these wheels is so arranged that when travelling on a hard surface the small wheels in contact with the surface are driven so that the whole system functions like a normal wheeled vehicle – except that skid steering is used. Should the ground surface be too soft for this form of drive to be effective, however, the small wheels can be braked and the drive transferred to the central axle. When this happens the whole three-wheel assembly rotates and the vehicle "walks" forward.

The drive mechanisms for the three minor wheels are identical so that it does not matter which pair of wheels is in contact with the ground when the drive is transferred back to the minor wheels. Low pressure tyres are used to ensure good traction in all forms of terrain.

DEVELOPMENT:

Developed by the Lockheed Aircraft Service Company under contract to the US Army Weapons Command.

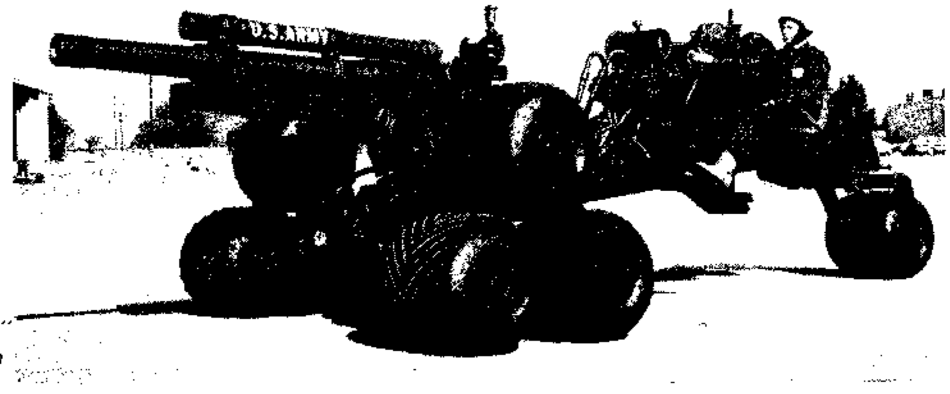
STATUS:

Trials.

MANUFACTURER:

Lockheed Aircraft Service Company, Ontario International Airport, Ontario, California, USA.

105 mm howitzer with auxiliary propulsion system operating in the "major wheel" mode in difficult terrain



M.101 105 mm Howitzer with "major-minor wheels" auxiliary propulsion

5512.103
105 mm HOWITZER M.102

DESCRIPTION:

The M.102 light towed howitzer, calibre 105 mm system is an airdroppable, direct-support artillery weapon for airborne and air-mobile divisions. It weighs 3,200 pounds (1,470 kg) is transportable in the Caribou fixed-wing plane and the Chinook helicopter and may be carried by sling under the Choctaw helicopter. The M.102 combines the features of the top and bottom carriage into one box-girder type structure shaped like a wishbone. This design allows 360 degree on-carriage traverse, minus five degrees to plus 75 degrees quadrant elevation and low silhouette. The low trunnion height and structural stiffness inherent in the box-trail type of construction assure stability far superior to that in other towed

105 mm Howitzer M.102

weapons. A variable type recoil mechanism uses its mass to provide lower trunnion reaction. Recoil varies from 50 inches at low quadrant elevations to 26 inches at higher quadrant elevations. This reduces trunnion reactions to acceptable limits and eliminates the need for a recoil pit. The M102 can fire all the current standard ammunition as well as a new family of cartridges. With the new ammunition it has a low range of 1,000 metres in the upper register and a high range of 15,000 metres. This compares with 2,000 minimum and 11,000 maximum of the current M.101A1 and its ammunition.

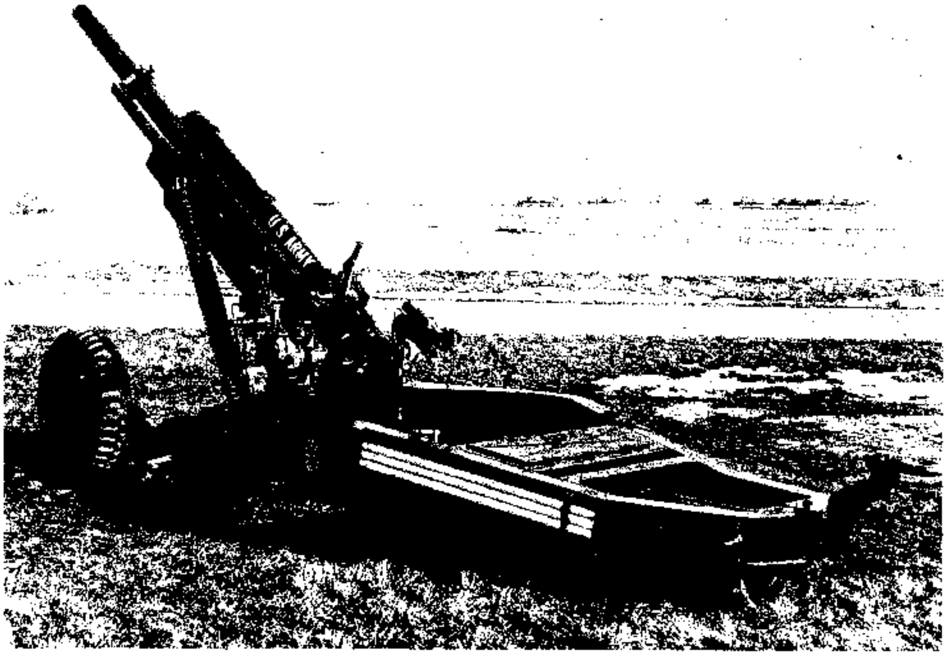
CHARACTERISTICS:
Overall length: 6.69 m
Width: 1.92 m
Height: 1.60 m
Total weight: 1,470 kg
Range—max: 11,500 m
Elevation: −5° to +75°
Traverse: 360° on platform
Ammunition: US M.1 system
Shell: HE, HEAT, Chemical, Illuminating, Anti-personnel flechettes
Sustained rate of fire: 3 rounds/minute
Crew: 8

STATUS:
In service.

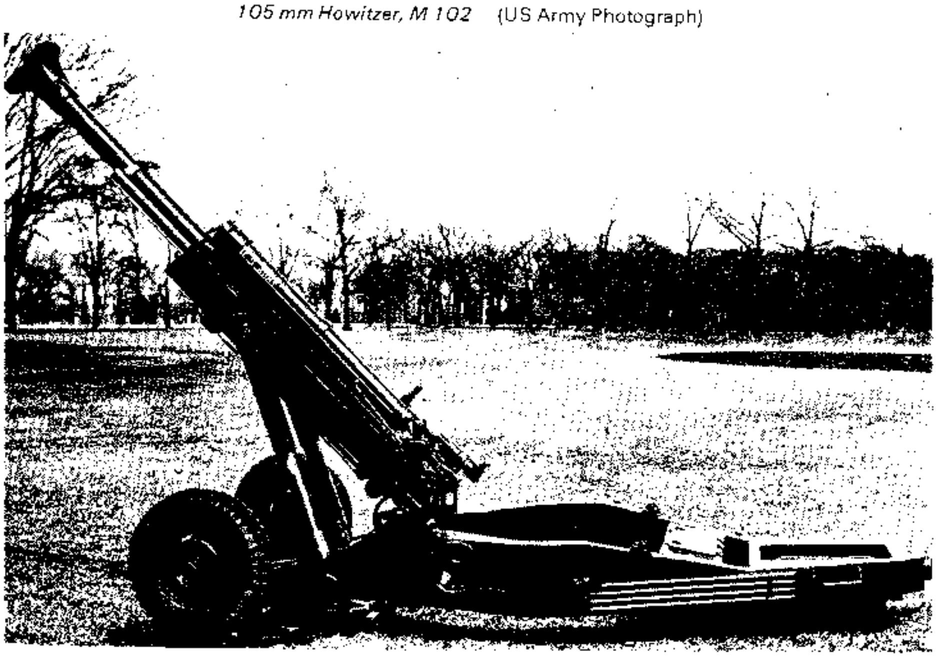
COUNTRIES SUPPLIED:
Apart from the USA only Cambodia and South Vietnam are believed to have this weapon.

SOURCE:
Department of Defense, The Pentagon, Washington, 25, DC.

M 102 Howitzer together with its ammunition, being carried into battle area by a CH-47 Chinook helicopter



105 mm Howitzer, M 102 (US Army Photograph)



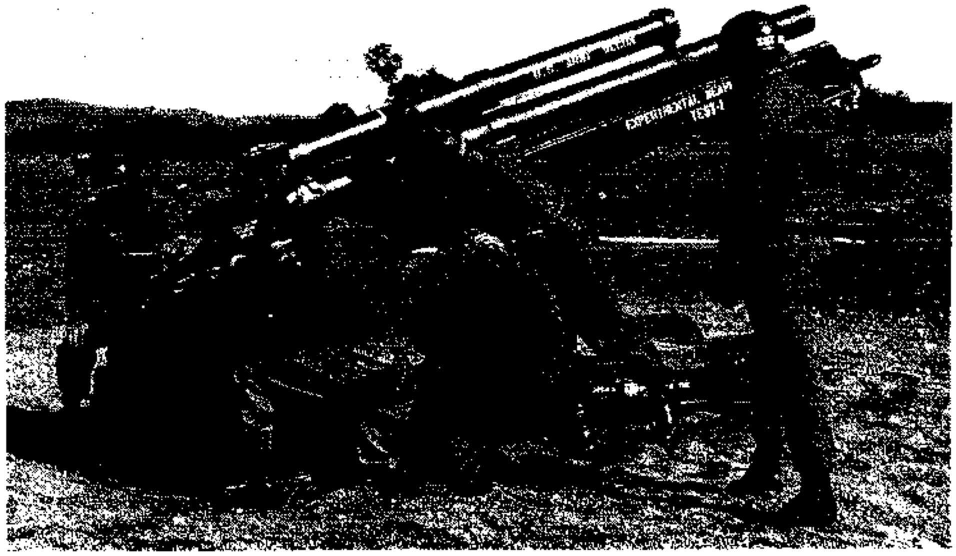
Modified version of the M102—1966 production model (US Army Photograph)

5572.103
105 mm FIELD ARTILLERY DIRECT SUPPORT WEAPON SYSTEM XM 204

DESCRIPTION:
This interesting new howitzer is being developed to provide the US Army with a cheap reliable weapon that is helicopter-transportable and has a range performance superior to that of the M101A1 weapon.

Novel feature of the design is the incorporation of a "soft recoil" mechanism, the principle of which is roughly illustrated in the accompanying diagrams. It is said that this technique results in very low recoil forces; and because of this it is possible to do without firing trails and ground anchors. As a further consequence of this and as can be seen from the accompanying picture, the introduction of a novel method of traversing the weapon has been made possible.

CHARACTERISTICS:
Weight: 2,027 kg
Length: 5.28 m
Width: 1.98 m
Height: 1.37 m at 0° QE
Elevation range: −5° to +75°
Traversing range: 360°
Emplacement time: 30 sec



Military potential testing of the XM204 soft recoil howitzer (US Army Photograph)

DEVELOPMENT:

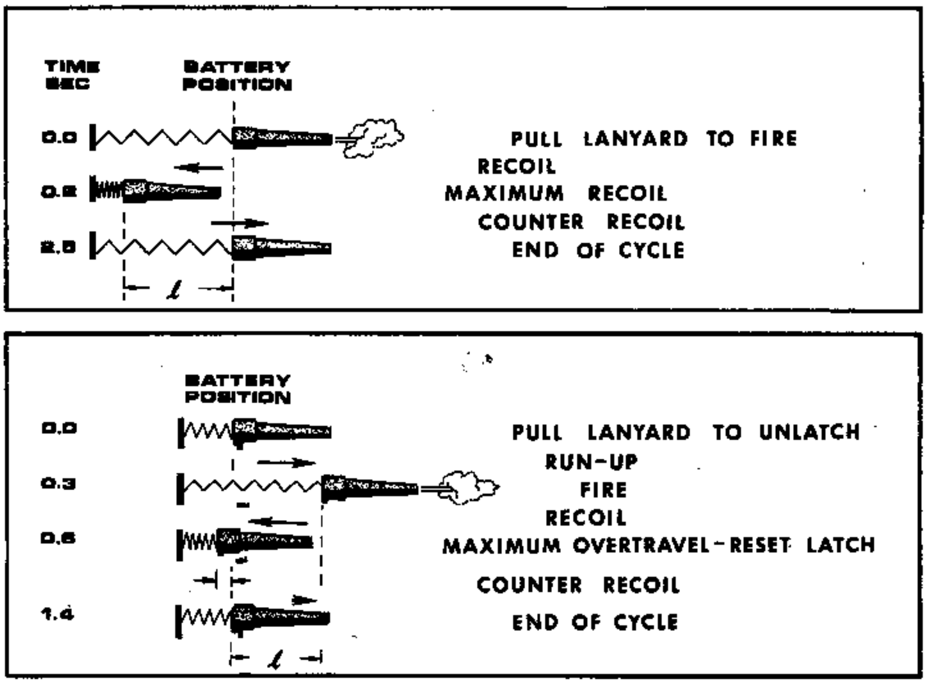
Design work on the XM204 began in 1968. The soft recoil concept is considerably older than this, however, and is believed to date back to 1957.

An advanced development (AD) model has been produced and extensively and successfully tested. It is illustrated here.

Rock Island Arsenal is responsible for carriage and recoil mechanism development, overall system integration and engineering support for system tests. Frankford Arsenal is responsible for developing the fire control equipment, Watervliet Arsenal for the development of the cannon and Picatinny Arsenal for developing the XM200 charge. The gun is expected to replace the M101A1 and M102 (**5512.103**) weapons.

RAP ROUND:

It has been reported that the XM204 gun is the one for which the 105 mm RAP round now in development is destined (see entry **2834.103**).



Principle of soft recoil process. Top picture shows the sequence of events for a conventional system. Bottom picture shows the sequence for soft recoil

5551.103

105 mm SP HOWITZER M52 and M52A1

DESCRIPTION:

This howitzer is no longer in first line service in the US Army, but quite large numbers were made and many are now with the US reserve army, or in service in NATO. The design dates from the early 1950s, and was replaced by the M.108 in the mid-60s. The 105 mm gun is of a slightly different pattern from that in the M.108 and of a marginally lower performance. The vehicle is larger and heavier than the SP howitzers now in service, and it has a noticeably smaller range of operation on the fuel carried. The M52A1 has a fuel injection engine.

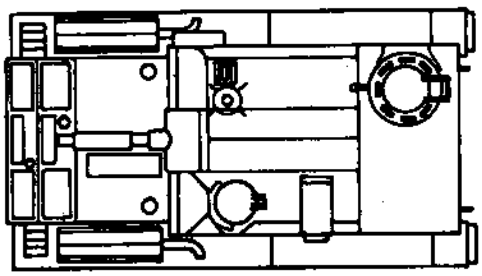
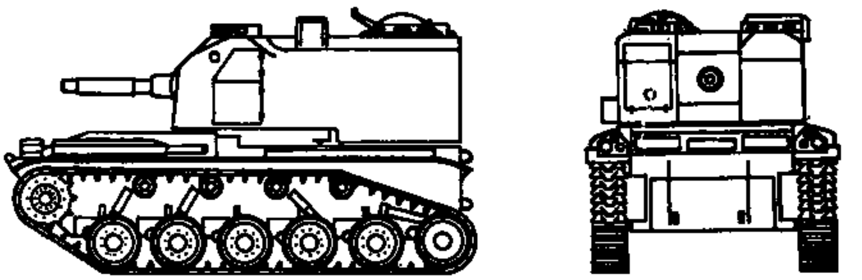
CHARACTERISTICS:

Overall length: 5.80 m
Width: 3.3 m
Height: 3.1 m
Total weight: 24,040 kg
Range—max: 11,200 m
Elevation: −9° to +60°
Ammunition: US M.1 105 mm series
Ammunition stowage: 102 rounds
Crew: 5
Cruising range: 150 km
Speed—max: 56 km/h

STATUS:

In service with some countries in NATO, with the Reserve Army in USA.

M52 105 mm self-propelled howitzer

105-mm SP Howitzer M52

5509.103

105 mm SP HOWITZER M.108

DESCRIPTION:

Initial development was by the Allison division of General Motors with the object of replacing the M.52 by a lighter and more mobile SP howitzer. The M108 has been in service since 1964 with the US Army, and has been sold to several NATO countries. It is a fairly large vehicle, and its size has the advantage that the crew have plenty of space in which to work the gun, and a useful ammunition load can be stowed inside.

The hull and turret are made from aluminium armour, and the vehicle floats with the aid of inflated flotation bags and wash screens which are carried inside. Water speed using the tracks for propulsion is 4 mph (7 km/h).

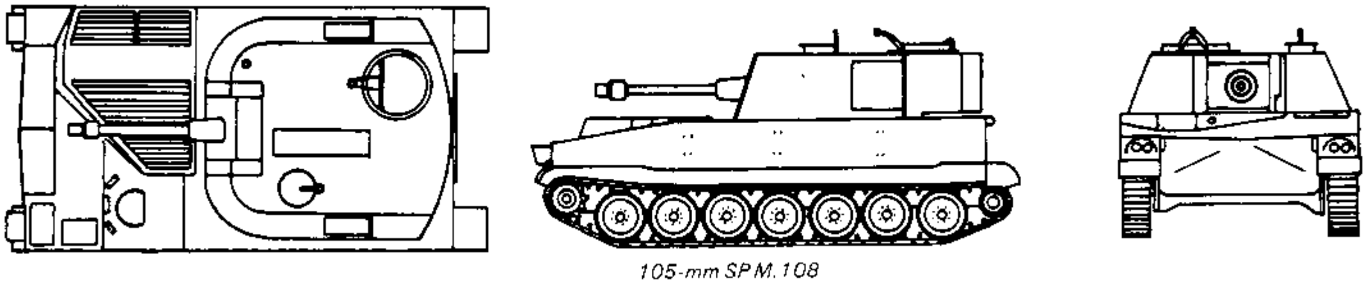
CHARACTERISTICS:
Overall length: 6.09 m
Width: 3.14 m
Height: 3.04 m
Total weight (gross): 22,452 kg
Range: 12,000 m
Traverse: 360°
Ammunition: HE, Chemical
Sustained rate of fire: 3 r.p.m.
Crew: 7 men
Secondary armament: .5 in MG

STATUS:
In first line service.

COUNTRIES SUPPLIED:
Belgium, Brazil and Spain.

105 mm self-propelled howitzer M. 108. This photograph shows the diesel-powered version (US Army Photograph)

M 108 in action in Vietnam. This picture gives a good idea of the size of the vehicle and turret. (US Army Photograph)



105-mm SP M. 108

2854.103
105 mm TANK GUN M-68

The 105 mm tank gun M-68 is fitted to the M-60 MBT (in mount M-116) and M-60A1 MBT (in mount M-140).

It is basically the British 105 mm gun (**2451.103**) built under licence in the United States. The breech block is of the sliding wedge, drop block type and opens on counter-recoil. The firing mechanism is electric. Estimated life of the barrel is 200/300 rounds.

CHARACTERISTICS:
Calibre: 105 mm
Weight of barrel: 753 kg
Elevation: −10° to +19°
Ammunition:
APDS-T m/v 1470 m/s proj. wt 5.9 kg
HEP-T m/v 730 m/s proj. wt 9.8 kg
HEAT-T m/v 1170 m/s proj. wt 10.9 kg
WP-T
TP-T
Canister
Rate of fire: 6-9 rounds/min
Range: 2,500 m
Accuracy: Figures quoted in public state that the 105 mm gun has the following chances of a first round hit against a stationary tank:-
85% at 1000m
40% at 2000m
25% at 2500m

STATUS:
In production and service.

2855.103
90 mm TANK GUN M.36

DESCRIPTION:
The 90 mm tank gun M-36 when used with mount M 78 is fitted to the M-47 tank. It has a vertical sliding breech block. Estimated life of the barrel is 700 rounds.

CHARACTERISTICS:
Calibre: 90 mm
Barrel length: 4.495 m
Barrel weight: 793 kg
Elevation: −5° to +19°
Ammunition: AP-T m/v 914 m/s
APC-T
HVAP and HVAP-DS-T
HE & HE-T m/v 731 m/s
HEAT MARKER WP etc.

STATUS:
In service.

2832.103
90 mm TANK GUN M-41

DESCRIPTION:
The 90 mm cannon M-41 in mount M-87 is the main armament of the M-48 tank (**5056.102**). The gun is in widespread service with NATO, SEATO and other countries. It has been used in the India-Pakistan war, Vietnam and by Israeli and Jordanian forces in the Middle East. Although many M-48s have been refitted with 105 mm guns, the 90 mm gun is still an effective weapon.

CHARACTERISTICS:
Calibre: 90 mm
Length in calibres: 48
Barrel length: 4.91 m

Barrel weight: 717 kg
Elevation: −9° to +19°
Ammunition:
HE & HE-T, m/v 731 m/s
WP m/v 731 m/s
AP-T m/v 930 m/s
HVAP m/v 1235 m/s
HVAP-PS m/v 1249 m/s
HEAT m/v 854 m/s
Canister
Rate of Fire: 8-9 rounds per minute
Range: 17,900 m
4,800 m practical
2,000 m effective
STATUS:
In service.

5526.103
ANTI AIRCRAFT SP GUN, TWIN 40 mm. M.42
DESCRIPTION:
The M 42 is an SP light anti-aircraft gun mounting twin L/60 Bofors guns on a fully tracked chassis, under armour. It is used in the forward areas of the battlefield to provide defence against low-level air attacks. Development began in 1951, and the weapon was in service in 1953. The short development time resulted from the pressures of the Korean War.

The gun mounting is an open-topped cylinder which rotates by power or by hand. The crew feed the clips of ammunition onto the guns by hand, and the maximum cyclic rate of fire is 240 rounds per minute. There are three separate sighting systems, but as no radar is carried on the vehicle its effectiveness is limited to the targets which the gunner can see visually. There is a computing sight, which calculates lead.

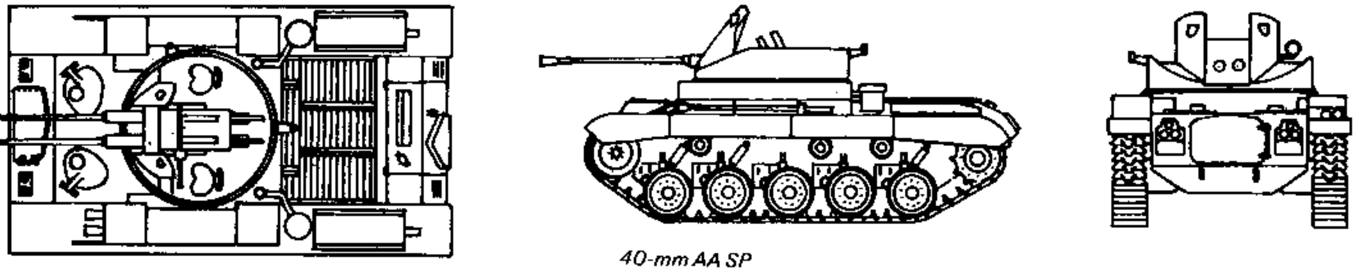
M 42 is elderly, rather heavy, and limited in range.

The protection which it offers its crew is less than is considered necessary in modern war, and the fire control system appears weak. It is rapidly being replaced by Vulcan and Chapparal.

CHARACTERISTICS:
Overall length: 6.35 m
Width: 3.20 m
Height: 2.84 m
Total weight: 22,452 kg
Range—max: 8,200 m
Elevation: −5° to +87°
Ammunition: As for Bofors L/70
Speed—max: 72 km/h
Cruising range: 160 km
STATUS:
In service.
COUNTRIES SUPPLIED:
Federal German Republic and some other NATO nations.

Twin 40 mm SP Gun M. 42

MANUFACTURERS:
Pacific Car and Foundry Co. Renton, Washington. 98055.



40-mm AA SP

2834.103
ROCKET-ASSISTED PROJECTILES (RAP)
DESCRIPTION:
In common with many European countries, the United States is devoting a lot of effort to the development of rocket-assisted projectiles for tube artillery.

In general, these developments relate to unguided projectiles, although some attention has been given to laser guidance systems for such rounds. A difficulty in developing the rocket-assisted rounds has been that of achieving sufficient accuracy; and a laser guidance technique would obviously assist in overcoming this difficulty. On the other hand the greatly increased cost of the guided over the unguided round makes it desirable to explore the possibilities of unguided rounds thoroughly before abandoning them in favour of guided missiles. Results so far appear to be encouraging.

A further difficulty is the loss of payload resulting from the incorporation of a rocket motor in the projectile. In parallel with the development of the RAP rounds, therefore, there is also a programme aimed at increasing the effectiveness of the reduced payload by the use of new materials and processes in the construction of the warheads.

The rocket motors in the projectiles must be designed to withstand very large stresses. Mean accelerations in guns currently in service are typically about 5,000 g for a 105 mm howitzer and about 20,000 g for a high-velocity tank gun, with 30-40,000 g in sight for the next generation of the latter. RAP rounds for field artillery may thus have to withstand chamber pressures in the order of 3,000 kg/cm^2 acceleration in the order of 18,000 g and rotation rates up to 17,000 rev/min.

Two RAP rounds, the 105 mm M548 and the 155 mm M549 are currently at the operational stage; following them are 203 mm and 175 mm projectiles and there may be others. Practical development and operational considerations suggest that such rounds should be in the range of calibres extending from 40 mm to 203 mm or thereabouts.

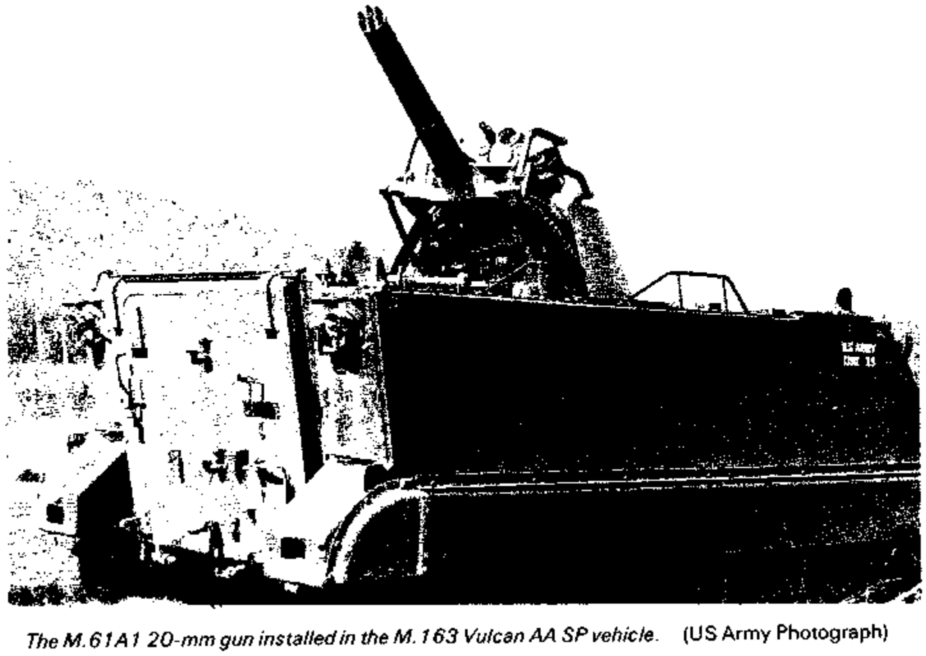
DEVELOPMENT:
RAP projects are controlled by (and much of the work is done at) Picatinny Arsenal, Dover, N.J., whose Solid Rocket Propulsion Laboratory is at the technical centre of this project family.

5547.103
M61A1 20 mm VULCAN AA GUN
DESCRIPTION:
The M61A1 is an externally powered, six barrel gun capable of firing 6,000 rounds per minute. This gun is the result of more than twenty years of continuous experiment and evolution.

The six barrels and their breeches and loading mechanism rotate as one unit. Ammunition is fed in to the loading slot from a linkless belt through which it is pushed by electric or hydraulic motors. In the gun the rounds are fed into each barrel by a cam action and fired and the empty case ejected without the barrels pausing in their circular motion. The advantage of this method is that very high rates of fire can be achieved for the whole system without each barrel having to fire at more than the normal rate for weapons of this calibre. Thus the weapon has a long life by reducing barrel erosion and heat generation.

The pattern of fire can be altered by changing the angular dispersion of the barrels, thus enabling some control over hit chance.

When used as an aircraft gun the Vulcan is used at its highest rates of fire, namely 4,000 and 6,000 per minute. In the air defence role, moun-

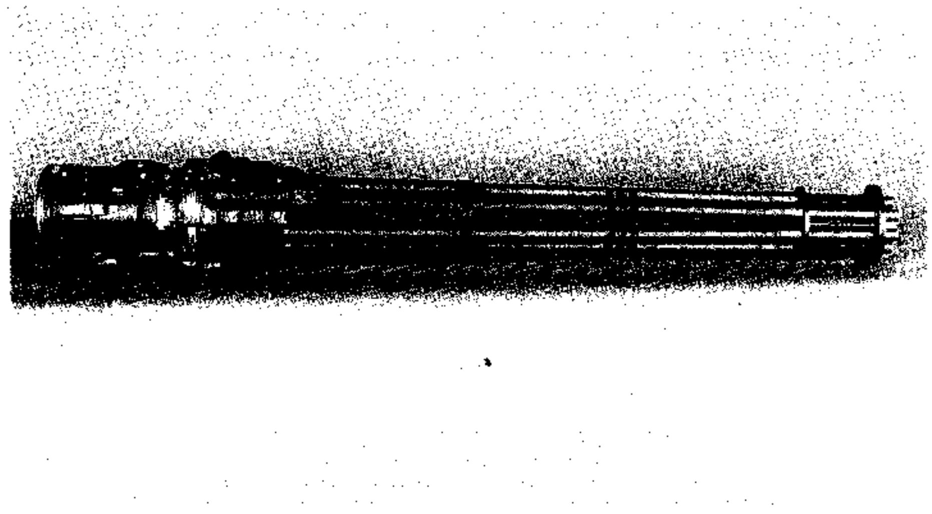


The M.61A1 20-mm gun installed in the M.163 Vulcan AA SP vehicle. (US Army Photograph) ted in the M 163 AA vehicle the rates of fire are 1,000 and 3,000. Electrically initiated ammunition is used, which requires an external power source for the gun.

The gun has been in service in one or other of its various forms since 1956.

CHARACTERISTICS:

Length of gun and breech: 1.85 m
Weight of bare gun: 115 kg
Weight of gun system complete with motors, and linkless feed system and 1,100 rounds: 1,306 kg
MV: 1,030 m/s
Average recoil force:
At 1,000 r.p.m. 272 kg
At 3,000 r.p.m. 816 kg
At 4,000 r.p.m. 1,206 kg
At 6,000 r.p.m. 1,730 kg
Barrel life: 20,000 rounds
Gun life: 145,000 rounds
Power requirements:
Firing circuit: 250-300 volts d.c. 0.5 amp
Clearing cam: 28 volts d.c. 28 amps



The M.61A1 20-mm gun

STATUS:

In service with the US Air Force, Navy and Army.

COUNTRIES SUPPLIED:

Not known.

MANUFACTURER:

Aircraft Equipment Division, General Electric, Burlington, Vermont, USA.

2859.103

30 mm CHAIN GUN

DESCRIPTION:

The Hughes Chain Gun is a single-barrel externally powered weapon having a rotating bolt mechanism driven by a simple and reliable chain drive. All-up weight of the gun is less than 100 lbs (45 kg) and rates of fire from 100 to 1000 rounds/minute are achievable. The ammunition feed is also of simple design and the complete weapon is expected to be very competitive in price.

Ammunition cased in brass, steel or aluminium can be fired with equal facility and the simple cycle of the gun permits safe use of the open bolt arrangement without the need for chargers, declutching feeders or other special devices.

Initially designed for helicopter use, the gun is now being proposed for a variety of AFV and similar applications.

CHARACTERISTICS:

Calibre: 30 mm
Barrel Length: Typically 35 calibres
Length overall: Typically 1.5 m
Weight: Typically 39 kg
Number of Parts: 97
Ammunition: XM552/639

STATUS:

Prototype firing began in April 1973 as part of an extensive and continuing development programme. The manufacturers state that production models could be phased in with all current US AFV schedules.

MANUFACTURER:

Hughes Helicopters and Ordnance Systems, Culver City, California 90230, USA.

2856.103

20 mm CANNON, M-197, PINTLE-MOUNTED

DESCRIPTION:

The M-197 cannon is a lightweight 3-barrel version of the M-61 Vulcan gun (**5547.103**) and is used in various airborne applications. Using a pintle mount and a hanging-loop ammunition container the gun can readily be used in vehicle applications.

CHARACTERISTICS:

Calibre: 3 × 20 mm
Rate of Fire: 350/700 rounds/min
Ammunition: M-50 Series
Ammunition Capacity: 500 rounds
System Weight: 191 kg excluding ammunition
Ammunition Weight: 157 kg
Power Requirement: 28 V DC, 100 A

2588.103

106 mm RECOILLESS RIFLE M40A2

DESCRIPTION:

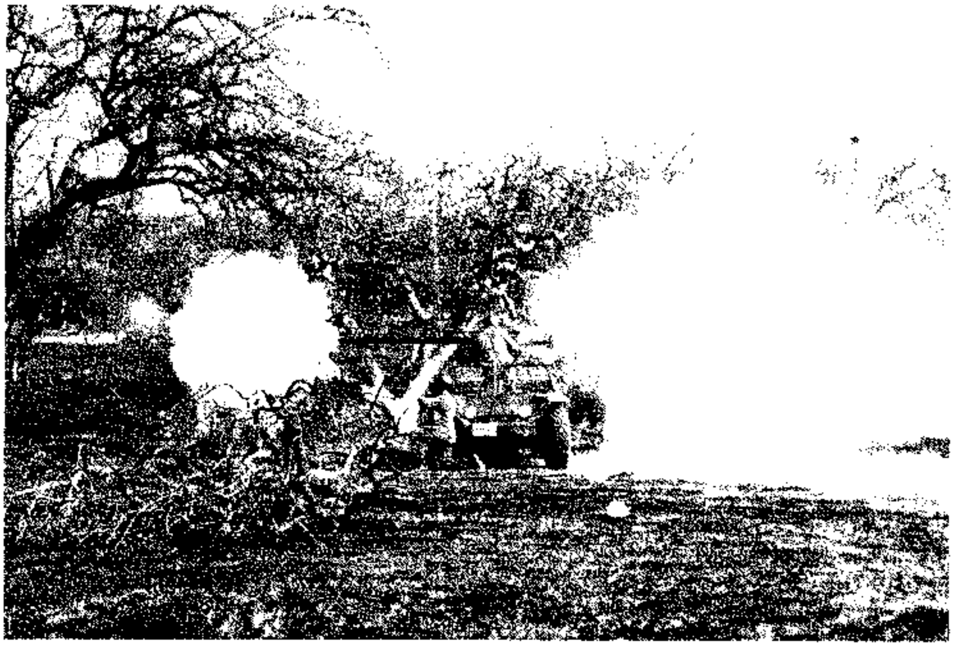
This is a crew-served, rifled recoilless weapon designed primarily for the anti-tank role. It can be fired from its wheeled-tripod mount or from a vehicle.

CHARACTERISTICS:

Calibre: 106 mm
Barrel length: 3.4 m
Elevation: −17° to +65°
Traverse: 360° if dismounted. Otherwise dependent on vehicle
Weight: 220 kg (weapon only) 236 kg (loaded)
Muzzle Velocity: 503 m/sec (HEAT round)
Range: 2,745 m maximum (HEAT round) Maximum effective 1,097 m
Rate of Fire: 1 round/min manually loaded
Ammunition: HEAT, HEP-T
Rifling: 36 grooves, 1 turn in 212 cm
Sighting: Spotting rifle with telescopic sight
Crew: 4

STATUS

Service.



Firing a 106 mm RR from a FMC XR311 vehicle

2561.103

75 mm RECOILLESS RIFLE M-20

DESCRIPTION:

No longer in United States Army service but still in use all over the world and much copied, the M20 75 mm RR is a breech-loading portable weapon designed to be fired from a MG tripod mount. Design started in March 1944 and the weapon was first produced by the Miller Printing Machinery Company of Pittsburgh in 1945.

CHARACTERISTICS:

Calibre: 75 mm
Weight: 5.2 kg excluding mount
Length: 2,073 mm on US MG mount
MV: 426 m/s
Range: 6,565 m
Rate of fire: 10 rounds/min
Ammunition: HE, HEAT, HEP, WP
Penetration: 91 mm at 0°

STATUS:

In service in many countries of Europe, the Middle East and the Far East.

2725.103
MINIATURE NUCLEAR WARHEADS

DESCRIPTION:

A range of small nuclear warheads for use with tactical surface-to-surface or air-to-surface weapons has been developed in the USA. Details of dimensions are not known, but the warheads are intended for use with conventional artillery and with missile systems. Prior to the development of these warheads, the smallest-calibre gun known to be capable of firing nuclear ammunition was the M-109 155 mm SP howitzer (**5508.103**); and since the yield of the new warheads is believed to be not more than a tenth of that of the earlier ammunition it would be reasonable to assume that nuclear ammunition could now be made available for weapons of 105 mm or perhaps even smaller calibre. The warheads would also be suitable for use with unguided artillery rocket systems or as multiple warheads with guided missiles such as Lance (**2682.111** and see also entry **2838.111**).

Yield of the warheads has been variously reported as 50 tons or 100 tons and it is said that the weapons would be "clean" – i.e. there would be no radioactive fission products of the explosion itself.

Concern has been expressed regarding the desirability of introducing such potent warheads into operational use in association with comparatively minor weapons. An earlier American nuclear weapon, the Davy Crockett mortar which had a range of about 8 km, was withdrawn from service because of the difficulty of deriving adequate control and fail-safe procedures for a weapon which must of necessity be used so far forward operationally; and similar arguments could be applied to the new warheads if they are to be used in ammunition for medium-range artillery. On the other hand their use as sub warheads for a large missile would appear not to be open to the same criticism.

STATUS:

Development. Reports of the 13th meeting of the NATO Nuclear Planning Group in 1973 suggested a possible deployment date of 1978.

THE UNION OF SOVIET SOCIALIST REPUBLICS

5513.103
GENERAL

The employment of mass artillery fire has always been a feature of Russian military operations, and at the end of World War II the proportion of artillerymen in the Soviet Army had risen to as high a figure as 35 per cent. Since then it has come down to 25 per cent, but this still represents an unusually heavy concentration of gunners when compared with Western Armies. Soviet artillery weapons are well designed and manufactured, with the chief design emphasis on range and terminal effects. Conventional surface-to-surface artillery is largely towed, which is somewhat different from the great emphasis which Western Armies are placing on self-propelled artillery capable of fast cross-country and amphibious movement.

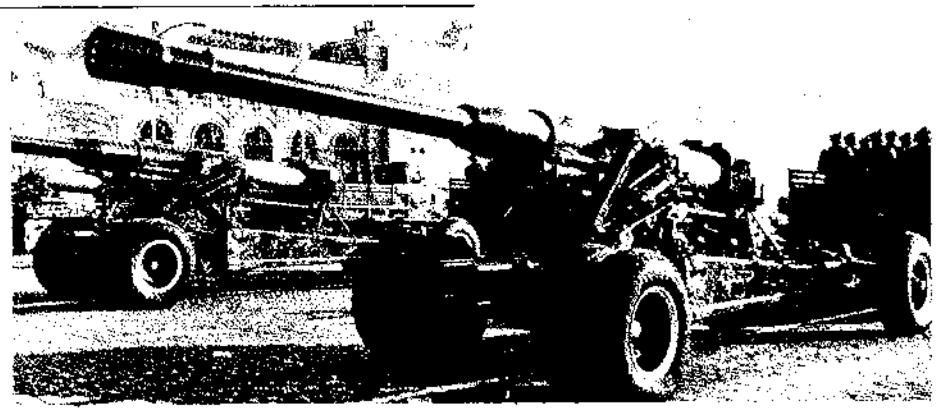
Almost all Soviet artillery equipment, with the possible exception of the highly sophisticated missiles, is supplied to the satellite countries. Thus, that which appears in a Soviet division may be taken as appearing in a similar type of satellite division. Some minor modifications are occasionally made by the secondary user, particularly the Czechs.

Although Soviet artillery is frequently seen, detailed information is often hard to come by.

5540.103
203 mm GUN HOWITZER M.55

DESCRIPTION:

This is the largest conventional gun in service in the Soviet Army. Its calibre is identical with the US 8-inch, and it is presumably employed in the same way. It would seem to fire a lighter shell. It is known that it fires nuclear shells, and to a greater range than any other gun except the US 280 mm. The precise deployment of the M.55 is not known, but it may be taken to be held at Army or Corps level, and may be used to provide general fire support with HE shell. It is seen on formal Moscow parades towed by a large truck which also carries the crew, but it may be assumed that in the field it has some sort of tractor to provide the motive force, and severa accompanying vehicles carrying the crew, firing equipment and ammunition.



203-mm Gun howitzers M.55 in Red Square on the anniversary of the October Revolution

STATUS:

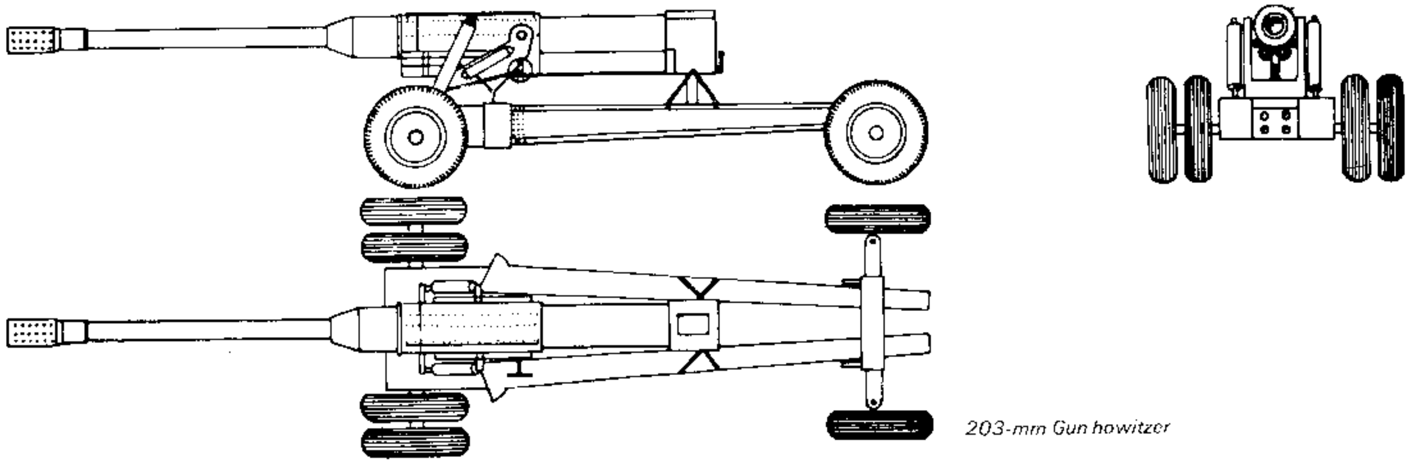
In service.

CHARACTERISTICS:

Total weight: 20,400 kg
Shell weight: 136 kg
Range – max: 29,000 m
Elevation: $-2°$ to $+50°$
Traverse: 44°
MV: 790 m/s

COUNTRIES SUPPLIED:

Thought to be confined to USSR only.



203-mm Gun howitzer

2927.103
180 mm FIELD GUN

DESCRIPTION:

According to reports from Israeli sources, a new 180 mm Russian field gun was encountered in service with Egyptian forces during the 1973 Arab-Israeli war. The epithet "new" should, of course, be treated with some reserve; it has not so far appeared to be standard USSR practice to field entirely new weapons with the armed forces of their overseas clients – unlike some Western manufacturers who sometimes find it easier to sell weapons overseas than to persuade their own authorities to spend money on them.

On the other hand it is surprising that, if the weapon is not new (and of course assuming, as is probable, that the report is accurate) it is surprising that it has not hitherto been seen in service with Warsaw Pact forces. We have not seen any pictures, however, and it could be that the "new" gun closely resembles a more familiar one of a different calibre.

According to the report, the gun has a range of 44 km. If true, this is a most impressive figure –

which may be compared with the 32.7 km of the American 175 mm M107 (**5524.103**) and the Russians' own 130 mm M-1946 (**5554.103**) which has a maximum range of about 31 km.

STATUS:
Presumably in service. No other details available.

2886.103
152 mm GUN-HOWITZER M-37
DESCRIPTION:
This is the earliest pattern of 152 mm gun howitzer still in service in Russia – and it is to be found there only in reserve units. Noticeably prewar in design and of massive construction it is a heavy and, by modern standards, unwieldy weapon. In performance however, although inferior to its modern replacement (M-55, **5521.103**), it is still a far from negligible weapon.
CHARACTERISTICS:
Calibre: 152 mm
Barrel length: 32 calibres
Elevation: $-2°$ to $+65°$
Traverse: 58°
Weight in firing order: 7.128 t
Shell weight: 43.5 kg
Range: 15,800 m
Rate of fire: 4 rounds/min
STATUS:
Reserve formations of the Russian Army. In more active service in less well-endowed client (and former client) countries of the Soviet Union.

5521.103
152 mm GUN-HOWITZER M-55
Twelve of these gun-howitzers appear in the organic artillery of the Soviet motor rifle division, and are employed to give general fire support. There is also a 152 mm howitzer, the difference being in the length of barrel and shorter maximum range. The M-55 is the version which is more generally encountered. It is a very large gun, equating to 6 inch calibre, and is heavy for a simple towed carriage. Mobility must be fairly restricted, but there is adequate range which is some compensation.

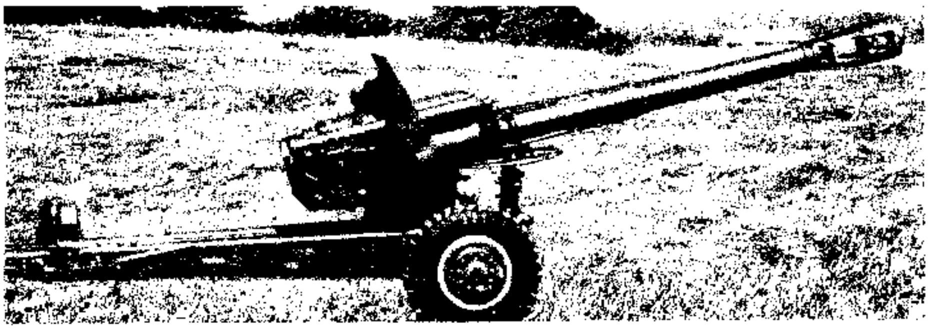
The design is quite old, although there have been successive modifications and variants. However, the present-day version still displays the basic Russian artillery philosophy of a simple, reliable robust gun firing the heaviest possible shell. This gun-howitzer is distinctive when moving by the fact that it has a small two-wheeled limber under the ends of the trail, and there are no reports of an SP version in service. There was a 152 mm assault gun mounted in the JS-2 chassis, and this was known as the JSU-152.

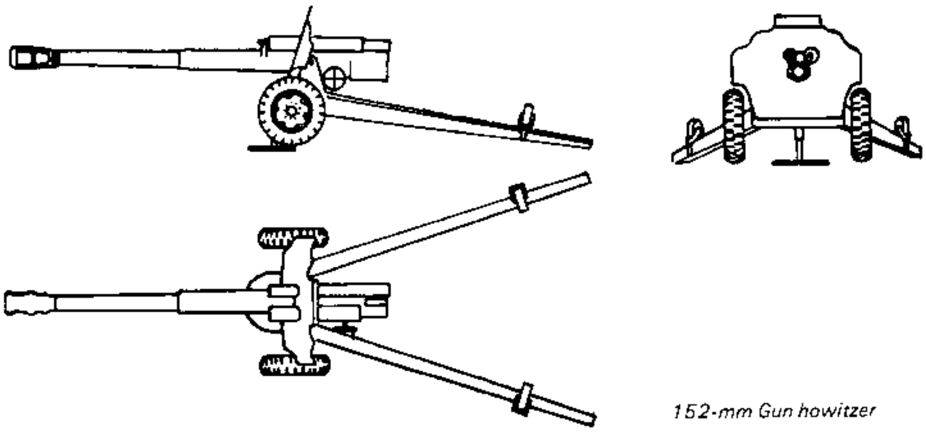
STATUS:
In service.

COUNTRIES SUPPLIED:
Czechoslovakia, East Germany, Poland.

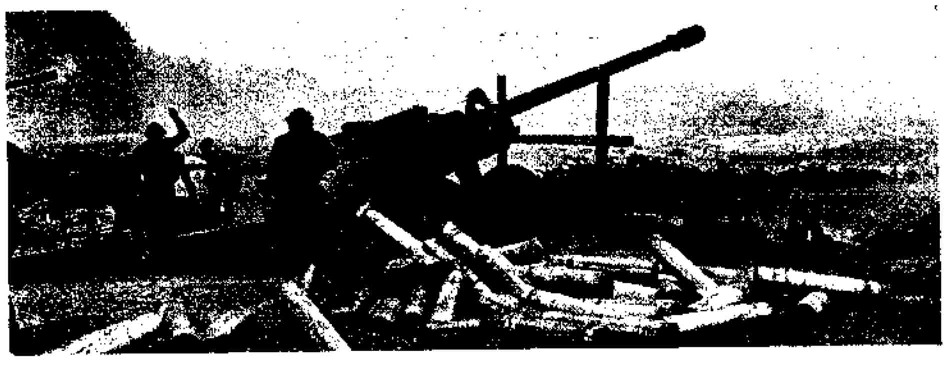
CHARACTERISTICS:
Gun-Howitzer M-55:
Barrel length: 37 calibre
Elevation: $-3°$ to $+63.5°$
Traverse: 60°
Total weight: (firing) 5,900 kg
Ammunition: Separate loading. Round weighs 48 kg HE, AP, Chemical
MV: 670 m/sec
Range: 18 km
Rate of fire: 4 rounds/min
Armour penetration: 100 mm
Crew: 8
Field Howitzer M-43:
Barrel length: 25 calibres
Elevation: $-3°$ to $+63°$
Traverse: 35°
Total weight: (firing) 3,600 kg
MV: 510 m/sec
Range: 12 km
Rate of fire: 4 rounds/min


152-mm Gun howitzer M-55 in travelling position


152 mm Field howitzer M-43 (Novosti)


152-mm Gun howitzer

5554.103
130 mm FIELD GUN M-46 AND M-54
DESCRIPTION:
These two weapons are similar in appearance and are essentially the 130 mm naval gun in a field mounting. The gun is used both as a field gun and as an anti-tank gun: it is also used for coastal defence. Details given below relate to the M-54 weapon.


130 mm Field Gun

CHARACTERISTICS:
Barrel length: 55 calibres
Total weight: 7,500 kg

Weight of shell: 33.5 kg
MV: 930 m/sec
Rate of fire: 5-6 rounds/min
Armour penetration: 170 mm

5578.103
130 mm ANTI-AIRCRAFT GUN M-55

DESCRIPTION:

Whereas the 130 mm field guns (**5554.103**) of the Russian Army appear to derive from the earlier surface-fire naval guns of the same calibre, the M-55 anti-aircraft gun appears to have been developed for army use and subsequently adapted for naval use. The M-55 is intended for static air defence and is used in conjunction with a fire control radar. It has an automatic fuse-setter and an automatic rammer, the design of which may well have been taken from the British 3.7-inch or 4.5-inch guns.

CHARACTERISTICS:
Elevation limits: —5° to +80°
Traverse: 360°
Total weight: 25,200 kg
Shell weight: 33.5 kg
MV: 945 m/sec
Max range: 25 km
Max height: 16.5 km
Rate of fire: 10-15 rounds/min

5520.103
122 mm HOWITZER M-1938

DESCRIPTION:

The M-1938 howitzer, or its later derivations, appears in the inventory of every type of Soviet, Chinese and Satellite Army Division. It is deployed in batteries of six guns, sometimes with three batteries to a Battalion, sometimes two. The howitzer provides general fire support for the division and army. Large numbers have been made, and whilst generally seen in the towed version, SP assault guns on a J8-2 chassis have also been produced.

The modest muzzle velocity restricts the range to rather less than would be accepted from a modern design, but this shortcoming is made up by the Soviet Army's aggressive tactics and their habit of keeping their artillery well forward.

For travelling, the barrel is retracted and fixed to the trail by a tie-rod.

A wide range of projectile is fired, and a total of nine charges used to get the necessary range overlap.

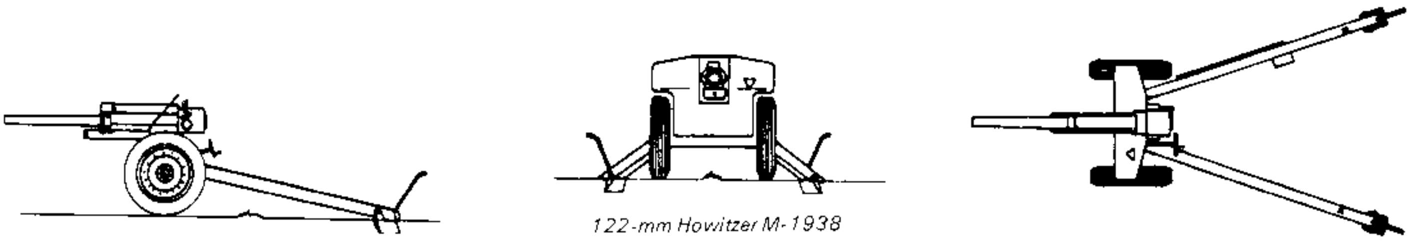
CHARACTERISTICS:
Total weight: 2,450 kg
Barrel length: 22.7 calibres
Range – max: 11,800 m
Elevation: —3° to +63°
Traverse (on carriage): 50°
Rate of fire: 5-6 rounds/min

122-mm M.38 Howitzers firing a ceremonial salute (Tass)

Ammunition: Separate loading. Round weighs 25.8 kg
Shell: HE, HEAT, Smoke, Illuminating, Chemical
Armour Penetration: 100 mm

STATUS:
In service.

COUNTRIES SUPPLIED:
All satellites. China. Egypt.



122-mm Howitzer M-1938

2894.103
122 mm GUN M-37

DESCRIPTION:

This gun dates from before the Second World War; and like its contemporary, the 152 mm gun-howitzer (**2886.103**), is now only to be found in reserve units. It is, however, deployed for coastal protection in Yugoslavia.

CHARACTERISTICS:
Calibre: 122 mm
Barrel length: 46 calibres
Elevation: —2° to +65°
Traverse: 58°
Weight in firing order: 7,117 kg
Weight of shell: 25 kg
MV: 800 m/sec
Range: 20.8 km
Penetration: 129 mm at 1,000 m and 60°
Trail: Spread

STATUS:
Reserve formations in Russia. Active overseas.

5519.103
122 mm GUNS D-74 and D-30

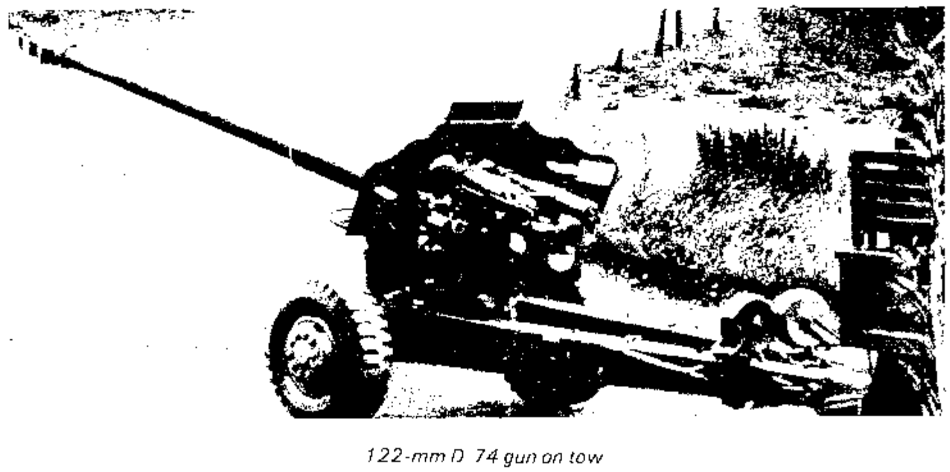
DESCRIPTION:

The 122 mm gun howitzers of the Soviet Army resemble the M.38 howitzer only in respect of their calibre. The gun fires a larger and more effective shell to a greater range than the howitzer achieves.

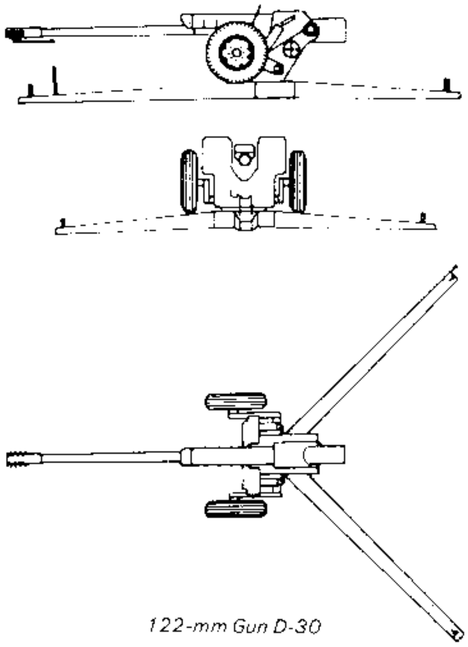
The D-74 is the older version, and is used to give general support to the infantry and mechanised divisions. It is also extensively used as an anti tank gun. In the latter role it appears to be large and difficult to conceal.

D 30 is a more modern gun, with a sophisticated mount permitting 360° traverse and stable platform. It is fitted with a multi baffle muzzle brake and appears to have a modified or new buffer and recuperator.

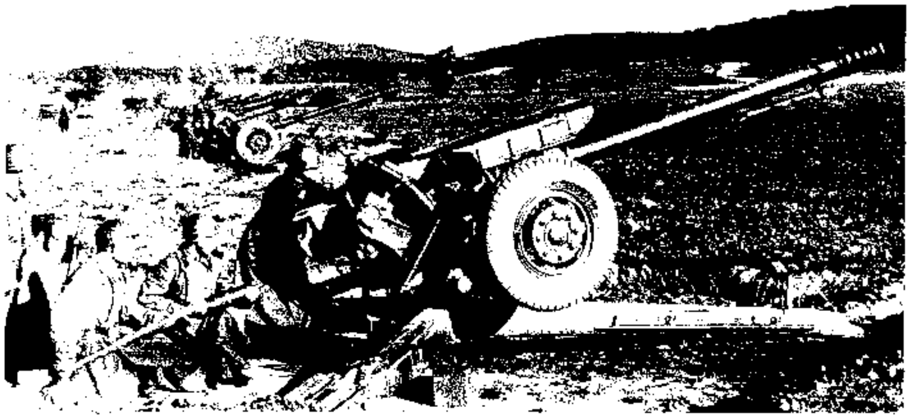
These gun howitzers provide the backbone of



122-mm D 74 gun on tow



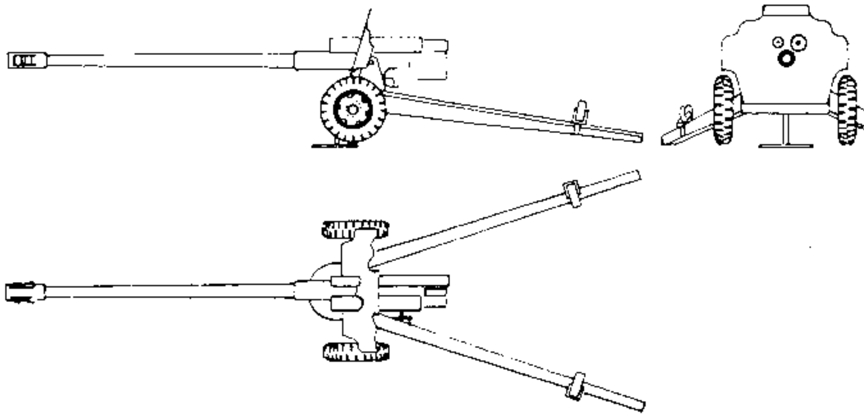
122-mm Gun D-30



122-mm gun D-30 emplaced and ready to fire. The trails are prominent in this view, and the raised wheels clearly shown (Tass)

the general fire support to the Soviet Army, their range is good and their shells effective. Variants of the 122 mm gun are fitted to equipment and tanks.

CHARACTERISTICS:
Range, both versions: 21,900 m
Ammunition: Separate loading. Round weighs 39 kg
Shell: HE, Smoke, Illuminating, APHE, Shell weight 21.7 kg
MV: 807 m/s
STATUS:
In service.
COUNTRIES SUPPLIED:
All Satellite armies. Egypt, Cuba, China.



122-mm Gun D-74

2972.103
115 mm TANK GUN U-5TS
DESCRIPTION:
The U-5TS is the main armament of the T-62 Main Battle Tank. It is a smoothbore gun and fires fin-stabilised ammunition. It has no muzzle brake but is fitted with a bore evacuator. The U-5TS also has a two-plane stabilisation system and infra-red night fighting equipment.

CHARACTERISTICS:
Calibre: 115 mm smooth bore
Barrel length: 55 calibres
6.325 m
Elevation: $-3°$ to $+17°$

Ammunition:

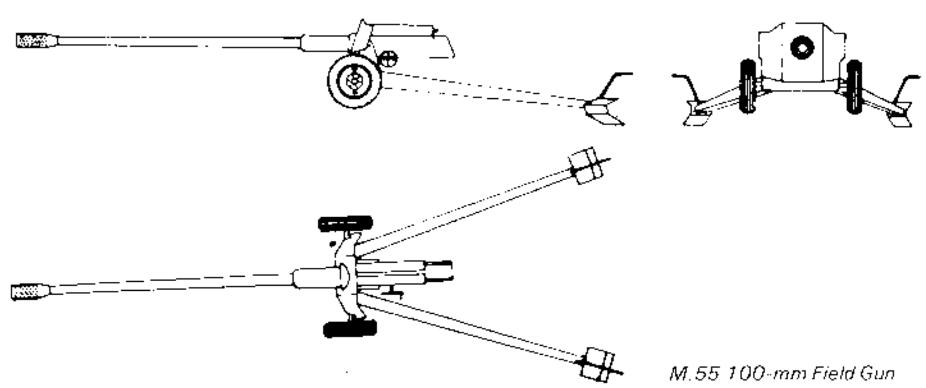
Type	Projectile weight	M/V
HE	17.7 kg	—
APDS	6.8 kg	1500+ m/s
HEAT	11.8 kg	1000 m/s

Rate of fire: 5 rounds per minute (maximum)
Penetration: APDS round will penetrate 300 mm of armour at 1000 m. HEAT round will penetrate 450 mm of armour at any range
STATUS:
In service.

5518.103
100 mm FIELD GUN M.1955
DESCRIPTION:
This gun has appeared in various forms, and has been described as both an anti-tank and a field gun. It seems to be equally effective in both roles, though as a field gun it cannot be used in the same way as such guns are in Western Armies, since it fires fixed ammunition and so will be unable to produce a wide range overlap. However, it still appears in the Soviet motor rifle division and several types of formation in Bloc countries. It is the main armament of the T-54A and T-55 tanks, and also appears on naval mountings. Its armour piercing rounds can penetrate considerable thickness of armour, and its HE rounds have a high anti-personnel capability. As a towed equipment it is heavy and cumbersome, and must be difficult to conceal, but these drawbacks are obviously thought to be worth while accepting for the sake of the heavy and effective shell which it fires.

As a tank gun it is now surpassed for the new battle tanks, but it is likely to survive for many years yet in the armies of the lesser satellites, and there are, no doubt, fairly large stores of ammunition in various countries.

100-mm Field Gun M.55 towed by its tractor



M.55 100-mm Field Gun

CHARACTERISTICS:
Total weight: 2,700 kg
Barrel length: 54 calibres
Elevation: $-5°$ to $+40°$
Traverse: 55°
Ammunition: Fixed
Shell: HE, APHE, AP, HVAP
Range – max: 21,000 m
Rate of fire: 10 rounds/min
Penetration (max): 181 mm armour
Crew: 8
STATUS:
In service. Probably still in production.
COUNTRIES SUPPLIED:
All satellites.

2888.103
100 mm SP ANTI-TANK GUN SU-100

DESCRIPTION:

This elderly but formidable gun is still in widespread use among the nations of the Warsaw Pact and in one or two others. It consists of a 100 mm L/54 gun mounted on a modified T34/85 chassis and has frontal armour up to 75 mm.

Operationally the weapon's main disadvantage is the small gun depression angle available. At only 2 degrees in earlier marks – improved to 4 degrees in the later, postwar, versions – it makes it difficult to engage a target from a reverse slope position without exposing the vehicle.

CHARACTERISTICS:
Crew: 4
Weight: 32 t
Main armament: 100 mm 54-calibre gun
MV: 900 m/sec
Rounds carried: 52
Secondary armament: MG
Engine: 520 bhp diesel
Road speed: 53 km/h
Range: 300 km
Ground pressure: 0.8 kg/cm²
Gradient: 30°
Dimensions: length 5.93 m (9.45 m with gun); width 3.0 m; height 2.45 m

STATUS:
In service in Warsaw Pact countries. Supplied also to Iraq, UAR and Yugoslavia.

5579.103
100 mm ANTI-AIRCRAFT GUN N-49

DESCRIPTION:

Although this weapon was designed a long time ago it appears still to be in use by AA batteries as the largest mobile AA gun in the Russian Army. It is radar controlled by a Fire Can radar (**2871.153**) – which is similar both in appearance and function to the American SCR-584 mobile fire control radar.

CHARACTERISTICS:
Barrel length: 54 calibres
Elevation limits: −5° to +82°
Traverse: 360°
Total weight: 11,000 kg
Shell weight: 15.9 kg
Muzzle velocity: 900 m/sec
Max range: 21 km
Max height: 13 km
Rate of fire: 15-20 rounds/min

2966.103
100 mm TANK GUN D10TG

DESCRIPTION:

This gun was designed during the Second World War and is based on a naval gun. The first version was the D-10T, which was mounted in the first T-54 tanks. Early D-10Ts did not have a bore evacuator, but later models did, and there was no stabilisation. The next model was the D-10TG, which has stabilisation in the vertical plane and is fitted to the T-54A. The D-10T2S is fitted to the T-54B, T-55 and T-55A tanks and has both vertical and horizontal stabilisation. Infra-red night fighting equipment is fitted.

CHARACTERISTICS:
Calibre: 100 mm
Barrel length: 56 calibres 5.608 m
Elevation: −4° to +17°
Ammunition: HE 15.7 kg projectile, MV 900 m/s; APHE 15.9 kg projectile, MV 1000 m/s; HEAT MV 800 m/s. In recent years the HEAT & APDS rounds have been fin-stabilised
Rate of fire: The figure usually quoted is 7 rounds a minute but reports from the Middle and Far East say that 2-4 rounds a minute is a good average
Penetration: APHE round will penetrate 185 mm of armour at 1000 m. HEAT round will penetrate 380 mm of armour

STATUS:
In service.

5517.103
85 mm ANTI TANK GUN D-48

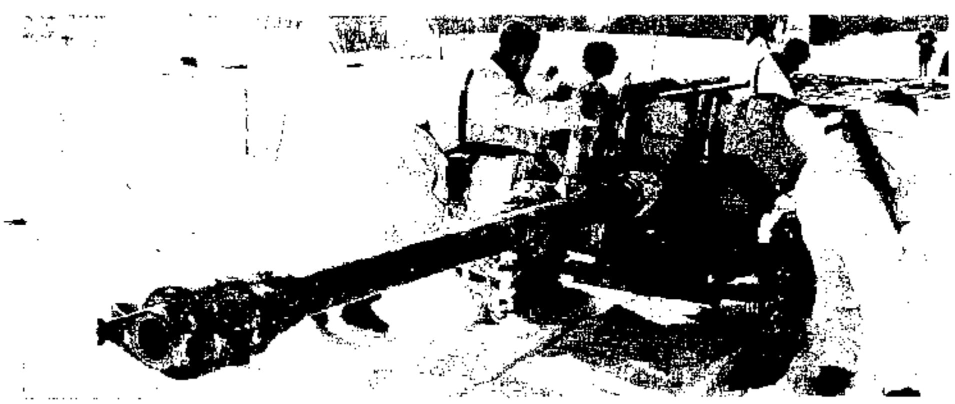
DESCRIPTION:

The 85 mm calibre has been in service with the Soviet forces since World War II, and although the design is old several varieties are still in use.

The D-48 anti tank gun is a reliable and effective weapon which appears in the inventories of most of the Armies of the Eastern Bloc. Guns of this type and size are no longer used in Western Armies where they have been replaced by missiles or recoilless guns. The D-48 is entirely conventional in design and appearance. Some versions have been seen with an auxiliary power unit mounted on the trail to provide a measure of mobility.

CHARACTERISTICS:
Barrel length: 53 calibres
Elevation limits: −5° to +25°
Traverse: 30°
Total weight: 1,725 kg
Range: 15.5 km
Rate of fire: 20 rounds/min

STATUS:
Obsolescent.



85-mm D-48 gun being manhandled by its crew (Tass)

COUNTRIES SUPPLIED:
Most, if not all of the Eastern Bloc, China and Egypt.

85-mm Anti-tank/Field gun D-48

5580.103
85 mm ANTI-AIRCRAFT GUN M-44

DESCRIPTION:

Long a standard AA weapon of the Russian Army, the 85 mm gun is used with the Fire Can S-band fire control radar. (**2871.153**).

CHARACTERISTICS:
Barrel length: 53 calibres
Elevation limits: −3° to 82°
Traverse: 360°
Total weight: 4,300 kg
Shell weight: 9.75 kg
Max range: 15.4 km
Max height: 9.4 km
Rate of fire: 15-20 rounds/min

5516.103
76 mm DIVISIONAL GUN M.1942 (ZIS-3)

DESCRIPTION:

The 76 mm family has followed through all branches of Soviet artillery, and has also appeared in naval mountings. There has been progressive improvement, and the ZIS 3 is described as a typical example of the mark. Over the years the carriage has become lighter, the range greater, and the shell more effective. There is a pack version which is used by mountain troops – particularly in Communist China – and one version was used as a tank gun.

Now no longer powerful enough for modern mechanised war, the 76 mm still appears in the satellite armies, and is supplied to many of the smaller emergent nations. It might be said to equate in versatility, age and general use to the British 25 pounder, though it would be unwise to carry the comparison too far.

CHARACTERISTICS:
Total weight: 2,500 kg
Range – max: 13,300 m
Elevation: max. 37°
Traverse: 54°
Ammunition: Fixed. Round weight 8.6 kg
Shell: HE, APHE, HVAP
MV: HE, 680 m/s, HVAP, 965 m/s
Penetration: 92 mm armour
Crew: 6

STATUS:
In service.

COUNTRIES SUPPLIED:
All Warsaw Pact, People's Republic of China, Indonesia, Cuba.

5515.103
57 mm ANTI-TANK GUN M 1943 (ZIS-2)

DESCRIPTION:

This is an elderly gun which is probably phasing out of the Soviet first line formations. It is known to be still in service with several satellite countries, and variants exist. Its penetration is no longer sufficient for modern Armoured Fighting Vehicles although APCs would be highly vulnerable to it. It is interesting that the calibre of this gun is the same as a German anti-tank gun, though whether the Soviets took the idea in such complete details as to copy the actual calibre is not known. This equipment has been seen with an Auxiliary Power Unit (APU) on the trail, thus giving it a limited capability for self-propulsion. This version of the gun is generally known as the M-55. Its characteristics are much the same as those of the M-43.

CHARACTERISTICS:
Total weight: 1,419 kg
with 20 hp trail motor: 1,800 kg
Elevation: 5° to 25°

Traverse: 54°
Shell: HE, APHE, AP, HVAP, weights from 1.75 kg to 3.74 kg
MV: HE, 700 m/s HVAP 1,270 m/s
Range: Approx 8 km
Rate of fire: 20 rounds/min
Penetration: HVAP, 100 mm armour

STATUS:
In service.

57 mm Anti-tank gun M-1943

COUNTRIES SUPPLIED:
All Warsaw Pact, People's Republic of China.

5514.103
57 mm TOWED AA GUN AND AA SP GUN

DESCRIPTION:

The towed anti-aircraft gun S-60 is in general use throughout the Soviet and Satellite Armies and Navies. It is a radar-controlled light gun with a dual capability of engaging aerial or ground targets. The design is thought to have come directly from the German 5.7 cm FLAK Gerat 58 which was not completed in 1945 and which was then taken over by the occupying Soviet Forces. From what is known of the gun it has a good performance, and is comparable with the Bofors 40 mm.

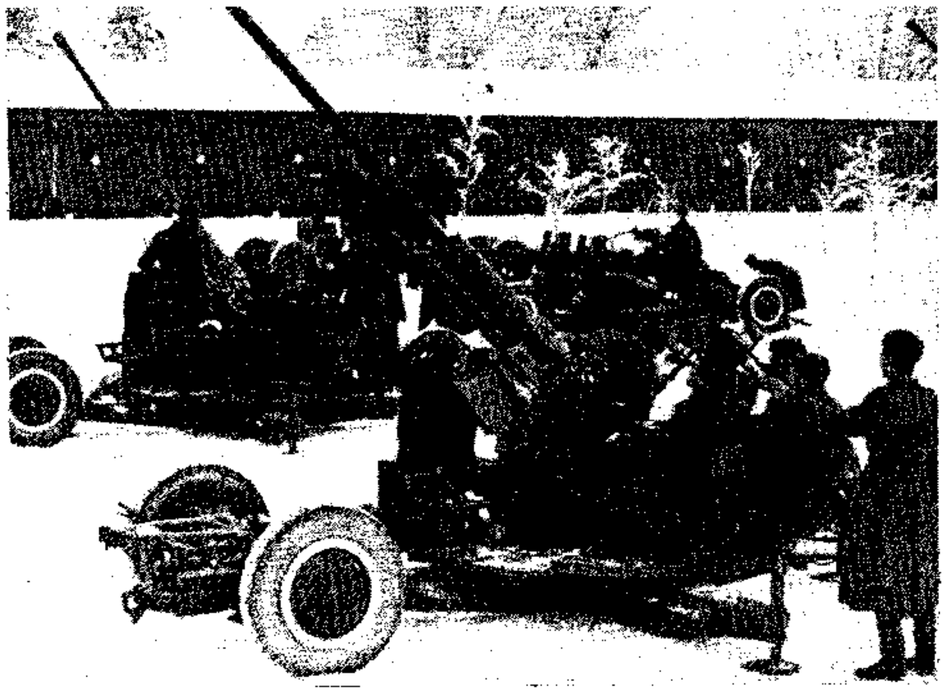
In the self propelled version, the ZSU 57 mounts two guns in a large square turret. The total cyclic rate of fire of this combination is about 240 rounds per minute, but it is not known how much ammunition is carried.

The chassis has four road wheels and no return rollers. The sprocket is at the rear, driven by the same engine as the T-54. The top deck is very flat, and not much higher than the track-guards, thus leaving space for the large and distinctive turret. The driver is in the extreme left front corner of the chassis.

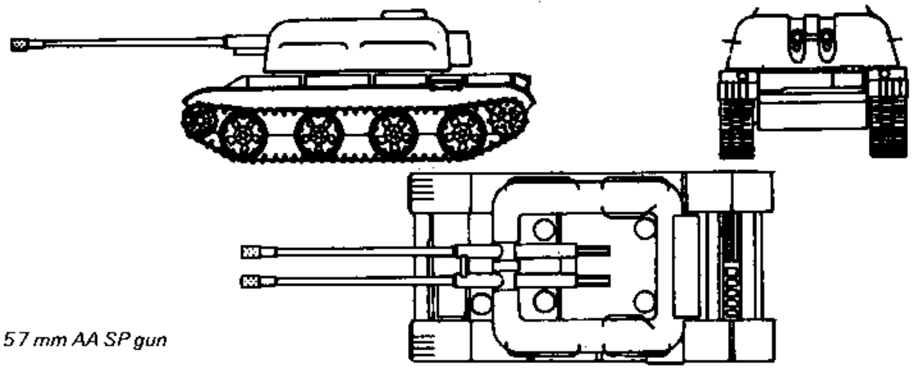
CHARACTERISTICS:
Overall length: 6.20 m
Width: 3.27 m
Height: 2.75 m
Total weight: 30,000 kg
Range: 4,875 m vertically, 1,200 m horizontally
Elevation: 2° to 87°
Traverse: 360°
Ammunition: 57 mm fixed
Shell: HE, weight 2.79 kg
Rate of fire: 120 r.p.m. per gun

STATUS:
In service.

COUNTRIES SUPPLIED:
Poland, Czechoslovakia, Egypt.



57 mm AA gun M-50. This is the towed version of the gun used in the SU-57 and has the same characteristics (Novosti)



57 mm AA SP gun

2887.103
37 mm ANTI-AIRCRAFT GUN M38/39

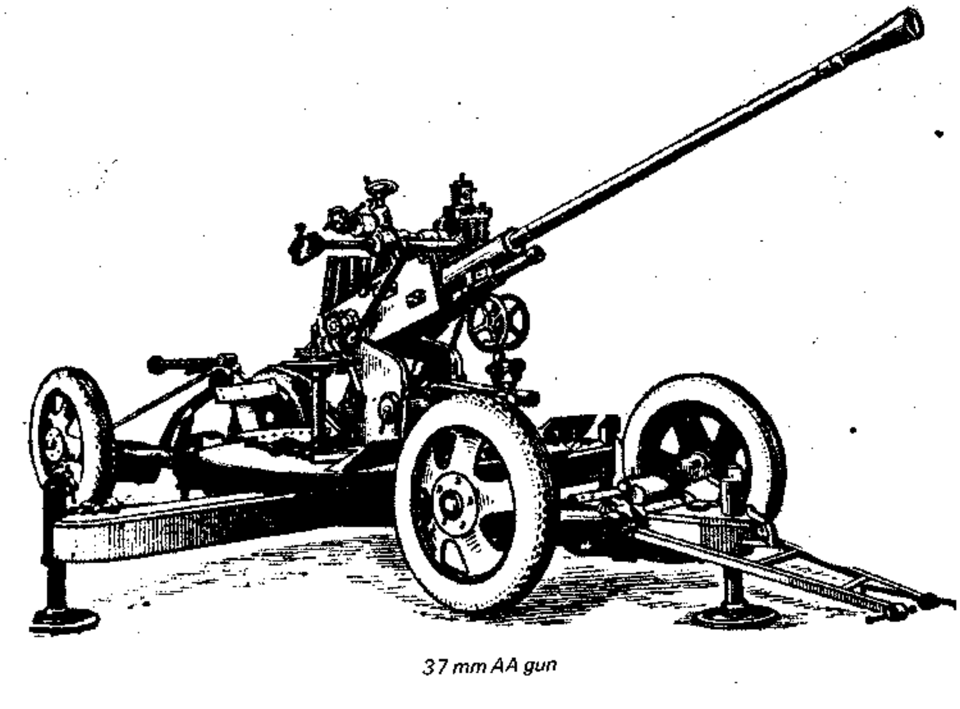
DESCRIPTION:

Probably the earliest light anti-aircraft gun still in service with Russian land forces, this weapon, though in more active use elsewhere, is now confined to reserve formations in Russia. Designed for use only with optical sights it is a mobile weapon with a very respectable performance. It is mounted on a four-wheel trailer for transport.

CHARACTERISTICS:
Calibre: 37 mm
Barrel length: 70 calibres
Elevation: −5° to +85°
Traverse: 360°
Weight in firing order: 2 t
Shell weight: 725 gm
MV: 960 m/sec
Range: maximum: 8,000 m
effective AA: 1,500 m
Rate of fire: 180 rounds/min

STATUS:

Reserve formations of USSR. Supplied to many other countries including Albania, Yugoslavia and North Vietnam, where it has recently been in action.



37 mm AA gun

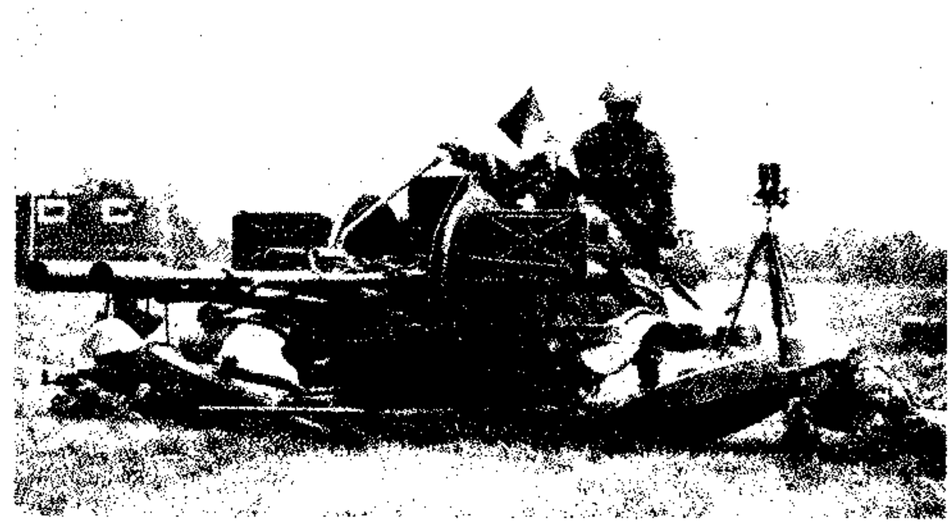
5581.103
23 mm AA CANNON

DESCRIPTION:

This is a twin-mounted 23 mm rapid-fire cannon mounted on a trailer the wheels of which can be detached to settle the gun on the ground. The guns are visually laid.

CHARACTERISTICS:

Barrel length: 80 calibres
Elevation limits: $-5°$ to $+90°$
Traverse: 360°
Total weight: 950 kg
Projectile Weight: 0.2 kg
MV: 970 m/sec
Max range: 7 km
AA engagement range: 1.2 km
Rate of fire: 1,000 rounds/barrel/minute



Twin 23 mm AA cannon

5582.103
QUAD-MOUNTED 14.5 mm AA MACHINE GUN ZPU-4

DESCRIPTION:

This is a quadruple-mounted version of a 14.5 machine gun that is also to be found in a variety of twin (ZPU-2) mountings on Russian AFVs. The quadruple mount is carried on a 4-wheel trailer drawn by a light truck. As can just be made out in one of the accompanying pictures, the trailer wheels can be detached when the weapon is in use. The other picture shows some detail of the guns and sight.

CHARACTERISTICS:

Barrel length: 93 calibres
Elevation limits: 0° to 90°
Traverse: 360°
Total weight: 2,100 kg
Projectile weight: 65 gm
M.V.: 1,000 m/sec
AA engagement range: 1,200 m
Rate of fire: 600 rounds/barrel/minute

ZPU-4 on exercise

Close-up of ZPU-4

5583.103
RECOILLESS ANTI-TANK GUNS

DESCRIPTION:

Russian Army units are known to have at least two different recoilless guns in service: one of these has a calibre of 82 mm and the other, which is a more modern weapon, a calibre of 107 mm.

CHARACTERISTICS:

Type:	**B-10**	**B-11**
Calibre:	82 mm	107 mm
Barrel length:	20 calibre	33 calibre
Total weight:	86 kg	225 kg
Shell weight:	3.6 kg	9.0 kg
MV:	320 m/sec	410 m/sec
Engagement range:	500 m	1,000 m
Armour penetration:	250 mm	380 mm

STATUS:

In service with Warsaw Pact armies. The Czech Army is equipped with 82 mm recoilless weapons of more modern design than the elderly B-10 described above. So far as is known, however, the Czech weapons – which are made at the Skoda works – are not yet in service with the army of any Warsaw Pact country other than Czechoslovakia. (See entry **5588.103**).

YUGOSLAVIA

2276.103
YUGOSLAV ORDNANCE

Yugoslav ordnance is both extensive and varied. Before the Second World War the country relied on imported weapons for its armed forces: important sources being Schneider (France) and the Skoda works. Since the war, however, a significant armaments manufacturing operation has been developed in the country.

In the following entries are listed those weapons that are or have been manufactured in Yugoslavia together with a few older weapons, of foreign manufacture, which are not known to be found elsewhere. Apart from these two categories of weapons, however, there are many current and obsolete weapons which have been acquired by the Yugoslavs over the years and kept in service. The following list is probably not comprehensive, but it at least gives some idea of the extent and variety of the weapons available.

Czechoslovakia
- Twin 30 mm SP AA gun M-52/59 (**2029.103**)

Germany
- 105 mm Light field howitzer M-18M (**2190.103**).

USA
- 155 mm Medium field howitzer M-1 (**5510.103**)
- 155 mm Gun M-2 (**5506.103**)
- 105 mm Light field howitzer M-2 (**5511.103**)
- 90 mm SP Gun M-36 (Jackson)
- 76.2 mm SP gun M-18 (Hellcat)
- 75 mm Recoilless gun M-20 (**5584.103**)

USSR
- 152 mm Gun-howitzer M-37 (**2886.103**)
- 122 mm Medium field howitzer M-38 (**5520.103**)
- 122 mm Gun M-37 (**2894.103**)

100 mm Anti-tank gun M-55 (**5518.103**) with locally modified muzzle brake
SU-100 Tank destroyer (**2888.103**)
85 mm Anti-aircraft gun M-44 (**5580.103**)
76.2 mm Anti-tank gun M-42 (**5516.103**)
57 mm Anti-tank gun M-43 (**5515.103**)
57 mm Anti-aircraft gun M-50 (**5514.103**)
SU-57 Twin SP AA guns (**2890.103**)
37 mm Anti aircraft gun M-39 (**2887.103**)

Status:
All these weapons are believed to be in service with active formations of the Yugoslav forces.

2267.103
105 mm FIELD HOWITZER M-56

Description.
This weapon is believed to be substantially a new development by the Yugoslavs; but since it exhibits features both of the US M-2 weapon (**5511.103**) and of the Rheinmetall modernisation thereof (**5576.103**) it is difficult to be sure. Most noticeable differences from the American weapon are the new shield and the muzzle brake.

Characteristics.
Calibre: 105 mm
Barrel length: 3.48 m
Elevation: −12° to +68°
Traverse: 52°
Weight: 2,100 kg
Weight of shell: 15 kg
MV: 570 m/sec
Range: 13 km
Rate of fire: 6-7 rounds/min
Ammunition: HE, HEAT, Smoke, Illuminating
Crew: 6 men

Status:
In service in considerable numbers.

Manufacturers:
Yugoslav State Factories.

105 mm Field Howitzer in production

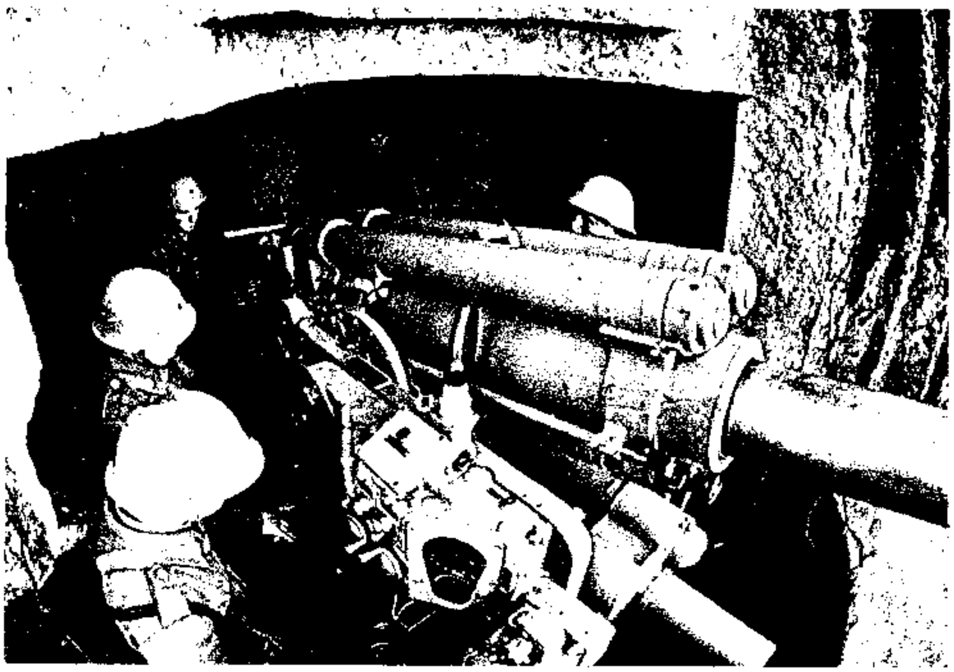
2274.103
88 mm COASTAL DEFENCE GUN (FLAK-36)

Description
Although described here as a coastal defence weapon, because that is the purpose for which it is currently deployed in Yugoslavia, this is in fact the famous 88 mm flak gun so extensively used by the German forces in the Second World War. The model in service in Yugoslavia is the Flak-36, effectively the second mark of the gun which incorporated the modifications designed to correct weaknesses revealed in the original Flak-18 during the Spanish Civil War.

Characteristics:
Calibre: 88 mm
Barrel length: 56 calibres
Weight in firing order: 5 t
Range: 14.8 km
Rate of fire: 15-20 rounds/min

Status:
In service in coastal installations on the Adriatic coast.

Manufacturer.
Originally Krupp.



88 mm Coastal Defence Gun emplacement

2268.103
76.2 mm MOUNTAIN GUN M-48 B-1

Description.
This weapon, built in Yugoslavia, is designed for use in all kinds of difficult terrain. It can be towed by truck or by horse and breaks down easily into loads which can be carried by pack animals. Conceptually it is not unlike the Italian pack howitzer (**5501.103**); the latter is a larger weapon, of course, but weight for weight the Yugoslav gun has a respectable performance.

Characteristics
Calibre: 76.2 mm
Barrel length: 15.5 calibres
Elevation: −15° to +45°
Traverse: 50°
Weight in firing order: 705 kg
Weight of shell: 6.2 kg
MV: 222.298 m/sec
Range: 500-8,600 m
Ammunition: HE, HEAT, Smoke
Rate of fire: 6-7 rounds/min
Trail: spread and folding

Status:
In service.

Manufacturers.
Yugoslav State Factories

2275.103
75 mm ANTI-TANK GUN M-40

Description:
This was a highly successful anti-tank gun used by the German Army in the Second World War. So far as is known, however, it is now in service only in Yugoslavia.

Characteristics:
Calibre: 75 mm
Weight in firing order: 1,500 kg
Weight of shell: 5.7 kg
MV: 550 m/sec
Range: 7,700 m

Status:
In service.

Manufacturer
Rheinmetall, Germany.

2265.103
TRIPLE 20 mm ANTI-AIRCRAFT CANNON M-55

Description.
The Triple 20 mm anti-aircraft gun M-55 consists of three Hispano-Suiza HSS 804 guns mounted on a HSS 630-3 towed carriage. The guns and carriage are built under licence in Yugoslavia. The Yugoslavs have also mounted the M-55 on some naval vessels.

Characteristics:
Calibre: 20 mm
Length of tube: 70 calibres
Weight in firing position: 1,171 kg
Length travelling: 4.04 m
Width travelling: 1.27 m
Height travelling: 1.93 m
Elevation: 5° to +83°
Traverse: 360°
Cyclic ROF per barrel: 700 r.p.m.
Capacity of magazine: 50 rounds/barrel
Effective A/A range: 1,500 m
Ammunition: HE and AP
Crew: 6

Status:
In service.

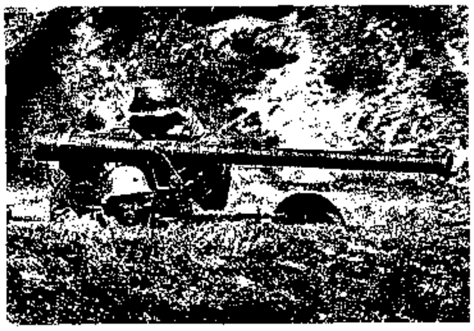
Supplier
Yugoslav State Factories.

2269.103
82 mm RECOILLESS ANTI-TANK GUN M-60

Description:
The larger of the two recoilless anti-tank guns in Yugoslav service, this is a fairly modern weapon of Yugoslav design and manufacture.
The weapon is mounted on a two-wheel trailer; the towing bar forms the third leg of a tripod

mount for firing.
CHARACTERISTICS:
Calibre: 82 mm
Elevation: —20° to +35°
Traverse: 360°
Weight: 122 kg both in travelling and firing order
Weight of shell: 7.2 kg
MV: 388 m/sec
Range: maximum, indirect fire: 4,500 m
practical, stationary target: 1,500 m
practical, moving target: 1,000 m
Ammunition: HEAT
Penetration: 220 mm, 25-90°
Rate of fire: 4-5 rounds/min
Crew: 2-5 men
STATUS:
In service

MANUFACTURERS:
Yugoslav State Factories.



82 mm Recoilless Anti-tank Rifle

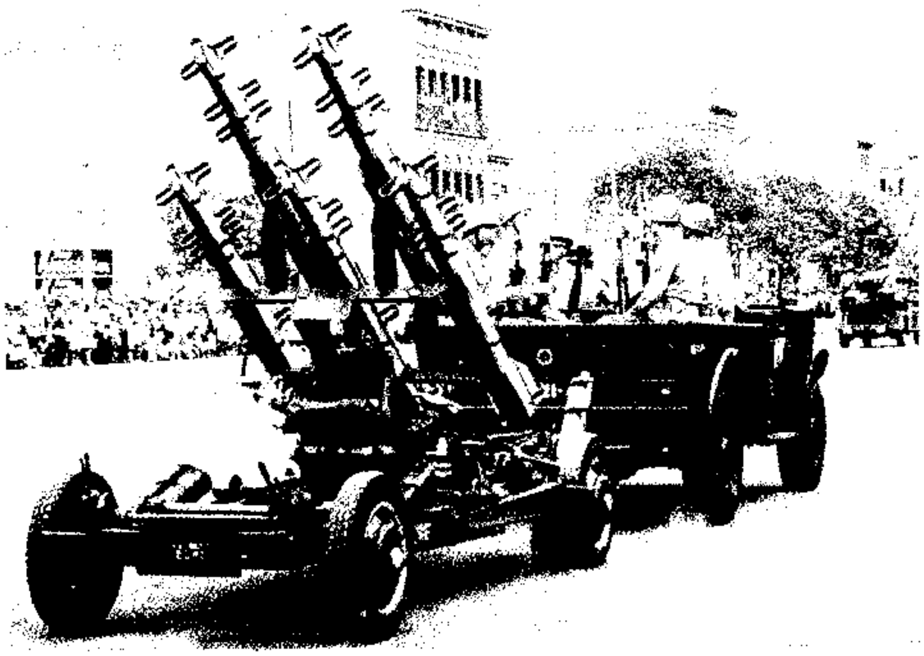
ARTILLERY ROCKETS

BRAZIL

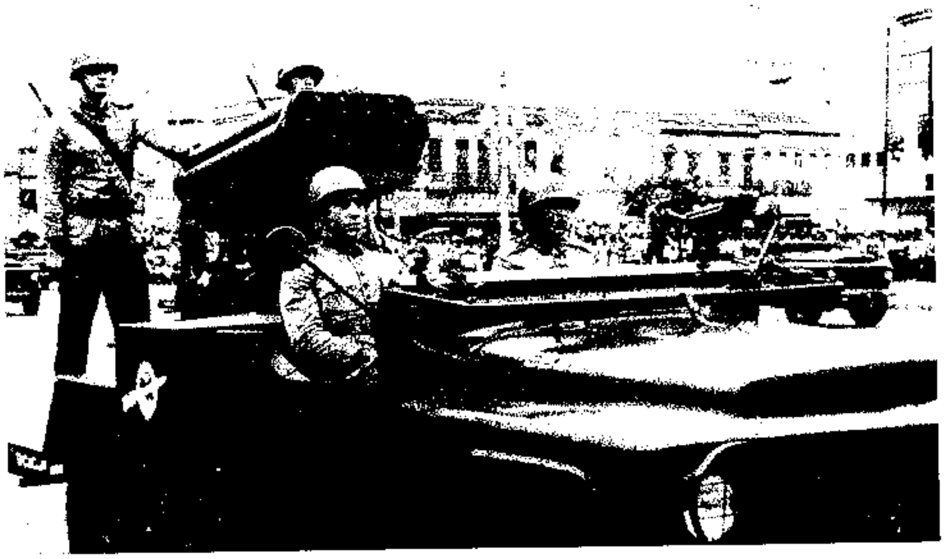
2026.103
ARTILLERY ROCKETS
DESCRIPTION:
Two types of solid-propellant artillery rocket – both launched from multiple launchers – have been developed by the Department of Studies and Technological Research.

114 mm Rocket
This is an unguided spin-stabilised rocket which is fired from a 5-round launcher which is an adaptation of a 40 mm anti-aircraft gun mounting. Spin is imparted by the rocket's cruciform fins.
The rocket is two metres in length, is powered by a two-stage solid-propellant rocket motor and has a high explosive warhead. Maximum speed is Mach 1.8 and the rocket has a range of 25 km.

Rocket Type 108-R
This is a simple unguided cylindrical rocket with no fins; spin-stabilisation being imparted by the canted nozzles of its solid-propellant rocket motor. It is fired from a 16-tube launcher which is designed for vehicle mounting. The rocket has a high-explosive warhead. Maximum range is believed to be about 12 km
DEVELOPMENT AUTHORITY:
Departamento de Estudos e Pesquisas Tecnológicas.



Brazilian Army's 114 mm artillery rockets (Ronaldo S. Olive)



Brazilian Army's Type 108-R artillery rocket launcher (Ronaldo S. Olive)

CZECHOSLOVAKIA

2024.103
RM-130 ARTILLERY ROCKET LAUNCHER
DESCRIPTION:
This is a multi-barrel rocket launcher similar in principle and appearance to weapons developed in several countries since the Second World War. The launcher assembly is commonly carried in the V2S Praga 6-ton 6 × 6 truck which is also made in Czechoslovakia.
CHARACTERISTICS:
Calibre: 130 mm
Number of barrels: 32

Elevation: 45°
Traverse: 360°
All-up weight: 12 t including truck
Weight of rocket: 26 kg
Speed at burnout: 410 m/sec
Maximum range: 8.2 km
Maximum rate of fire: 300/min

STATUS:
In service in the Czechoslovakian and Austrian armies. A similar weapon is in service in the Rumanian Army but mounted on a SIL-157 vehicle.

FRANCE

2134.103
RAP 14

DESCRIPTION:
RAP 14 is a short-medium range unguided fin-stabilised ground-to-ground artillery rocket system. Launched either singly or in salvoes from a multiple launcher it is a robust and simple weapon, easy to handle and of high reliability.

HANDLING AND FIRING:
Rockets are stored with the warhead and body separate in special fireproof, damp-proof and shock-resistant containers. When required for use the warhead is assembled to the body and loaded into the multiple container/launcher that holds 21 rockets. A safety pin that renders the fuse totally inoperative is withdrawn when the warhead is assembled to the rocket.

Further security is provided by a mechanism that ensures that even after the safety pin has been withdrawn the fuse remains locked until after the warhead has been subjected to an acceleration of at least 15g for more than 0.2 seconds. This means in practice that the warhead cannot be detonated until the rocket is at least 500 metres from the launcher.

Firing is controlled by a sequencer connected to the trailer on which the multiple launcher is mounted by a multicore cable. Rotation of the launcher turntable is hydraulically actuated and the trailer is fitted with hydraulic brakes and hydraulic levelling jacks.

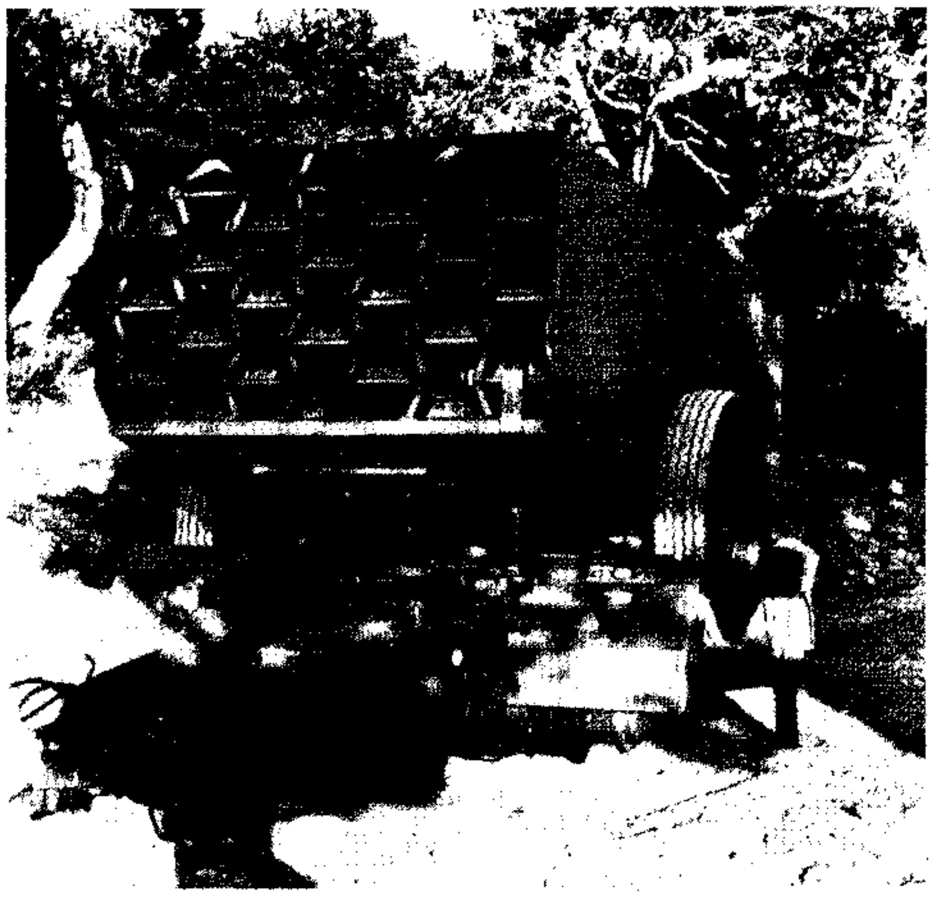
The low dispersion of the system makes it possible to use the kind of ranging techniques traditionally employed with conventional artillery as well as making use of it as a quick-reaction barrage weapon. Moreover, this low dispersion means that a salvo fired by RAP 14 can concentrate a very great weight of missiles on a small area and can do so with minimal warning.

The original design of the rocket incorporated a fragmentation warhead. Currently in development, however, is a new type of warhead which projects a large number of metal balls and which is considered to be more effective than the fragmentation type. Incendiary, smoke and illuminating heads can also be fitted.

Another development is of a new type of proximity fuse. Particular features of the new design are an accurate height of operation, the dispersion of which is measured in centimetres rather than metres, and independence of the reflection coefficient of the ground and the impact angle of the projectile.

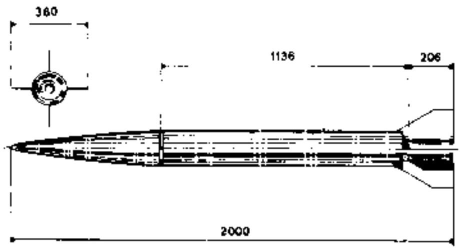
Recently introduced is a device which will correct the effect of the surface wind on the trajectory of the rocket, thus making the use of an anemometer unnecessary and avoiding the need for observing the impact of the shots. Observation of a single round in flight is used to generate a correction which is applied before ripple fire commences.

CHARACTERISTICS:
Missile:
Propulsion: Single-stage solid propellant rocket motor



Multiple Launcher for RAP 14

Warhead: Fragmentation (but see text). Weight 19 kg with 5.5 kg of explosive
Fuse: Impact or proximity.
Total rocket weight: 54 kg.
Launch method: Rocket guided by two rectilinear launch rails and simultaneously rotated by a helical ramp.
Stabilisation: By non-rotating cruciform monobloc fin assembly (thus there is no induced lag).
Burn-out speed: About Mach 2 after 2 seconds.
Range: 16 km (20 km rocket RAP-14S in development).
Circular error probable: 90 m.
Launcher:
Type: Trailer-mounted, road-rail compatible, air-transportable.
Capacity: 21 rounds.
Combat weight: 4.8 tons.
Elevation: 0-52°, hydraulic operation, elevation determined by range setting
Traverse: 360°, hydraulic operation.
Time into action: 2 minutes
Firing method: Electronic sequencing.
Rate of fire: 10 seconds for 21 round salvo.
Interval between salvoes: 4 minutes with manual reloading or 1 minute by replacement of container launcher.



The RAP-14 rocket and its dimensions in millimetres

MANUFACTURERS:
Construction Navales et Industrielles de la Méditerranée (CNIM), 50 avenue des Champs Elysées, Paris 8e, France.

GERMANY (FEDERAL REPUBLIC)

5577.103
LARS—110 mm ARTILLERY ROCKET LAUNCHER

DESCRIPTION:
A multiple rocket launcher mounted on a 7.5 ton 6 × 6 Magirus Jupiter vehicle. The launcher comprises two groups of 18 launch tubes (4-5-5-4), which can be mechanically trained and elevated, from which are launched 100 mm calibre

rockets. These rockets can be equipped with a variety of warheads and can be launched singly or in partial salvoes or salvoes. The rockets are flight stabilised by fins which are folded and protected by a cover for storage and handling.

CHARACTERISTICS:

Missile:

Calibre: 110 mm

Propulsion: Single-stage, solid-propellant rocket motor.

Warhead: Choice of high-explosive, incendiary or smoke.

Range: 15km. Minimum 6.5 km

Launcher:

Capacity: 36 rockets in two groups of 18 launch tubes mounted on a 6 × 6 wheeled prime mover.

Laying: Mechanical.

Traverse limits: +105°.

Elevation limits: 0-55°

Rate of fire: 36 rockets in 18 seconds.

Weights: Rocket 25 kg. Truck and launcher 13 t. System weight in battle order 15 t.

STATUS:

209 supplied to German Army.

MANUFACTURERS:

Wegmann, W. Germany. Rocket by Diehl-Werke under licence from Dynamit Nobel.

110 mm Artillery Rocket Launcher

INTERNATIONAL

2194.103

RS80 ARTILLERY ROCKET SYSTEM

DESCRIPTION:

Accompanying the trilateral FH 70 and SP 70 155 mm gun projects (**2195.103**) and (**2196.103**) is a British-German-Italian project for a multiple artillery rocket system.

Little has yet been said officially about this project, which appears to have originated in a British project code-named *Foil*, but it seems likely that it will use a fin-stabilised rocket with a calibre in excess of 150 mm and a range of 20-30 km.

STATUS:

Project definition – early development.

MANUFACTURERS:

Not definitely known – but it is believed that the German interest will be looked after by Messerschmitt-Bolkow-Blohm and that OTO Melara, CGE-Fiar and SNIA Viscosa will be Italian participants. British participation is not known.

ISRAEL

2593.103

WOLF BATTLEFIELD MISSILE

DESCRIPTION:

Little is known about this missile at the time of writing: although, apparently, it was used extensively by Israeli forces in the 1973 Arab-Israeli war, its existence was not revealed until some six months after the cease-fire.

It appears that the weapon, known as Ze'ev (Wolf) is a short-range ground-to-ground missile – or rather missiles, since there are two significantly different versions. One version has a 170 kg warhead and a range of only about 1,000 metres: the other carries a 70 kg warhead up to 4,500 metres: The missile, which is fired from a framework-type launcher, is said not to be very accurate but effective against large concentrations of men and vehicles.

STATUS:

Believed operational in Israel only.

ITALY

2044.103

154 mm ARTILLERY ROCKET SYSTEM BR 51 G3

DESCRIPTION:

This is a battlefield area weapon system which is being developed by Breda Meccanica. It involves a multi-tube launcher arrangement which is in some respects similar to the now numerous other artillery rocket systems; but which differs from many of them by being mounted on a tracked vehicle; and is believed to be unique in making provision for adjusting the range of its 158 mm rockets by means of an air brake.

CHARACTERISTICS:

Rocket calibre: 158 mm

Type: Fin-stabilised, unguided

Range: adjustable up to 24 km

Rocket weight: 123 kg

Warhead weight: 60 kg

Warhead types: pre-formed fragmentation, canister, anti-tank, incendiary

CEP: 0.75% of range

Rate of fire: 300 rounds/hr

STATUS:

Believed late development. Work on this project will certainly be relevant to the new RS 80 rocket project (**2194.103**).

2594.103

BORA ARTILLERY ROCKET

DESCRIPTION:

Bora is the name given by its makers to that of their family of artillery rockets which has the longest range. It is a substantial weapon which will normally be launched from a 3-round two-wheel trailer launcher (either singly or in salvo) and will carry a 20 kg warhead over a range in excess of 10 km. Like the other missiles of the family it uses a hypergolic fuel which is characterised by the difficulty that it presents to an enemy seeking to locate the launch point.

CHARACTERISTICS:

Type: ground-to-ground

Range: over 10 km

Cut-off speed: 390 m/sec

Take-off acceleration: 384 m/sec^2

Overall length: 4,700 mm

Body diameter: 194 mm

Fin span: 474 mm

Total take-off weight: 226 kg

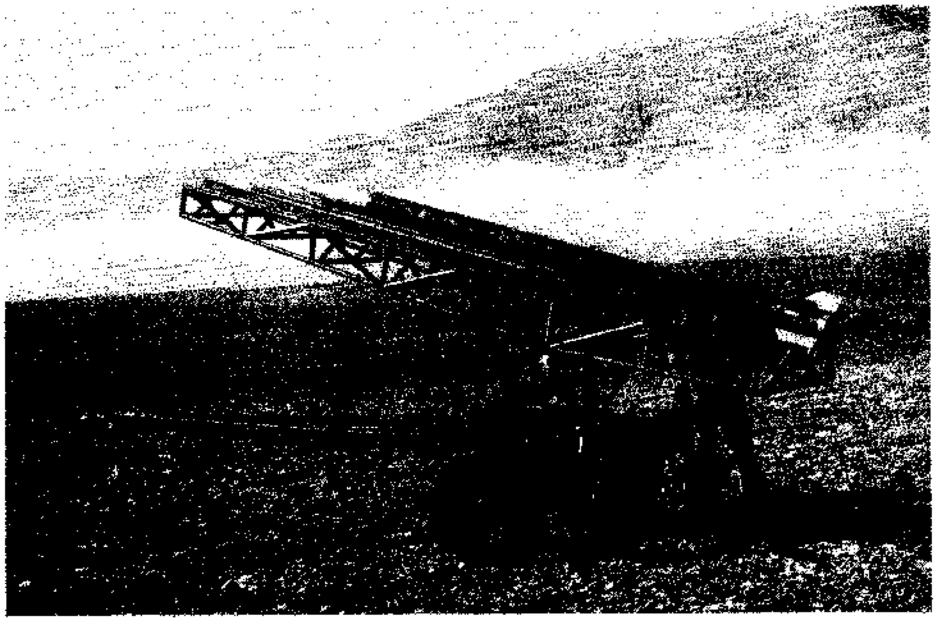
Warhead: 20 kg HE fragmentation semi-armour piercing

Fuse: Impact

Rocket engine: pre-packaged hypergolic self-pressurised liquid propellant unit

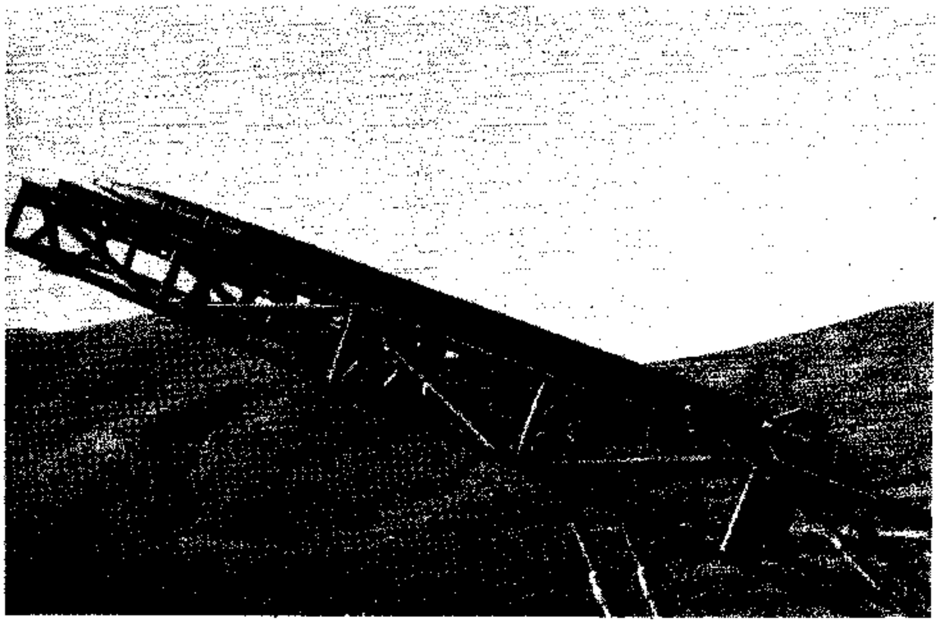
MANUFACTURER:

SAI-Ambrosini SpA, Passignano sub Transimeno Perugia, Italy.



Bora Rocket

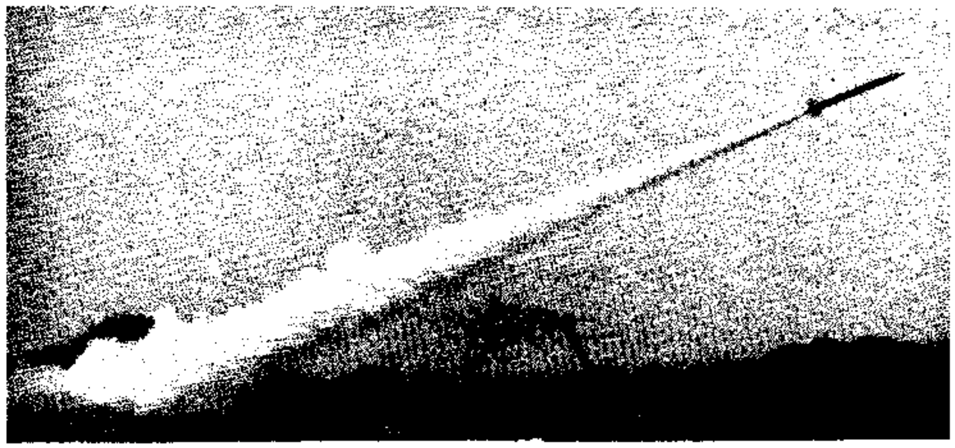
2595.103
MIRA ARTILLERY ROCKET
DESCRIPTION:
Mira is the name given by its makers to an artillery rocket which is similar to Bora (**2594.103**) but smaller and having a shorter maximum range. It carries a 10 kg warhead over a distance of some 5 km. It can be fired either from a 12-round trailer launcher (singly or salvo) or from a man-pack single launcher.
CHARACTERISTICS:
Type: Ground-to-ground
Range: over 5 km
Max cut-off speed: 280 m/sec
Take-off acceleration: 338 m/sec^2
Overall length: 2,960 m
Body diameter: 108 mm
Fin span: 268 mm
Total take-off weight: 50 kg
Warhead: 10 kg. HE fragmentation semi-armour piercing
Fuse: impact
Rocket engine: pre-packaged hypergolic self-pressurised liquid propellant unit
MANUFACTURER:
SAI- Ambrosini SpA, Passignano sul Transimono, Perugia, Italy.


Mira Rocket

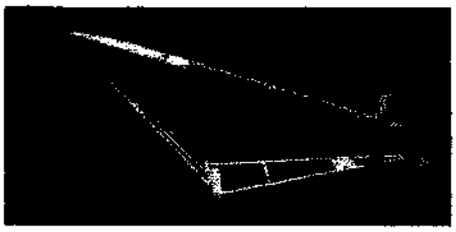
2152.103
ATTILA MK II ROCKET
DESCRIPTION:
This weapon is a successor to the now-obsolete Attila Mk I (**5553.103** 1973-74) and is a fin-stabilised 82.5 mm ground-to-ground rocket which can be launched either from a portable launcher – with which it forms a man-pack – or from a mobile 40-rail launcher-trailer from which a sequential salvo can be fired.

The rocket carries a 3 kg warhead which is normally of the AP fragmentation type and has a range in excess of 4.5 km. Propulsion is by a pre-packaged hypergolic self-pressurised liquid propellant unit, the exhaust trail of which has no flashback and cannot be picked up by conventional IR detectors.

CHARACTERISTICS:
Length: 1.4 m
Body Diameter: 82.5 mm
Fin-span: 225 mm
Launch Weight: 14 kg
Warhead Weight: 3 kg
Fuse: Impact
Propellant: See text
Max Cut-off Speed: 295 m/sec
Range: More than 4.5 km
STATUS:
Production.


Attila II launch

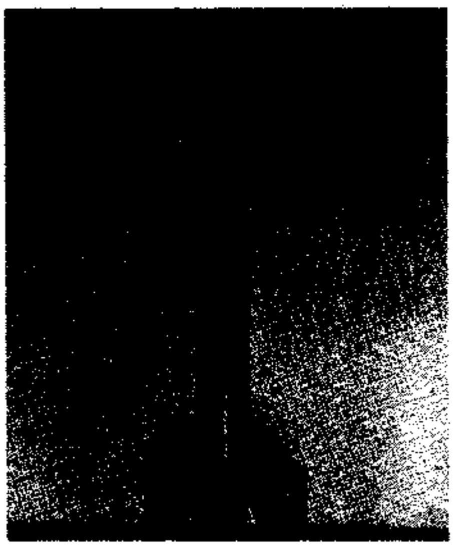
MANUFACTURERS:
Design: Centro Studi Trasporti Missilistici, Via Squarcialupo 19/A 00162 Roma, Italy.
Production: SAI-Ambrosini SpA, Passignano sul Trasimeno (Perugia), Italy.


Attila II

5590.103
SAMURAI ARTILLERY ROCKET
DESCRIPTION:
This is a low cost artillery and air-to-ground rocket that is currently under development. The propulsion system is a self-pressurised liquid unit with a specific impulse of about 300 sec.

CHARACTERISTICS:
Dimensions: Overall length 1,200 mm. Calibre 76 mm, fin span 200 mm.
Weights: Total launch weight 10.6 kg. Warhead weight 3.0 kg.
Performance: Maximum speed 1,100 m/sec. Maximum range 18 km. Total impulse 1,000 kg/sec.

MANUFACTURER:
Centro Studi Trasporti Missilistici, Via Squarcialupo 19/A 00162 Rome, Italy.


Samurai Rocket

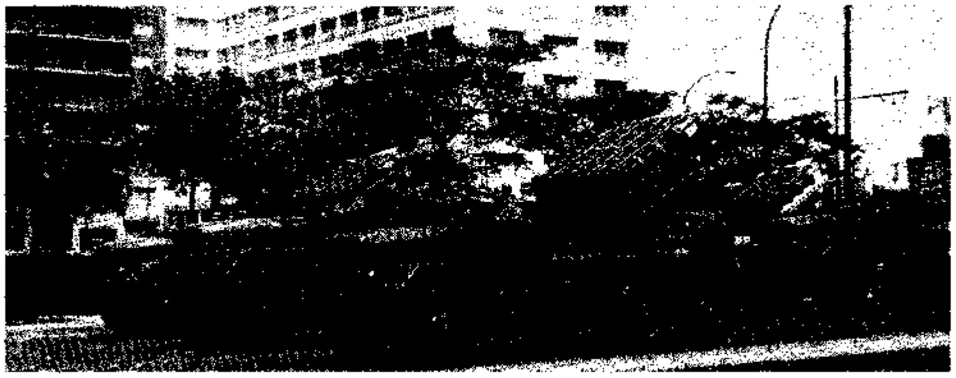
JAPAN

2255.103
ARTILLERY ROCKETS
DESCRIPTION:
A range of surface-to-surface solid-propellant unguided rockets has been made in Japan over many years. Formerly undertaken by the Prince Motor Car Engineering Co. Ltd, the development and production of these rockets is now part of the activities of the Nissan Motor Co Ltd, with whom Prince merged in 1966. The Prince Space and Aeronautical Department (itself derived from the pre-World War II Nakajima Aircraft Company) is now a department of Nissan.
Largest of the series of rockets is the "30-rocket" a 300 mm unguided missile that can be launched from a mobile (prime mover) twin launcher. It has a range of 25 km.
MANUFACTURER:
Space and Aeronautical Department, Nissan Motor Co Ltd, 5-1 3-chome, Momoi, Suginami-ku, Tokyo.

Japanese Type 30 rockets

SPAIN

2033.103
SPANISH ARTILLERY ROCKETS
DESCRIPTION:
Three types of artillery rocket and launcher have been developed in Spain. It is interesting to note that whereas most Western European nations have developed or are developing rockets of less than 150 mm calibre, two of the Spanish weapons are significantly larger than this.



D-3 rocket launchers

CHARACTERISTICS:

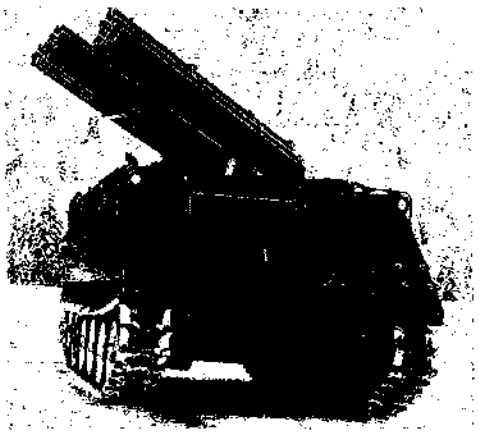
Type:	**R-2B**	**E-3**	**D-3**
Calibre:	108 mm	216 mm	300 mm
Weight:	16.4 kg	101.1 kg	247.5 kg
Range:	7.5 km	14.5 km	17.0 km
Rockets in launcher:	18	21	10

STATUS:
In service with Spanish forces.

SWITZERLAND

2386.103
DIRA 8 cm ROCKETS
DESCRIPTION:
DIRA is an unguided spin-stabilised and fin-stabilised rocket which can be used for a variety of military purposes. It can be used with the Oerlikon multiple rocket launcher or in various other field and naval applications but it is also suitable for use as an airborne rocket.

CHARACTERISTICS:
Calibre: 81 mm
Length: (rocket) 1.3 m
Weight: complete rocket: 16 kg. Warhead: 7 kg
Max velocity: 490 m/sec
Max range: 8.7 km
MANUFACTURER:
Machine Tool Works, Oerlikon Bührle Ltd, Birchstrasse 155, Zürich, Switzerland.



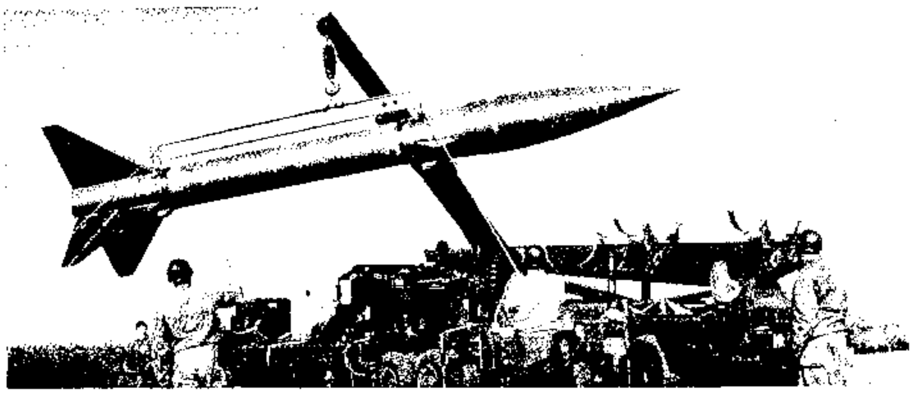
Oerlikon 8 cm DIRA rocket launcher

UNITED STATES OF AMERICA

2652.103
HONEST JOHN BATTLEFIELD SUPPORT MISSILE
DESCRIPTION:
Honest John is a simple surface-to-surface free-flight rocket that has the accuracy of standard artillery and considerably better battlefield mobility. Operational for several years with the US and NATO forces the system has undergone substantial improvement. The unguided rocket is driven by a single-stage solid propellant motor and can carry either a nuclear or a high-explosive warhead.
Designed to fire like conventional artillery in battlefield areas, Honest John is now the oldest missile system still fielded by the US Department

of Defense. Studies were begun by US Army Ordnance in 1950, and shortly after that Douglas Aircraft (now McDonnell Douglas) submitted proposals based on the Ordnance specifications and became prime contractor for the system. Firing tests were successfully completed in 1951 at White Sands, New Mexico.

The resultant system comprises a simple rocket and a highly mobile self-propelled launcher. Operation is simple – there are no electrical controls – and normal crew training and standard fire control techniques are employed.


Honest John being swung on to its launcher

CHARACTERISTICS:
Military Designation: MGR-1B
Type: Mobile surface-to-surface unguided tactical missile
Propulsion: Single-stage solid-propellant rocket motor
Warhead: Nuclear or high-explosive
Length: 7.5 metres
Diameter: 76 cm
Launch Weight: 2,040 kg
Range: 7.5 to 37 km

STATUS:
Honest John has been in service with the armed forces of Belgium, Denmark, the Federal German Republic, France, Greece, the Netherlands, South Korea, Turkey, the United Kingdom and the USA. Production ceased some time ago; and the missile is being replaced, in US Army service by Lance (**2682.111**); replacement is expected to be complete in 1975. Many other NATO nations are expected to replace Honest John by Lance in due course.

5585.103
ARTILLERY ROCKETS

DESCRIPTION:
Multiple rocket launchers in the US Army appear not to be intended primarily for barrage purposes as they are in some other armies: instead it seems that their primary purpose is envisaged as part of a chemical warfare operation. Be that as it may, there are two such launchers currently in US Army service, the M-21, 114 mm 24 barrel launcher and the M-91 115 mm 45-rocket launcher. Both are trailer-mounted.

CHARACTERISTICS:

	M-21	M-91
Calibre	114 mm	115 mm
Number of rockets	24	45
Weight of each rocket	18-19 kg	25.9 kg
Total weight (less rockets)	694 kg	544 kg
Range	5-8 km	11.3 km

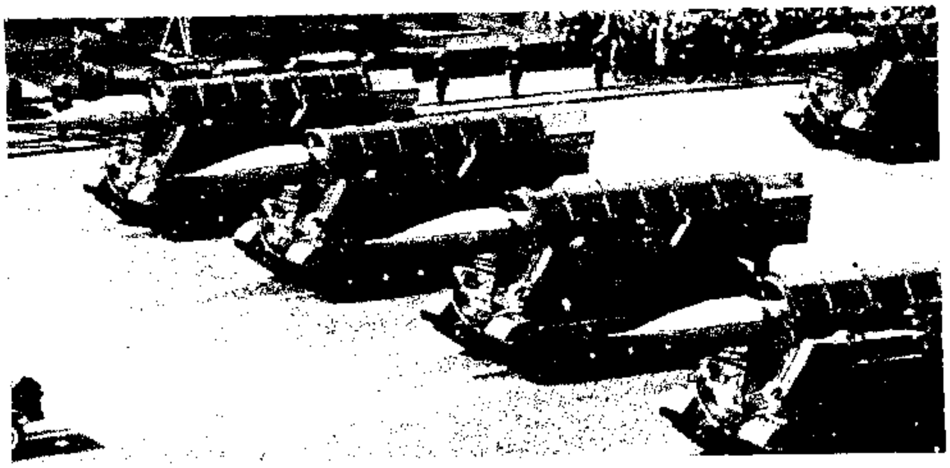
THE UNION OF SOVIET SOCIALIST REPUBLICS

2920.103
FROG 1 BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:
The series of unguided tactical missiles known by the NATO code name Frog and numbered from 1 to 5 is generally of a type similar to the US Honest John missile. References to these missiles in Warsaw Pact literature suggest that the Russian name for at least some of them is Luna.

Frog 1 is a spin-stabilised missile carried on a tracked vehicle based on the JS III amphibious reconnaissance AFV with enclosed accommodation for the crew. The missile is covered by a heavy ribbed casing which elevates with it to form a launch-tube. This container also incorporates a heating unit to prime the solid propellant.

CHARACTERISTICS:
Type: Surface-to-surface spin-stabilised unguided tactical missile
Propulsion: One solid-propellant sustainer
Warhead: Nuclear or high-explosive
Length: About 10 metres
Diameter: About 85 cm
Launch Weight: About 3,000 kg
Range: Estimates vary from 25-65 km


FROG 1 Battlefield Support Missile in 1966 Parade in Moscow (Novosti)

STATUS:
Frog 1 first appeared around 1957 and is certainly obsolescent. Since the Russians seem rarely to discard anything that works, however, these may well be still in service – though almost certainly only in the USSR.

2921.103
FROG 2 BATTLEFIELD SUPPORT MISSILE

DESCRIPTION:
Similar in general conception to Frog 1 the unguided spin-stabilised missiles known by the NATO code names Frog 2, 3, 4 and 5 are all carried on tracked vehicle launchers derived from the PT 76 amphibious reconnaissance tank. Frog 2 differs from Frog 3, 4 and 5 in being powered by a single-stage motor whereas the others have two stages in tandem.


FROG 2 Battlefield Support missile in Moscow Parade (Novosti)

CHARACTERISTICS:
Type: Surface-to-surface spin-stabilised unguided tactical missile
Propulsion: One solid-propellant sustainer
Warhead: Nuclear or high-explosive
Missile Length: About 9 metres
Diameter: About 60 cm
Launch Weight: About 2,400 kg
Range: About 25 km
STATUS:
Frog 2 is of much the same age as Frog 1 and is probably also obsolescent and in limited service.

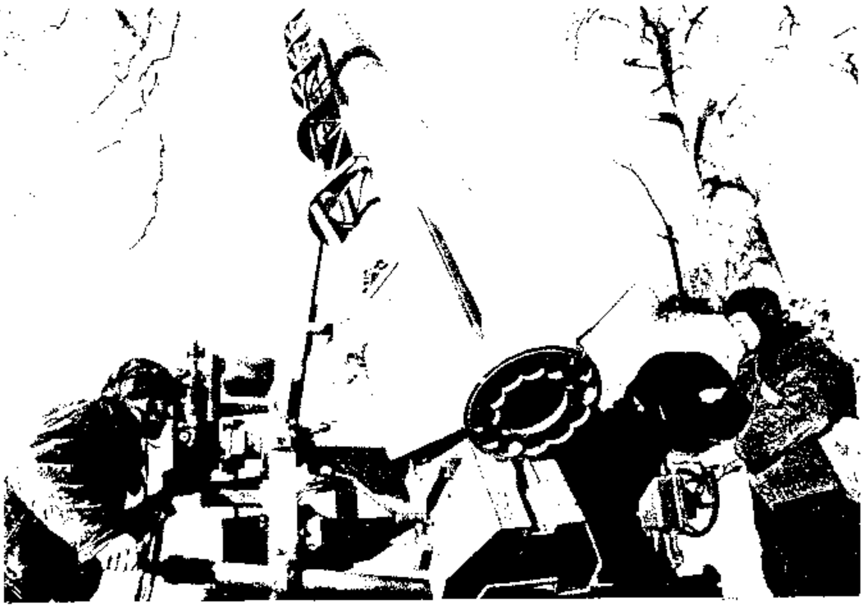
2922.103
FROG 3 BATTLEFIELD SUPPORT MISSILE
DESCRIPTION:
The main difference between this missile and Frog 2 is that it has two rocket stages in tandem giving it a greater range. Like Frog 2 it is mounted on the PT-76 derived armoured vehicle which is lighter than the massive Frog 1 vehicle (about 15 tonnes aginst about 36) and much more mobile – the vehicle has a range of about 235 km and a maximum road speed of about 35 km/hr.
CHARACTERISTICS:
Type: Surface-to-surface spin-stabilised unguided tactical missile
Propulsion: Two-stage solid-propellant motor
Warhead: Nuclear or high-explosive, 250 kg
Missile Length: 10.5 metres
Diameter: About 55 cm
Launch Weight: About 2,000 kg
Range: About 40 km
STATUS
Although of more recent date (about 1960) than Frogs 1 and 2, Frog 3 is also almost certainly obsolescent.

FROG 3 Battlefield Support missile on tactical exercise (Novosti)

2923.103
FROG 4 BATTLEFIELD SUPPORT MISSILE
DESCRIPTION:
Substantially similar to Frog 3, the most obvious difference of this missile from its predecessor is in the shape of the warhead which has the same diameter as the body of the missile but is otherwise similar in appearance to that of Frog 3.
CHARACTERISTICS:
Type: Surface-to-surface spin-stabilised unguided tactical missile
Propulsion: Solid-propellant sustainer and booster in tandem
Warhead: Nuclear or high-explosive
Missile Length: 10.2 metres
Diameter: About 40 cm
Launch Weight: About 2,000 kg
Range: 50 km
STATUS:
Believed operational in USSR.

2924.103
FROG 5 BATTLEFIELD SUPPORT MISSILE
DESCRIPTION:
The only known difference between this missile and Frog 4 is yet another change of shape of warhead, the nose cone of which is almost perfectly conical. Otherwise it is assumed to have much the same characteristics as its predecessor.
STATUS:
Operational in USSR and some other Warsaw Pact countries.

FROG 5 Missile (Tass)



FROG 5 unguided tactical missile on its launcher (Tass)

2926.103
FROG 7 BATTLEFIELD SUPPORT MISSILE
DESCRIPTION:

The introduction of Frog 7, first shown to the public in 1967, marked a new departure in carrying vehicles – the vehicle used being a modern, wheeled, erector launcher (ZIL-135). The missile, too, has a more modern look about it: reverting to the original single-stage design and having a cylindrical warhead of the same diameter as the missile. It has a much cleaner appearance than its predecessors.

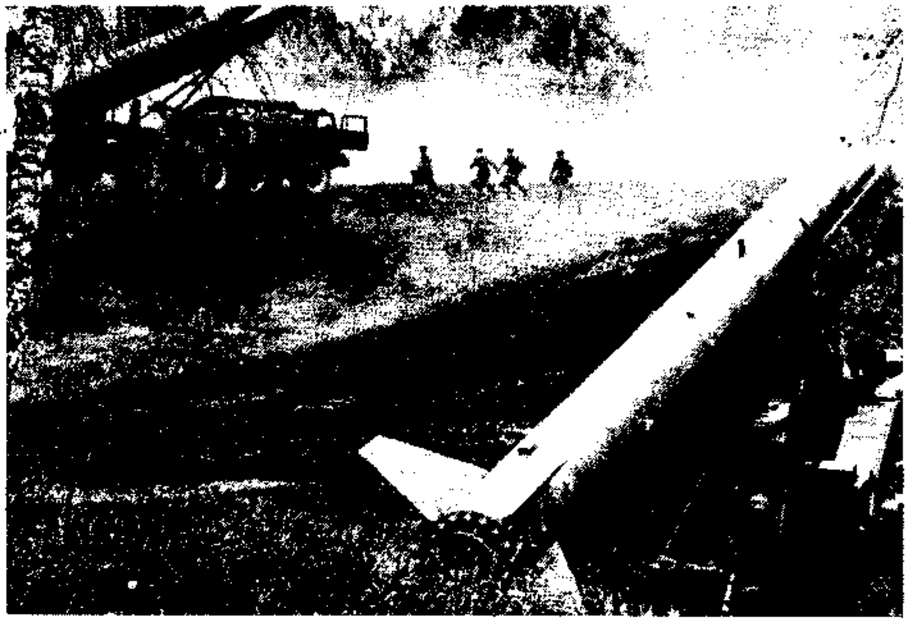
The main nozzle of the single-stage rocket motor is surrounded by a ring of much smaller nozzles.

CHARACTERISTICS:

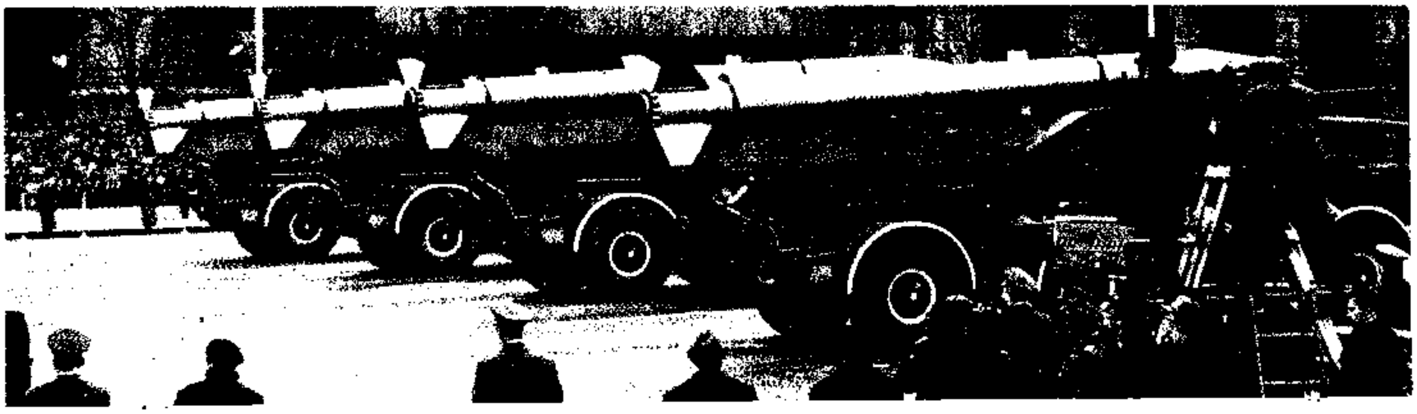
Type: Surface-to-surface, spin-stabilised unguided tactical missile
Propulsion: Single solid propellant motor
Warhead: Nuclear or high-explosive
Length: About 9 metres
Diameter: About 60 cm
Launch Weight: About 6.3 t
Range: About 60 km

STATUS:

Operational in the armies of several Warsaw Pact countries. Also supplied in quantity to the United Arab Republic. Some Frog 7 missiles, supplied by the Russians to Syria, were actually fired against the Israelis in the 1973 Arab-Israeli war. They were equipped with high-explosive warheads. It is not certain however whether they were this unguided version or a guided version (**2927.111**) of Frog 7. In any case they appear not to have been very effective as HE weapons.



FROG 7 missiles in launch position (Tass)



FROG 7 single-stage tactical missiles

5555.103
ARTILLERY ROCKETS
DESCRIPTION:

Artillery rockets have been a feature of Soviet Army operations for many years. They first became famous in 1941 when the Katyusha rockets went into action. Few details of the performance of the various types currently in service with the Soviet forces are available, but a selection of these weapons is illustrated here and the available information is tabulated below.

CHARACTERISTICS:

There are five basically different types of multiple rocket launcher in use in the Russian army. One of these (BM-14) has several different configurations and a second (BM-24) appears on two different vehicles.

Number and calibre of rockets:
BM-14, 8, 16 or 17—140 mm
BM-21 40—122 mm
BM-24 12—240 mm
BMD-20 4—200 mm
BMD-25 6—250 mm

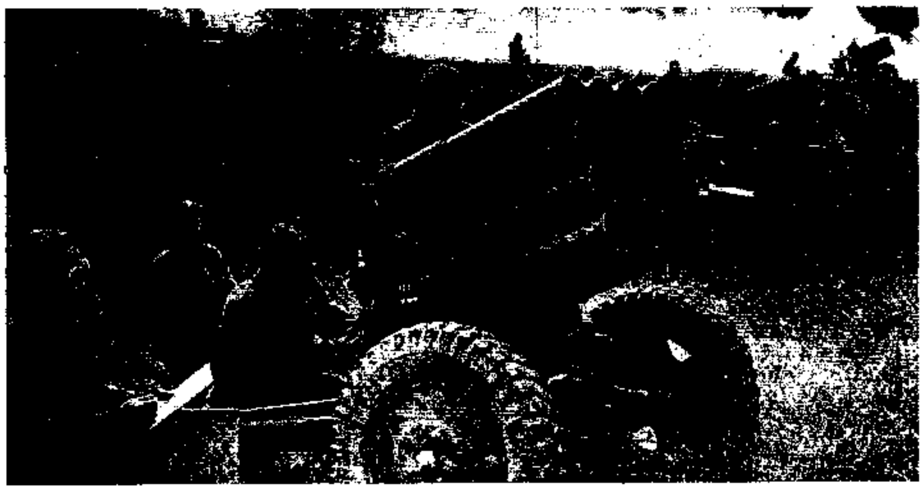
Rocket weight and range:
BM-14 41 kg—9 km (note A)
BM-21 46 kg—15 km
BM-24 113 kg—7 km
BMD-20 194 kg—18 km
BMD-25 450 kg—20 km

BMD-25 rockets in foreground BM-14/17 rockets can just be seen to the right of the picture

Total weight and associated vehicles:
BM-14 (8) 0.6t, GAZ-63 towing
BM-14 (16) 8.2t, SIL-151 mounted (note B)
BM-14 (16) M-1965 1.5t trailer
BM-14 (17) 4.5 t, GAZ-63 type; mounted
BM-21 11.5t, URAL-375
BM-24 9.6t, SIL-151 or 15t AT-5
BMD-20 8t, SIL-151
BMD-25 18.2t, JAAS-214

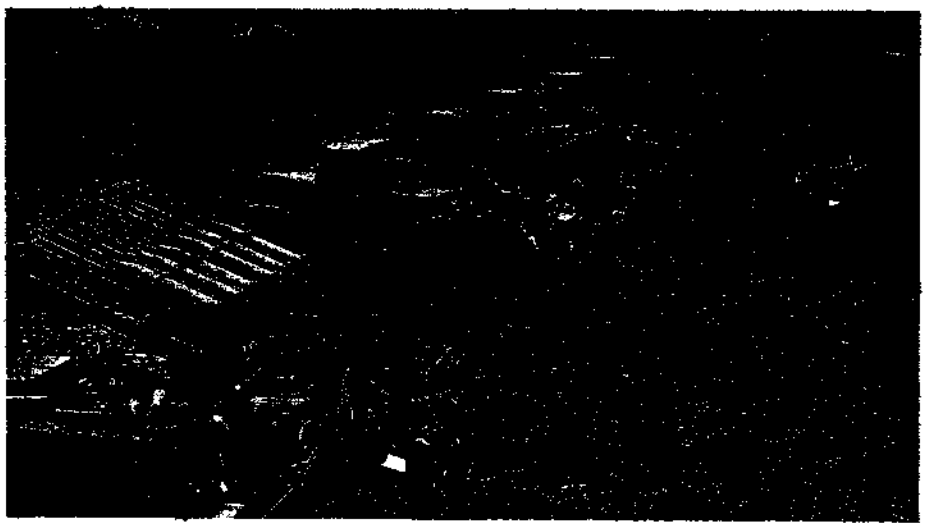
Note A
One source gives two different weights and ranges for BM-14 rockets. For the BM-14 (8) it gives a weight of 39.6 kg and a range of 10.5 km; for all other BM-14 variants it gives 37.1 kg and 9 km.

Note B
This is the earlier of the two BM-14 (16) arrangements. The rockets are arranged in two rows of eight and mounted on a turntable on the vehicle. The later, M-1965, version is a trailer-mounted arrangement in four rows of four launchers.



BM-14 M1965 Rocket Launcher (Novosti)

BM-21 rockets on URAL-375 truck (Tass)



BM-24 rockets on ZIL-151 / 157 truck (Novosti)

YUGOSLAVIA

2266.103
130 mm ROCKET LAUNCHER M-66
DESCRIPTION:
Based on the Czech RM-130 rocket launcher (**2024.103**) this artillery rocket system is made in Yugoslavia. It comprises a 32-tube launcher for 128 mm spin-stabilised rockets. The launcher is mounted on a two wheel trailer and the road wheels, together with the spread trails form the platform for the launcher when in operation. The launcher assembly can be elevated or depressed by handwheel: there is also a traverse handwheel, but the available traverse is limited to a few degrees for correction of aim – otherwise the launcher box would foul the road wheels. Firing is electrical.

CHARACTERISTICS:
Rocket: calibre: 128 mm
length: 80 cm
weight: 23 kg
Launcher: capacity 32 rockets
weight 2.5 t approx
Elevation: 0° to 48°
Traverse: 30°
System range: 9.6 km
Rate of fire: 160 rounds/min
Crew: 3-5

STATUS:
Service.

MANUFACTURER:
Yugoslav State Factories.

MORTARS
CHINA

2176.103
160 mm MORTAR TYPE 60
DESCRIPTION:
China is reported to have a 160 mm mortar in its inventory and it is believed that this, designated Type 60, is based on the M-1953 Russian weapon of the same calibre (**2931.103**). Available details regarding this weapon will be found in the USSR entry.

STATUS:
No definite information.

2175.103
120 mm MORTAR TYPE 53/55

DESCRIPTION:
Designation of the Chinese 120 mm mortar is uncertain: it has been referred to both as the Type 53 and as the Type 55. It is a copy of the Russian 120 mm M-1943 weapon (**5567.103**) which is in widespread service with Warsaw Pact countries and their clients. Available details are given in the USSR entry.

STATUS:
In service. Supplied to North Vietnam, Pakistan and Tanzania.

2174.103
90 mm MORTAR TYPE 97
DESCRIPTION:
Based on a pre-war (and now believed to be obsolete) Japanese mortar of the same designation, the Chinese Type 97 90 mm weapon is also similar in appearance to the US 81 mm M-1 mortar (**2570.103**).

Total weight of the Chinese weapon is 105 kg and it has a range of some 3.7 km.
STATUS:
In service. Has also been exported to Algeria.

2173.103
82 mm MORTAR TYPE 53
DESCRIPTION:
Based on the Russian M-1937 weapon of the same calibre (**5566.103**), the Type 53 82 mm mortar is a modified version built in China. No details of the modifications are known: available data on the basic weapon can be found among the USSR entries.

STATUS:
In service with Chinese forces. Exports to Cambodia, North Vietnam, Pakistan, Tanzania and Uganda.

FRANCE

2089.103
120 mm RIFLED MORTAR MO-120-RT-61
DESCRIPTION:
This Thomson-Brandt 120 mm rifled mortar weighs about 570 kg and is designed to fire two types of 120 mm calibre pre-rifled bomb. The PR.14 bomb is comparable with the standard 105 mm artillery shell in accuracy and lethality. It weighs 15.7 kg and has a maximum range of 8,350 metres. The PRPA (Projectile Rayé à Propulsion Additionelle) weighs about 15.6 kg and has a maximum range of 13,020 metres resulting from additional rocket propulsion initiated during flight. PR 14 bombs are available in smoke and coloured HE versions as well as in HE; for illumination the Preclair round can be used with a range of 8,000 m. It has a burning time of 40 secs and produces 1.6 million candles. The mortar will also fire standard fin-stabilised bombs—M44, PEPA or PEPA LP—but a range conversion table must be used because these bombs are calibrated for a different barrel length. The mortar is fired from its wheels, stability being provided by the base plate. Time into action is 2 minutes.

The barrel is 1.75 metres long and is rifled with 40 grooves with a uniform twist of 10.5 degrees. The breech piece is screwed on and has a spherical boss with one flat which is inserted and locked into the rocket on the base plate. The firing mechanism is completely watertight. There is a muzzle towing attachment which can be screwed on the barrel and serves as a muzzle cap when the weapon is not in use.

Traversing and cross-levelling mechanisms are similar to those of the standard AM50 mortar: the elevation gear, however, is different. Rough elevation is obtained by varying the position of the cradle axis relative to that of the wheels by means of a worm drive. Fine adjustment is obtained by varying the position of the cradle collar on the barrel—which is externally threaded for this purpose.

CHARACTERISTICS:
Barrel:
Length (including breech): 208 cm
Weight: 105 kg
Weight of towing ring: 16 kg
Mount:
Weight: 257 kg
Field of fire in mid position: 250 mils
Elevation limits: 30° to 85°
Base plate:
Weight: 192 kg
Weight of clamping collar: 4 kg
General:
Overall length: 301.5 cm
Overall width: 193.0 cm
All-up weight: 574 kg

Thomson-Brandt 120 mm Rifled Mortar

Firing method: Manual or automatic
Normal rate of fire: 6 rounds/min
Maximum rate of fire: 10 rounds/min
Time into action: 3 minutes

STATUS:
Mass production.

MANUFACTURER:
Compagnie Francaise Thomson Houston Hotchkiss Brandt, 52, avenue des Champs Elysées, 75-Paris 8e, France.

2087.103
120 mm HEAVY MORTAR MO-120 AM 50
Designed for use by ground forces in all kinds of operational conditions, this weapon can be fired either from its own road wheels or from a bipod. Standard bombs used are the PEPA/LP long-range finned bomb, the M44 explosive bomb and the Mk 62 smoke and illuminating bombs.

CHARACTERISTICS:
Barrel:
Length (including breech): 164.7 cm
Weight (with breech and towing ring): 76 kg
Mount:
Weight: 86 kg
Field of fire in mid-position: 300 mils
Elevation limits: 45° to 80°
Base Plate:
Weight: 80 kg
Weight of collar: 8kg
Undercarriage:
Weight (with wheels): 137 kg
Weight of pospective casing: 17 kg
General:
All-up weight: 402 kg
Weight without undercarriage: 242 kg
Firing method: Manual or automatic
Normal rate of fire: 8 rounds/min
Maximum rate of fire: 12 rounds/min

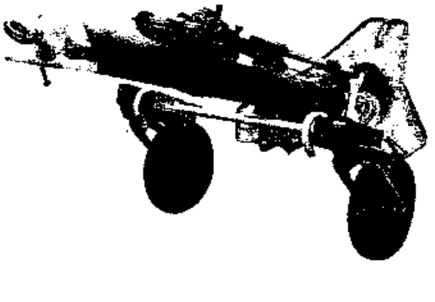
STATUS:
In service in the French Army.

MANUFACTURER:
Thomson-Brandt, Branche Armement & Mécanique Générale, 52 avenue des Champs Elysées, 75008-Paris, France.

2086.103
120 mm MORTAR-MO-120-M-65
This weapon has been designed to incorporate as much as possible of the performance of the AM 50 heavy mortar (**2087.103**) while retaining much of the lightness and mobility of the M60 light mortar (**2088.103**). Like the latter it is fired from a bipod, the breech of the mortar being clamped to a light (36 kg) base plate.

Normally transported by towing on a removable two-wheeled undercarriage, the mortar can also be carried by soldiers – the total weight of the weapon (144 kg) being distributed in three loads of similar weight.

Ammunition that can be used includes the long-range PEPA/LP bomb up to charge 6, the HE bomb M44/60 also up to charge 6 and the Mk 62 illuminating which produces one million candlepower with a burning time of a minute.
CHARACTERISTICS:
Barrel:
Length (including breech): 164 cm
Weight: 44 kg
Mount:
Weight: 24 kg
Field of fire in mid-position: 300 mils
Elevation limits: 40° to 85°
Base Plate:
Weight: 36 kg
Undercarriage and Towing Ring:
Weight: 40 kg
General:
All-up weight: 144 kg
Weight in firing position: 104 kg



120 mm Mortar M-65

Firing method: Manual or automatic
Normal rate of fire: 8 rounds/min
Maximum rate of fire: 12 rounds/min
Maximum range: PEPA/LP HE: 8,370 m
M.44/66: 6,150 m
Mk 62: 4,900 m

STATUS:
Mass production.

MANUFACTURER:
Thomson-Brandt, Branche Armement & Mécanique Générale, 52 avenue des Champs Elysées, 75008-Paris, France.

2088.103
120 mm LIGHT MORTAR (MO-120 M60)

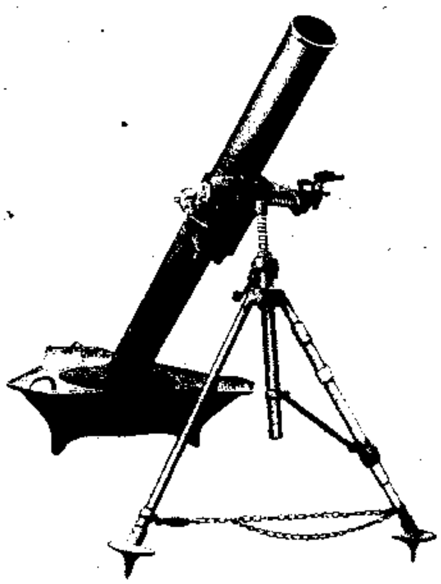
The lightest in the Thomson Houston-Hotchkiss Brandt family of 120 mm mortars the M60 has a total weight, in its minimum configuration, of only 92 kg – which can be divided into three loads for easy transport.

Inevitably, this weight reduction has meant the elimination of most refinements and there is a range penalty in that bombs can be used only up to charge 4 – whereas the M65 (**2086.103**) can use up to charge 6 and the AM50 (**2087.103**) up to full charge. Nevertheless the weapon has valuable fire power for highly mobile forces.

CHARACTERISTICS:
Barrel:
Length (including breech): 163.2 cm
Weight: 34 kg
Bipod and Base Plate:
Weight of bipod: 25 kg
Weight of base plate: 33 kg
Elevation limits: 40° to 80°
General:
All-up weight: 92 kg
Normal rate of fire: 8 rounds/min for 3 mins
Maximum rate of fire: 15 rounds in one minute

STATUS:
In mass production and in service with the French Army.

MANUFACTURER:
Thomson-Brandt, Branche Armement & Mécanique Générale, 52 avenue des Champs Elysées, 75008-Paris, France.

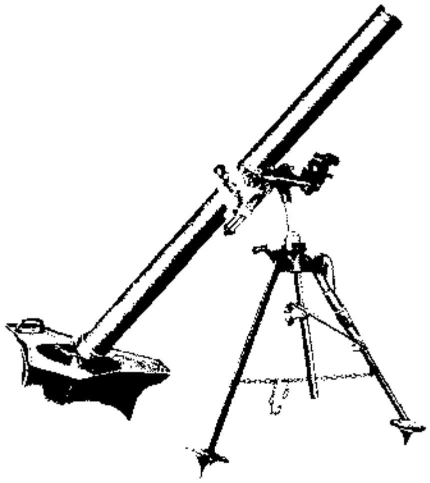

120 mm Mortar M-60

5559.103
81 mm LIGHT MORTAR MO-81-61

DESCRIPTION:
This mortar has been designed to support dismounted, carried or parachuted infantry in all battle conditions. It is light, easy to use and accurate and can be brought into action quickly.

Two alternative barrel lengths are available, the long-barrelled and short-barrelled versions being designated MO-81-61L and MO-81-61C respectively. Each consists of a barrel, bipod mount and base-plate and each of these makes a reasonable load for one man.

High explosive, smoke, illuminating and practice bombs can be fired from either weapon. M57D ammunition can be fired from either – giving a maximum range of 4,100 metres for high-explosive – or MK61 ammunition from the long-barrel mortar. Maximum range for the larger ammunition is 5,000 metres with high explosive.


81 mm Light Mortar M-61

CHARACTERISTICS:	MO-81-61C	MO-81-61L
Calibre	81 mm	81 mm
Barrel length	1.15 m	1.45 m
Barrel weight	12.4 kg	14.5 kg
Base plate weight	14.8 kg	14.8 kg
Mount weight (excluding sight)	12.2 kg	12.2 kg
Azimuth laying	Unrestricted	Unrestricted
Minimum Elevation:	30°	30°
Maximum Elevation	85°	85°
Rate of fire	15 rounds/min	15 rounds/min
Standard ammunition	M57D	MK61
Weight of H.E. round	3.3 kg	4.325 kg
Minimum range	120 m	75 m
Maximum range	4,100 m	5,000 m
Illuminating ammunition	Mk 62	Mk 68
Maximum range	2,300 m	4,100 m
Burning time	More than 35 sec	More than 40 sec
Candle Power	More than 250,000	More than 400,000

STATUS:
In production. MO-81-61C is in service with the French Army using M57D ammunition

MANUFACTURER:
Thomson-Brandt, Branche Armement & Mécanique Générale, 52 avenue des Champs Elysées, 75008-Paris, France.

5560.103
60 mm LIGHT MORTAR (MO-60-63)

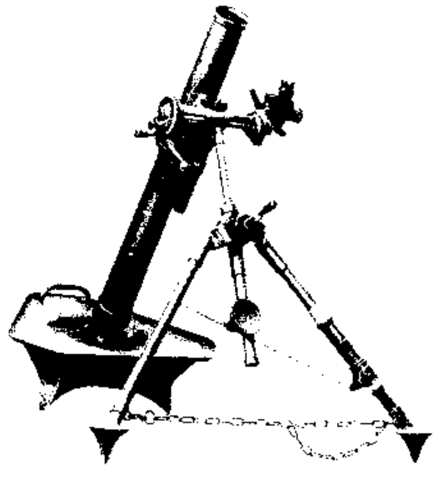
DESCRIPTION:
A portable mortar of conventional pattern, this weapon has been designed for infantry use in mobile operations. With an all-up weight of less than 15 kg the complete mortar can readily be carried by one man. An eight-round pack makes a similar load.

Barrel length is 724 mm (including breech) and it weighs 3.8 kg. The base plate weighs 6.0 kg and the bipod 5.0 kg. The base plate design permits firing on all azimuths and the adjustment with bipod erected gives a traverse of 300 mils. Elevation limits are 40° and 85°.

Ammunition suitable for the mortar include the old Brandt and US 60 mm bombs. The 60 mm MK61 bombs, however, provide a full range of possibilities; with these, ranges from below 50 to 2,000 metres can be achieved with high-explosive bombs. The H.E. round weighs 1.73 kg. The Mk 63 illuminating bomb can also be used: this has a range of 1,750 m and will produce in excess of 180,000 candles for more than 30 seconds.

STATUS:
Both the mortar and the MK61 ammunition are in production.

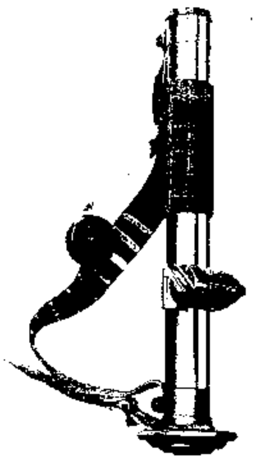
MANUFACTURER:
Thomson Brandt, Branche Armement & Mécanique Générale, 52 avenue des Champs Elysées, 75008-Paris, France.


60 mm Mortar M-63

5561.103
60 mm "COMMANDO" MORTARS
DESCRIPTION:

These two lightweight mortars have been designed for use by infantry on special operations where a short-range, highly portable weapon is required. Both weapons fire the same ammunition: the principal differences between them are in weight and in the fact that the lighter weapon has a fixed firing pin whereas firing from the other can be controlled. Each has a breech base plate and is supported by hand: a simple clinometer is provided.

Standard ammunition is the 60 mm MK61 but there is a restriction on the charge that can be used; normally this should not exceed charge 2 but as an exception charge 3 may be used.



Commando Mortar (Automatic)

Commando Mortar (Controlled)

STATUS:
Both mortars are in production.

MANUFACTURER:
Thomson-Brandt, Branche Armement & Mécanique Générale, 52 avenue des Champs Elysées, 75008-Paris, France.

CHARACTERISTICS:	Controlled firing	Automatic firing
Barrel length	650 mm	650 mm
Overall length	850 mm	680 mm
Total weight	10 kg	8.1 kg
Firing method	Breech control	Fixed pin
Range (charge 2)	1,050 m	1,050 m

2151.103
60 mm VEHICLE MORTAR (60-MC-A1)
DESCRIPTION:

Designed for installation on light combat vehicles or APCs, this weapon can be used either as a conventional mortar or in a direct-fire role.

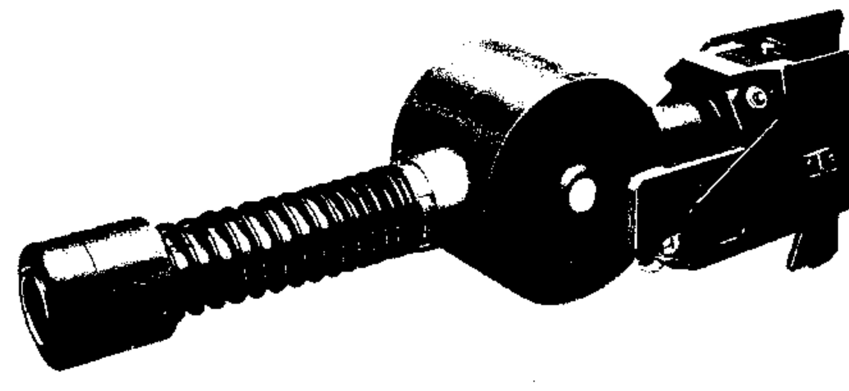
To enable it to be used in both these alternative roles and to be mounted on a wide variety of either soft or hard skinned vehicles, the mortar is arranged for both breech and muzzle loading and is equipped with a hydraulic recoil and recuperator mechanism which reduces the firing stress on the vehicle and makes for greater consistency in aiming.

Provision is made for the firing pin to be withdrawn so as to avoid premature firing when breech loading is used; alternatively the pin can be fixed forward for rapid gravity firing in the mortar role. The firing mechanism can be operated either manually or electrically and is provided with mechanical safety devices.

When used in the direct fire role, with the barrel at low elevation angle, the bomb is held against the firing pin bush by two spring-loaded retaining pins which engage in recesses in the tail fins. These are withdrawn on firing.

The recoil system comprises a piston working in an oil-filled cylinder as the main energy absorber. A spring which is compressed on recoil helps to absorb energy and provides the recuperation force required to move the barrel forwards again.

The mortar fires the same Mk 61 ammunition as is fired by the 60 mm standard and commando mortars (**5560.103** and **5561.103**). It can also fire the special Mk 72 series of bombs which have longer ranges. These bombs are similar to the Mk 61 series but are fitted with a plastic obturating ring around the rear of the ribbed guide band. This ring reduces windage and leads to a higher and more consistent muzzle velocity. At maximum charge the maximum range with the Mk 72 bomb is 2,590 m compared with 2,050 m for the Mk 61.



60 mm Vehicle Mortar

CHARACTERISTICS:
Overall length: 1,210 m
Shot travel length: 0.905 m
Total weight: 50 kg
Recoiling mass: 42 kg
Recoil length within vehicle: 135 mm
Maximum recoil thrust: 2.0 kg
Minimum range: 100 m
Maximum range: Mk 61 bomb: 2,050 m
Mk 73 bomb: 2,590 m

STATUS:
In service in several countries.

MANUFACTURER:
Thomson-Brandt, Branche Armement & Mécanique Générale, 52, avenue des Champs Elysées, 75008-Paris, France.

5562.103
60 mm CS MORTAR TYPE 1969
DESCRIPTION:

This mortar is a breech-loading weapon designed for mounting in the turrets of an armoured vehicle. It fires the same ammunition as the other French 60 mm mortars. All-up weight is 18 kg, overall length 1,325 mm and maximum range 1,600 m.

The weapon is loaded by opening the breech and withdrawing the breech block along a guide to the rear of the weapon. In so doing a receptacle for the bomb is withdrawn and when this clears the breech, the bomb can be inserted. Breech block and bomb are then slid home and the breech locked. An interlock between the breech lock and the trigger prevents the weapon from being fired with the breech unlocked. When thus inserted, the bomb is prevented from moving along the barrel and away from the firing pin by a retaining device which releases the bomb after firing when the pressure in the breech chamber reaches a predetermined level. Firing is electrical and a second interlock prevents a second firing if the trigger plunger has not returned to its normal rest position after firing. Double loading is prevented by arranging that if the breech is opened with an undischarged round in position the round is withdrawn with the breech block and must be removed before another round can be inserted. In addition, of course, there is a safety catch on the trigger.

In other respects the weapon behaves in a manner similar to that of a standard smooth-bore mortar except that provision is made for varying the range of the weapon without altering the charge or the elevation setting. This is achieved by venting a variable fraction of the propellant gases to the outside air, thus reducing the energy transferred to the bomb. This venting is controlled by a 40-position control.

STATUS:
Prototype

MANUFACTURER:
Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211 Saint Cloud, France.

ISRAEL

2318.103
160 mm TAMPELLA MORTAR

DESCRIPTION:

The 160 mm Tampella mortar has a smooth-bore, close-tolerance barrel and fires fin-stabilised bombs. For transport purposes it breaks down into two main units – carriage and base plate – and the weapon is normally towed by a standard army vehicle. In firing position the travelling wheels are turned inwards – their tangent position permitting the mortar to be traversed around on a full 360° arc – quickly by using the wheels or more slowly by the traversing mechanism which is situated on the left hand travelling wheel.

The carriage incorporates the barrel with breech piece, recoil-buffer, elevating and divergence correcting mechanism, and the slow-motion traversing gear. The spring loaded striker is actuated by pulling a lanyard attached to the firing lever. A folding elevation gear permits the barrel to lower itself automatically, thus enabling fast and easy loading of the mortar. A counter-balance mechanism facilitates the raising of the barrel after loading the bomb. Israel uses large numbers of these weapons mounted on Sherman tank chassis.

CHARACTERISTICS:
Calibre: 160 mm
Barrel length: 2,850 mm
Range: 9,300 m
Accuracy: ¾ to 1 ¼% of range
Rate of fire: 5-8 rounds per minute
Total weight: 1,450 kg (travelling order without base plate)
1,700 kg in firing position
Weight of sight: 1.45 or 1.57 kg
Weight of base plate: 250 kg
Elevation limits: +43° to +70°
Traverse: 360°
Ammunition: HE bomb weighs 40 kg with fuze, of which 5 kg is TNT.
Propellant system is made up of a primary charge and a combination of up to 9 secondary charges.
Smoke Bombs (two types)
Practice bomb

STATUS:
In service.

SUPPLIER:
Soltam Limited, Israel.

2317.103
120 mm TAMPELLA MORTAR

DESCRIPTION:

The 120 mm Tampella mortar has a smooth barrel. Normally towed by a vehicle, for mountain and jungle warfare it may be dismounted into four main components – barrel, bipod, base plate and carriage, weighing approximately 90 kg each – and carried by pack mules. It may also be man-handled for short stretches, parachuted for airborne operations as well as being mounted on armoured vehicles. The baseplate is circular, designed for stability and strength and enables the mortar to be fired over an arc of 360° by moving the bipod only. It has a maximum elevation of +87° giving a high trajectory with steep angle of descent and allowing the mortar to engage targets effectively on reverse slopes or behind cover.

CHARACTERISTICS:
Calibre: 120 mm
Length travelling: 2.65 m
Width travelling: 1.53 m
Height travelling: 1.05 m
Height travelling: 1.05 m
Range: 6,500 m (maximum)
400 m (minimum)
Total weight: 346 kg all up, or 220 kg (firing position)
Barrel: 84 kg
Sight: 1.45 or 1.57 kg
Bipod: 66 kg
Baseplate: 72 kg
Carriage: 110 kg
Barrel length: 1.94 m
Elevation limits: +39° to +87°
Traverse: 240 mils
Ammunition: HE bomb weighs 12.6 kg (of which 2.25 kg is TNT). There is a primary charge and up to 9 secondary charges. Two types of smoke bomb. Practice bomb.

STATUS:
In service.

SUPPLIER:
Soltam Limited, Israel.

2316.103
120 mm LIGHT TAMPELLA MORTAR

DESCRIPTION:

The light 120 mm Tampella mortar consists of four main units, barrel with breech piece, base plate, bipod and sight. It can be transported on a two wheeled trailer, mounted in an armoured vehicle or carried in three man pack loads. An important feature of this weapon is the capability of firing the standard 120 mm Tampella ammunition with the same degree of accuracy.

CHARACTERISTICS:
Calibre: 120 mm
Barrel length: 1.73 m (including breech piece)
Range: 6,200 m (maximum)
300 m (minimum)
Total weight: 108.5 kg (firing position)
Barrel Weight: 38.6 kg
44 kg (with breech piece)
Sight: 1.57 kg
Bipod: 27.5 kg
Baseplate: 37 kg
Elevation limits: +45° to +70°
at 45° elevation 83 mils
at 70° elevation 130 mils
Weight of round: HE bomb weighs 12.6 kg (of which 2.30 kg is TNT)
Three types of smoke bomb (FM, PWP and WP)
Practice

STATUS:
In service.

SUPPLIER:
Soltam Limited, Israel.

2315.103
81 mm TAMPELLA MORTAR

DESCRIPTION:

The 81 mm Tampella mortar has a smooth-bore barrel and fires fin-stabilised bombs, with primary and secondary charges, from a stable base plate. The mortar breaks down to three one man loads of approximately 13 kg each, consisting of the barrel, bipod and base plate. Special carrying equipment is provided for this purpose. If required it can be mounted in an armoured fighting vehicle, for example a M-113 or a half-track.

CHARACTERISTICS:
Calibre: 81.4 mm
Barrel length: 1,455 mm (long barrel)
1,155 mm (short barrel)
Range: 4,660 m long barrel (maximum)
150 m long barrel (minimum)
3,980 m short barrel (maximum)
140 m short barrel (minimum)
Total weight: 40 kg (long barrel)
37 kg (short barrel)
Barrel weight: 14.5 kg (long barrel)
11.5 kg (short barrel)
Sight: 1.45 or 1.57 kg
Bipod: 12.3 kg
Baseplate: 13.2 kg
Elevation limits: +43° to +80°
Traverse: at 45° elevation 100 mils
Weight of round: 3.86 kg (HE bomb with fuse), primary charge and up to 7 secondary charges. Also Smoke (two types) and practice.

STATUS:
In service.

SUPPLIER:
Soltam Limited, Israel.

2313.103
81 mm TAMPELLA MORTAR TYPE C

DESCRIPTION:

This differs from the standard 81 mm mortar (**2315.103**) only in the barrel design. The barrel consists of two parts of approximately equal length joined by an overlapping interrupted thread, which ensures a tight fit and eliminates any possible gas escape. Total length of the barrel, as well as ballistic data, are identical with the standard 81 mm mortar. Total weight of the barrel is 17.5 kg compared with 15.5 kg of the standard model.

STATUS:
In service.

SUPPLIER:
Soltam Limited, Israel.

2314.103
60 mm TAMPELLA MORTAR

DESCRIPTION:

The Tampella 60 mm mortar is an extremely light, simple and mobile weapon, capable of producing a large volume of fire, quickly and accurately, on any target within its range.

It has been designed to be employed in all phases and types of land warfare on every type of terrain under weather conditions ranging from the tropics to the arctic. The mortar can be used with or without the bipod.

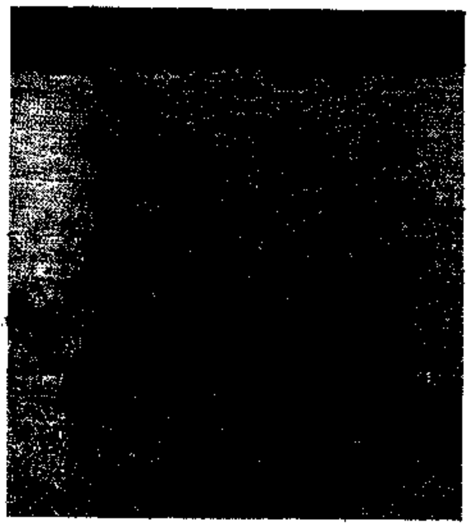
CHARACTERISTICS:
Calibre: 60.75 mm
Range: 2,555m (maximum)
150 m (minimum)
Total weight: 14.50 kg
Barrel and breech piece: 5.50 kg
Sight: 1.10 kg
Bipod: 4.50 kg
Baseplate: 3.40 kg
Barrel length: 740 mm
Elevation limits: +40° to +79°
Traverse: at 50° elevation 116 mils
at 70° elevation 137 mils
Weight of round: HE weight 1.54 kg (4 charges)
Smoke weight 1.54 kg

STATUS:
In service.

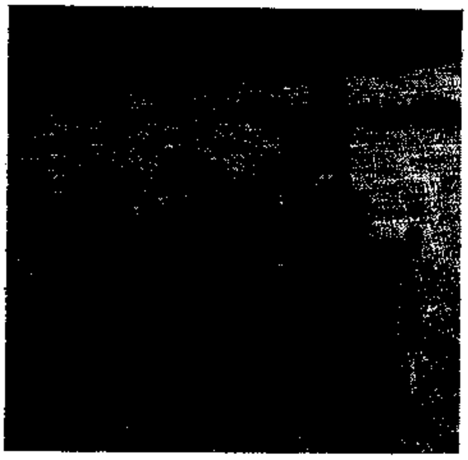
SUPPLIER:
Soltam Limited, Israel.

SPAIN

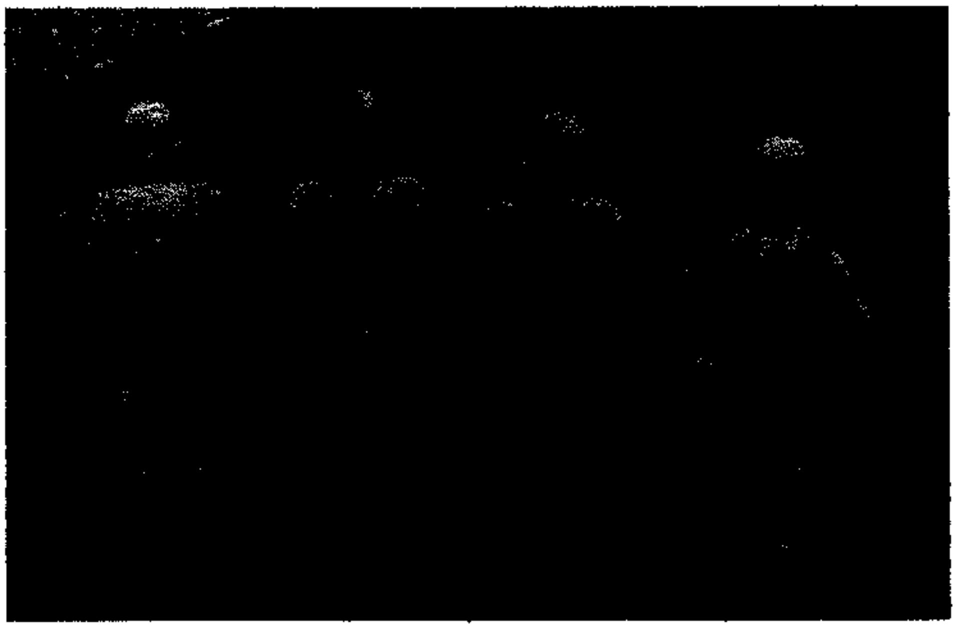
2600.103
120 mm MORTARS ECIA MODELS L & SL
DESCRIPTION:
These are conventional mortars which are normally carried on a two wheeled carriage and towed behind a vehicle, for example a Land Rover or M-113 APC. When required for action they can be quickly assembled.
CHARACTERISTICS:
Calibre: 120 mm
Barrel length: 1,600 mm (both models)
Range: SL 5,000m maximum with N bomb
5,940 m maximum with L bomb
L 6,660 m maximum with L bomb
5,700 maximum with N bomb
Weight travelling: SL: 257 kg
L: 316 kg
Weight firing: SL: 123 kg
L: 213 kg
Maximum rate of fire: 12 rounds per minute
Ammunition:
Round N: HE wt 16.745 kg, filling 3.175 kg TNT, effective damage radius 150 m
Round L: HE wt 13.195 kg, filling 2.34 kg of TNT, effective damage radius 150 m
Smoke and practice
STATUS:
In service
SUPPLIER:
Esperanza Y Cia, S A Marquina, Spain


120 ECIA mortar Model SL

2599.103
105 mm MORTAR ECIA MODEL L
DESCRIPTION:
This mortar is mounted on a bipod and has a circular base plate. For transportation it breaks down and is carried on a two wheeled trailer; this trailer also carries 12 rounds of ready ammunition.
CHARACTERISTICS:
Calibre: 105 mm
Barrel length: 1,500 mm
Maximum range: 7,050 m
Weight in firing position: 105 kg
Weight of the carriage: 111 kg
Total weight travelling: 239 kg
Maximum rate of fire: 12 rounds per minute
Ammunition: HE round weighs 9.20 kg of which the TNT filling weighs 1.704 kg
Length of round = 546 mm
Diameter = 104.25 mm
Effective radius is 150 m
Smoke
Practice
STATUS:
In service.
SUPPLIER:
Esperanza Y Cia, S A Marquina, Spain.


105 mm ECIA mortar

2601.103
81 mm MORTARS MODELS ECIA L & L1
DESCRIPTION:
These mortars are unusual in that instead of having a bipod they are used with a tripod. If required they can be broken down to form three man pack loads – tripod, base plate and barrel. The Model L and L1 differ only in the lengths of their barrels.
CHARACTERISTICS:
Calibre: 81.35 mm
Barrel length: 1.15m or 1.45 m
Range: 4,500 m (1.45 barrel)
4,100 m (1.15 m barrel)
Weight in firing position: 45 kg (1.45 m barrel)
43 kg (1.15 m barrel)
Maximum rate of fire: 15 rounds per minute
Ammunition: Bomb N(HE)wt 4.13 kg, filling .675 kg effective damage radius 100 m Smoke and Practice
Bomb NA(HE)weight 3.20 kg, filling .496 kg, effective damage radius 100 m.
Illuminating
STATUS:
In service
SUPPLIER:
Esperanza Y Cia, S A Marquina, Spain.


81 mm ECIA mortar divided into man-pack loads

2602.103
60 mm MORTAR ECIA MODEL L
DESCRIPTION:
This is a small smooth-bore weapon which is carried in a man pack complete with accessories weighing less than 15 kg. It is fired from a tripod stand.
CHARACTERISTICS:
Calibre: 60 mm
Barrel length: 650 mm
Range: 2,100 m
Elevation: 49.5° to 89.5° (approx)
Weight in firing position: 11.46 kg including round
Complete man pack: 14.96 kg with accessories
Rate of fire: Normal 15 rounds/min. Maximum 30 rounds/min
Ammunition: HE weight 1.44 kg, filling 0.232 kg effective damage radius 50 m. Smoke, Practice.

STATUS:
In service.

MANUFACTURERS:
Esperanza Y Cia S A, Marquina, Spain.

SWITZERLAND

2392.103
120 mm HEAVY MORTAR Mw 41
DESCRIPTION:
This design has been in service for many years but still has an important role to play in the Swiss armoury. It is, of course, a heavy weapon and is not, as are some mortars of similar calibre, permanently trailer mounted, and therefore is somewhat unwieldy in use.
CHARACTERISTICS:
Calibre: 120 mm
Weight in firing order: 262 kg
Weight of bomb: about 13 kg
MV: 270 m/sec
Range: 5 km
Rate of fire: 10 rounds/min
STATUS:
In service with reconnaissance battalions and armoured regiments of the mechanised divisions. Formerly in service also with the artillery of the frontier divisions but now replaced by howitzers.

2391.103
81 mm MEDIUM MORTARS Mw 33 and Mw 72
DESCRIPTION:
In external appearance the Mw 33 mortar resembles the M-29 American weapon of the same calibre (**5564.103**). Quoted characteristics, however, are significantly different.
CHARACTERISTICS:
Calibre: 81 mm
Barrel length: 15 calibres
Elevation: 45°-75°
Weight in firing order: 62 kg
Weight of bomb: 3.25 kg
MV: 300 m/sec
Mobility: Mounted on two-wheel trailer for transport
STATUS:
Deployed in the heavy company of fusilier battalions

Mw 72 Mortar
For use initially by mountain troops but possibly by others later this weapon is understood to be similar to the Mw 33 but much lighter. No other details are available except that it was due to be introduced in 1972, and it is believed that it was

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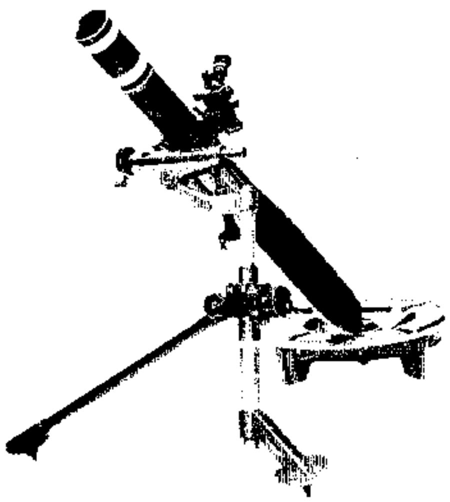
UNITED KINGDOM

5563.103
81 mm LIGHT MORTAR L1A1
DESCRIPTION:
Currently in service with the British Army and several others, this mortar is man-portable in three loads, the heaviest of which weighs 12.3 kg. It is normally fired from the ground, but a special mounting is available that allows it to be fired from the FV432 APC.
Developed as a replacement for the 3-inch mortar (**2485.103**) the L1A1 is strictly a joint British/Canadian project because the base plate and sight were designed in Canada.
CHARACTERISTICS:
Range: 4,500 m with standard charge or 5,600 m with special charge
Accuracy: 0.5% probable error in range 1½ miles in direction
Rate of fire: 15 rounds/min with standard ammunition. Slightly less with special charge
Total Weight: Excluding sight, 35.4 kg
Barrel: 127 cm, 12.3 kg
Bipod: 11.8 kg. Elevation range 45-85°. Traverse ∓ 100 mils at 45° elevation
Box plate: 11.4 kg. Diameter 558 mm
Sight unit: (C2) 1.25 kg or 5.22 kg including case and illuminating apparatus
STATUS:
In service in the UK and at least 10 other countries.
SUPPLIER:
Ministry of Defence Sales, St. Christopher House, Southwark St, London SE1, England.


81 mm mortar

2485.103
THREE-INCH MORTAR
DESCRIPTION:
No longer in British Army service but still in world-wide use, the 3-inch (76 mm nominal but 81 mm actual calibre) was developed before the Second World War but later marks were introduced during the war. An improved sight was introduced with the Mk IV and the Mk V was designed for jungle warfare.
It is a smooth-bore muzzle-loaded drop-fire weapon with a distinctive cross-levelling clamp and plate at the top of the bipod and a rectangular heavily-ribbed baseplate.
CHARACTERISTICS:
Calibre: 81 mm
Length of tube: 122 cm
Elevation: +45° to +80°
Traverse: 36°
Combat weight: 56.3 kg
MV: 192 m/s
Range: 2,560 m
Rate of fire: 10 rounds/min
Ammunition: HE, Smoke, Chemical
Crew: 3
STATUS:
In service in many countries – especially the Middle and Far East.

UNITED STATES OF AMERICA

5564.103
81 mm MORTAR M-29
DESCRIPTION:
Replacement for the 81 mm mortar M-1, which has a shorter barrel and correspondingly lower performance, this is the standard medium mortar of the US Army. Despite its better performance it weighs considerably less than the M-1.
Barrel length is 1.3 m, all-up weight 48.5 kg and maximum range at full charge nearly 4,000 metres. Elevation limits are from 40° to 85° and a traverse of 10° is possible without moving the bipod. A rate of fire of 25 rounds per minute can be achieved.
STATUS:
In production and in service with US and other NATO forces.

5565.103
107 mm MORTAR M-30
DESCRIPTION:
Formerly known as the 4.2-inch mortar, and known in Italy as the 106/7 mortar, this is the heaviest mortar in standard US service.
Barrel length is 152 cm (compared with 173 cm for the British 4.2-inch mortar) and the total weight is 290 kg. With full charge it has a maximum range of 5,490 metres. Elevation limits are from 45° to 85.8° and a traverse of 14° is possible


Russian troops with medium mortars (Novosti)

without altering the position of the front support. A rate of fire of 25 pounds per minute is possible.

The M-30 mortar is intended to be transported into action using a M-24 or similar vehicle.

STATUS:
In service with US and other NATO forces.

THE UNION OF SOVIET SOCIALIST REPUBLICS

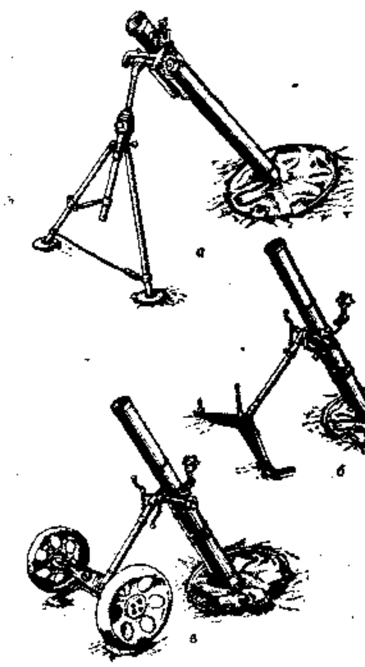
5566.103
82 mm MEDIUM MORTAR
DESCRIPTION:

Various marks of this mortar are in service with the Warsaw Pact countries, but the following data is typical:

Barrel length is 15 calibre (1.23 metre) and all-up weight 56 kg. Base plate mounting permits all-azimuth firing and a traverse mechanism on the bipod mount gives a lateral movement of 6 deg without moving the bipod. Elevation limits are from 45 deg to 85 deg. Firing its own ammunition, the mortar has a full-charge maximum range of approximately 3,000 metres and a firing rate of 25 rounds per minute can be achieved. The choice of 82 mm calibre means that the mortar can also fire 81 mm NATO ammunition.

For transport, the mortar can be broken down into three one-man loads, man-handled on a two-wheel carriage or carried on a vehicle.

STATUS:
In service with Warsaw Pact Forces. Scale of issue is 3 or 6 mortars per motorised infantry battalion.



82 mm mortars. Top – 1937 model. Centre – 1941 model. Bottom – 1943 model

5568.103
160 mm HEAVY MORTAR M-53 (& M-43)
DESCRIPTION:

Warsaw Pact forces are extensively armed with mortars and the 160 mm M-53 is one of the largest of their weapons. It is capable of firing either conventional ammunition or small atomic weapons. The older M-43 is still in service but it is smaller and probably not suitable for use with atomic ammunition.

The M-53 has a 28-calibre barrel (448 cm) and an all-up weight of 1,470 kg. It is mounted on a two-wheel trailer and is not demounted for firing so that it is not easy to traverse quickly. Hand-wheel adjustment on the trailer, however, gives a traverse of 6 deg. Elevation limits are from 45 deg to 85 deg. The weight of a conventional round is 40.8 kg and the maximum range at full charge is just over 8 km. A rate of fire of 3 rounds per minute can be achieved.

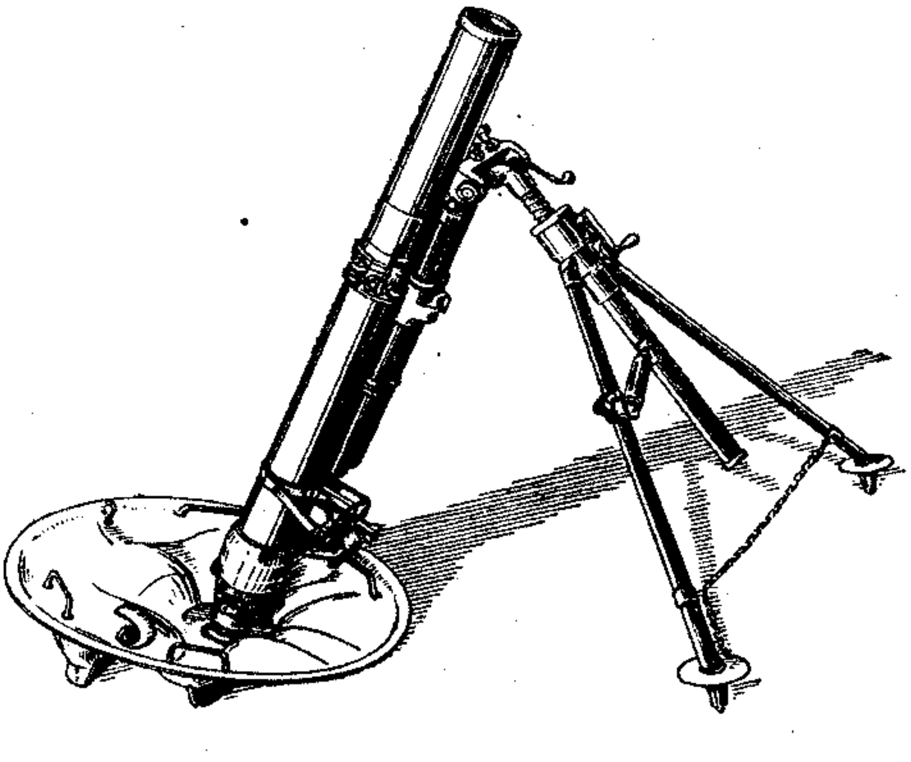
Significant differences of the older M-43 weapon are a shorter barrel (290 cm), a lower weight (1,100 kg) and a shorter range (about 5 km).

STATUS:
In service with Warsaw Pact forces. Scale of issue is 12 mortars per motorised infantry division or, in special circumstances, 6 mortars to a mortar company in place of 120 mm mortars (**5567.103**).

5567.103
120 mm MEDIUM MORTARS M-38 and M-43
DESCRIPTION:

These mortars are standard equipment of the mortar companies of the motorised rifle regiments of the Warsaw Pact forces.

Typical characteristics are a barrel length of 13 calibres (156 cm) and an all-up weight of 272 kg. The base plate mounting permits all-azimuth firing and a 6° traverse is available without change of bipod position. Elevation limits are from 45° to 80°. Weight of the round is about 16 kg and maximum range at full charge nearly 6,000 metres. A firing rate of 15 rounds per minute can be achieved.



120 mm Mortar

STATUS:
In service with mortar companies as noted above. Scale of issue is 6 mortars per company.

Training with M-38 medium mortar (Novosti)

5569.103
240 mm HEAVY MORTAR M-53
DESCRIPTION:
This is the largest mortar in standard service in the Warsaw Pact forces. Like the 160 mm weapon (**5568.103**) it can be used to fire either conventional or atomic ammunition.

Barrel length is 25 calibres (6 metres) and all-up weight 4,150 kg. Elevation limits are not known but a top limit of 70°-80° seems likely and a bottom limit of 45° fairly certain. The mortar is not easily trained over large angles but a training adjustment of some 17° appears to be possible.

Weight of a conventional round is 130 kg and this can be projected to a maximum full-charge range of nearly 10 km. One shot per minute appears to be the maximum practical rate of fire.

STATUS.
In service. Scale of issue 6 weapons per motorised infantry division.

YUGOSLAVIA

2270.103
120 mm HEAVY MORTAR UBM-52
DESCRIPTION:
This is the heaviest modern mortar in Yugoslav service, although there were, and probably still are, some old American, German and Russian mortars remaining from the Second World War (see, in particular, entry **5567.103** for 120 mm Russian mortars, some of which were certainly in Yugoslav service until recently). It is made in Yugoslavia under licence from Thomson-Brandt, the French designation being MO-120 AM 50.

Mounted for travelling on a two-wheel trailer, the mortar can be fired from this or from a tripod mount. It is towed by a ring attached to the muzzle cap.

CHARACTERISTICS:
Calibre: 120 mm
Barrel length: 1.29 m
Elevation: 45° to 85°
Traverse: 6° to 45°
Weight in firing order: 420 kg (without trailer wheels)
All-up weight: 470 kg
Weight of bomb: 15.9 kg (heavy) 12.25 kg (light)
Range: 4,760-6,010 m
Rate of fire: 25 rounds/min
Crew: 5
STATUS:
In service.
MANUFACTURER:
Yugoslav State Factories under licence from Thomson-Brandt (France).

2271.103
81 mm MEDIUM MORTAR M-68
DESCRIPTION:
This is the most modern medium mortar in Yugoslav service. Based on, and very little different from the French (Thomson-Brandt) MO-81-61L mortar (**5559.103**), it is made in Yugoslavia. Brief performance details are given here: further information can be found in the entry for the French weapon.

CHARACTERISTICS:
Calibre: 81 mm
Weight in firing order: 41.5 kg
Weight of bomb: 3.2 kg or 4.2 kg
Range: 5,000 m
Rate of fire: 25 rounds/min

The only apparent difference between the two mortars lies in the mechanical construction of the bipod, but there may be other minor differences.
STATUS:
In service.
MANUFACTURER:
Yugoslav State Factories. Made under licence from Thomson-Brandt (see **5559.103**).

2272.103
81 mm MEDIUM MORTAR M-38
DESCRIPTION:
In appearance this medium mortar is very much like the American M-1 mortar of the same calibre (**5564.103**). Its performance, however, is somewhat different.
CHARACTERISTICS:
Calibre: 81 mm
Weight in firing order: 61.5 kg
Weight of bomb: 3.2 kg or 4.2 kg
Range: 4,100 m
Rate of fire: 25 rounds/min
STATUS:
In service.

MANUFACTURER:
Yugoslav State Factories.

2273.103
60 mm MORTAR M-57
DESCRIPTION:
Similar to the American M-1 mortar, the M-57 is made in Yugoslavia. Weighing less than 20 kg including baseplate it is a highly mobile weapon which, while lacking the extreme portability of the old British 2-inch mortar – and, of course, of the even lighter weapons of recent years – can still be readily manhandled into action.
CHARACTERISTICS:
Calibre: 60.75 mm
Weight in firing order: 19.7 kg
Weight of bomb: 1.35 kg
MV: 159 m/sec
Range: 1,690 m
Rate of fire: 30 rounds/min
STATUS:
In service.
MANUFACTURER:
Yugoslav State Factories.

PORTABLE UNGUIDED ANTI-TANK WEAPONS

2589.103
INTRODUCTION

In parallel with the extensive development of portable – and notably of shoulder-fired – guided missile systems in recent years, there has also been considerable activity in the field of development of shoulder-fired unguided weapons.

Some of these are simply the lineal descendants of the wartime "bazooka" weapon, but there has also been a move recently in the direction of single-shot disposable weapons.

Some recent developments are described in this section together with a selection of well-established (and in some cases obsolescent) weapons but it is emphasised that the list is not exhaustive.

BELGIUM

5595.103
100 mm ANTI-TANK ROCKET LAUNCHER
DESCRIPTION:

One of the most powerful of current man-portable infantry rocket launchers, this Belgian weapon differs from many others in this section in having a bipod mount forward. The launch tube, like many others, is in two parts for greater ease of carriage.

CHARACTERISTICS:
Calibre: 101 mm
Launch tube length: 180 cm
Weight in launcher: 12 kg
Weight of projectile: 2.75 kg
MV: 195 m/sec
Effective range: 220 m
Penetration: 400 mm

STATUS:
In service in the Belgian Army.

CHINA (PEOPLE'S REPUBLIC)

2305.103
57 mm RECOILLESS RIFLE TYPE 36
DESCRIPTION:

Based on the American M-18 RR of the same calibre (**5596.103**) the Type 36 57 mm recoilless rifle made in China is said to be a modified version of the American original. No details of the modifications are known, however, and the reader is referred to the US entry for details of the unmodified weapon. It is assumed that the modifications do not preclude firing from the shoulder.

STATUS:
This weapon has been in extremely widespread use among both NATO and NATO-friendly countries on the one hand and Third World countries on the other, and is probably still to be found in many of them even though it is no longer in the US inventory. Most supplies to other countries probably originated in the USA but China may have exported some.

5598.103
ANTI-TANK GRENADE LAUNCHER P-27
DESCRIPTION:

This is a heavier weapon than either of the two grenade launchers in service with Russian forces (**5597.103**). In principle of operation it is the same, however – a recoilless man-portable launcher firing a fin-stabilised hollow-charge grenade.

CHARACTERISTICS:
Calibre of launcher: 45 mm
Calibre of grenade: 112 mm
Weight of launcher: 6.4 kg
Weight of grenade: 3.75 kg
Effective range: 150 m
Penetration: 200-230 mm

STATUS:
In service with Czech forces.

FINLAND

2043.103
55 mm RECOILLESS ANTI-TANK GRENADE LAUNCHER M-55
DESCRIPTION:

This weapon, which is the current light anti-tank weapon of the Finnish Army, is of rather more elaborate construction than many such man-portable recoilless launchers. Replacing an earlier 41 mm launcher, the weapons are issued on a scale of six per company in the motorised battalions. The weapon was developed in Finland.

CHARACTERISTICS:
Calibre: 55 mm
Launcher length: 0.94 m unloaded; 1.24 m with grenade in place
Weight: weapon: 8.5 kg; grenade: 2.5 kg
Effective anti-tank range: 200 m
Rate of fire: 3-5 rounds/min
Penetration: About 300 mm

STATUS:
In service.

FRANCE

2068.103
ACL/APX 80 LIGHT COLLECTIVE ANTI-TANK WEAPON
DESCRIPTION:

This is a shoulder-fired portable 80 mm rocket-launcher weighing less than 16.5 kg loaded and with the sight attached. It has a powerful anti-tank action and will perforate the double NATO armour plate and be effective beyond.

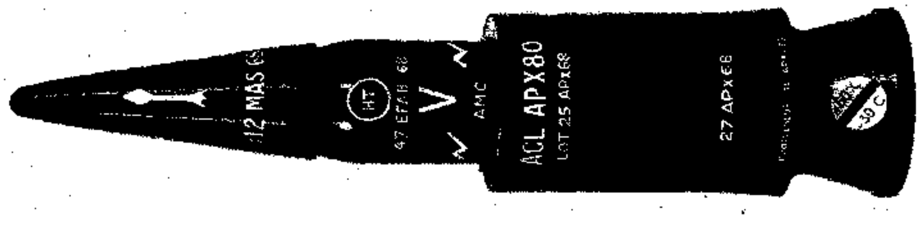
The rocket is launched using the recoilless gun principle and after launch a sustainer charge ignites to complete the flight. Direct-fire range is 550 metres and time of flight to this range is 1.2 seconds.

CHARACTERISTICS:
Weapon:
Type: Shoulder-fired rocket launcher
Length: 1.4 metre
Weight, unloaded: 13 kg
Weight, all-up: 16.44 kg
Direct-fire range: 550 m
Operational temperature: —40° to +50°C
Ammunition:
Types: Armour-piercing, anti-personnel, smoke or illumination
Calibre: 80 mm
Length: 530 mm
Weight – single round: 3.44 kg
Weight – two-round pack: 8.7 kg

STATUS:
Tests complete. Manufacture in hand.

SOURCE:
Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.

ACL/APX 80 in firing position



The ACL/APX 80 round

2055.103
ACL-STRIM ANTI-TANK ROCKET LAUNCHER

DESCRIPTION:

This is a man-portable anti-tank weapon that has been adopted by the French Army where it is known as the 89 mm LRAC Model F.I.

Designed primarily for infantry use, the ACL-STRIM is a lightweight rocket launcher that fires an 89 mm rocket with an effective range of 400 metres. In the firing position the weight of the launcher and rocket is 7.3 kg: for transport, the launcher units weigh 4.5 kg and each round of ammunition in its container weighs 3.2 kg. The system is thus readily carried into action by combat troops.

The launching tube is made of glass and resin laminate and its shoulder piece and foregrip can be adjusted to suit the user. The firing generator handle is made of plastic and carries the trigger and the safe-arm lever. This handle contains the electromagnetic system for generating the firing current. The safe-arm device is primarily mechanical in character; but as an added safety precaution it incorporates a microswitch which is wired in series with a similar switch on the trigger and both switches must be closed to fire the weapon.

A sighting telescope, which is detached for transport, is clipped to the side of the launching tube.

The missile comprises a warhead and a propulsion system. The warhead has a streamlined plastic cap in which is mounted a piézo-electric generator that detonates the charge on impact with the target. The shaped charge is contained in an aluminium alloy casing streamlined by a plastic fairing. To the rear of this is the base fuse which is at safe in the transport position and is armed in flight by gases tapped off from the propulsion system. A new 'brush-type' charge is used to propel the missile and the body and nozzle are made of light alloy. In the tail of the body are nine retractable horns that are designed to stabilise the missile in flight. These are spun out into the flight position as the missile leaves the launching tube, the spinning motion having been imparted to the missile while in the tube by nozzle vanes.

Combustion of the propellant is very rapid and is complete before the missile leaves the tube. There is thus no danger to the user. Moreover, the arming of the base fuse is not complete until the missile is several metres from the launcher.

For transport the missile is carried in a sealed container which in operation forms part of the launching tube and contains the electrical circuits that mate with the firing circuits in the launcher. It is therefore unnecessary to remove the missile from its container before firing.

At normal incidence the missile will penetrate 400 mm of armour and the weapon is effective at incidence angles up to 75 degrees from normal.

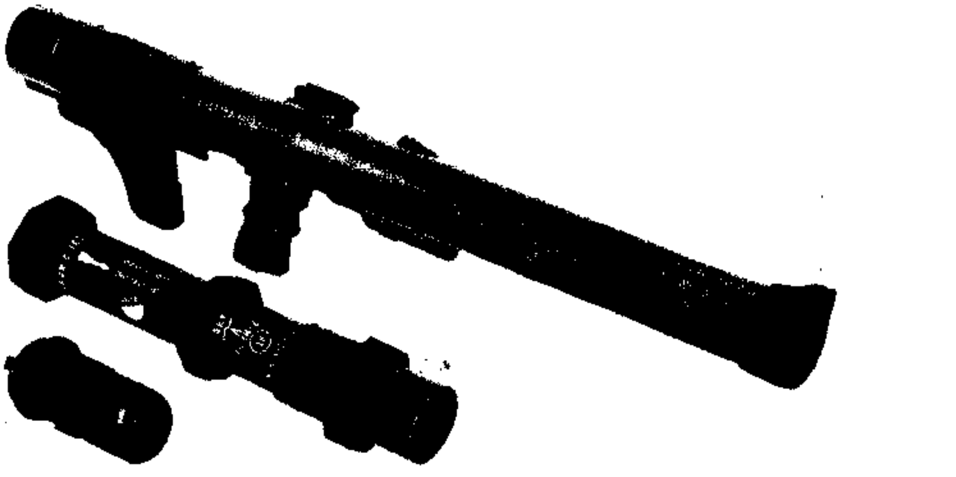
OPERATION:

Operation is simple. All that the firer has to do is to remove the protective caps, clip the sighting telescope to the launcher, insert the missile container into the rear of the launcher, set the safe-arm lever to the armed position, aim and fire.

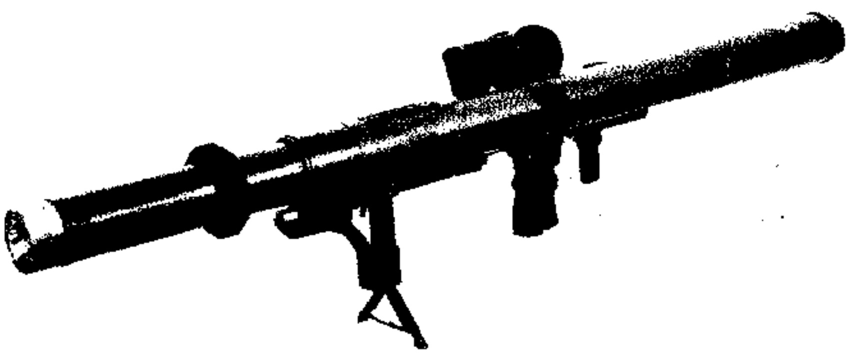
Targets can be effectively engaged up to a range of 400 metres. Since the time of flight at this range is about 1.5 seconds, significant aiming-off for movement is necessary only for crossing targets moving at relatively high speeds. The NATO standard – which is also adopted by the French Army – calls for a flight time of no more than 1.25 seconds, and this corresponds to a range of 330 metres with the ACL-STRIM. Standards adopted by some other armies, however, accept flight times as long as 2.2 seconds—corresponding to a range of 550 metres with the ACL-STRIM.

DEVELOPMENT:

Development of the ACL-STRIM was initiated by Luchaire S.A. and the first design study was made in 1964. The system is now in production and went into service with the French Army in 1969.



ACL-STRIM container assembly and shielded sighting telescopic during transport



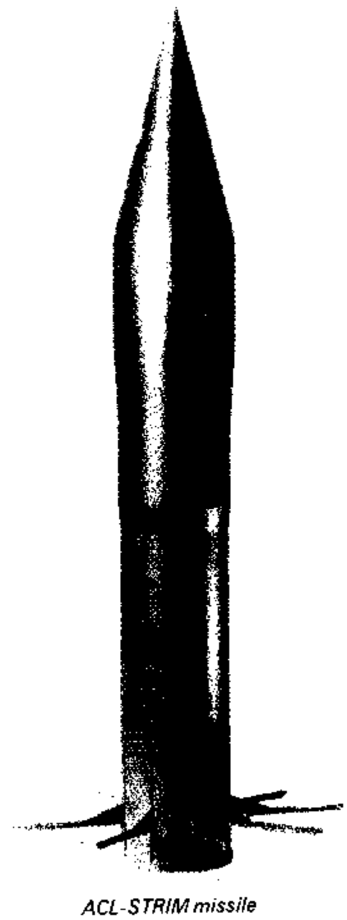
ACL-STRIM loaded and ready to fire

TRAINING EQUIPMENT:

Instruction equipment is provided by the manufacturers. No details are known.

CHARACTERISTICS:

Weapon:
Calibre: 88.9 mm
Length during transport: 1.168 m
in firing position: 1.600 m
Mass during transport, with 0.5 kg sighting telescope: 4.5 kg
In firing position: 7.3 kg
Missile:
Diameter: 88.9 mm
Diameter of shaped charge: 80 mm
Total length: 0.600 m
Container length: 0.626 m
Total mass, without container: 2.2 kg
with container: 3.2 kg
Mass of explosive of the shaped charge:
0.565 kg
Ballistic Characteristics:
Muzzle velocity:
at +20°C, 291.2 m/s
at +51.5°C, 293.2 m/s
at –31.5°C, 287.2 m/s
Combat range for a 1.25 s flight time (maximum ordinate: 1.9 m) 330 m
For a 2.30 m maximum ordinate (1.36 s): 360 m
Effective range: 400 m
Time of flight at 400 m range: 1.56 s
Effectiveness of the shaped charge:
Thickness of armour plating steel perforated at 0° incidence: 400 mm
NATO targets 80-90% perforated:
– single target, heavy tank, 120 mm/65°
– dual target, heavy tank, 40+110 mm/60°
Operating limit incidence: 74-75°



ACL-STRIM missile

MANUFACTURERS:

The system is being produced jointly by the STRIM department of Luchaire S.A., 171, Boulevard Haussmann, 75 Paris 8e, and by the Manufacture Nationale d'Armes de St Etienne. Subcontractors include SAGEM Manurhin and Atelier de Construction de Puteaux.

2085.103
ARPAC 68 mm ANTI-TANK ROCKET LAUNCHER

DESCRIPTION:

ARPAC is a small, highly portable anti tank weapon using a tube-launched rocket projectile to engage tanks and fortifications at ranges up to about 50 metres.

The most unusual feature of this launcher is that the launch tube is mounted on top of a supporting arm which carries a periscopic sight: the weapon can thus readily be armed and fired while the user is still under cover. The rocket is stored in the launch tube: and for carriage the tube and sight fold together making – with a cover which hermetically seals the whole – a one-shot expendable weapon.

The rocket is fin-stabilised, the fins opening out as the rocket leaves the tube. Arming is automatic on firing and takes place about 6 metres from launch.

STATUS:

Preproduction.

CHARACTERISTICS:

Type: Expendable single-shot anti tank rocket launcher
Weight: Storage: 1.850 kg. Ready-to-fire: 1.395 kg. Rocket only: 0.850 kg
Dimensions: Folded: 340 × 155 × 74 mm
Open: 340 × 395 × 74 mm
Initial velocity: About 75 m/s
Penetration: 300 mm
Incidence: More than 70°
Range: 50 m

MANUFACTURER:

Thomson-Brandt, Branche Armement & Mécanique Générale, 52, avenue des Champs Elysées, 75008-Paris, France.

2090.103
SARPAC 68 mm ANTI TANK ROCKET LAUNCHER

DESCRIPTION:

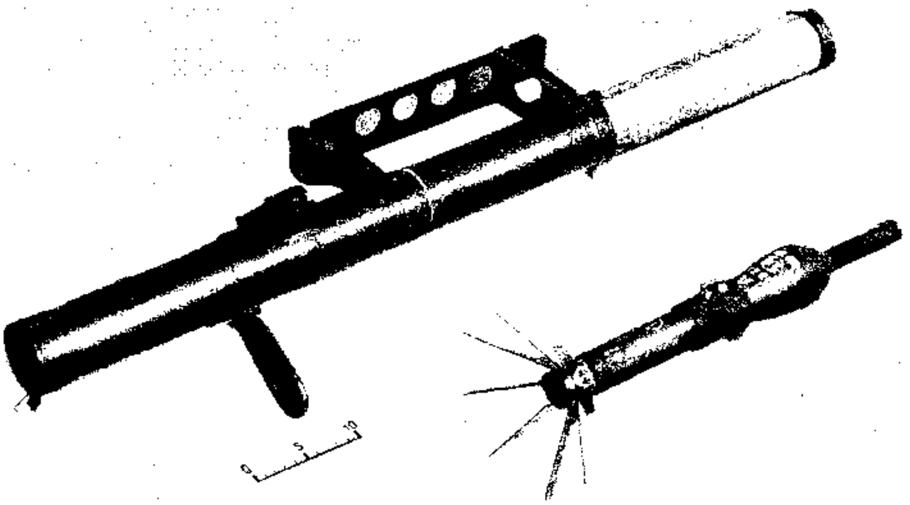
Primarily designed for anti-tank operations, the SARPAC portable rocket launcher may also be used against blockhouses, earthworks and other fortifications.

The launcher consists of a telescopic tube to which is attached a sight, a percussion firing mechanism and a shoulder butt. In the carrying position the telescopic tube is retracted, thereby rendering the firing mechanism inoperative—so that the weapon can safely be carried with a round in position. The sight is hinged with a parallelogram motion and lies flat against the tube in the carrying position. The completely folded weapon can be carried by a sling harness.

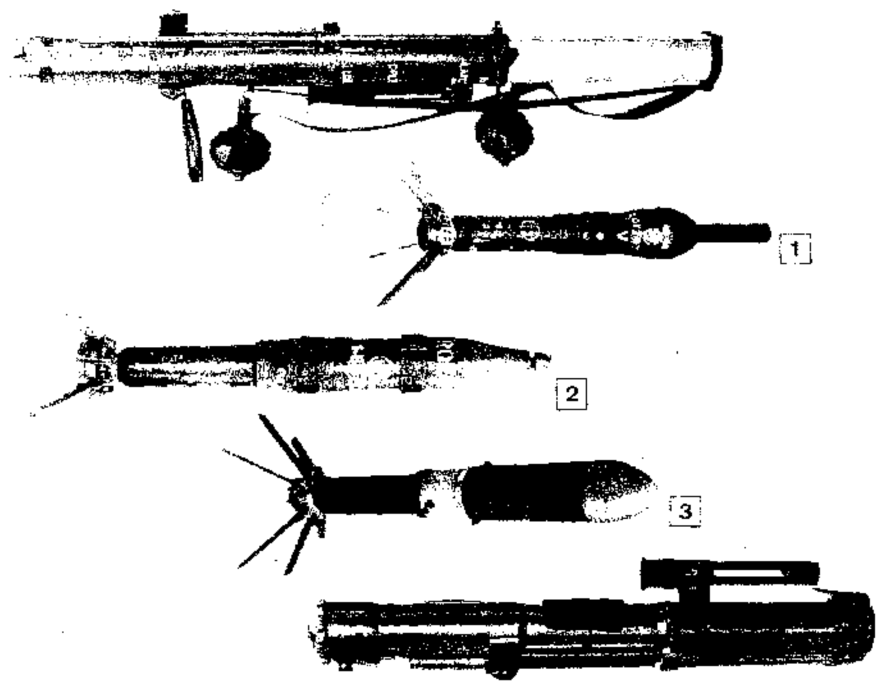
A fin-stabilised rocket is fired, the eight fins being folded while the round is in the tube and springing out after launch. The rocket is armed by gas pressure during launch but a delay element ensures that it is about 10 metres from the launcher.

SARPAC is designed for short-range operation, engaging targets at ranges of up to 150-200 metres. With a total weight of around 3 kg it can be fired from the shoulder in the standing, kneeling or lying positions.

The first design of launcher was extremely simple and inexpensive: and while it could probably be used to fire more than one round it could not be used for many. Since then an improved design has been produced which may be re-used for 20 rounds and can be fitted with an improved sight to fire anti-personnel or illuminating rounds.



Original designs of SARPAC (launcher with rear round)



SARPAC (launcher open and closed) and the types of projectile that can be launched by it

CHARACTERISTICS:

Launcher (improved pattern):
Calibre: 68 mm
Length:
—open, 99.7 cm
—folded, 73.4 cm
Weight:
—empty, with sling, 1.90 kg
Rocket—HEAT round:
—fins folded, 472 mm
—fins open, 505 mm
Weight: 1.07 kg
Initial velocity: 150 m/sec
Flight before arming: About 10 m
General:
Effective range: 150-200 m
Armour penetration: 300 mm at 0°
Effective incidence: 70° or less
HEAP round (ROCAP):
Weight: 1.8 kg
Initial velocity: 92 m/sec
Flight before arming: 10 m
Weight of fragmenting body: 0.83 kg
Effective range: 650 m
ROCLAIR (Illuminating) round:
Weight: 1.3 kg
Initial velocity: 138 m/sec
Effective range: 700 m
Burn time: More than 30 sec
Candle power: More than 180,000

STATUS:

Mass production.

MANUFACTURER:

Thomson-Brandt, Branche Armement & Mécanique Générale, 52, avenue des Champs Elysées, 75008-Paris, France.

GERMANY (FEDERAL REPUBLIC)

2184.103
ARMBRUST-300 INFANTRY ANTI-TANK WEAPON

DESCRIPTION:

Armbrust-300 is a man-portable, shoulder-fired expendable infantry anti-tank weapon with a practical anti tank range of 300 metres and an armour penetration capacity of 300 mm when a hollow-charge shell is used.

The weapon is recoilless and produces no firing report, muzzle flash, rear flash or blast, and no smoke. A soldier can thus use it close to an enemy vehicle without giving away his position. Sighting and firing is easy for any rifle trained soldier.

Armbrust is a single-shot weapon, but since it weighs only 4.8 kg it is perfectly possible for a soldier to carry three of them looped together. Although primarily designed as an anti-tank weapon it can also be used against other types of target and both a fragmentation and a flare shell version are available for this purpose.

After firing the launch tube and associated sighting and firing ancillaries are discarded.

CHARACTERISTICS:

Type: Shoulder fired, recoilless, unguided anti-tank weapon.
Length: 820 mm
Tube Diameter: 74 mm
Hollow charge diameter: 67 mm
Total weight: 4.8 kg

Firing the Armbrust-300

Armbrust-300 Infantry Anti-tank Weapon

Armour penetration: 300 mm armoured plate. Specified NATO impact angle greater than 73°.
Muzzle velocity: 220 m/sec
Flight duration: 300 m in 1.5 sec
Sights: Reflex sight, notch and bead.
Controls: Pistol trigger mechanism with cocking lever and safety catch.
Arming distance: 7.12 m
Rear safety area: 20 m for training; 10 m for field operation. No acute danger beyond 3 m.
Sound pressure[2]: At firer's ear, less than 135 dB.

MANUFACTURER:

Messerschmitt-Bolköw-Blohm Ottobrunn, Munich.

2591.103
PANZERFAUST LEICHT – PORTABLE ANTI-TANK WEAPON

DESCRIPTION:

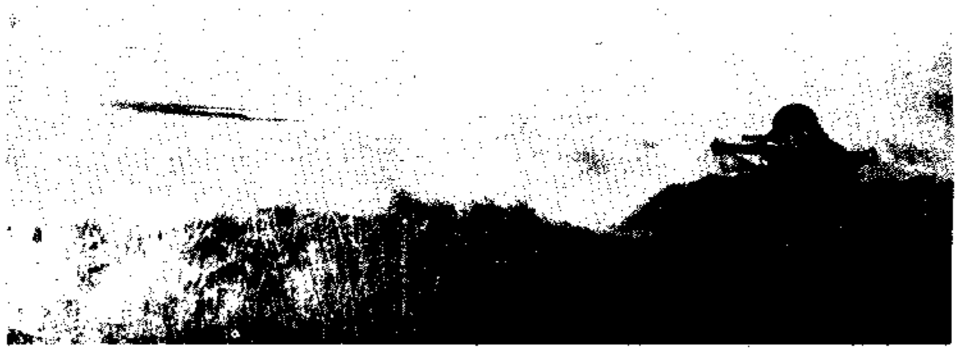
This weapon is similar to but more effective than the PZF-44 (**5591.103**). It is a light muzzle-loaded recoilless anti-tank weapon firing a fin-stabilised rocket-propelled projectile with an effective range of 400 metres and an armour penetration capability of 370 mm.

Unloaded, the weapon is 88 cm long; and when loaded with the 55 cm long projectile the total length becomes 116.2 cm. All-up weight, loaded, is 10.3 kg, and the weapon can be fired from the shoulder in the standing, kneeling or prone positions.

MANUFACTURER:

Dynamit Nobel AG.

Panzerfaust aimed from the prone position



Firing the Panzerfaust

5591.103
LIGHT ANTI-TANK GRENADE LAUNCHER PZF-44

DESCRIPTION:

This is a lightweight short-range, shoulder-fired projectile working on the recoilless weapon principle and capable of inflicting considerable damage on armoured vehicles at ranges up to about 200 m.

CHARACTERISTICS:

Launch tube: Calibre: 42.8 mm. Length: 88 cm
Grenade: Calibre: 81 mm. Weight: 2.1 kg
Total weight: 6.9 kg
MV: 107 m/sec
Effective range: 200 m
Penetration: 320 mm

STATUS:

In service in Germany.

ITALY

2257.103
FOLGORE ANTI-TANK WEAPON

DESCRIPTION:

Little information concerning this weapon had reached us up to the time of going to press. It appears, however, that Folgore is a simple shoulder-fired unguided anti-tank weapon. The calibre of the rocket is understood to be 80 mm and the rocket is equipped with a hollow-charge warhead. Range is said to be 600 m.

STATUS:

Development. Intended to enter service in the 1980s.

MANUFACTURER:

Breda Meccanica Bresciana SpA, Via Lunga 2, 25100 Brescia, Italy.

SPAIN

2330.103
89 mm ANTI-TANK ROCKET LAUNCHER M-65
DESCRIPTION:
This is a Spanish-developed weapon of fairly conventional design similar to that of the American M-20 bazooka and fired from the shoulder in the same way. It can also use the American 3.5 inch ammunition.
CHARACTERISTICS:
Calibre: 88.9 mm (3.5 inches)
Launcher length: 1.6 m
Weight: weapon. 5.4 kg; rocket 2.0 kg
MV: 230 m/sec
Effective anti-tank range: 450 m
Penetration: 330 mm at 450 m and 90°
STATUS:
In service in the Spanish Army.

SWEDEN

5557.103
84 mm RCL CARL-GUSTAF
DESCRIPTION:
Two versions of this weapon are described—the 84 mm RCL Carl-Gustaf M2 and the more recently developed M2-550.

M2 Weapon
This is a recoilless gun intended primarily for use as an anti-tank weapon but suitable also for other assault roles. It can fire HEAT, HE, smoke or flare ammunition and has practical ranges, with HEAT rounds, against moving or stationary targets of 400 or 500 metres respectively and with HE rounds of 1,000 metres. Smoke can be fired up to 1,300 metres and flare shells up to 2,300 metres. A rate of fire of about 6 rounds per minute is readily achieved.

The weapon can be carried, loaded and fired by one man but a two-man team is standard—one carrying and firing the gun and the other carrying ammunition and assisting in the loading operation.

The gun is breech loaded and cannot be fired until the venturi has been rotated back into position and locked after the round has been inserted. The round is fired by a percussion-operated side primer, the firing mechanism being contained in a tube on the right-hand side of the barrel. This mechanism is hand-cocked, is operated by a two-pressure trigger and has a safety-catch.

Open or telescopic sights can be used: the telescopic sight has a ×2 magnification and a 17° field of view and is fitted with a temperature correction device. The weapon is fired from the shoulder, and when fired in the prone position, or over a trench or parapet, a sprung bipod gun mount provides support just forward of the shoulder pad.

Cartridge cases of the ammunition are made of light metal alloy with a plastic blow-out disc at the rear. HE, smoke and flare shells are spin-stabilised, the HEAT shell is aerodynamically stabilised and fitted with a slipping ring to ensure that the hollow charge performance is not reduced by excessive speed of rotation.

M2-550 Weapon
The 84 mm RCL Carl-Gustaf M2-550, also described as the Anti-Tank System FFV 550, is a later development of the M-2 weapon and features a range- and lead-finding sight and a new rocket-assisted HEAT round.

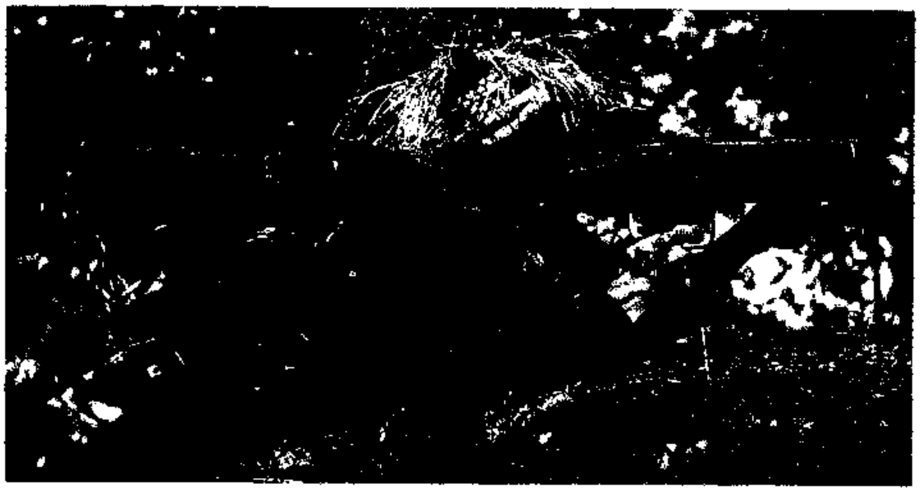
The FFV 555 sight, which replaces the earlier telescopic sight, is an optical-electronic system comprising a telescope, a range-finder and a lead-finder. The range-finder is a coincidence device with a range drum that is rotated to bring the upper and lower parts of the "picture" into coincidence. Range can be read out (or set in) if required.

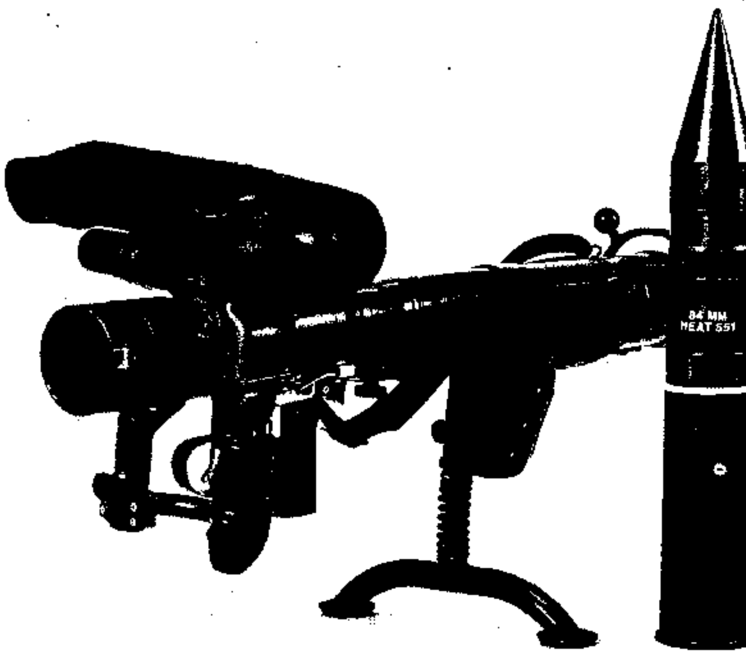
By means of an ammunition control lever the sight mechanism is set to HEAT or HE (SMOKE) ammunition, and this, when range finding automatically results in the correct elevation of the weapon for the type of ammunition selected. When a trigger control on the sight is operated, the electronic unit of the sight produces light pulses (twinkles) which appear in the field of view at intervals, corresponding to the time of flight of the HEAT shell for the determined range. By noting the amount of movement of the target in the graticule between two twinkles the required lead can be determined and the target thereafter engaged.

The 84 mm FFV 551 HEAT round is stabilised by fins which unfold as the round leaves the barrel and has a rocket motor which increases the shell speed from its muzzle velocity of 260 m/sec to a maximum of 350 m/sec. The rocket motor comes into operation when the shell is about 18 m from the muzzle and burns for 1.5 seconds. The shell will penetrate 400 mm of armour, and the piezo-electric fuse system enables the weapon to function up to 80° incidence.

Like the HEAT round for the M2 weapon the FFV 551 round is fitted with a Teflon slipping ring to reduce the spin imparted by the rifling of the Carl-Gustaf barrel. Practical engagement range with this ammunition is 700 m.

The family of ammunition for the earlier M2 version is compatible with the 550 system.


Firing the Carl-Gustaf M-2



M-2 550 weapon with double FFV 551 round


Firing the M-2 550

CHARACTERISTICS:	M2	M2-550
Calibre:	84 mm	84 mm
Weapon length:	1,130 mm	1,130 mm
Weight of gun and mount:	15 kg	15 kg
Weight of sight:	1 kg	3.4 kg
Weight of HEAT round:	2.5 kg	3.2 kg
Anti-Tank Range:	4-500 m	700 m

TRAINING EQUIPMENT:
Sub calibre adapters are available for both weapons to enable them to be used with small-arms ammunition for training purposes.
STATUS:
In production, and in service in several countries.
MANUFACTURER:
Förenade Fabriksverken, Eskilstuna, Sweden.

5558.103
MINIMAN RECOILLESS ANTI-TANK WEAPON

A light short-range one-man anti-tank weapon, the Miniman, complements the Carl Gustav (**5557.103**) recoilless anti-tank rifle.

Miniman has an effective range of about 200 metres – but it weighs only 3.25 kg and is pre-loaded. It is thus an extremely convenient emergency weapon for infantry and is simple and inexpensive enough to be used on a large scale.

The projectile is a HEAT round which will penetrate 340 mm of armour at zero incidence.

STATUS:
In production and in service.

MANUFACTURERS:
Förenade Fabriksverken, Eskilstuna, Sweden.

SWITZERLAND

2394.103
83 mm PORTABLE ANTI-TANK ROCKET LAUNCHER M-58

DESCRIPTION:
This is a small shoulder-fired man-portable rocket launcher which is in service with the Swiss Federal Army. Of simple construction with open sights, it is fitted with a shield (with a sighting window) to protect the firer's hands and face from the rocket blast.

CHARACTERISTICS:
Calibre: 83 mm
Launch tube length: 1.3 m
Weight: launcher: 7.5 kg; rocket: 1.82 kg
MV: 300 m/sec
Effective range: 200 m

STATUS:
In service in fusilier battalions of infantry regiments.

THE UNITED STATES OF AMERICA

5593.103
90 mm ANTI-TANK RIFLE M-67

DESCRIPTION:
This is the heaviest of the man-portable recoilless anti-tank weapons in US service. It fires a 3.1 kg projectile with an effective range of 400 metres.

CHARACTERISTICS:
Calibre: 90 mm
Barrel length: 135 cm
Weight of rifle: 15.9 kg
Weight of projectile: 3.1 kg
MV: 213 m/sec
Rate of fire: 5 rounds/min

STATUS:
In service with US and West German forces.

5592.103
LIGHT ANTI-TANK WEAPON (LAW) M-72

DESCRIPTION:
This lightweight rocket launcher is replacing the M-20 bazooka in many applications. Weighing only 2.5 kg complete with a round and folding down to a length of only 63.5 cm for carriage, it lends itself readily to infantry use. A ready round can be carried in the folded weapon, and to launch it all that the soldier has to do is open the launch tube, withdraw the inner tube, raise the sights, aim and fire.

CHARACTERISTICS:
Calibre: 66 mm
Length: Launch tube closed, 63.5 cm
Launch tube extended, 88.9 cm
Weights: Launch tube, sights etc, 1.25 kg: projectile 1.25 kg
MV: 145 m/sec
Effective range: 250 mm
Penetration: 260 mm

STATUS:
In service with NATO forces.

5594.103
3.5 inch ROCKET LAUNCHER M-20A1

DESCRIPTION:
Better known as the "super bazooka" this weapon, after many years of successful service in the American, British, French, Italian and other armies, has largely been replaced by more modern weapons. Much of its success has no doubt been due to its simplicity of design and operation – which is certainly reflected in one of its successors, the M-72 Light Anti-tank Weapon (**5592.103**).

CHARACTERISTICS:
Calibre: 88.9 mm (3.5 inch)
Length of launch tube: 1.53 m (in two parts)
Weight of complete weapon: 5.9 kg excluding projectile
Projectile weight: 3.31-4.09 kg
MV: 148.97 m/sec
Effective range: 100-150 m
Rate of fire: 8 rounds/min
Penetration: 279 mm

STATUS:
Obsolescent

5596.103
57 mm RECOILLESS ANTI-TANK RIFLE M-18A

DESCRIPTION:
This American rifle is no longer in service with the American Army but was in fairly widespread NATO use and may still be encountered.

With a weight of more than 20 kg it is on the heavy side for a portable weapon while naturally lacking the performance of the vehicle-borne or towed recoilless rifles. Nevertheless it has a useful specification.

CHARACTERISTICS:
Calibre: 57 mm
Barrel length: 157 cm
Weight of weapon: 20.15 kg
Weight of projectile: 1.25 kg
MV: 366 m/sec
Effective range: 450 m
Maximum range: 4,000 m
Rate of fire: 15 rounds/min

STATUS:
Obsolescent.

2795.103
SMAWT ANTI-TANK ROCKET LAUNCHER

DESCRIPTION:
It is understood that a new anti-tank rocket launcher is being developed at the US Army Missile Command's MICOM research and development laboratories, with some help from the Army Material Command.

Known as SMAWT (Short-range Man-portable Anti-tank Weapon Technology) the weapon is evidently of light weight and simple construction. Few details are available at this time, and the accompanying photograph is not very informative, but it is understood that the MICOM programme was selected after a competition with a recoilless rifle being developed jointly by the US Army Weapons Command and Army Munitions Command. It is believed that the launch tube is made wholly or partly from glass fibre and that a new carborane propellant has been developed for the weapon: this propellant has a high burning rate and is said to be immune to temperature variations.

STATUS:
Prototype.

SMAWT anti tank weapon

USSR

5597.103
ANTI-TANK GRENADE LAUNCHERS RPG-2 AND RPG-7

DESCRIPTION:

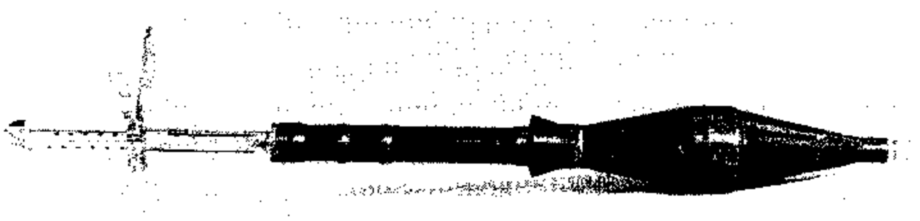
RPG-2 has long been a standard weapon with Russian forces. RPG-7 is a comparatively recent and significantly improved version. Both are conventional, highly-portable, recoilless launchers firing fin-stabilised hollow-charge grenades.

CHARACTERISTICS:

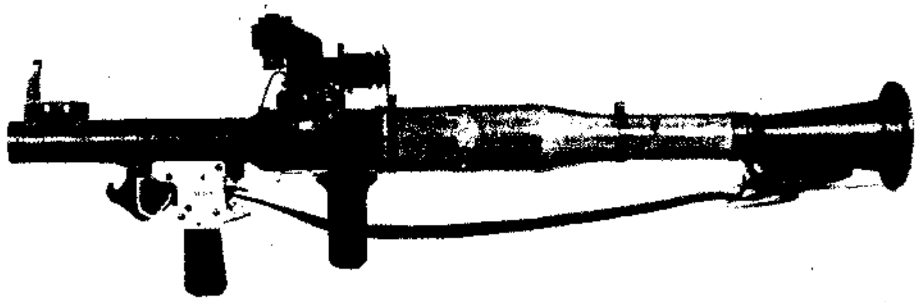
	RPG-2	RPG-7
Launcher calibre:	40 mm	40 mm
Grenade calibre:	82 mm	100 mm
Weight of launcher:	2.75 kg	5 kg
Weight of grenade:	1.6 kg	2.5 kg
Effective range:	150 mm	300 mm
Penetration:	180 mm	200-250 mm

STATUS:

In service.



RPG-7 rocket



RPG-7 launcher

2928.103
76 mm RECOILLESS RIFLE SPG-9

DESCRIPTION:

This is similar to the American 75 mm recoilless rifle M-20. It is mounted on a tripod and has a weight of 55 kg. Crew consists of three men. It fires fin-stabilised anti-tank rounds to a maximum effective range of 900 m. The ammunition will penetrate 300 mm of armour. Rate of fire is 6 rounds a minute.

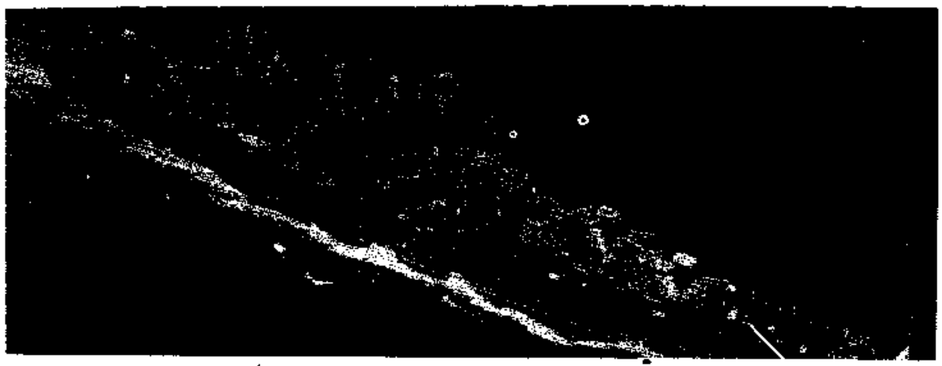
STATUS:

In service.

NAVAL GUNS AND BOMBARDMENT ROCKETS

ARGENTINA

6080.203
TRIPLE 6-inch GUN MOUNTING
DESCRIPTION:
Main armament of the cruiser *La Argentina* are three triple 6-inch (152 mm) 50-calibre gun mountings. These guns were made by Vickers and are of a type first introduced in 1923. They fire a projectile weighing 45 kg, have a muzzle velocity of 850 m/sec and an effective range of some 20 km (11 nm). A rate of fire of 5 rounds per barrel per minute can be achieved.
STATUS:
Operational but no longer in production and not available.



The cruiser 9 de Julio. *Main armament forward consists of nine 6-inch 47-calibre guns in triple mountings. The eight 5-inch guns are mounted singly, four on each side abreast of the superstructure* (Official Argentine Navy Photograph)

6050.203
SINGLE 5 inch DUAL-PURPOSE GUN MOUNTING
DESCRIPTION:
This 5-inch (127 mm) gun is mounted on the ex-US "Brooklyn" class cruisers of the Argentine Navy – and on similar vessels in the Chilean Navy. The gun is a short 25-calibre weapon and is mounted as eight single installations.
These weapons are assumed to be of American manufacture, but 5-inch guns of this calibre are no longer in service in the US Navy.
It should be noted that the 6-inch guns shown in the accompanying photograph of the cruiser *9 de Julio* are not of the same type as those on *La Argentina* (**6080.203**. They are of American manufacture and are described later in this section.

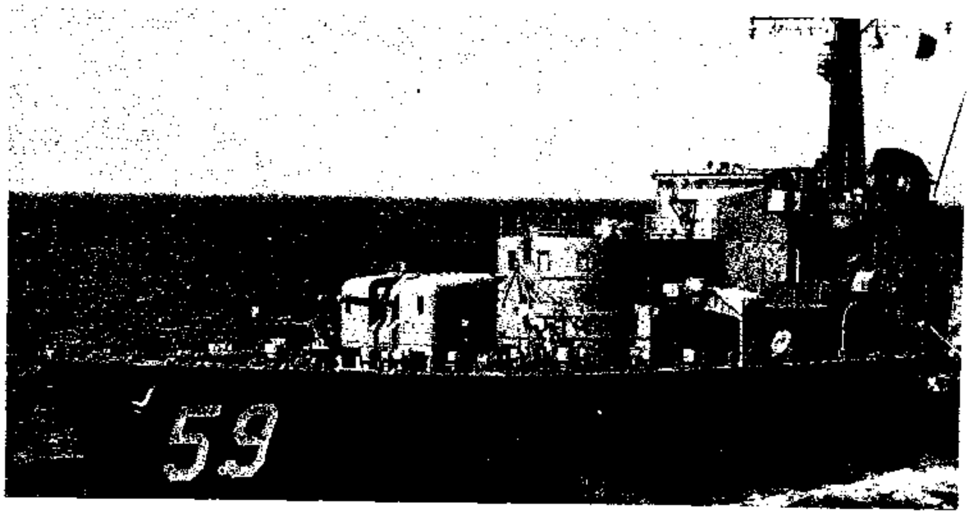
STATUS:
Operational.

6081.203
SINGLE 4.7-inch (120 mm) GUN MOUNTING
The three surviving "Buenos Aires" class destroyers carry either three or four 4.7-in (120 mm) 31-calibre guns. These destroyers were built in the United Kingdom in the 1930s and the guns were made by Vickers. This type of gun was first introduced in 1931; it fires a projectile weighing 28 kg with a muzzle velocity of 850 m/sec. Range is about 16.5 km (9 nm). A rate of fire of 8 rounds per minute is possible.

STATUS:
Operational but no longer in production and not available.

AUSTRALIA

6051.203
TWIN 4.5-inch GUN MOUNTING
DESCRIPTION:
Similar to the British Mk 6 Gun Mounting (**6012.203**) the twin 4.5-inch (114 mm) guns in the Australian "Battle" class destroyer *Anzac* were made entirely in Australia.
Weight of the turret is about 50 tons. The guns are fully automatic and have a rate of fire of approximately 25 rounds per minute. The shell weighs about 24 kg and can be fired accurately at ranges up to about 19 km (10 nm).
STATUS:
Operational.



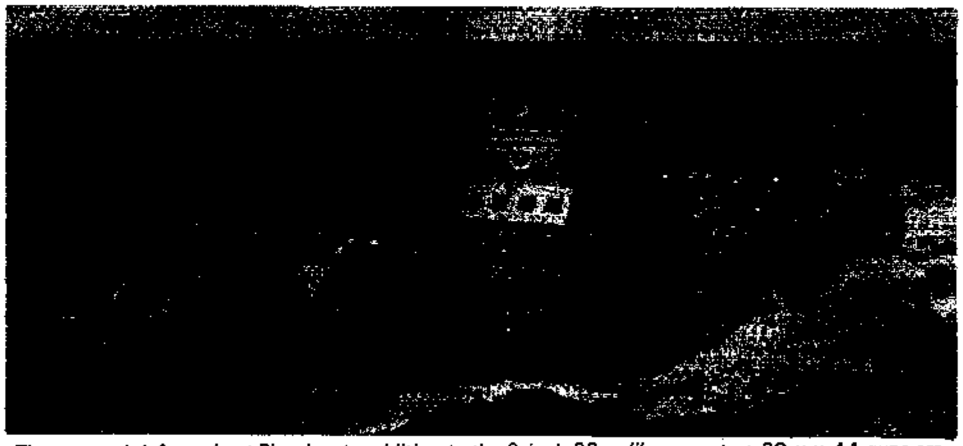
Twin 4.5 inch gun mounting on the destroyer Anzac (Official Royal Australian Navy photograph)

BRAZIL

6052.203
SINGLE 3-inch DUAL-PURPOSE GUN MOUNTING

DESCRIPTION:
A 3-inch (76 mm) dual-purpose 23-calibre weapon is carried by the "P" class seaward defence vessels of the Brazilian Navy. These vessels were built at Rio de Janeiro, but the origin of the guns is not known. Most probably they were made in the USA.

STATUS:
Operational on the one remaining vessel in the class (*Piraque*).



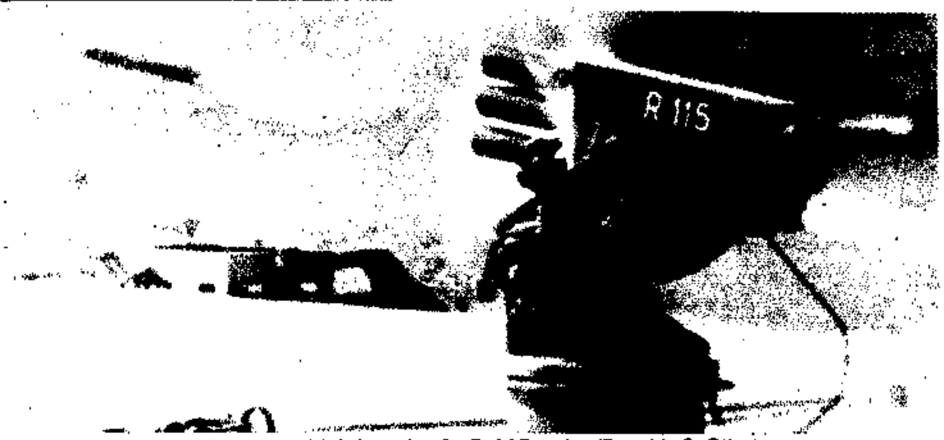
The seaward defence boat Piranha. *In addition to the 3-inch 23-calibre gun, two 20 mm AA guns are carried* (Official Brazilian Navy Photograph)

2027.203
SHIPBORNE BOMBARDMENT ROCKET R-115

DESCRIPTION:
This shipborne bombardment rocket is deployed operationally by the Brazilian Navy's Marine Corps in mobile launchers towed by motor vehicles. It is planned to equip ships of the Brazilian Navy with the missile, however, using special shipboard launchers, one of which is illustrated here.

R-115 is a cylindrical metal fin-less rocket. Its power plant is 1,400 kg st solid-propellant motor and the missile is spin stabilised by means of canted nozzles.

CHARACTERISTICS:
Type: Surface-to-surface bombardment rocket
Propulsion: Solid-propellant rocket motor. Propellant weight 3.1 kg. Static thrust 1,400 kg. Burning time 0.5 sec
Warhead: High-explosive. 1.35 kg



Shipborne multiple launcher for R-115 rocket (Ronaldo S. Olive)

Launch weight: 17.5 kg
Range: 7.5 km

MANUFACTURER:
Companhia de Explosivos Valparaiha, Brazil.

2553.203
SHIPBORNE BOMBARDMENT ROCKET FB.R127

DESCRIPTION:
This finless ship-launched bombardment missile has an ogival nose-cone, housing a high-explosive warhead, and a cylindrical body. Like the R-115 it is spin-stabilised by the canted nozzles of its motor.

CHARACTERISTICS:
Type: Surface-to-surface bombardment rocket
Propulsion: Solid-propellant rocket motor. Propellant weight 8.3 kg. Static thrust 2,000 kg. Burning time 0.8 sec
Warhead: High-explosive. Weight unknown but probably about 3 kg
Launch weight: 44 kg
Range: 10 km

MANUFACTURER:
Companhia de Explosivos, Valparaiha, Brazil.

CANADA

6053.203
TWIN 3-inch AA GUN MOUNTING

DESCRIPTION:
Certain of the destroyer escorts of the Canadian Navy are fitted with twin 3-inch (76 mm) AA guns of Canadian manufacture. This is a 70-calibre weapon in a light turret and it replaced the forward 3-inch 50 calibre American mount (**6030.203**), the aft mount being left unaltered.

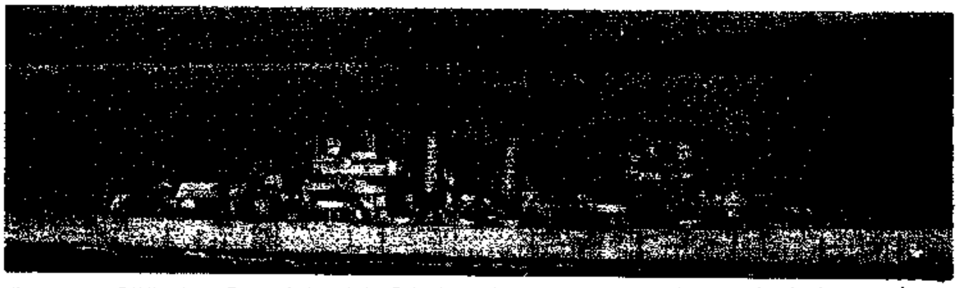
STATUS:
Operational.

Twin 3-inch 70-calibre guns on the destroyer escort Chaudière. (Official Canadian Maritime Command Photograph)

CHILE

6054.203
SINGLE 5-inch DUAL-PURPOSE GUN MOUNTING

Eight of these guns are fitted to each of the two ex-US "Brooklyn" class cruisers of the Chilean Navy—*O'Higgins* and *Capitan Prat*. They are believed to be of the same type as those installed in similar ships of the Argentine Navy (**6050.203**)



The cruiser O'Higgins. *Four of the eight 5-inch dual-purpose guns can be seen in single mountings abreast of the superstructure* (Official Chilean Navy Photograph)

6082.203
SINGLE 4-inch DUAL-PURPOSE GUN MOUNTING

DESCRIPTION:

This fully-automatic 60-calibre weapon is mounted as four single mounts on the two "Almirante" class destroyers of the Chilean Navy.

Built by Vickers (as were the destroyers) and introduced in 1955, the gun fires a projectile weighing about 16 kg with a muzzle velocity of 900 m/sec. Range is about 18.5 km (10 nm) for surface fire and aircraft can be engaged up to about 12,000 metres with a maximum elevation angle of 75°. Maximum rate of fire is said to be 40 rounds per minute. The gun and turret weigh a little over 26 tons.

STATUS:

Operational but no longer in production and unobtainable from the manufacturers.

CHINA (PEOPLE'S REPUBLIC)

6055.203
CHINESE NAVAL ORDNANCE

DESCRIPTION:

Much of the Chinese Navy is made up of vessels originally designed and constructed in the Soviet Union and subsequently transferred to China. A further section – but one of diminishing importance – consists of ex-Japanese and World War II ships inherited by the present regime from that of Generalissimo Chiang Kai Shek. Most of these latter vessels are now at least obsolescent if not obsolete.

Since the mid-1950s, however, the Chinese people have been building many of their own fighting ships. At first these were mainly built from parts supplied by the Soviet Union; but since the two countries became estranged the Chinese people have had to rely increasingly on their own resources.

Because of this overlapping supply situation it is not possible to say exactly for which vessels the guns have been built in China, or which of those have been entirely manufactured in China. It seems probable, however, that there are Chinese-built guns of at least the following types currently in service – 100 mm dual-purpose (twin and single mounts), 37 mm AA (twin mounts), 25 mm AA (twin mounts) and 20 mm AA (single mounts). Guns of several other calibres are in service with the fleet, and must therefore be being serviced in Chinese yards, but it cannot be said with certainty that they have been built in China.

A fast gunboat of the "New Shanghai" class designed for series production in China. Armament consists of four 37 mm and four 25 mm guns and a mortar (forward). The guns look very much like those used in the Soviet Navy but may well have been built in China

FRANCE

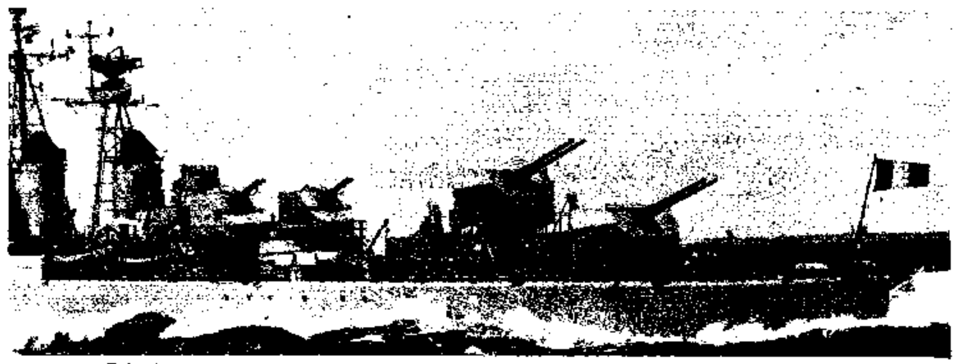
6063.203
TWIN 5-inch DUAL-PURPOSE GUN MOUNTING

DESCRIPTION:

Although this 127 mm gun is of French design and manufacture it was designed to use standard American 5-inch gun ammunition, and for that reason it has here been described by its Imperial measure calibre.

Now fitted only in "Surcouf" class destroyers (and not in those that have been fitted with surface-to-air missiles) these guns have elsewhere been replaced by the new single 100 mm gun (**6064.203**).

Barrel length is 54 calibres and the gun fires a projectile weighing about 32 kg with a muzzle velocity of 850 m/sec. Range against surface targets is about 22 km (12 nm) and aircraft can be engaged up to 13,000 metres with a maximum elevation angle of 80° Maximum rate of fire is 15 rounds per minute. The twin-gun turret weighs about 45 tons.



5-inch guns on the destroyer Maillé Brézé. *The smaller weapons are 57 mm guns* (Official French Navy Photograph)

6064.203
SINGLE 100 mm DUAL-PURPOSE GUN MOUNTING

DESCRIPTION:

This single gun is the medium-calibre weapon on which the French Navy has now standardised for new gun installations. It is already fitted in many ships including the guided-missile frigates *Suffren* and *Duquesne*.

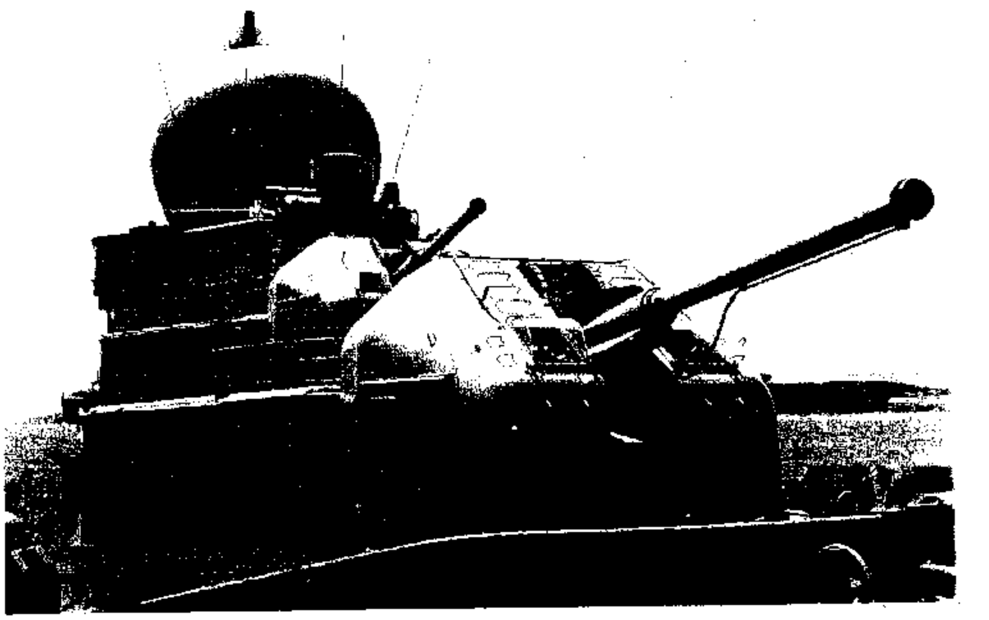
The gun is entirely automatic and operates with an unmanned turret. Firing rate is 60 rounds per minute; the cartridge weighs 23.2 kg, the shell 13.5 kg and the explosive charge 1.04 kg; the muzzle velocity is 870 m/sec; and the maximum range against surface targets is 17 km. Anti-aircraft engagement range is between 6,000 and 8,000 metres. Weight of the complete mounting is 24.5 t.

STATUS:

Operational in the French Navy, the gun has also been supplied for new installations in destroyers and frigates of the Navies of the Federal German Republic and Portugal.

MANUFACTURERS:

Developed as a programme laid down by the Direction Technique des Constructions Navales, 2, rue Royale, 75800 Paris. Work mainly carried out at the naval arsenal at Ruelle. SIGTEL gun remote control equipment is by CSEE, 2-8 rue Caroline, 7501 / Paris.



100 mm dual-purpose gun mounting

6065.203
TWIN 57 mm AA GUN MOUNTING
DESCRIPTION:

This 57 mm Bofors gun is still widely used in the French Navy but it is believed that it is no longer being fitted. It is still to be found on the "Surcouf" class destroyers and the "Le Normand" and "Le Corse" class fast frigates. On one of the latter, however, the after turret was replaced experimentally by a single 100 mm gun and the vessel in question still retains this gun. It may be, therefore, that guns of the 57 mm calibre will in due course be replaced either by 100 mm guns or by 30 mm or similar cannon.

The 60-calibre guns are mounted in pairs in turrets weighing some 15 tons. Maximum elevation is 80° and aircraft can be engaged up to 9,000 metres with a slant range of 14,500 metres. Projectile weight is about 2.6 kg and muzzle velocity about 900 m/sec.

6083.203
HS 30 mm GUN MOUNTINGS
DESCRIPTION:

Mountings of various kinds for the HS 30 mm gun are in service with many vessels of the French Navy. One of the more modern of these, the CAS 62 is described in entry **2559.203**. Another mounting, believed still to be in development, is described in entry **6035.203**, both mountings being by SAMM. It was at one time believed that the 30 mm gun was to be the small-calibre standard for the French Navy, the 100 mm gun (**6064.203**) being the medium calibre standard but the precise position is not known at the time we go to press.

2559.203
SINGLE 30 mm MOUNTING TYPE CAS 62
DESCRIPTION:

This is a remotely controlled turret which can be operated from an external aiming post or aimed by one or two gun layers. The gun is the HSS 831A and it can be used for either surface or anti-aircraft fire and with explosive, incendiary or practice rounds.

The principle of operation of the CAS 62 mounting is generally similar to that of the SAMM S401A turret on the AMX DCA 30 AA weapon system (**5539.103**).

CHARACTERISTICS:
Calibre: 30 mm
Rate of fire: 600 rounds/min
Ready rounds: 215
MV: 1000 m/s
Range: Maximum 10,000 m; practical 2,800 m
Mounting weight: 3,620 kg
Combat weight: 3,920 kg
Train limits: 350°; 50°/sec; 70°/sec^2
Elevation limits: −18° to +83°; 40°/sec; 240°/sec^2

STATUS:
In service in the French Navy at least.

MANUFACTURER:
SAMM SA, 224 Quai de Stalingrad 92130 Issy-les-Moulineaux, France.

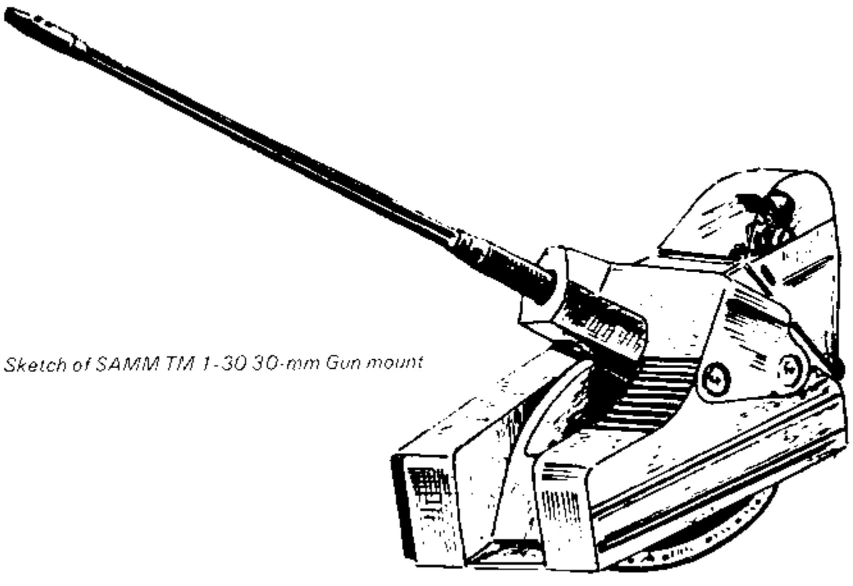
6035.203
SAMM/HS 30 mm GUN MOUNT TYPE TM-1-30
DESCRIPTION:

This new close range naval gun mount is being developed by Société D'Applications des Machines Motrices as an anti-aircraft weapon for installation in small or very small vessels. It employs the well known 30 mm calibre Oerlikon-Hispano 831 SL gun.

The mount is designed for local or remote control and has optical local stabilised aiming arrangements. The designed slewing and elevation rates are 90 and 60 degrees per second which should provide good ability to engage nearby high speed targets.

STATUS:
Under development.

MANUFACTURER:
Société d'Applications des Machines Motrices, 224, Quai de Stalingrad, 92-Issy les-Moulineaux, France



Sketch of SAMM TM 1-30 30-mm Gun mount

2125.203
RAP 14 NAVAL BOMBARDMENT ROCKETS
DESCRIPTION:

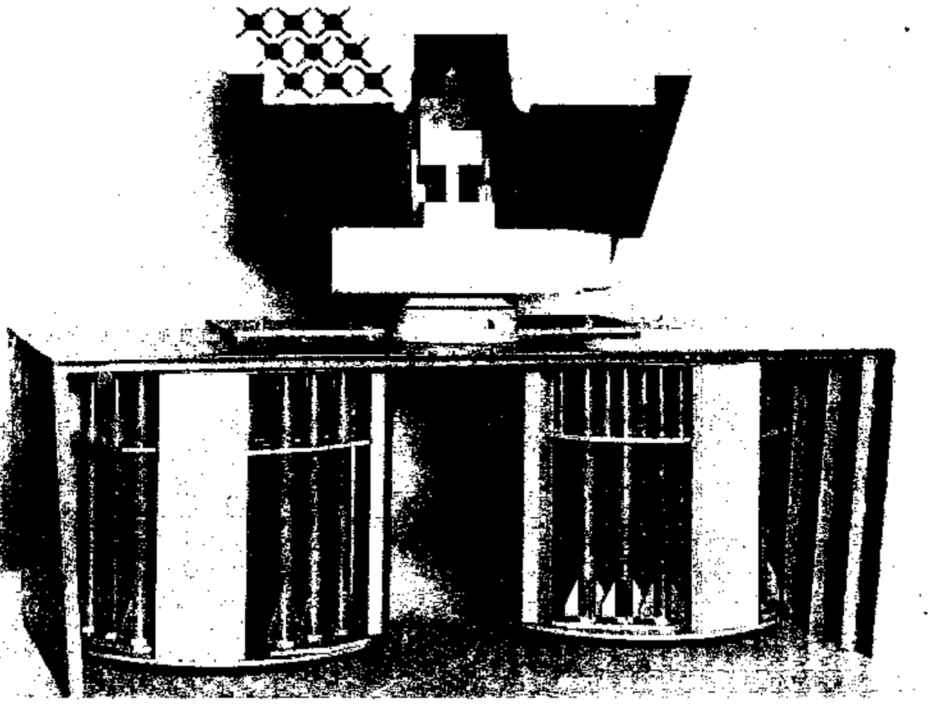
The multiple unguided rocket bombardment system known as RAP 14 is now firmly proposed for naval applications.

The land based version, which is at a much more advanced stage, is described in some detail in entry number **2024.103**, so that it is necessary here to draw attention only to these features that are peculiar to the naval version.

As can be seen from the accompanying picture of a model of the system, the naval version will have a 2 × 9 rocket launcher on a remotely controlled mounting with provision for automatic reloading from below deck with the launcher in the vertical position. Each of the two magazine drums will contain 36 rockets, giving a total capacity, with a full launcher and full magazine, of 90 rockets. The model shown here is of an installation suitable for ships of the "La Combattante II" type; other configurations are possible.

CHARACTERISTICS:
Weight: Complete launcher assembly, less rockets: 10.4 t. Complete assembly with rockets: 15 09 t.
Magazine dimensions: 5.9 × 2.5 × 2.5 m
Launch combinations: any number from one to eighteen
Range: maximum for standard rocket. 16 km
Rate of fire: 9 seconds for 18-round salvo
CEP: 90 m
Effective beaten zone: single salvo 10 hectares (25 acres)
Rocket calibre: 140 mm
Weight: 54 kg
Warhead: 19 kg HE standard. Special warheads possible
Speed: maximum Mach 2

MANUFACTURER:
System: C.N.I.M. (Constructions Navales et Industrielles de la Méditerranée). 50 avenue des Champs-Elysées, 75008 Paris, France.
Launcher: Creusot-Loire, Groupes Marine Schneider, 15 rue Pasquier 75008 Paris, France.



Model of shipborne launcher for RAP 14 rockets

ITALY

5534.203
SINGLE 127/54 GUN MOUNTING

DESCRIPTION:
The 127/54 is a dual purpose gun mount of an intermediate calibre and so more suitable to a slightly larger class of ship than the others in the new OTO series. It is intended as a main armament for frigates and destroyers.

Design work started in October 1965 as a joint venture with the Italian Government. The first prototype was completed in May 1969.

Ready use ammunition is held in three drums just below the turret. A central elevator hoists the ammunition, chosen from one drum, and delivers it to the turret where two oscillating arms perform the final movement to the loading trays.

The three drums are automatically reloaded through two hoists manually loaded in the magazine.

The three drum layout permits stowing of three different types of ammunition in the ready use magazine which can be chosen appropriate to the type of action. Remote controlled fuse setters are provided in the oscillating arms.

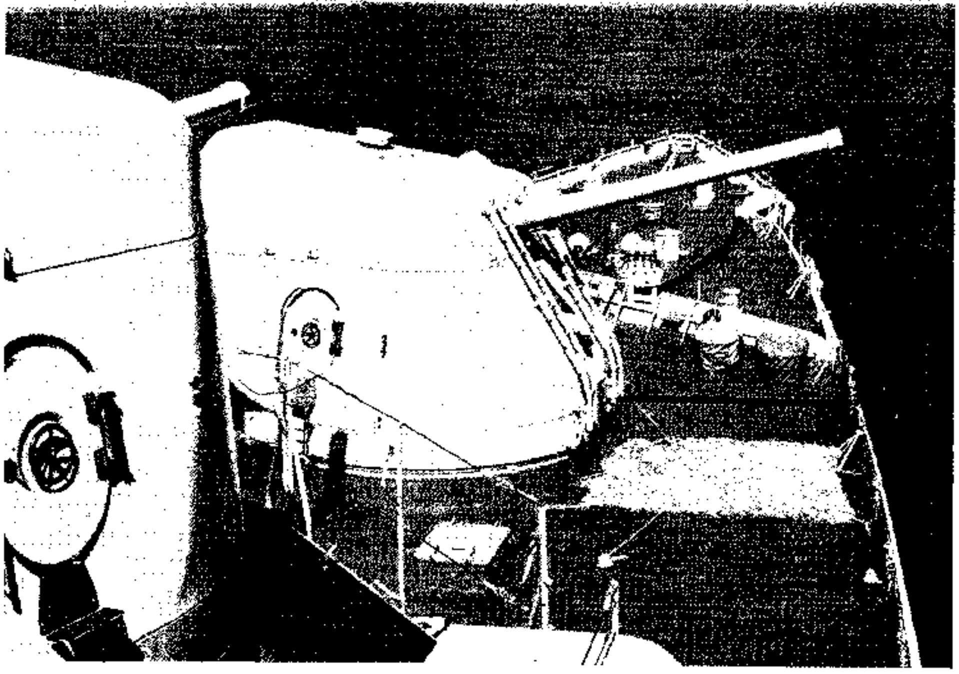
The reloading, feeding, loading and firing sequence is controlled by a control console operated by a single man.

The electrically-operated remote control servo-system is of modular construction using controlled rectifiers. The modules are the same as those used on other modern OTO Melara weapon systems.

Optionally, the mount can also be fitted with a stabilised line of sight local control system. The main technical features are the light alloy construction, the compact installation, and the light weight control mechanism.

The barrel is fitted with a multi-muzzle brake. The shield is of fibreglass and is watertight.

CHARACTERISTICS:
Calibre: 127 mm
Weight: 34 tons
Rate of fire: 45 rounds per minute



127/54 OTO Single Barrel Naval Mount

Ready ammunition: 66 rounds (3 × 22)
Trunnion thrust: 24,000 kg
Elevation: Maximum: 85°. Minimum: −15°
Traverse: 330°
Elevating speed: 30°/sec
acceleration: 40°/sec^2
Traverse speed: 40°/sec
acceleration: 45°/sec^2

STATUS:
In production.

COUNTRIES SUPPLIED:
Italian and Canadian Navies.

MANUFACTURER:
OTO Melara, Via Valdilocchi, 15 La Spezia, Italy.

5532.203
SINGLE 76/62 OTO M.M.I. GUN MOUNTING

DESCRIPTION:
The 76/62 OTO M.M.I. single barrel automatic gun has been developed to a Government contract as a secondary armament for use on board ships of the frigate and corvette type as a dual-purpose anti-aircraft and anti-ship weapon system.

The gun is a single barrel, water-spray cooled, on a powered mounting. It is protected by a watertight splinterproof shield, which also houses the one man required to direct the gun. Great efforts have been made to reduce the crew, and all operations are performed automatically.

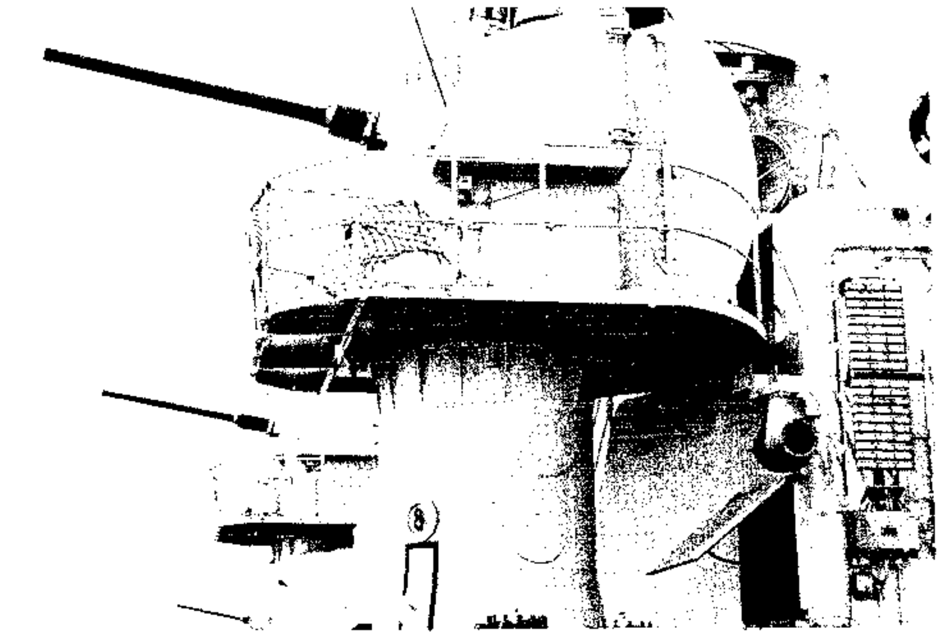
Ammunition is fed from the magazine up to the loading trays, from where it is rammed into the breech. This feed system can vary in length from a minimum of 2.50 metres to a maximum of 11 metres, and will therefore accommodate a wide range of alternative deck and magazine locations.

The gun has a high rate of fire for its calibre, the maximum being about 60 rounds per minute. Ammunition is fixed, and the empty cases are ejected automatically.

Elevation and traverse is by electric and hydraulic control, with an emergency manual operation. The whole system can be controlled remotely or the Fire Director can exercise local control from his position beside the gun.

Reloading of the ammunition system requires a maximum of three men. They receive ammunition from the magazine and stack it on a lower platform below rotating the gun mounting. From here it is automatically fed through an elevating duct to another platform just below the gun, and the final movement to the loading tray is by oscillating arms.

Development of this gun system began in 1958, the first prototype was completed in 1961, and the first production models entered service in 1962.



OTO 76/62 M.M.I. Single gun mountings

CHARACTERISTICS:
Calibre: 76 mm
Overall Weight: 12 tons
Rate of Fire: 55 to 65 rpm
Ready to Fire Rounds: 59
Elevation: $-15°$ to $+85°$
Traverse: 360°
Elevation Speed: 40°/sec
Traversing Speed: 70°/sec
Elevation Acceleration: 70°/sec^2
Traversing Acceleration: 100°/sec^2

STATUS:
84 in service with the Italian Navy. No longer in production and not available from the manufacturers.

5533.203
SINGLE 76/62 COMPACT GUN MOUNTING

DESCRIPTION:

The 76/62 OTO compact is a light, small calibre gunmount intended for installation in ships of any type and class down to motor gun boats and hydrofoils as a dual purpose anti-aircraft and anti-ship weapon system.

The gun and mounting was developed from the 76/62 OTO M.M.I. mounting (**5532.203**), the design study being started in 1964, and the first production units came into service in March 1969.

The mounting may be considered in two parts, the shank which is below the weather deck, and the turret which is installed on deck. The shank contains the ammunition feed system, which consists of a rotating platform and a hoist.

The gunhouse holds a loading tray, loading arms, and a feed drum. The hoist and feed system is very simple and reliable, but well able to maintain a high rate of fire. Individual rounds of ammunition are hoisted in a series of short movements rather than long continuous travel with the object of reducing accelerations on the moving parts and the round itself.

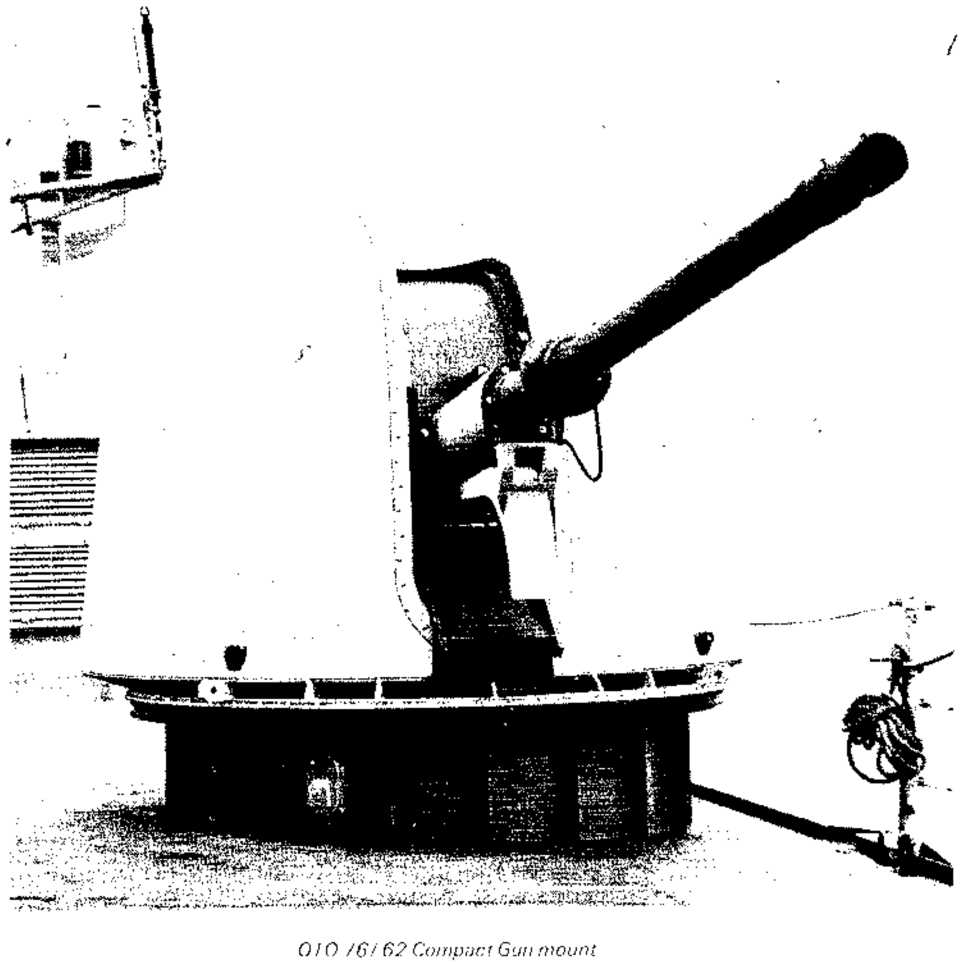
The lower platform will hold up to 80 rounds ready to fire, and the rate of fire is adjustable from 10 to 85 rounds per minute.

Generally, the system is controlled remotely, optionally it can also be fitted with a stabilised line of sight local control system.

The mount is fitted with modular servo-systems of very light weight using electric motors with controlled rectifiers, for both training and elevating motion. With remote control, the gun can be readily laid onto fast moving targets such as aircraft and retained in lay despite severe ship movement in all planes. The response time of the servos is fast, and accelerations on the gun can be quite high. There is an emergency local control.

The shield is made of fibreglass, and is watertight. It offers complete protection against nuclear fall-out. The gun barrel has a small multi-hole muzzle brake and a fume extractor.

STATUS:
Presently being manufactured in series for Italy, Federal German Republic, Venezuela, Denmark and Argentina.



OTO 76/62 Compact Gun mount

CHARACTERISTICS:
Calibre: 76 mm
Overall weight: 7.5 tons
Rate of fire: 85 rounds per minute
Maximum trunnion thrust: 7,000 kg
Elevation: Maximum: 85°. Minimum: $-15°$
Traverse: unlimited
Elevation Speed: Maximum. 35°/sec
acceleration: 72°/sec^2
Traverse speed: Maximum. 60°/sec
acceleration: 72°/sec^2

MANUFACTURER:
OTO Melara, Via Valdilocchi, 15, La Spezia, Italy.

6068.203
QUADRUPLE 40/56 BOFORS GUN MOUNTING

This multi-barrelled Bofors 40 mm 56 calibre gun mounting is found on the two destroyers *Impetuoso* and *Indomito*.

These two destroyers may be converted to carry Tartar missiles. If and when this happens the present four American 5-inch 38 calibre guns (**6026.203**) will be replaced by two OTO Melara guns of the same calibre and the Bofors guns by four OTO 3-inch (76 mm) guns.

2557.203
BREDA/BOFORS NAVAL MOUNTINGS

DESCRIPTION:

In collaboration with Bofors in Sweden, Breda Meccanica Bresciana make a range of single and twin naval anti-aircraft gun mountings incorporating a variety of different automatic feed systems. They also make some similar mountings for mobile use on land.

Set out in the following entries are brief details of current mountings. All use the 40 mm L/70 increased rate of fire pattern of Bofors gun (**2360.203**) which has the following general characteristics (which are not repeated in the individual entries below).

Calibre: 40 mm
Barrel length: 70 calibres
Weight of shell: 0.96 kg
MV: 1,005/m sec (range 12.5 km maximum)
Rate of fire: 300 rounds/min (per barrel)
Train: unlimited
Elevation: $-10°$ to $+85°$

STATUS:

As noted below. Mostly in service.

MANUFACTURER:

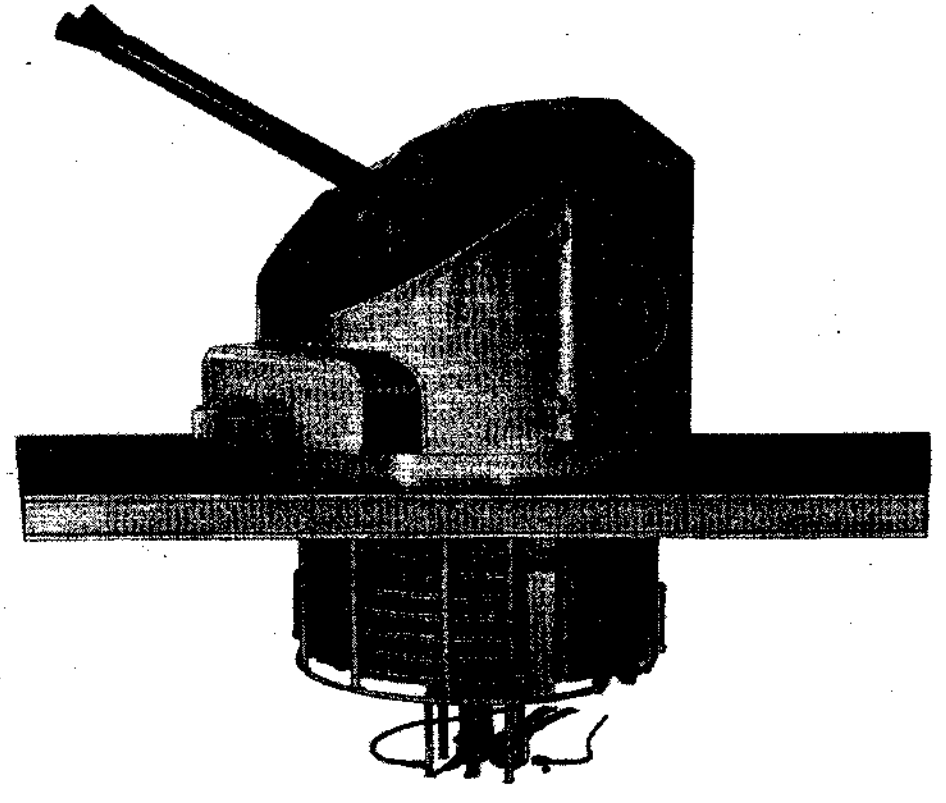
Breda Meccanica Bresciana, Via Lunga 2, 25100 Brescia, Italy.

2258.203
BREDA COMPACT TWIN 40 mm L/70 NAVAL MOUNTING TYPE 70

DESCRIPTION:

This twin 40 mm L/70 naval mounting has been developed by Breda Meccanica Bresciana in close cooperation with Bofors in Sweden as part of the Breda/Bofors System 75 (see also entry **2349.131**) which is particularly intended for point defence against aircraft and anti-ship missiles.

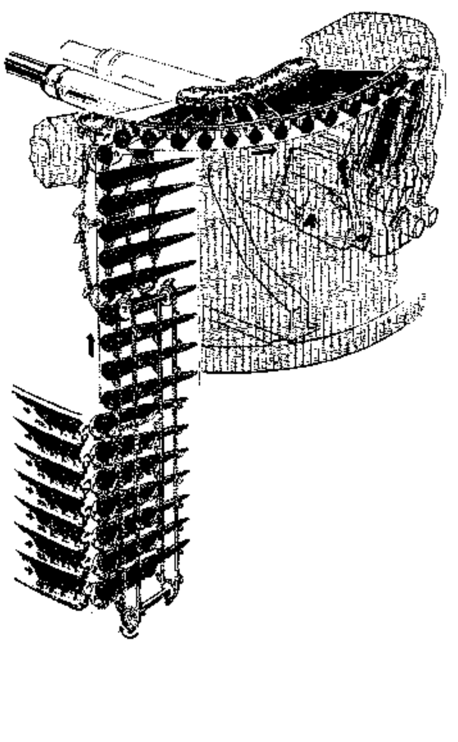
Claimed to be the lightest and smallest 40 mm mounting currently available, the compact mount is fully automatic in operation, employs new remote controlled servo-systems of high performance to improve accuracy – which is also improved by the reductions in weight, inertia and recoil disturbance resulting from the exceptionally small separation between the two barrels – and features a high rate of fire and a substantial supply of ready-use ammunition.



Breda Compact Twin 40 mm Naval Mounting

CHARACTERISTICS:

Calibre: 40 mm
Barrel length: 70 calibres
Max recoil: 250 mm
Elevation: $-13°$ to $+85°$
Traverse: unlimited
Elevation rate: 90°/sec
Traverse rate: 90°/sec
Elevation acceleration: 120°/sec^2
Traverse acceleration: 120°/sec^2
MV: 1,000 m/sec
Range: maximum: 12.5 km; maximum altitude 8,500 m
Rate of fire: 300 rounds/barrel/min
Ready rounds: 736 or 440
Weights:
Unloaded mounting: for 440 rounds: above deck 5.0 t; below 4.7 t
for 736 rounds: above deck 5.5 t: below 5.0 t
Loaded mounting: with 440 rounds: above deck 6.1 t; below 5.8 t
with 736 rounds: above deck 7.3 t: below 6.8 t
Heights:
Gun mounted on deck: 2.30 m; with 440 round loader: 2.92 m; with 736 round loader 3.29 m. Loader below deck: 0.94 m for 440; 1.32 m for 736 rounds
Swept radius: 3.0 m



Method of operation of the ammunition hoist of the Breda Compact Mounting

STATUS:

The mount is being installed on ships currently under construction in an Italian shipyard.

MANUFACTURER:

Breda Meccanica Bresciana SpA, Via Lunga 2, 25100 Brescia, Italy.

2556.203
TWIN 40 mm NAVAL MOUNTING TYPE 64

DESCRIPTION:

This is a sophisticated Breda / Bofors mounting comprising two 40 mm L/70 guns and twin 100-round automatic magazines. It can be controlled remotely or locally. A graticule, Mirasole or NIFE reflection sight can be fitted.

CHARACTERISTICS:

Generally as other 40 mm L/70 mountings.

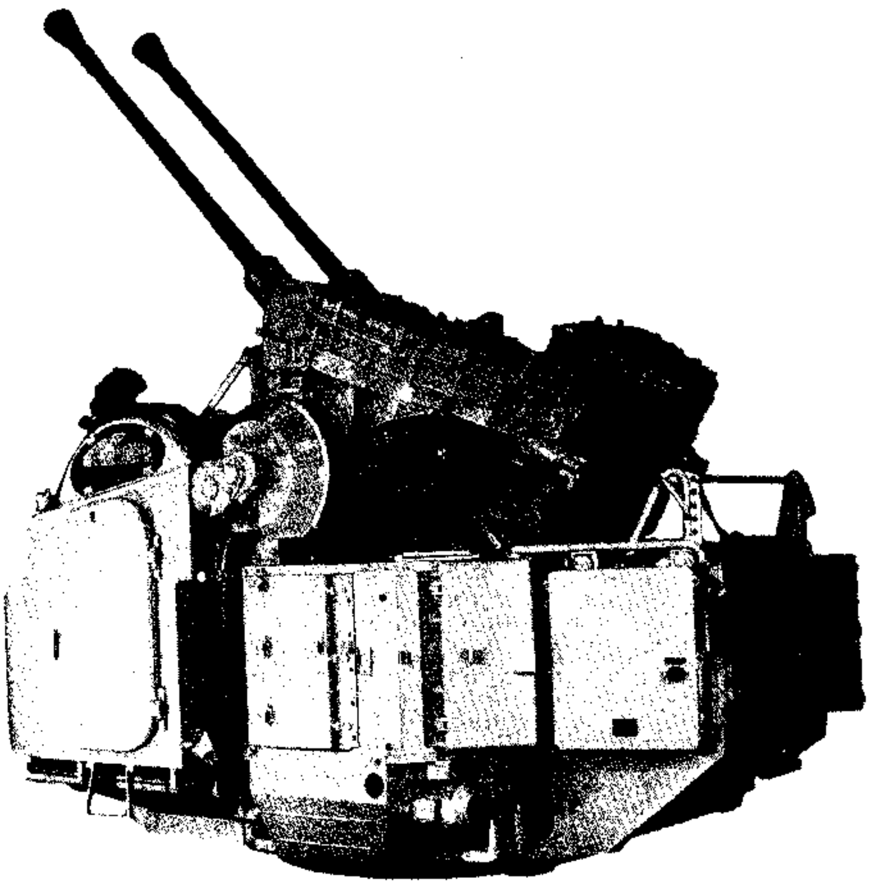
Total weight: excluding ammunition 7,900 + 150 kg
Training speed: 85°/sec minimum
Elevation speed: 95°/sec minimum
Training acceleration: 110°/sec^2 minimum
Elevation acceleration: 125°/sec^2 minimum
Power requirement: 6 kW each for training and elevation motors plus 1.6 kW for the feeder motor

STATUS:

Production.

MANUFACTURER:

Breda Meccanica Bresciana, Via Lunga 2, 25100 Brescia, Italy.



Breda / Bofors twin mounting Type 64

2558.203
TWIN 40 mm NAVAL MOUNTING TYPE 106

DESCRIPTION:

This Breda/Bofors 40 mm L/70 mounting comprises two guns and two 32-round magazines. It can be controlled remotely, locally – by means of the "cloche" on the left of the mount – or manually. Ammunition feed may be either automatic by means of the Breda 32-round feeder or manually by inserting a 4-round charger into the auto-loader of the elevating mass. The aiming device is either the NIFE type SRS-5 or the Mirasole line-of-aim type.

CHARACTERISTICS:

Generally as for other 40 mm L/70 mountings.

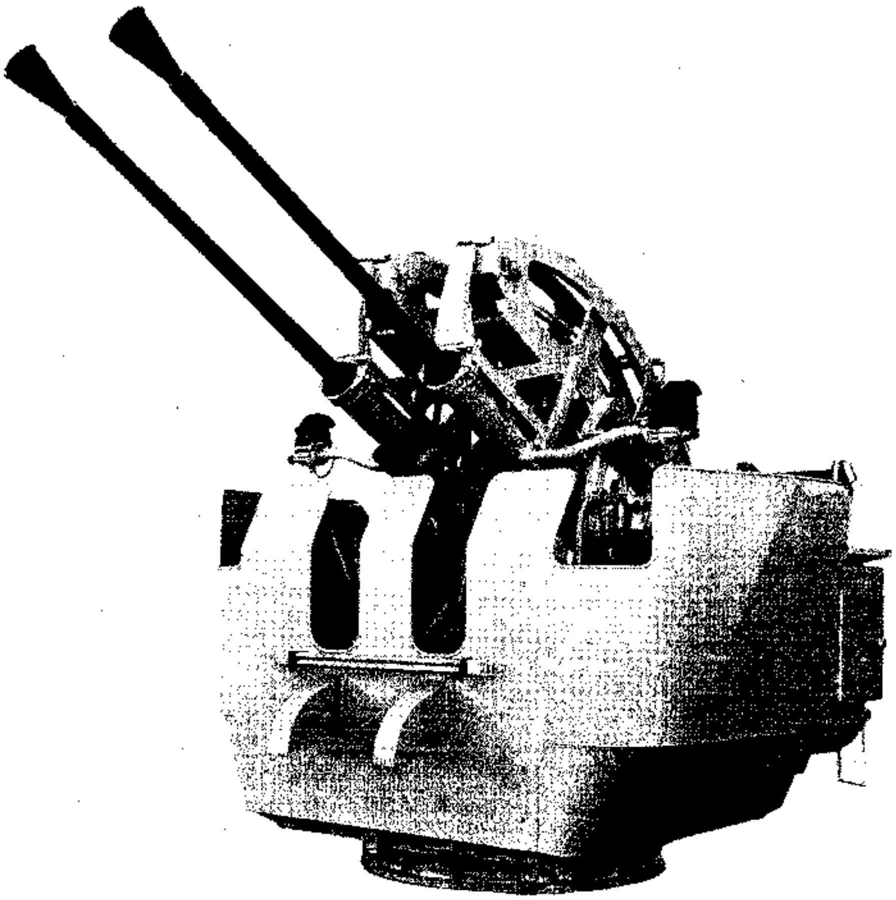
Gun weight: with feeder and battery, less ammunition 6/510 + 100 kg
Training speed: 95°/sec
Elevation speed: 95°/sec
Acceleration: 125°/sec^2
Power required: Elevation and training 4 kW each.
Recoil force: 2 × 2,700 kg

STATUS:

In production and service.

MANUFACTURER:

Breda Meccanica Bresciana, Via Lunga 2, 25100 Brescia, Italy.



Breda / Bofors twin mounting with 32 round magazines

2554.203
SINGLE 40 mm NAVAL MOUNTING TYPE 564

DESCRIPTION:

This mounting differs from earlier Breda versions of the Bofors L/70 gun in being equipped with a Model 1971 144-round automatic feed of compact design. This permits a more effective use of the gun's high rate of fire and reduces the number of men required on the mount to two – with a third at standby near the mount to reload the automatic feed. This reloading operation can obviously be carried out during lulls in the firing; but with a little practice it is possible to reload while the gun is firing.

A further advantage of this feed system is that it can be fitted retrospectively to gun mountings which incorporate earlier types of feed. Complete modification kits to enable a purchaser having access to reasonable engineering facilities to arrange for the modification to be carried out, under Breda supervision, at any convenient location.

CHARACTERISTICS:

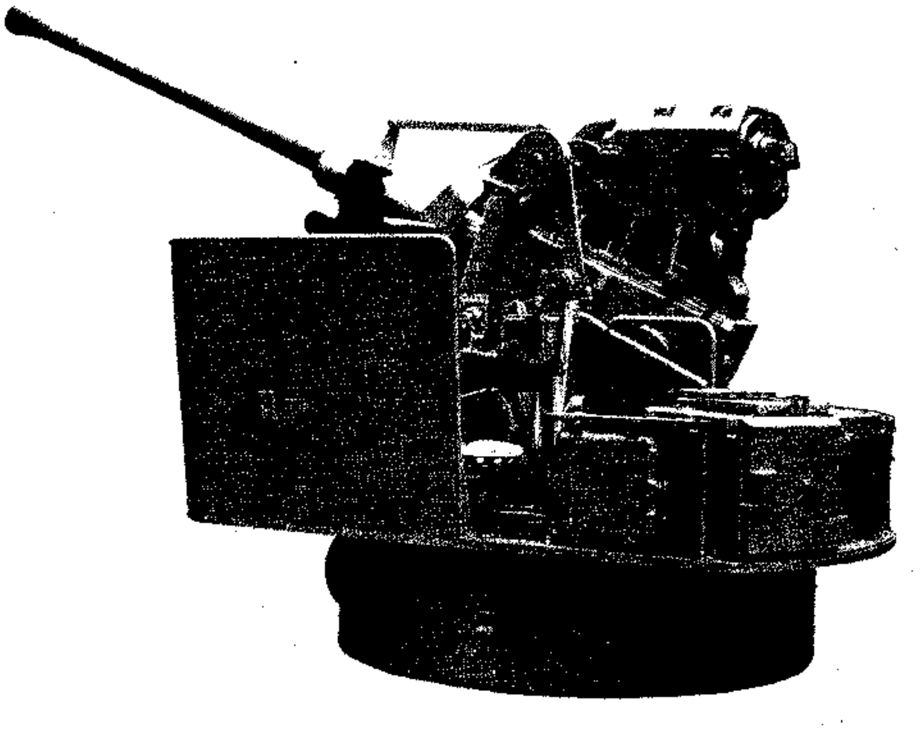
Generally as for other 40 mm L/70 gun mountings.
Gun weight: with automatic feeder and with battery but excluding ammunition—3,300 + 100 kg
Training speed: local or remote control—80°/sec
Elevation Speed: local or remote control—45°/sec
Training acceleration: 120°/sec^2
Elevation Acceleration: 130°/sec
Power Consumption: 6 + 8 kW

STATUS:

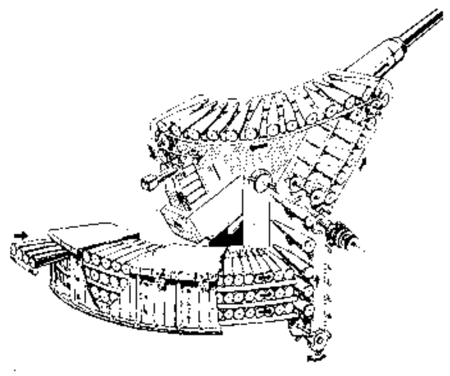
In service and in production.

MANUFACTURERS:

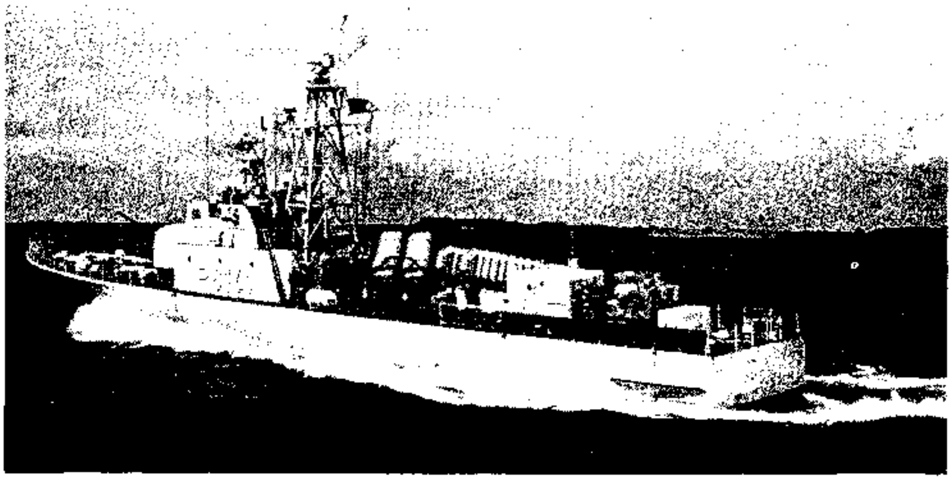
Breda Meccanica Bresciana SpA, Via Lunga 2, 25100 Brescia, Italy



Breda/Bofors 40 mm L/70 naval mounting with 144-round automatic feed



Method of operation of the 144-round automatic feed

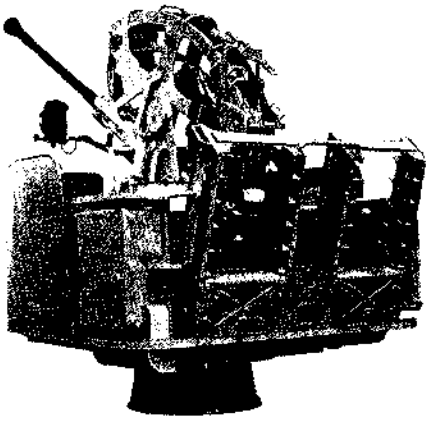


Type 148 missile boat (Federal German Republic) with Breda/Bofors Type 564 mounting aft

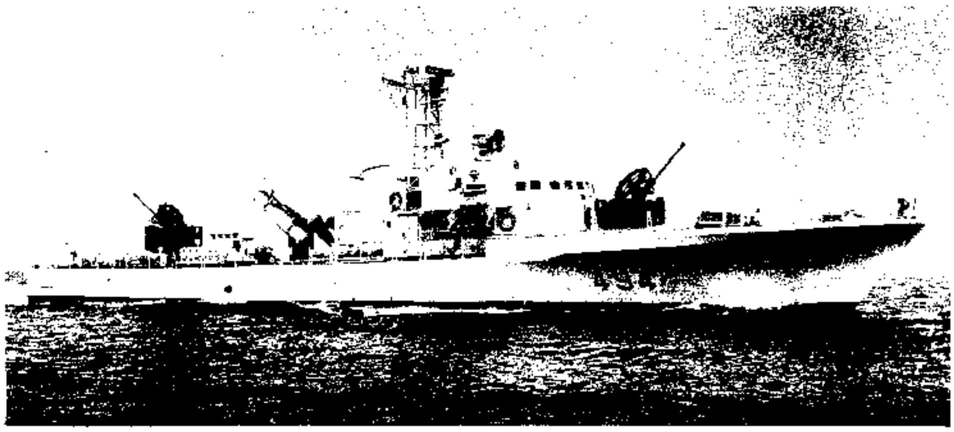
2555.203
SINGLE 40 mm NAVAL MOUNTING TYPE 107

DESCRIPTION:

This Breda/Bofors mounting comprises a single 40 mm L/70 gun and a 32-round magazine feed. It can be controlled remotely, locally – by means of the "cloche" on the left of the mount – or manually. Ammunition feed may be either automatic by means of the Breda 32-round feeder or manually by inserting a 4-round charger into the auto-loader of the elevating mass. The aiming device is either the NIFE type SRS-5 or the "Mirasole".



40 mm Breda/Bofors Mounting Type 107



40 mm Breda/Bofors guns on the FPB Saetta *of the Italian Navy. Missile launcher is for Sea Killer Mk I*

CHARACTERISTICS:
Generally as for other 40 mm L/70 mountings
Gun weight: with feeder and battery, less ammunition 3,610 + 100 kg
Training speed: 95°/sec
Elevation speed: 95°/sec
Acceleration: 125°/sec^2
Power required: Elevation and training 4 kW each
Recoil force: 2,700 kg

STATUS:
In production and service.

MANUFACTURER:
Breda Meccanica Bresciana, Via Lunga 2, 25100, Brescia, Italy.

5535.203
TWIN 35 mm OE/OTO GUN MOUNTING

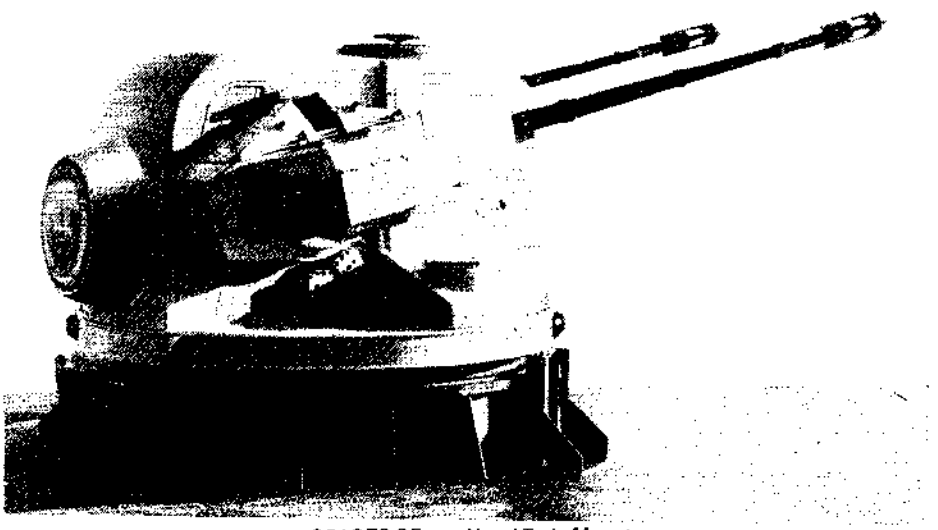
DESCRIPTION:
The 35 mm OE/OTO mounting has been produced as a private venture and is intended for use in any type of ship down to motor gun boats and hydrofoils, or as local defence for merchant ships in time of war. It is primarily for close anti-aircraft defence, with a secondary anti-ship and anti-shore role.

Two types of turret have been designed the first for installation above the weather deck thus not utilising any room below deck; and the second for installation with the shank below deck level. For each type there are three fire control systems: a remote control, a local control with sight for optical tracking, and a radar and computer in an integrated system with a sight for optical tracking.

The mounting utilises a high proportion of light alloys in its construction, this having been a feature of the 3 inch and 5 inch OTO Mountings. The shield is made of fibreglass and is watertight.

The mounting, as the 3 inch and 5 inch OTO, is fitted with modular servo-systems of very light weight using electric motors with controlled rectifiers developed by OTO Melara.

The Oerlikon gun has a high rate of fire and is belt fed. An interesting feature is that two belts are fed to each gun, and either may be selected in about 2 seconds. Thus the mounting can switch very rapidly from firing, say, anti-aircraft ammunition to armour-piercing. Each gun is provided with EVA at the muzzle to measure muzzle velocity, and this information is fed back into the computer to permit corrections in laying to be applied.


OE/OTO 35 mm Naval Twin Mount

STATUS:
Private Venture – prototype under evaluation trials.

CHARACTERISTICS:
Calibre: 35 mm
Barrel length: 90 calibres (3.150 m)
Maximum recoil: 60 mm
Range—max: 5,000 m (aerial targets)
6,000 m (surface targets)
Elevation: —15° to +85°
Traverse: unlimited
Elevating speed: maximum: 70°/sec
Traversing speed: maximum: 120°/sec
Elevating acceleration: 130°/sec^2
Traversing acceleration: 160°/sec^2
Crew: 3 (2 loaders, 1 layer, if not remotely controlled)

MANUFACTURER:
OTO Melara, Via Valdilocchi, 15, La Spezia, Italy.

2261.203
TWIN 35 mm ANTI-AIRCRAFT GUN MOUNTING (ITALY)

DESCRIPTION:
The twin 35 mm AA gun mounting type GDM-A using the Oerlikon gun type KDC is described in entry number **6036.203** (Switzerland) over the name of the parent manufacturing company, Oerlikon-Bührle of Zurich.

The same mounting is also available from Oerlikon Italiana. No differences between the two mountings are known.

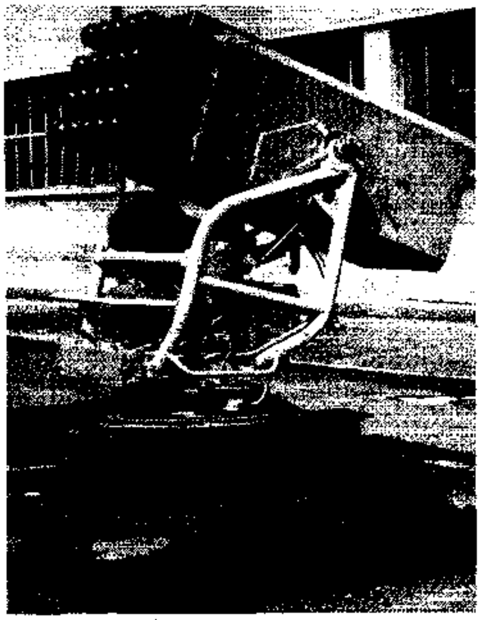
MANUFACTURER:
Oerlikon Italiana SpA, Via Scarsellini 14, Milan, Italy.

2278.203
MULTI-PURPOSE CHAFF/FLARE ROCKET LAUNCHER

DESCRIPTION:
Designed primarily for electronic warfare applications, but capable of being used for other purposes, and described as a third-generation device, this is a servo-controlled mounting which can be trained and elevated by remote control and on which is mounted a multi-tube launcher assembly for 105 mm rockets.

Both the mounting and the individual launch-tubes are remotely controlled from a console of sophisticated design. The twenty rockets can be fired in various sequences or in accordance with a fixed programme. Either chaff or flare rockets are normally used: the launcher could, of course, also fire similar rockets with HE warheads but so far as is known this has not been done (see, however, entry **2279.203** below).

MANUFACTURER:
Breda Meccanica Bresciana, Via Lunga 2, 25100 Brescia, Italy.


Multi-Purpose Chaff/Flare rocket launcher

2279.203
SCLAR MULTI-PURPOSE NAVAL ROCKET SYSTEM

DESCRIPTION:
SCLAR is a shipboard system for launching illuminating rockets and long-range or short-range chaff dispensing rockets. It can also be used for rockets with HE warheads.

Rockets are launched from tubes mounted in a 20-tube launcher which can be elevated and trained by remote control. The complete SCLAR system includes the Elsag fire control sub-system from which this remote control is exercised.

The rockets are of 105 mm calibre and are fin-stabilised, there being four fins on the short-range and six on the long-range rockets. These light alloy fins are pivoted so that they can be folded up flat against the rocket casing when inserted in the launch tube after launch they are twisted downwards and outwards by aerodynamic forces, settling firmly in position for the flight. Two types of chaff rocket are available for short and long-range operation, their lengths being 1,142 mm and 1,849 mm and weighs 18.4 kg and 27.0 kg respectively, and one type of illuminating rocket (long) is used. HF rockets are not available as standard but can be supplied if required and the warhead weight for all rockets is 10.2 kg. Rockets are fired electrically by remote control. Maximum ranges are 2,100 m and 11,600 m.

MANUFACTURERS:
Rockets: Snia Viscosa—BPD Division SpA, Via Lombardia 31, Rome, Italy.
Launcher: Breda Meccanica Bresciana SpA, Via Lunga 2, 25100 Brescia, Italy.
Fire Control: Elettronica San Giorgio SpA, Via Hermada 6, Genova-Sestri, Italy.

NORWAY

2299.203
NORWEGIAN NAVAL GUNS

The full extent of Norwegian involvement in naval gun manufacture is not known. It is known, however, that the Bofors single 3-inch (76 mm) automatic gun mounting (which is installed on the Norwegian "Storm" class fast patrol boats) is made, by arrangement with Bofors, in Norway (see entry **2302.203**).

It is possible that other Bofors guns, which are fitted in many Norwegian ships, may be made or modified in Norway.

MANUFACTURERS:
A/S Kongsberg Vaapenfabrikk, Postboks 25 3601 Kongsberg, Norway.


Norwegian "Storm" class fast patrol boat with Bofors 3 inch gun forward and power-operated 40 mm gun aft

SPAIN

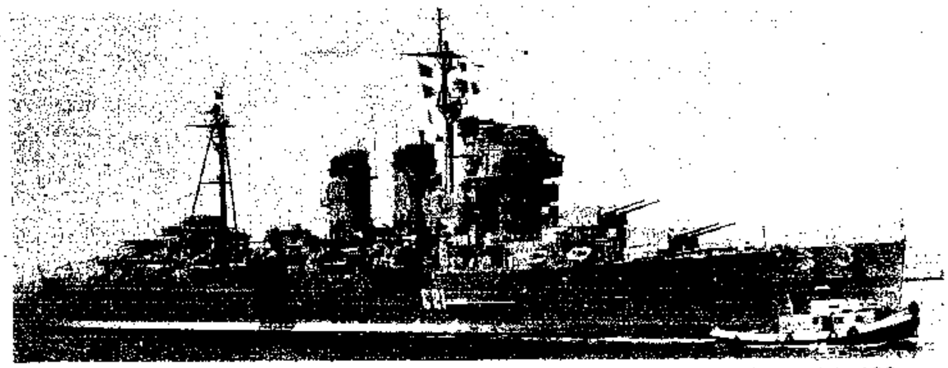
6058.203
TWIN 8-inch GUN MOUNTING

DESCRIPTION:
Slightly smaller than the 8-inch (203 mm) guns of the US Navy these are the second heaviest naval guns in service.

Fitted as four twin turrets in the heavy cruiser *Canarias*, these 50-calibre guns are of a design that was first introduced by Vickers in 1924. The *Canarias* was built by the Sociedad Española de Construction Naval, El Ferrol, was laid down in 1928, launched in 1931 and completed in 1936. Her design was basically that of the contemporary British "Kent" class cruisers.

A notable feature of the gun at the time of its construction was the maximum elevation capability of 70 degrees—comparing favourably with the contemporary US 8-inch gun of only 40 degrees. The later US 55-calibre gun (1944 model) had an elevation capability of 80 degrees.

Projectile weight for these guns is about 113 kg and the muzzle velocity is about 840 m/sec. Maximum range is about 30 km (16 nm) and rate of fire 6 rounds per minute.


The heavy cruiser Canarias. *Her 8-inch guns are mounted in twin turrets fore and aft, the eight 120 mm guns are mounted in single mountings four on each side.* (Official Spanish Navy Photograph)

STATUS:
Operational but weapon no longer available.

6060.203
TWIN 120 mm GUN MOUNTING

DESCRIPTION:
These 50-calibre semi-automatic 120 mm guns are fitted in the "Oquendo" type anti-submarine destroyers. They are of Spanish manufacture. Some of the "Oquendo" class were modified before completion to take 5-inch (127 mm) 38 calibre American guns.


Forward twin 120 mm gun mounting on the Oquendo *anti submarine destroyer.* (Official Navy photograph)

6059.203
SINGLE 120 mm AA GUN MOUNTING

DESCRIPTION:
Eight single 120 mm 45 calibre AA guns are mounted on the heavy cruiser *Canarias*. Like the cruiser's 8-inch guns, these are also of Vickers design, dating from 1923. Maximum elevation is 90° and aircraft can be engaged at heights up to 10 000 metres and slant ranges up to 16,000 metres. Projectile weight is 22 kg, muzzle velocity about 820 m/sec and rate of fire 9 rounds per minute. The guns can be seen in the illustration accompanying entry **6058.203** above.

MANUFACTURERS:
Vickers Ltd, Shipbuilding Group, Barrow Engineering Works, Barrow in Furness, Lancashire, England.

6061.203
SINGLE 120 mm AA GUN MOUNTING

DESCRIPTION:
This gun was installed as the principal weapon of the first "Bidasoa" class fleet minesweepers which were of the same design as the German M Boote 40. Some of these vessels were fitted with an 88-mm gun in place of the 105 mm weapon.

The 105 mm guns were made by Krupp and are of a design first introduced in 1933. The gun can be elevated to 90°, fires a 17.5 kg projectile with a muzzle velocity of 900 m/sec and can engage targets at heights up to 12,500 metres and slant ranges up to 17,500 metres. Rate of fire is 20 rounds per minute.


105 mm gun mounted on the "Bidasoa" class fleet minesweeper Lerez. (Official Spanish Navy photograph)

2303.203
SINGLE 3 inch (76 mm) 50-CALIBRE GUN MOUNTING MARK 34
DESCRIPTION:
This is an American-designed weapon built in Spain and mounted on destroyers and frigates of the Spanish Navy. Details of this mounting and of the American-designed and built twin Mk 33 mountings, which are also mounted on Spanish destroyers and frigates, will be found in entry **6030.203**, but the main data for the Mk34 are recapitulated below.
Mount weight: 7,700 kg
Range: 13 km (7 nm, 14,000 yds)
Projectile weight: 6 kg
Rate of fire: 45 rounds/min
STATUS:
Operational.
MANUFACTURER:
Fabrica de Artilléria, Sociedad Española de Construcción Naval, San Fernando, Spain.

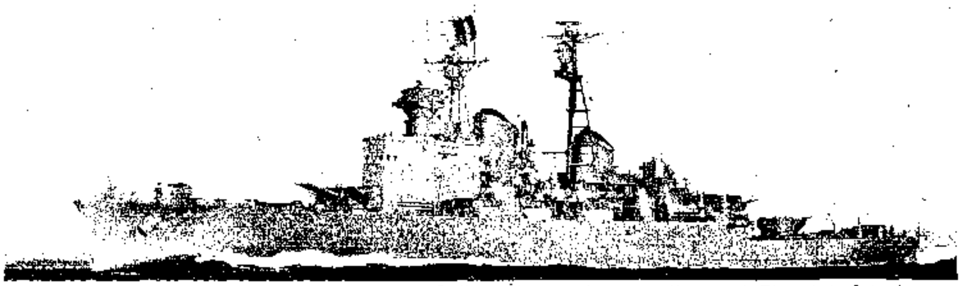
2304.203
40 mm L/70 LIGHT ANTI-AIRCRAFT GUN
DESCRIPTION:
This is a version of the Bofors L/70 gun (**2360.203**) built under licence in Spain. It is understood that the design used is that of the original version of the 40/70 weapon and that it has the characteristics set out below.

CHARACTERISTICS:
Calibre: 40 mm
Barrel length: 70 calibres
Elevation: 10° to +90
Elevation speed: 45°/sec
Traverse speed: 85°/secs unlimited
Range: 12 km maximum
Rate of fire: 240 rounds/min
Weight: 2.5 t
Power consumption: 220 V dc: 8 kW
24 V dc: 0.2 kW
110 V ac 50 c/s: 2KVA
120 V ac 400 c/s: 0.25 KVA
STATUS:
Operational in ships of the Spanish Navy.
MANUFACTURER:
Empresa Nacional Bazán, San Fernando, Spain.

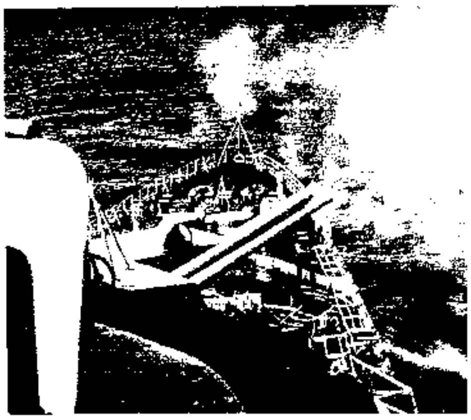
6084.203
SINGLE 37 mm AA GUN MOUNTING
DESCRIPTION:
Like the Krupp 105 mm gun (**6061.203**) this 50-calibre AA gun is to be found on the *Eolo* class frigate minelayers and the *"Bidasoa"* class fleet minesweepers of the Spanish Navy.
Built to a Krupp design dating from 1932 the gun has a maximum elevation angle of 70°, fires a 0.9 kg projectile with a muzzle velocity of 830 m/sec and can engage targets flying at heights up to 3,000 metres and slant ranges up to 4,000 metres. Rate of fire is 80 rounds per minute.

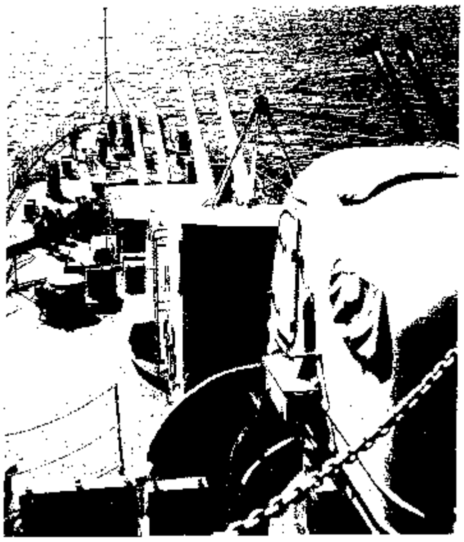
SWEDEN

6070.203
TRIPLE 6-inch GUN MOUNTING
DESCRIPTION:
These 6-inch (152 mm) Bofors guns were first introduced in 1942 and are now to be found as a triple mounting only in the cruiser *Latorre* of the Chilean Navy (formerly the *Göta Lejon* of the Royal Swedish Navy). This ship is the survivor of two cruisers programmed in 1941, laid down in 1943, launched in 1945 and completed in 1947.
Projectile weight is 46 kg, muzzle velocity 900 m/sec and range 26 km (14 nm). A rate of fire of 10 rounds per barrel per minute can be achieved.
MANUFACTURER:
AB Bofors, Bofors, Sweden.

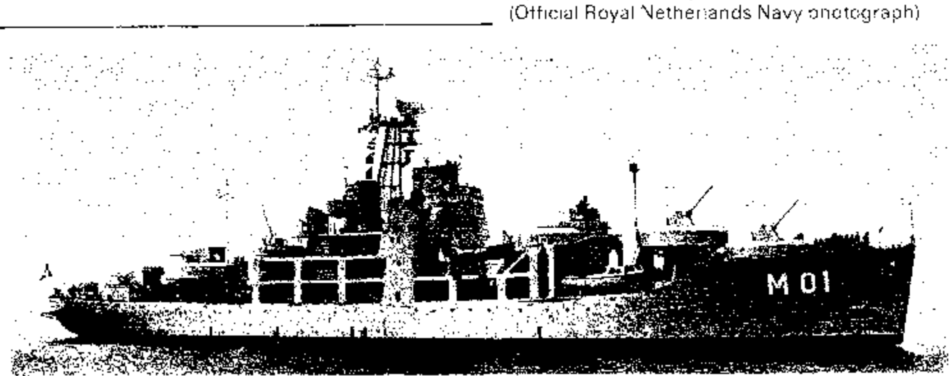

The cruiser Göta Lejon *(now transferred to the Chilean Navy and renamed* Latorre*). The triple 6-inch gun mounting forward can be seen clearly in this picture, less clearly seen are the two twin mountings aft.* (Official Royal Swedish Navy Photograph)

6085.203
TWIN 6-inch GUN MOUNTING
DESCRIPTION:
The Bofors 6-inch guns described in entry **6070.203** above are to be seen as twin mountings in the *Latorre* (two twin mountings aft) and in the cruisers *Almirante Gran* of the Peruvian Navy (formerly the *De Ruyter* of the Royal Netherlands Navy) and *De Zeven Provincien* of the Royal Netherlands Navy. It appears that in these mountings the guns can be elevated only to 60° – as compared with the 70° mentioned for the triple mount. There may be a genuine difference here, but it seems rather more likely that one of the figures is wrong. Conversely, the same source credits the 6-inch guns of the two Dutch cruisers with a rate of fire of 15 rounds per minute.
The guns are fully automatic and radar controlled
MANUFACTURER:
AB Bofors, Bofors, Sweden.


6-inch guns at firing practice (Official Royal Netherlands Navy photograph)


6-inch guns on a cruiser of the Royal Netherlands Navy. Guns in the foreground are of 57 mm calibre (Official Royal Netherlands Navy photograph)

6069.203
SINGLE 6-inch GUN MOUNTING
DESCRIPTION.
Two of these guns are mounted in the minelayer/training ship *Alvsnabben*, which formerly carried four – the two forward guns having been replaced by Bofors 57 mm AA guns. The ship was completed in 1943 and the guns are probably basically the same as those in the *Latorre* (**6070.203**).



The minelayer/training ship Alvsnabben. *The forward guns are Bofors 57 mm AA, the two larger mountings aft are for the single 6 inch guns*

6086.203
TWIN 120 mm DUAL-PURPOSE AUTOMATIC GUN MOUNTING

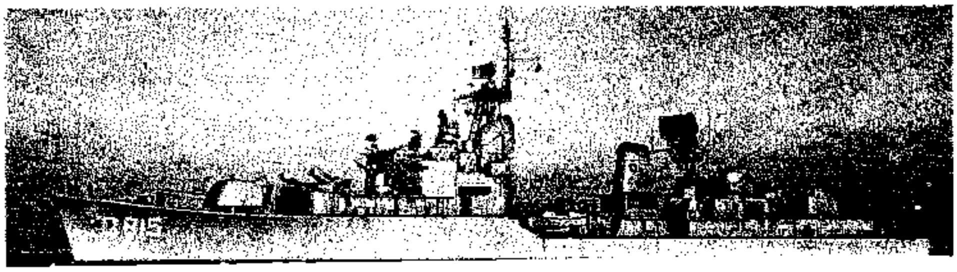
DESCRIPTION:

These 50-calibre Bofors 120 mm guns are mounted in twin mounts on the "Halland" class destroyers of the Royal Swedish Navy and on the "Halland" and "Friesland" class anti submarine escorts of the Royal Netherlands Navy.

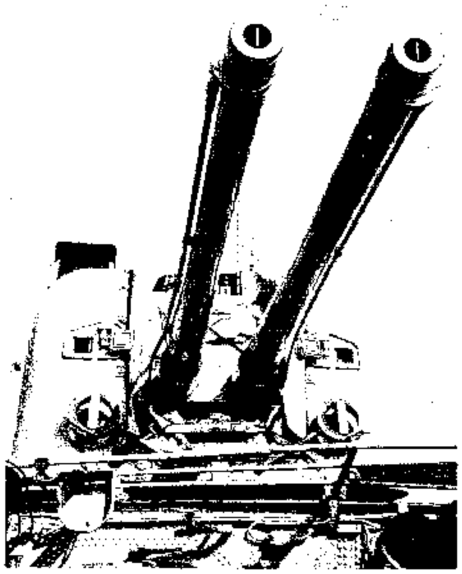
Introduced in 1950, the guns are fully automatic and radar controlled. They fire projectiles weighing 23.5 kg with a muzzle velocity of about 850 m/sec and can engage targets at ranges up to 20.5 km (11 nm) and heights up to 12,500 metres (at 85° elevation). Rate of fire is 40 rounds per barrel per minute. The complete twin mounting weighs 67 tons.

MANUFACTURER:

AB Bofors, Bofors, Sweden.



The "Friesland" class anti-submarine destroyer Overijssel *with twin 120 mm dual-purpose gun mountings fore and aft*



Twin 120 mm gun mounting
(Official Royal Netherlands Navy photograph)

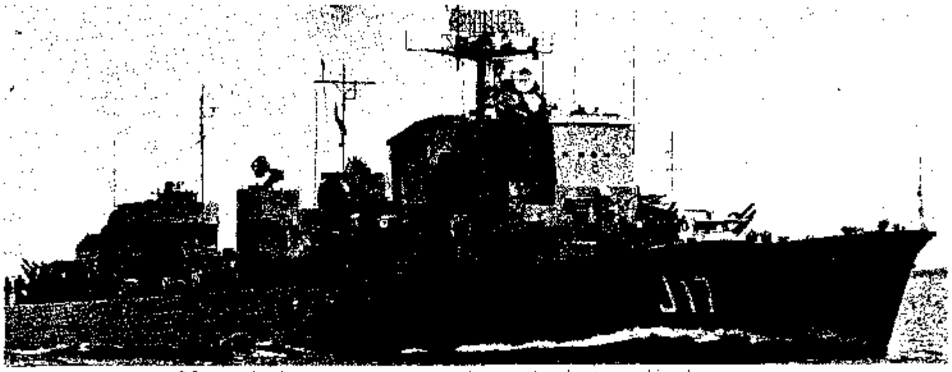
6074.203
TWIN 120 mm DUAL-PURPOSE SEMI-AUTOMATIC GUN MOUNTING

DESCRIPTION:

These guns are installed in the "Oland" and "Ostergötland" class destroyers of the Royal Swedish Navy. They are semi-automatic and mounted in lightly-armoured turrets. The guns can be elevated to 80 degrees and fire a 23.5 kg shell with a muzzle velocity of 850 m/sec. Range is about 19 km (10 nm) against surface targets and aircraft can be engaged up to 13,000 metres. Rate of fire is 20 rounds per minute.

MANUFACTURER:

AB Bofors, Bofors, Sweden



120 mm dual-purpose gun mounting on the destroyer Uppland
(Official Royal Swedish Navy Photograph)

6073.203
SINGLE 120/46 AUTOMATIC GUN MOUNTING

DESCRIPTION:

The Bofors L/46 120 mm Automatic Gun is designed for use against both surface and airborne targets and has a very high rate of fire.

Housed in a 4 mm steel turret mount the gun has two magazines, mounted on the elevating cradle, which are manually filled from a fixed-structure motor-driven rod hoist. Electro-hydraulic remote control is standard with the alternative of gyro-stabilised one-man local control. Telescopic sights are also fitted and the hoist and the elevation and traverse mechanisms can be operated by hand. The gun barrel is liquid cooled and has an exchangeable liner.

HISTORY:

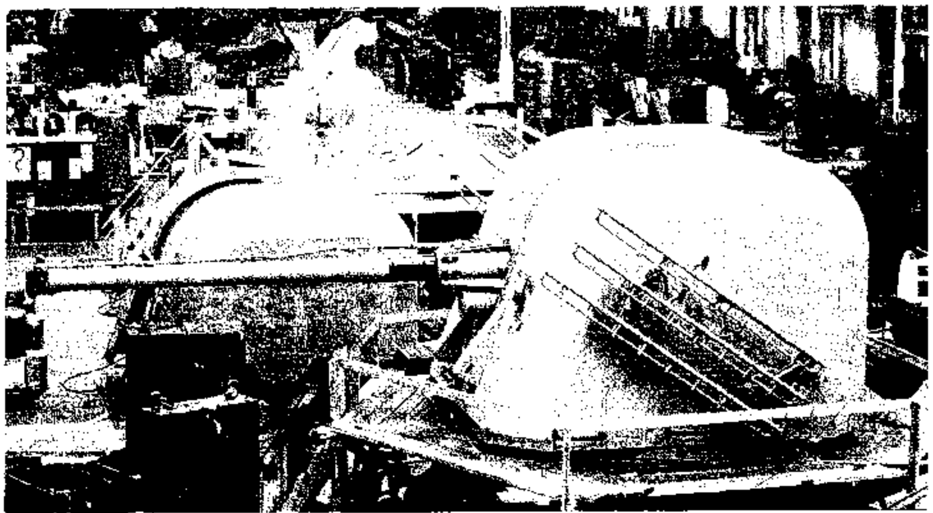
Bofors started work on this gun as a private venture in 1963 and the prototype was test-fired in 1967. It is not in regular production but is supplied to special order. It has been manufactured for the Finnish Navy for use in their "Turanmaa" class frigates, in which it has been in service since 1968.

MANUFACTURER:

AB Bofors, Bofors, Sweden.

CHARACTERISTICS:

Weight (excluding ammunition): 28.5 tons
Traversing speed: 40 deg/sec
Elevating speed: 30 deg/sec
Traverse limits: Unlimited
Elevation limits: −10 to +80 deg
Power Supplies: 440 V, 3-phase, 60 Hz
Power consumption: (Mean when firing): 60 kW
Number of rounds in magazine: 52
Rate of fire: 80 rounds/min
Weight of round: 35 kg
Weight of shell (HE): 21 kg
Weight of charge: 3.15 kg
Muzzle velocity: 1800 m/sec
Time of flight to 10 km: 21.7 sec
Range: 18.5 km

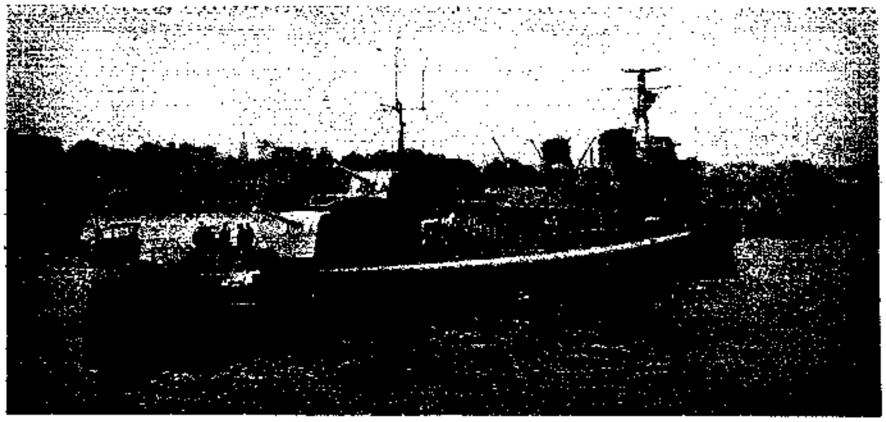


Bofors 120 mm 46 calibre gun on the assembly line

6071.203
SINGLE 120 mm DUAL-PURPOSE GUN MOUNTING

DESCRIPTION:

This gun mounting is found on some of the older fast anti-submarine frigates of the Royal Swedish Navy—the *Karlskrona* and some of the "Visby" class. Of pre war Bofors design it has long been superseded by more modern weapons. The gun is believed to be the 1934 pattern 50-calibre weapon which fires a 24 kg projectile with a muzzle velocity of 900 m/sec, has a range of 20 km (11 nm), and has a rate of fire of 12 rounds per minute.



Two of the three single 120 mm dual-purpose gun mountings on the fast anti-submarine frigate Karlskrona

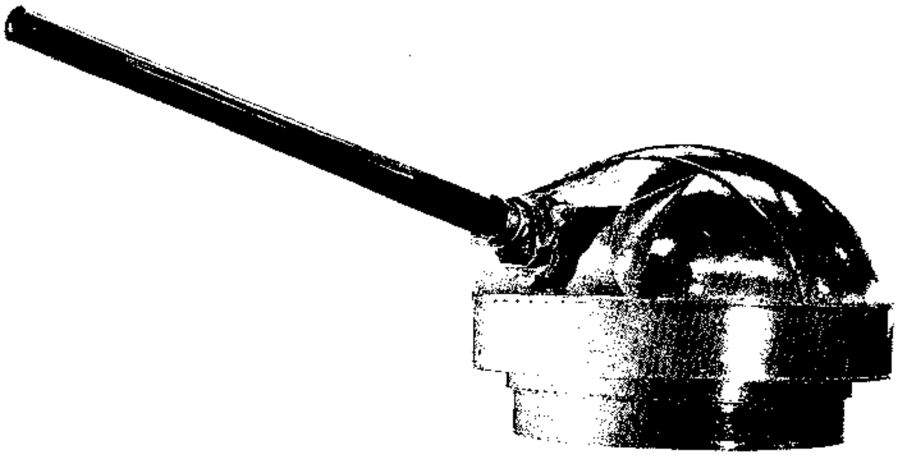
2362.203
SINGLE 3-inch AUTOMATIC GUN MOUNTING

DESCRIPTION:

The Bofors L/50 3-inch (76 mm) Automatic Gun is designed for surface fire.

This is a sturdy, simple, remotely-controlled single gun. Weighing only 6,500 kg and requiring only two loaders in the ammunition room, it is suitable for installation in small ships and is currently in service on "Storm" class fast patrol boats of the Norwegian Navy.

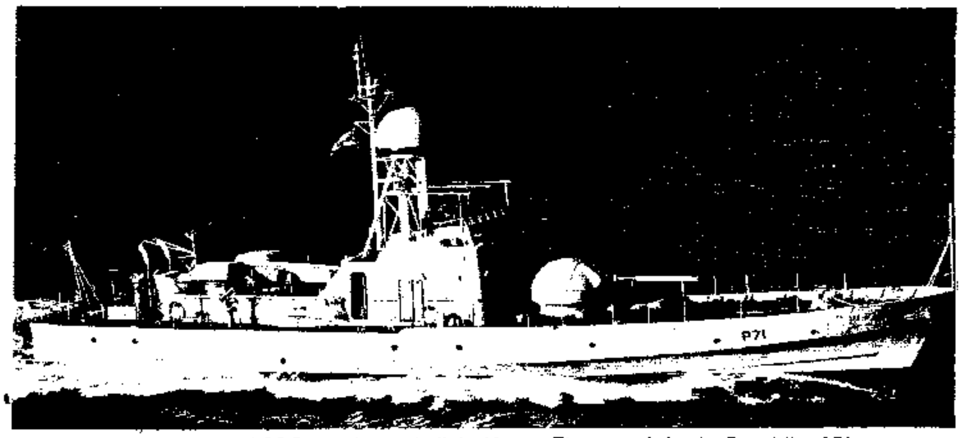
Electro-hydraulic remote control is used. The gun is mounted in a 6 nm steel gun house and has a fixed motor-driven hoist with lifting link levers and 5-round feed device. The gun has a monobolic barrel.



Bofors 3-inch automatic gun

STATUS:

Designed and developed as a private venture by Bofors, this gun was first conceived in 1962 and went into service with the Norwegian Navy in 1965.



Bofors 3-inch gun on RSS Sovereignty, *built by Vosper Thornycroft for the Republic of Singapore*

CHARACTERISTICS:

Weight, excluding ammunition: 6.5 tons
Traversing speed: 25 deg/sec
Elevating speed: 25 deg/sec
Traverse limits: +175 deg
Elevation limits: —10 to +30 deg
Power supplies: 440 V 3-phase 60 Hz
Power consumption: Mean when firing: 12 kW
Number of rounds in hoist and ammunition room: 100
Rate of fire: 30 rounds/min
Weight of round: 11.3 kg
Weight of shell: (H.S. Mk 27): 5.9 kg
Weight of charge: 0.54 kg
Muzzle velocity: 825 metres/sec
Time of flight: to 6 km: 13 sec
Range: (30 deg elevation) 12.6 km
Minimum operating crew: 2

MANUFACTURERS:

AB Bofors, Sweden and Kongsberg Weapon Factory

6087.203
TWIN 57 mm AA GUN MOUNTING

DESCRIPTION.

Introduced in 1950 these 60-calibre guns were at one time widely fitted. Now, however, they are to be found in the cruiser *Latorre* (formerly *Göta Lejon*) of the Chilean Navy and the "Halland" class destroyers of the Royal Swedish Navy. The same gun in a slightly different twin mounting is still in service in the French Navy (**6065.203**).

The complete turret of the Swedish installations weighs some 24 tons and the guns can be elevated to 90°. Aircraft can be engaged up to 9,000 metres with slant ranges of up to 14,500 metres. The projectile weight is about 2.6 kg, the muzzle velocity about 900 m/sec and the maximum rate of fire 130 rounds per barrel per minute.

MANUFACTURER:

AB Bofors, Bofors, Sweden.

2361.203
SINGLE 57 mm L-70 AUTOMATIC GUN MOUNTING

DESCRIPTION:

This 57 mm Bofors single gun in a plastic gun house is designed for both surface and anti-aircraft fire.

Alternatives of electro-hydraulic remote control or gyro-stabilised one-man local control are available. The gunfeed system contains 40 rounds of "ready use" ammunition with 128 rounds stowed in racks within the gunhouse, and there are dual step-by-step fixed supply hoists. The barrel is liquid-cooled.

Two types of ammunition are available: one is a proximity-fused and pre-fragmented shell for use against aerial targets; the other is a special surface target shell which penetrates the target and is detonated after a short delay.

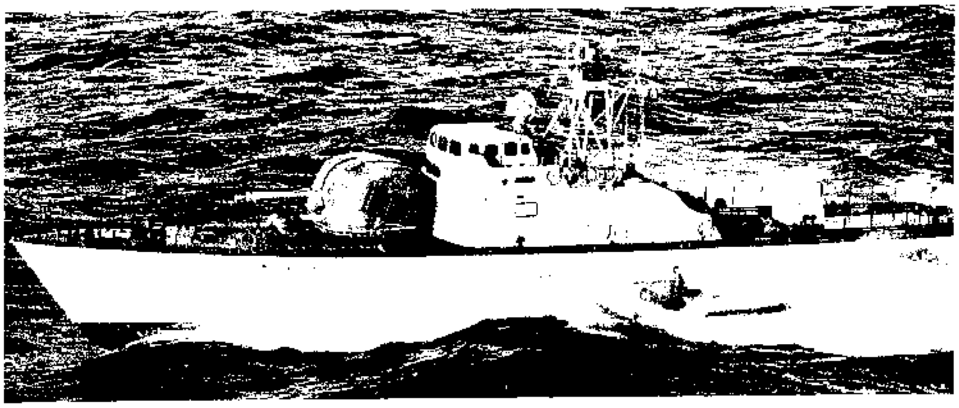
The gun can be equipped with rocket-launching rails for 2-inch (51 mm) rockets.

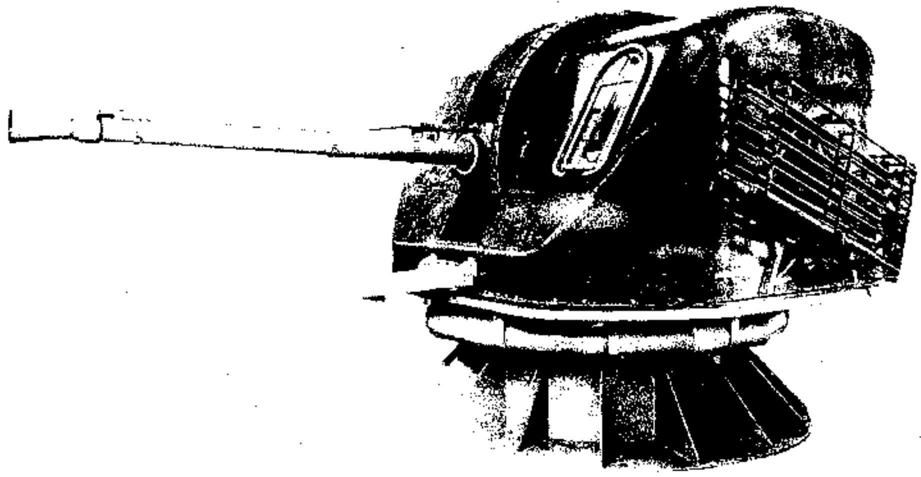
STATUS:

Operational in the Royal Swedish Navy and other navies, and is the only defensive weapon on the second series of "Spica" boats of the Swedish Navy.

CHARACTERISTICS:
Weight, excluding ammunition: 6.0 tons
Traversing speed: 55 deg/sec
Elevation speed: 40 deg/sec
Traverse limits: Unlimited
Elevation limits: −10 to +75 deg
Power supplies: 440 V 3-phase 60 Hz
Power consumption: Mean, when firing: 10 kW
Rate of fire: 200 rounds/min
Weight of round: 5.9 kg
Weight of shell: (H.E.: DA or proximity fuse): 2.4 kg
Muzzle velocity: 1,025 metres/sec
Time of flight: 3 km 3.8 sec
Range: 14 km

MANUFACTURER
AB Bofors, Bofors, Sweden.


Swedish "Jagaren" class FPB with Bofors 57 mm L/70 gun


Bofors 57 mm L/70 gun

2360.203
SINGLE 40 mm L/70 AUTOMATIC GUN MOUNTING

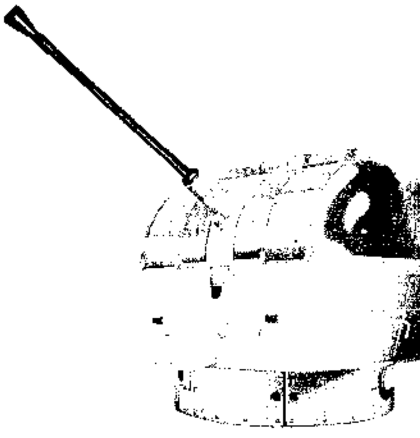
DESCRIPTION:
Bofors make a range of different mountings for their shipborne 40 mm L/70 gun for use against both surface and airborne targets.

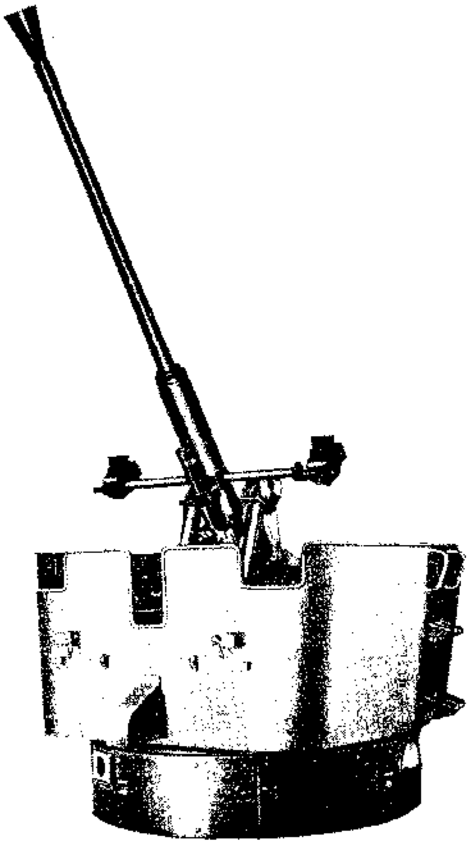
Three versions are illustrated here. The simplest is a manually-controlled mount with reflex sight and speed rings: layer and trainer being separate. The second has electro-hydraulic drive and can be remotely controlled. The third has a lightweight plastic gun-house to give weather protection, the lower part of the mounting being of 3 mm steel plate. This model is also electro-hydraulically driven and can be remotely controlled or locally controlled with gyro stabilisation. The gun has a monobloc barrel which can be rapidly changed, and there is a feed device for an initial 18 rounds.

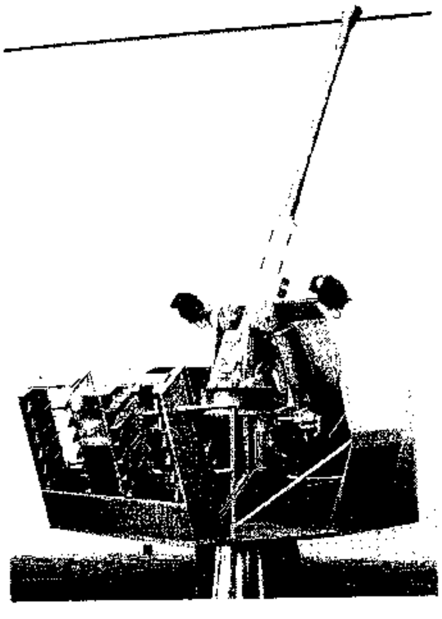
STATUS:
Operational in Swedish Navy and many other navies.

CHARACTERISTICS:
Weight, excluding ammunition: 1.7, 2.8 or 3.0 tons
Traversing speed: (Powered mounts): 85 deg/sec
Elevating speed: (Powered mounts): 45 deg/sec
Traverse limits: Unlimited
Elevation limits: −10 to +90 deg
Power supplies: (Powered mounts): 440 V 3-phase 60 Hz
Power consumption: (Powered mounts): 5 kW
Rate of fire: 300 rounds/min
Weight of round: 2.4 kg
Weight of shell: (H.E.): 0.96 kg
Muzzle velocity: 1,005 metres/sec
Range: 12 km

MANUFACTURER
AB Bofors, Bofors, Sweden.


40 mm Bofors gun with plastic gun-house

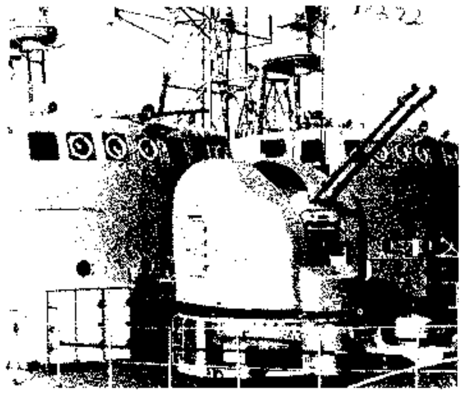

Power-operated version of the 40 mm Bofors gun


Manually controlled 40 mm Bofors gun

6088.203
SINGLE 40/60 AA GUN MOUNTING
DESCRIPTION
This 60-calibre version of the well-known Bofors 40 mm AA gun was introduced in 1942 and is still in service in many places. Its performance is, as one would expect, somewhat inferior to that of the modern 70-calibre weapon. Projectile weight is 0.9 kg, muzzle velocity 830 m/sec, slant range 10,000 metres and ceiling 5,500 metres. Rate of fire is 120 rounds per minute.
STATUS:
In service and still fitted in reconditioned form but obsolescent and no longer in production.
MANUFACTURER:
AB Bofors, Bofors, Sweden.

SWITZERLAND

6036.203
TWIN 35 mm ANTI-AIRCRAFT GUN TYPE GDM-A
DESCRIPTION:
This gun is similar in concept and design to the successful Oerlikon field gun. It is primarily intended for convoy protection or self-protection against air attack, but can also be used to engage surface targets.
DESCRIPTION:
Type GDM-A is an electrically-controlled, biaxial stabilised twin gun that can function equally well either with a radar fire control equipment or with an optical director equipment with auxiliary computer. In addition the gun is equipped with locally stabilised column control and a gunsight. High laying accelerations and speeds are an important feature of the design.
The 35 mm gun is gas-operated with a positively locked supporting snaplock. Both weapons are completely interchangeable and can be assembled for left or right feed without the use of additional parts. The hand cocking devices and barrels belonging to each weapon are also completely interchangeable.
OPERATION:
Four modes of operation are possible – three electrical and one mechanical. Electrical modes are automatic control by radar fire control equipment, or by optical director with auxiliary computer, or column control on the gun, with local stabilisation and auxiliary computer. The mechanical mode is control by handwheel on the gun and gunsight.
CHARACTERISTICS
Gun: Type KDC
Calibre: 35 mm
Length of barrel: 3,150 mm
Rate of fire per barrel: 550/min
Muzzle velocity: 1,175 m sec-1
Ammunition supply:
Ready-use ammunition Type MDC, in 8 clips: 56 rounds per cannon
Reserve containers Type LDC, in 16 clips: 112 rounds per cannon
MANUFACTURER:
Machine Tool Works, Oerlikon-Bührle Ltd, Zürich.

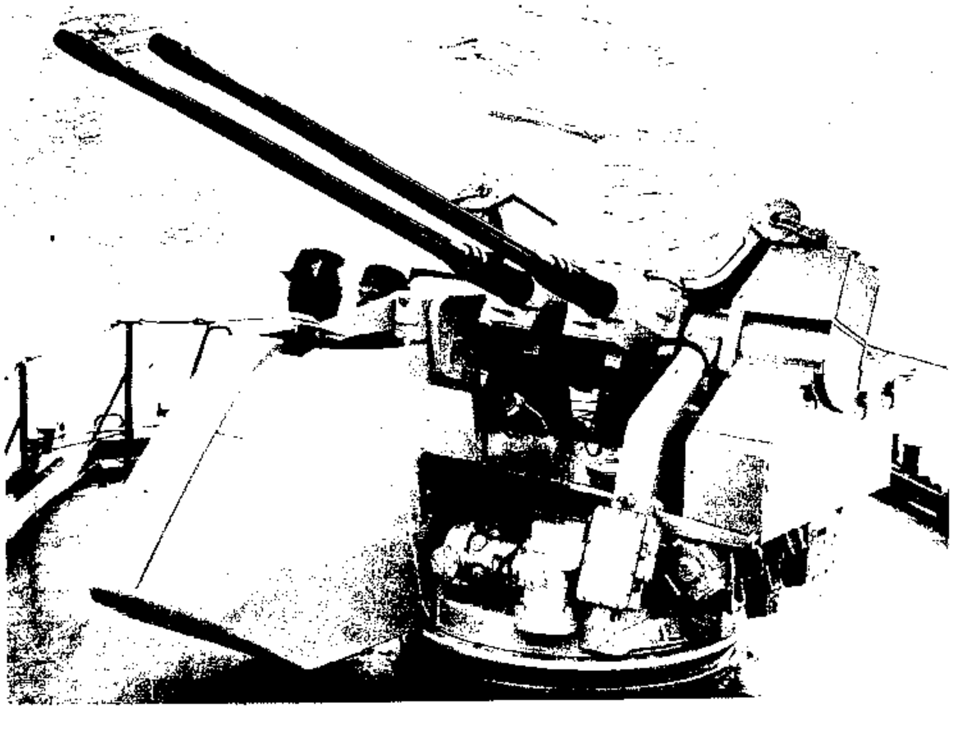

Oerlikon 35-mm Twin Naval AA Gun Type GDM-A

2395.203
TWIN 30 mm NAVAL MOUNTING TYPE A32
DESCRIPTION.
This twin Oerlikon mounting embodies the *Oerlikon cannon type 831 and is designed for in-*stallation on any of a wide range of vessels. Easy to operate and maintain, the guns can be operated by either local or remote control.

CHARACTERISTICS.
Calibre: 30 mm
Elevation: $-15°$ to $+80°$
Traverse: unlimited
Elevation rate: 60°/sec
Traverse rate: 90°/sec
MV: 1080 m/sec

Rate of fire: 650 rounds/min/barrel
Ready use ammunition: 160 rounds/barrel
Weight: complete with ammunition 2,018 kg

MANUFACTURER:
Machine Tool Works, Oerlikon-Bührle Ltd, Zürich.


30 mm Oerlikon naval mounting type A32

2396.203
20 mm NAVAL MOUNTING TYPE A41/804
DESCRIPTION:
This widely used Oerlikon mounting incorporates the type 804 drum-fed cannon. Suitable for small and very small naval vessels it is operated entirely by one man and can be used for either AA or surface fire. Sighting is by ring and bead.

CHARACTERISTICS
Calibre: 20 mm
MV: 835 m/sec
Rate of fire: 800 rounds/min
Ready rounds: 60 in drum magazine
Weight: including ammunition 240 kg
STATUS:
Weapon operational but no longer available.


20 mm Oerlikon naval mounting type A41/804

2397.203
20 mm NAVAL MOUNTING TYPE GAM/204 GK

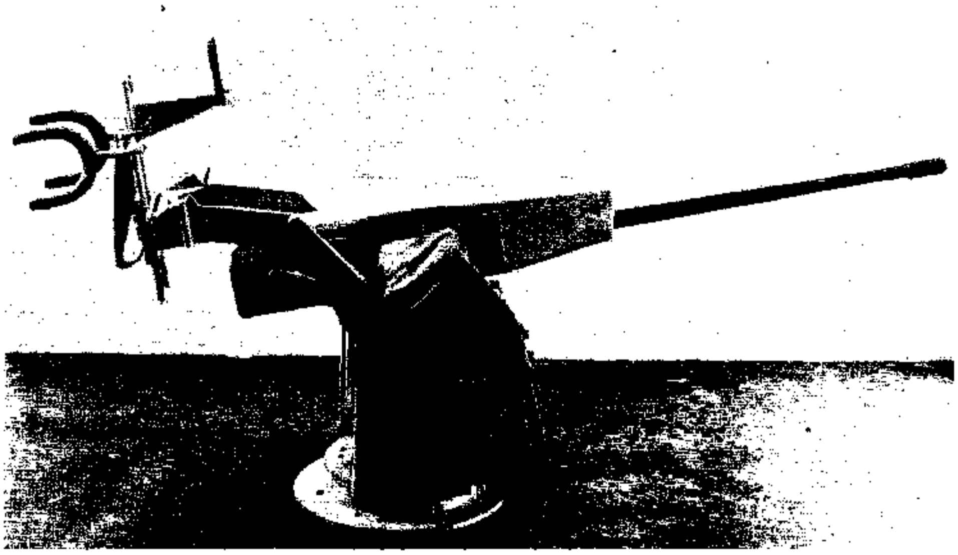
DESCRIPTION:

The Oerlikon GAM/204GK mounting is a simple, but modern and efficient, 20 mm naval mounting embodying the well proven 204GK cannon.

All-up weight is low enough to permit installation on any type of naval vessel and the gun can be used for either AA or surface fire. No electrical power is needed: the gun is laid by the gunner using a shoulder harness and sighting is by simple ring and bead.

CHARACTERISTICS:
Calibre: 20 mm
Elevation: $-15°$ to $+60°$
MV: 1,050 m/sec
Rate of fire: 1,000 rounds/min
Ready rounds: 200
Feed system: link belt
Weight with ammunition: 480 kg

MANUFACTURER:
Machine Tool Works, Oerlikon-Bührle Ltd, Zürich, Switzerland.


20 mm Oerlikon naval mounting type GAM/204GK

2398.203
81 mm ROCKET LAUNCHER

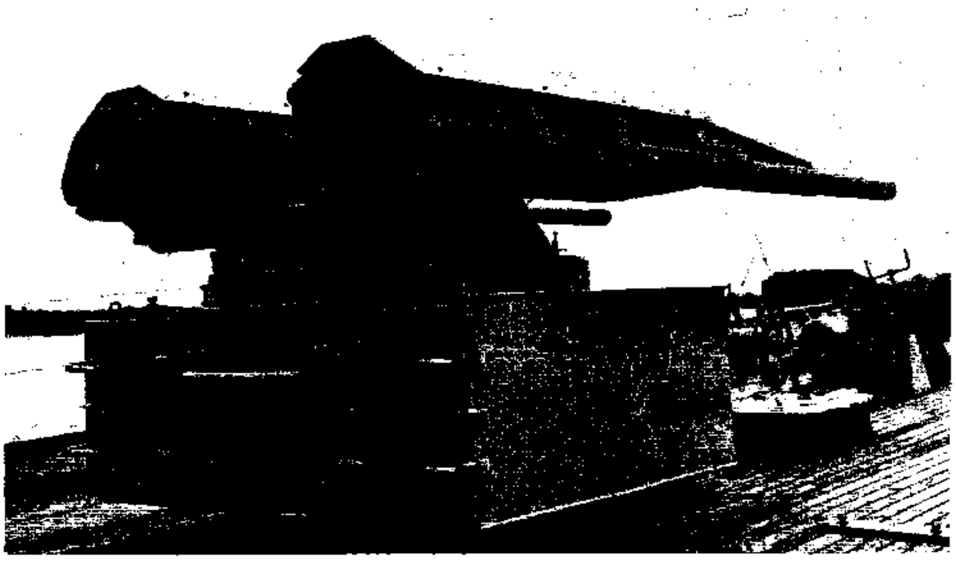
DESCRIPTION:

This Oerlikon unguided rocket launcher has been developed for installation on FPBs and other light naval vessels. It is also suitable for installation in light armoured vehicles.

The complete mounting comprises two single barrel-launchers, each of which has a 9-rocket magazine, mounted on a turntable. The mounting is power-operated and remotely controlled.

CHARACTERISTICS:
Rocket calibre: 81 mm
Elevation: $-10°$ to $+50°$
Traverse: unlimited
Rate of fire: about 80 rounds/min/launcher
Length overall: about 3 m
Weight: (without rockets) about 900 kg

MANUFACTURER:
Machine Tool Works, Oerlikon-Bührle Ltd, Zürich, Switzerland.


Oerlikon 81 mm naval rocket launcher

THE UNITED KINGDOM

6089.203
TRIPLE 6-inch GUN MOUNTING

DESCRIPTION:

This Vickers gun was first introduced in 1934 and has a barrel length of 50 calibres. It fires a projectile weighing about 50 kg with a muzzle velocity of about 820 m/sec and has a range of about 23 km (12 nm). A rate of fire of 8 rounds per barrel per minute can be achieved. Weight of the triple turret is about 135 tons. Elevation limit is 45° and the guns can be trained 120° either side of the fore and aft line. Training rate is about 7°/sec(powered). Hand training is possible.

STATUS:

The only remaining British ship carrying these guns mounted in this way is the cruiser *Belfast* which is no longer in commission but has been preserved as a floating museum on the Thames in London. The triple 6-inch gun mounting on the Indian cruiser *Mysore* (formerly HMS *Nigeria*) is, however, believed to be of similar pattern and to use the same guns. The *Mysore* is still operational.

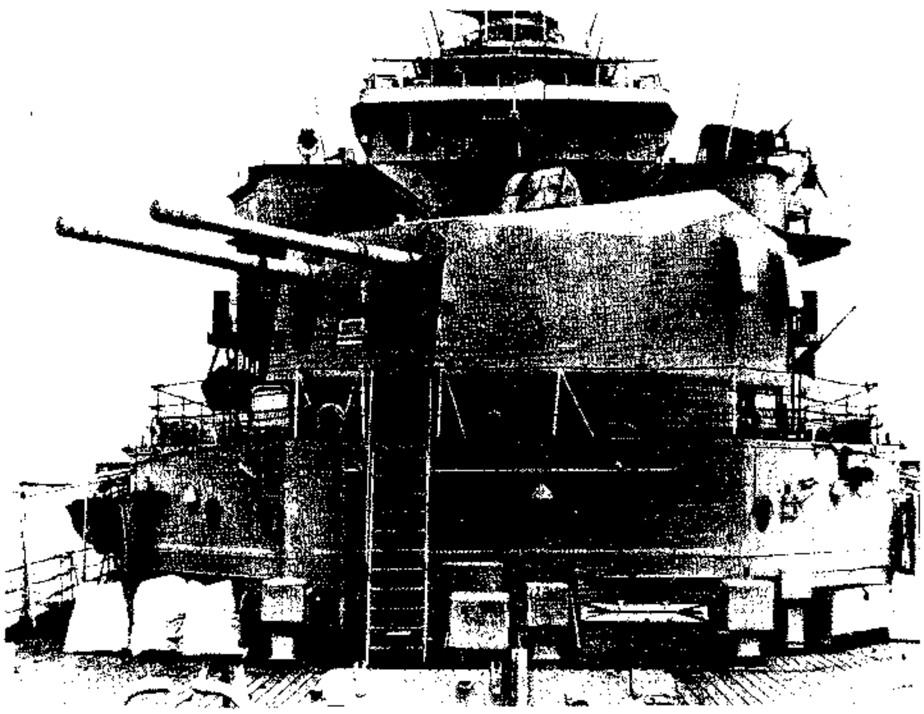
6017.203
TWIN 6-inch GUN MOUNTING Mk 26

DESCRIPTION:

Six-inch (152 mm) calibre, twin automatic dual-purpose naval gun mount. Remotely radar-controlled, electrically trained and elevated. Capable of high angle fire (up to 80°). Fitted with local sighting arrangements and joystick control. Ammunition consists of various types of shell and the propellant is encased in cartridges. Rate of fire about 20 rounds per gun per minute. Turret weight about 163 tons.

STATUS:

Operational in "Tiger" class cruisers. Weapon no longer available.



Mk 26 6-inch gun mounting

6012.203

TWIN 4.5inch GUN MOUNTING Mk 6

DESCRIPTION:

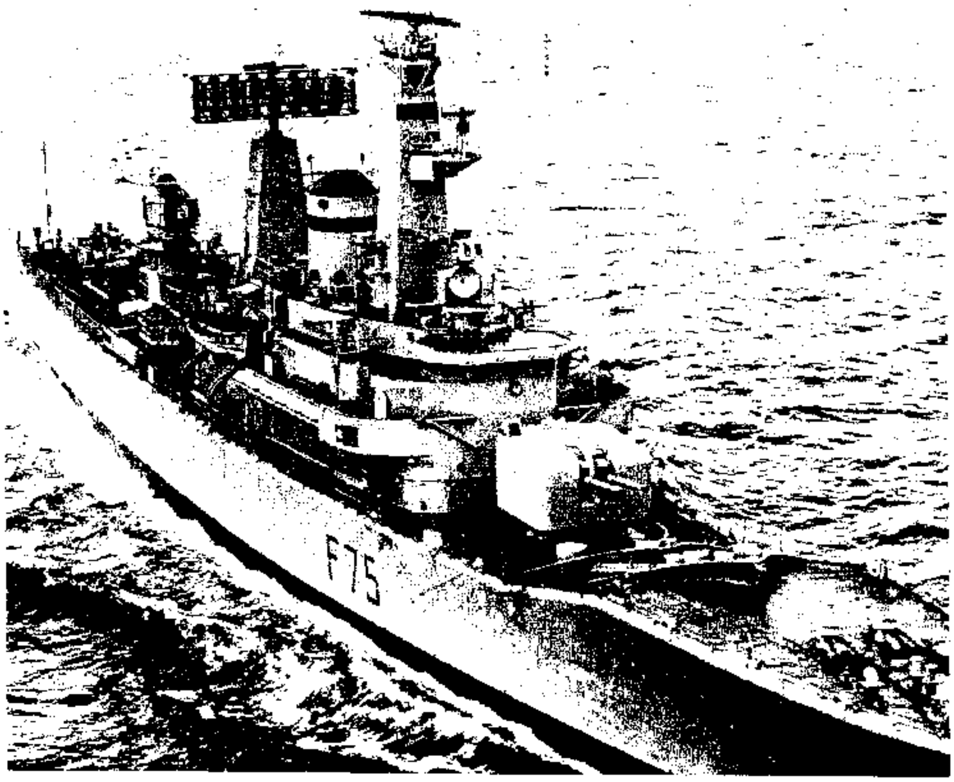
Twin-barrelled remotely controlled power operated, 4.5 inch (114 mm) naval gun mount. Electro-hydraulic power control normally remotely controlled, but can be locally controlled using joystick. Semi-automatic loading cycle. Ammunition comes up hoists from gun bay in separate hoists for shell and cartridge. The shell and cartridge are manually loaded into the loading tray and the loading cycle is automatic. Rate of fire about 14 rounds per gun per minute. Turret weight about 50 tons. Projectile weight about 25.5 kg.

STATUS:

Operational in British and Commonwealth navies.

MANUFACTURERS:

Vickers Ltd., Shipbuilding Group, Barrow Engineering Works, Barrow-in-Furness, Lancs



4.5-inch Mk 6 gun mount in HMS Charybdis
(Ministry of Defence (Navy) photograph)

6011.203

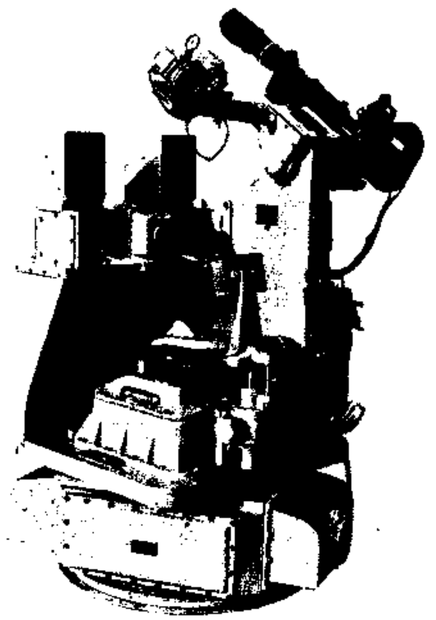
SINGLE 4.5-inch GUN MOUNTING Mk 8

DESCRIPTION:

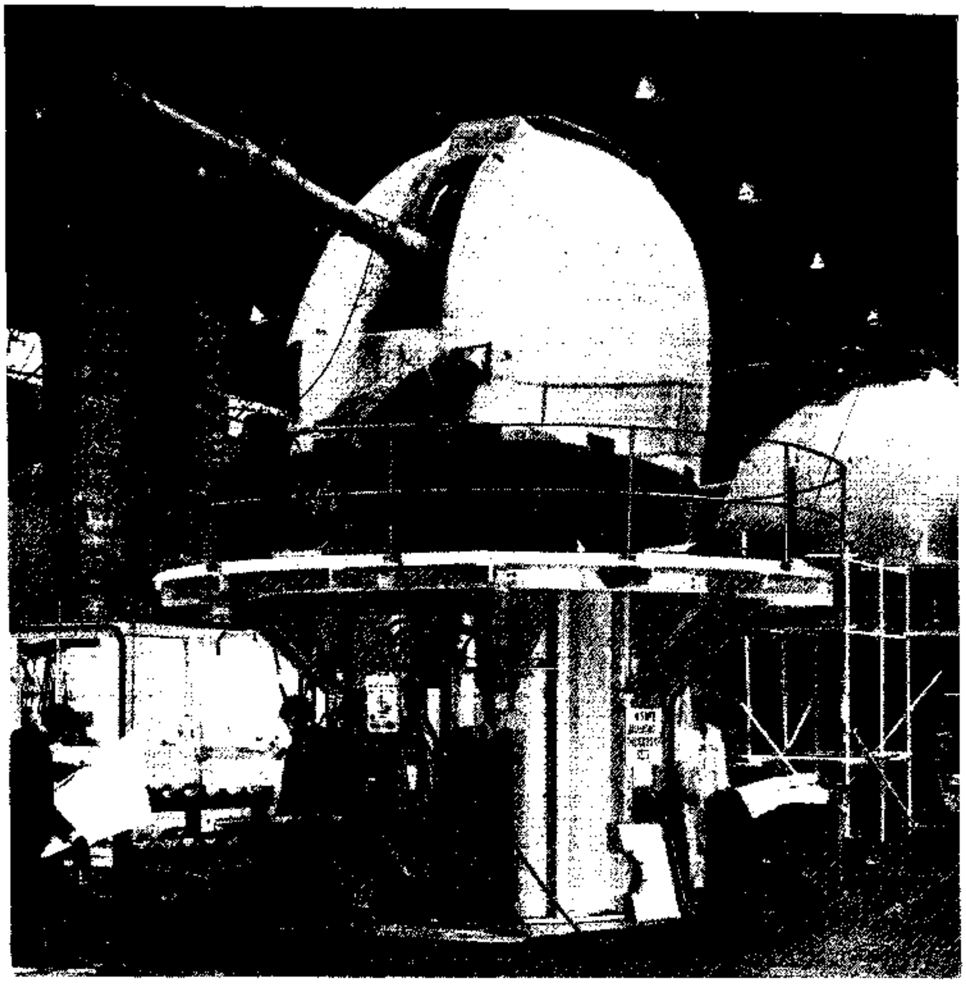
This fully-automatic single-barrelled 4.5 inch (114 mm) gun has been designed for the Royal Navy by the Royal Armament Research and Development Establishment. It is modelled on the British Army's Abbot gun (**5503.103**) and is fitted with muzzle brake and fume extractor. A completely new range of fixed ammunition has also been designed.

The major features of design of the mounting have been a simple ammunition feed system with the minimum number of transfer points, and a remote power control system with large stability margins that requires a stiff mounting structure with low inertia. To this end the revolving structure has been kept as light as possible and a sandwich construction glass-reinforced plastic gun-shield fitted. To keep the trunnion height as low as possible the gun is mounted front heavy,

Vickers 4.5-inch Mk 8 gun mounting on a frigate of the Imperial Iranian Navy



Vickers Mk 1 look-out and aiming sight used with the Mk 8 gun mounting. This combines the separate functions of an air look-out sight and an aiming sight in a single fully-stabilised unit.



4.5-inch Mk 8 gun in production

balance being restored by an oil spring. To reduce inertia the training gear is fitted to the fixed structure, the training motors are fitted inside the mounting pedestal, and the driving motors are secured vertically to the ring bulkhead which is part of the ship's structure.

The loading system is hydraulically operated from one power plant sited below decks. The system employs only four transfer points between the gunbay (ready use magazine) and the gun, and is designed so that the nature of ammunition may be changed without unloading or firing out a large number of rounds. A stockpile of ammunition may be accommodated at the mounting and fired remotely from the Operations Room with no crew closed up at the mounting.

A conventional coarse/fine system is used in both elevation and training for remote power control of the mounting. Processing of the error signal is carried out in transistor modules. The main feature of the remote power control system is the use of a new static direct armature control thyristor system, which is lighter and requires far less maintenance than the conventional rotating machines.

Fail-to-safe interlocks are included in all major operations to safeguard equipment and ammunition, and facilities are arranged for manual control of the various motors for maintenance purposes.

STATUS:

Development is complete and the gun is in production. In the Royal Navy it is fitted to the Type 82 Guided Missile Destroyer HMS *Bristol*, the Type 42 Destroyers – of which the first, HMS *Sheffield*, was launched in mid-1971 – and the Type 21 Frigates – the first of which, HMS *Amazon* was launched early in 1972. The gun has also been ordered by five overseas navies.

MANUFACTURER:

Designed and manufactured by Vickers Ltd, Shipbuilding Group, Barrow Engineering Works, Barrow-in-Furness, Lancashire, England.

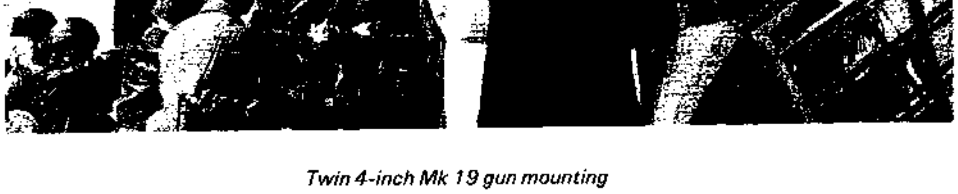
6014.203
TWIN 4-inch GUN MOUNTING Mk 19

DESCRIPTION:

Designed by Vickers, this is a twin-barrelled, hand loaded, remotely-controlled naval gun mount. Electrically trained and elevated. Normally laid by remote control, but can be locally controlled using joysticks. Fuse setting arrangements alongside each trunnion support. An extremely reliable and well proven gun mount. A good gun crew can achieve rate of of fire of up to about 16 rounds per barrel per minute. Projectile weight about 16 kg, muzzle velocity about 760 m/sec, range about 19.5 km (10.5 nm) and ceiling about 13,500 metres (80° elevation).

STATUS:

Operational in British, Commonwealth and many other navies. No longer in production but guns removed from older ships are still being reconditioned for use in new ships – e.g. the corvettes recently built by Vosper Thornycroft for the Nigerian Navy.



Twin 4-inch Mk 19 gun mounting

6010.203
SINGLE 4.5 inch GUN MOUNTING Mk 5

DESCRIPTION:

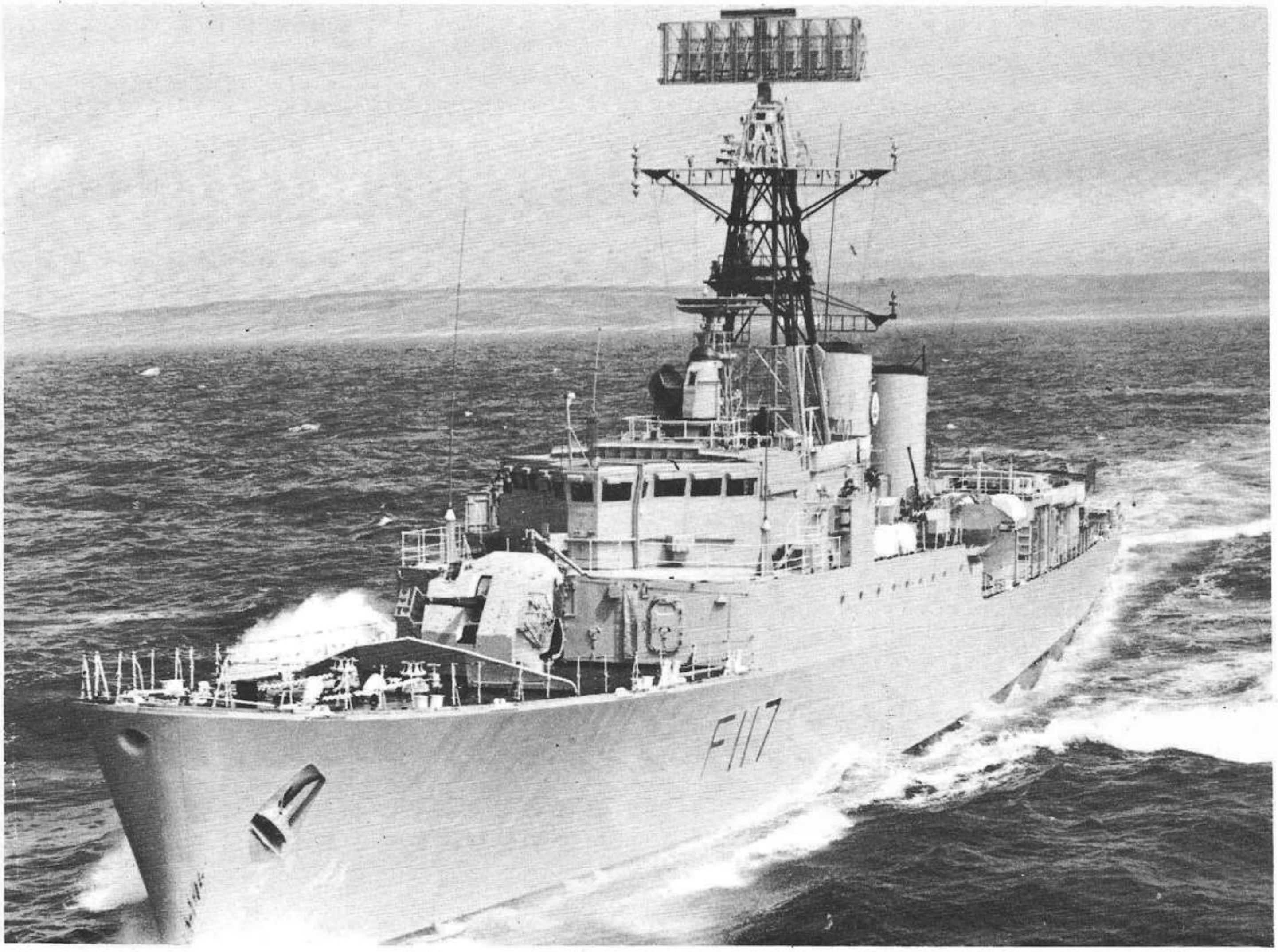
Single-barrelled remotely controlled 4.5 inch (114 mm) manually loaded naval gun mount. Can be controlled locally using a joystick. Automatic ramming of separate ammunition. Limited elevation of about 50 degrees. Rate of fire with a well drilled crew about 14 rounds per minute.

STATUS:

Operational in British and certain other navies.

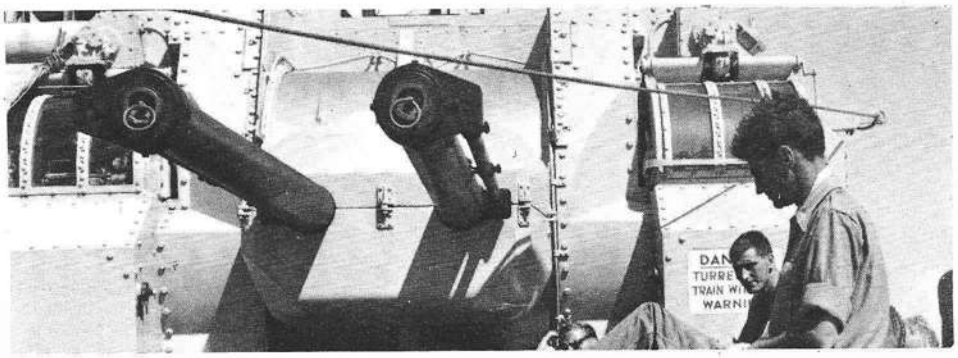
MANUFACTURERS:

Vickers Ltd., Shipbuilding Group, Barrow Engineering Works, Barrow-in-Furness, Lancs.



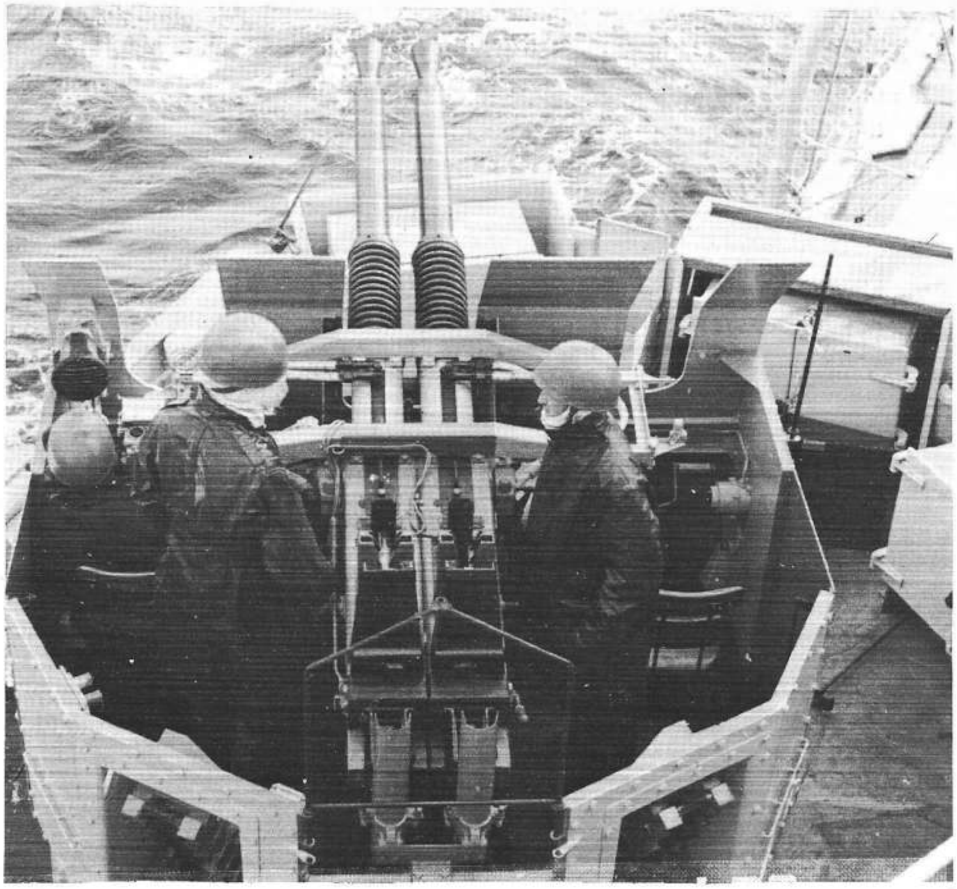
4.5-inch Mk 5 gun mount in Ashanti *frigate*

6016.203
TWIN 3-inch GUN MOUNTING Mk 6
DESCRIPTION:
Twin-barrelled three-inch (70-calibre) automatic dual-purpose, remotely controlled naval gun mount. Fully automatic electrically driven gun mount. Local control arrangements are provided; but the mounting can be operated "unmanned". Rate of fire about sixty rounds per gun per minute. Water cooled barrels to allow sustained fire. Turret weight about 38 tons.
STATUS:
Operational in British and Canadian Navies.
MANUFACTURERS:
Vickers Ltd, Shipbuilding Group, Barrow Engineering Works, Barrow-in-Furness, Lancs.



Twin 3-inch Mk 6 gun mounting on HMS Tiger

6015.203
TWIN 40 mm (BOFORS) GUN MOUNTING Mk 5
DESCRIPTION:
Remotely or locally controlled twin Bofors 40 mm 70-calibre close-range naval gun mount. Splinter protection shield to front of mounting. One "on mounting" loader per gun. One operator to lay and train the gun in "local control". Separate emergency manual laying and training arrangements using two men. Rate of fire about 300 rounds per minute per gun.
The Bofors guns used in this mounting are of an earlier pattern than the 40/70 guns described in entry number **2360.203** above. Characteristics are, however, generally similar.
STATUS:
Operational in many British and Commonwealth naval vessels.



Mk 5 twin 40 mm Bofors gun mounting

6013.203
SINGLE 40 mm (BOFORS) Mk 7 GUN MOUNTING

DESCRIPTION:

Single barrelled Bofors 40 mm power operated ships gun mounting. Lightweight mounting suitable for fitting in FPBs as well as larger vessels. One man control by joystick. Gyro sight for aiming. One man "on mounting" for loading. Rate of fire about 300 rpm.

For details of the gun in this mounting see entry number **2360.203** above.

STATUS:

Operational. Widely fitted in British and Commonwealth naval vessels.

Bofors 40 mm gun on Mk 7 mounting

5522.203
TWIN 30 mm GUN MOUNTING A.32

DESCRIPTION:

This 30 mm Twin Naval Mounting was developed by Hispano-Suiza (now Oerlikon Hispano) to provide close anti-aircraft defence for ships of all classes. The mounting gives a rate of fire of 1,300 rounds per minute, and thus a high hit probability against aircraft, whilst also offering a worthwhile weapon for ship-to-ship and ship-to-shore encounters.

There is an optional mounting available without cabin, sights or manual controls, and it is intended for use with Fire Director Control only. A metadyne power control system incorporates a coarse/fine positional servo to ensure accurate tracking and gun firing, whilst target selection can be made from the Fire Director Control.

Under local control, the mounting is operated by a gunner who is housed in a cabin on the front right hand side. He is assisted by two rate gyros which stabilise the gun against the effects of roll pitch, and yaw. A special feature which can be incorporated if needed allows the gunner in one mounting to operate a second mounting in a completely remote controlled condition.

Simple reflector sights are fitted as standard, and manual traverse, elevation, and firing gear are fitted for emergency use.

Two types of ammunition supply are available. Type A utilises twin 80 round magazines with the ammunition in coupled 20 round belts. The ammunition pattern can be changed by substituting different 20 round racks. Type B utilises twin magazines which have a continuous 140 round belt.

The two cannon are the Hispano-Suiza type 831 L, which is a well-proven and widely used design of considerable reliability.

CHARACTERISTICS:

Ordnance:
Cannon: HS 831 L
Calibre: 30 mm
Muzzle Velocity: 3,450 fs (1,080 ms)
Rate of Fire: 600-650 rounds/min
Weight: 343 lb (156 kg)
Recoil Thrust:
Maximum 3,520 lb (1,600 kg)
Average: 3,320 lb (1,510 kg)
Mounting:
Weight: remote and local control: 2,744 lb (1,698 kg)
Traverse arc: 360°
Elevation: −15° to +80°

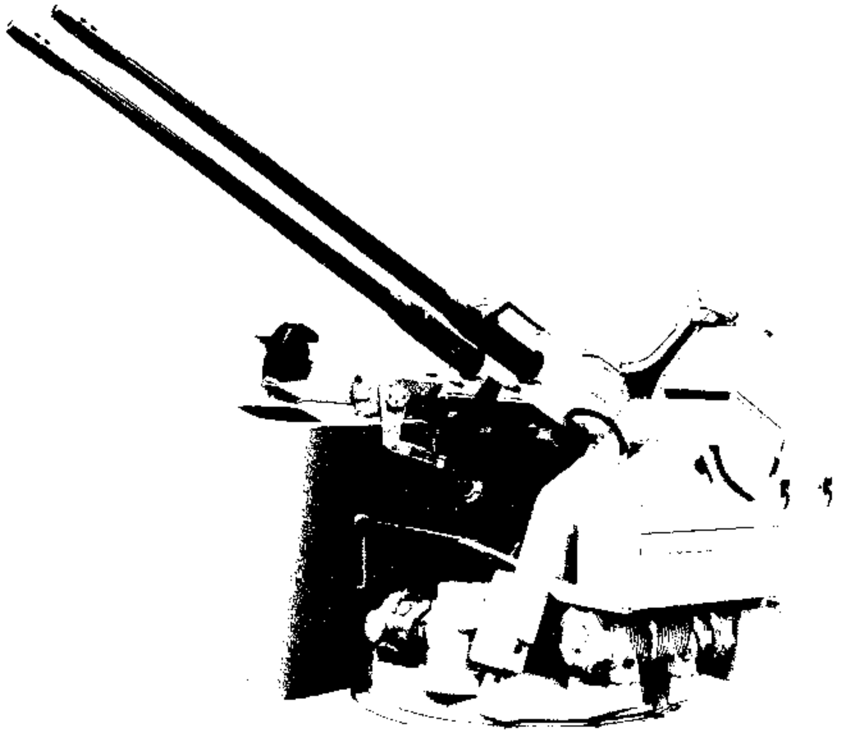
Traverse velocity: 90°/sec
Elevation velocity: 60°/sec
Overall height: 4.80 ft (1.46 m)
Electrical power supply: 440 V 3 phase, 60 c/s, 2 to 4 KVA during tracking. 10 KVA peak while firing and tracking
115V, 1 phase, 400 c/s 150 VA servo equipment, synchros, and gyros
Gunsight: Gyro. NIFE Reflector or Delta IV

Ammunition:
Practice:

Two types	HE-P	An inert practice shell
	HET-P	An inert tracer shell
HE:		
Two types	HEI	High explosive Incendiary
	HEIT	High explosive Incendiary Tracer
Armour Piercing:		
Three types	**APDI**	Armour Piercing Incendiary with double effect.
	APICT	Armour Piercing Incendiary with hard metal core and Tracer.
	APHET	Armour Piercing Incendiary with self destruction.

STATUS:
In production.

MANUFACTURER:
British Manufacture and Research Co. Ltd. Springfield Road, Grantham, Lincolnshire, England.

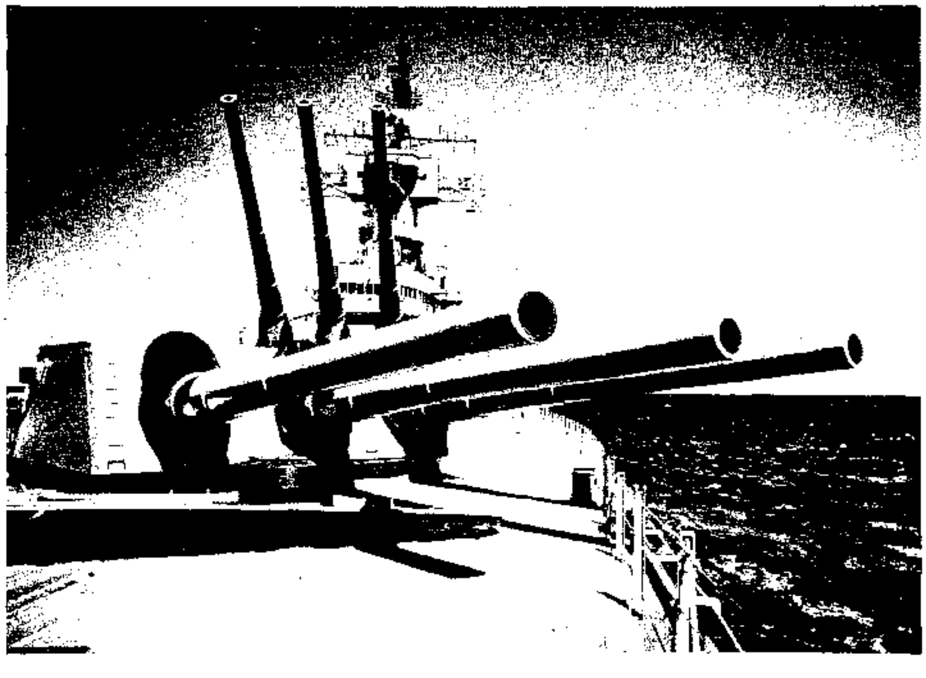


A.32 mounting for twin Hispano-Suiza 30 mm cannons

THE UNITED STATES OF AMERICA

6023.203
TRIPLE 16-inch GUN MOUNTING

DESCRIPTION:
These 16-inch 50-calibre guns were the main armament of the "Iowa" class battleships of the US Navy. Firing a projectile with a weight of 1,230 kg and with a muzzle velocity of about 850 m/sec they had a range of 39 km (26 nm). Rate of fire was two rounds per barrel per minute. The individual guns weighed about 125 tons and the complete triple mounting some 2,000 tons. Bagged charges were used for the propellant of which 300 kg was used in 6 bags at a time.
STATUS:
The last of the "Iowa" class to be in service – and indeed the last battleship in the world to be in action – was the USS *New Jersey* whose guns are illustrated here. She was last decommissioned in December 1969 and placed in the Pacific reserve.



The 16-inch guns of the battleship USS New Jersey (US Navy photograph)

6090.203
TRIPLE 8-inch MARK 16 GUN MOUNTING

DESCRIPTION:
In the *Salem* class heavy cruisers of the US Navy an 8 inch 55-calibre gun designed to fire cased ammunition was installed in triple turrets. Apart from the modification to fire the new ammunition fully automatically the gun characteristics were generally similar to those of the earlier 8-inch semi-automatic guns (see **6024.203** below). The turrets were larger, however, and the rate of fire was 10 rounds per barrel per minute instead of five.
STATUS:
There were three heavy cruisers in the "Salem" class, but of these, at the time of writing, only the *Newport News* is still in commission.

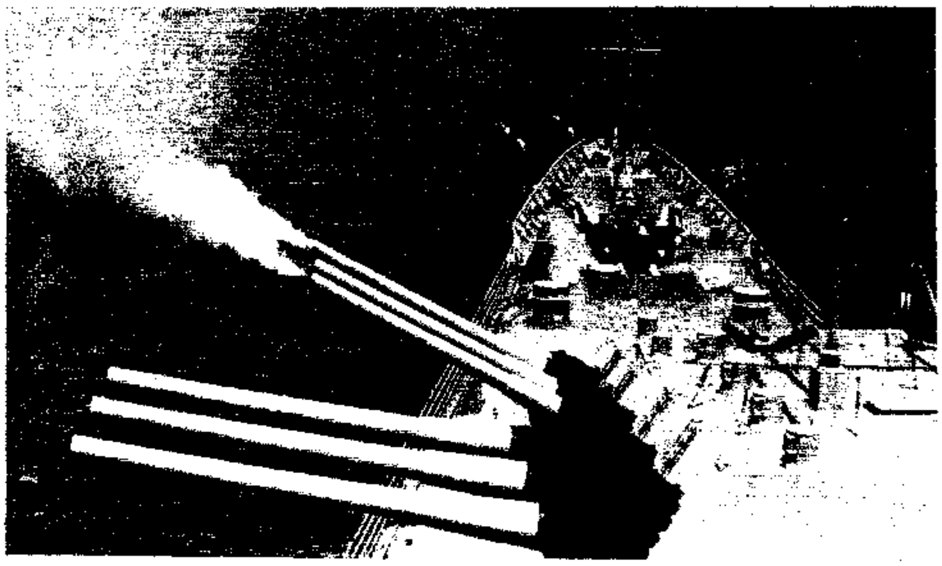
6024.203
TRIPLE 8-inch MARK 15 GUN MOUNTING

DESCRIPTION:

8 inch (203 mm) 55 calibre triple gun mount. The mount is remotely controlled and guns are independently laid. The projectile weight is approximately 125 kg and is propelled by separate bagged charges with a muzzle velocity of about 900 m/sec. Maximum range is about 28 km (15 nm) and the rate of fire is 5 rounds per barrel per minute. The barrels weigh 37,000 lbs (16,800 kg). The turret probably weighs about 500 tons. The original design of turret dates from 1935, but modifications since that date have considerably improved laying accuracy and reliability. The barrel is of two piece design featuring a radially expanded tube and a shrunk-on jacket.

STATUS:

Installed in some of the older US heavy cruisers now in reserve.



8-inch triple turrets of the guided missile heavy cruiser USS Boston *in action*

6091.203
TRIPLE 8-inch MARK 15 GUN MOUNTING (MODIFIED)

DESCRIPTION:

A modification was made to the 8-inch 55-calibre Mark 15 guns of the 'Baltimore' class cruiser *Saint Paul* during the war in Vietnam to enable them to fire 8-inch rocket-assisted projectiles.

Details of the modifications are not known, but it is understood that the weight of the projectile was less than half of that of the standard round – about 51 kg instead of 125 – and that a surface range of about 55 km (30 nm) was achieved during shore bombardments off Vietnam. This is believed to be a record for gun-launched projectiles: the range of the 16-inch guns of the '*Iowa*' class battleships was only about 39 km (21 nm).

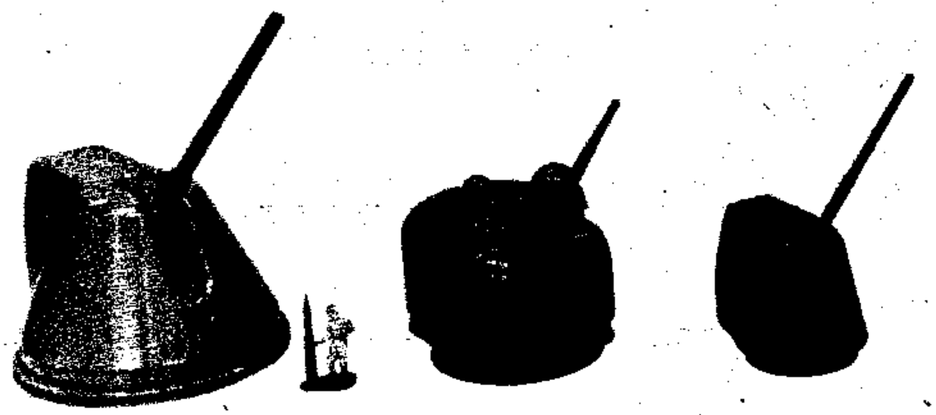
STATUS:

No longer in operational service. The USS *Saint Paul* was decommissioned at the end of April 1971. Rocket-assisted gun-launched projectiles – both guided and unguided – are, however, active US Army projects. Notes on such guided and unguided projectiles will be found in entries **2837.111** and **2834.103** respectively.

6094.203
SINGLE 8-inch MAJOR CALIBRE LIGHTWEIGHT GUN

DESCRIPTION:

An eight-inch gun is proposed for use with destroyer-size ships of the US Navy. No details of this weapon are known other than those implied by its title "Major Calibre Light Weight Gun" (MCLWG) and what can be inferred from the accompanying picture which shows a model of the new gun alongside models of the 5in/54 Mk 42 (see **6028.203** below) and the 5in/54 Mk 45 (**6029.203**).



The proposed lightweight 8-inch (left) *compared with the Mark 42* (centre) *and Mark 45* (right) *5-inch 54-calibre mountings*

6025.203
TRIPLE 6-inch MARK 16 GUN MOUNTING

DESCRIPTION:

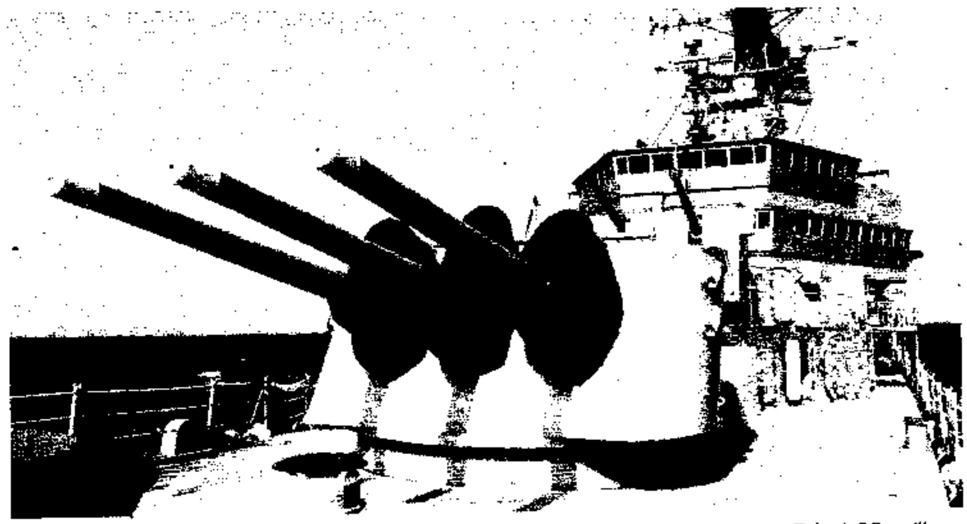
This 6-inch 47-calibre gun mounting in a triple turret is of an old semi-automatic design but is still in service in a few light cruisers of the US Navy. The turrets are remotely controlled but have local sighting and ranging facilities. The guns are independently laid.

Projectile weight is about 46.5 kg and muzzle velocity about 900 m/sec, giving a maximum range of about 23.5 km (13 nm). Rate of fire is 10 rounds per barrel per minute. The turret weighs 154 tons.

STATUS:

As noted above, these guns are in service in operational light cruisers and in cruisers in the US reserve fleet. It is believed that they are the same as the guns on the ex-US Navy cruisers now serving in various South American navies.

A later version of this gun adapted to fire cased ammunition and to be used as a dual-purpose weapon was mounted in twin turrets on the large '*Worcester*' class light cruisers. The ships concerned have now been scrapped, however, and so far as is known no other examples of this later version of the Mark 16 gun exist today.



A 6-inch triple turret on the USS Little Rock. *The guns immediately aft of this turret are 5-inch 38-calibre Mk. 12 dual purpose* (US Navy Photograph)

6026.203
TWIN 5-inch 38 CALIBRE GUN MOUNTING MARK 32

DESCRIPTION:

This is the oldest design of 5-inch mounting still in service with the US Navy, but it is also one of the most widely used. The 5-inch 38 calibre gun has indeed been described as "the prototype of the conventional US naval gun".

The Mark 32 mounting contains two Mark 12 5-inch 38 calibre guns and an enclosed mounting with ammunition-handling room beneath. It requires a crew of 13 on the mounting and 26 in all. Remotely-controlled, semi-automatic, dual-purpose it also has local laying facilities on the mounting. Normal rate of fire is 15 rounds per barrel per minute; but the gun's capacity for sustained fire is in excess of this and a good crew can achieve 22 rounds per minute over short periods. Train limits are 300° apart and elevation limits from —15° to +85° but train and elevation velocity and acceleration are significantly lower than those of the later 5-inch mountings.

Semi-fixed ammunition is used, consisting of a projectile weighing about 25 kg (varying according to type) and a case assembly weighing about 13 kg including a full powder charge of 6.8 kg. With a full charge the muzzle velocity is 792.5 m/sec giving a maximum horizontal range of 16.5 km (9 nm) and a ceiling of 11,400 metres. The ammunition is raised to the gun house by hydraulically powered hoists. The complete mounting weighs about 53 tons.

STATUS:

Twin mountings were installed in the *'Iowa'* class battleships, many heavy cruisers and a great many destroyers. Some of these are still in service in both the active and reserve fleets of the US Navy as well as in ex-US ships of other navies. They are also in service with Spanish-built ships of the Spanish Navy.

5-inch twin 38 calibre guns on the USS E. G. Small *in action* (US Navy photograph)

6092.203
SINGLE 5-inch 38 CALIBRE GUN MOUNTINGS

DESCRIPTION:

In addition to the enclosed twin mounting of the 5-inch 38 calibre gun (**6026.203**) there have been three other general types of mounting for this gun. They are:

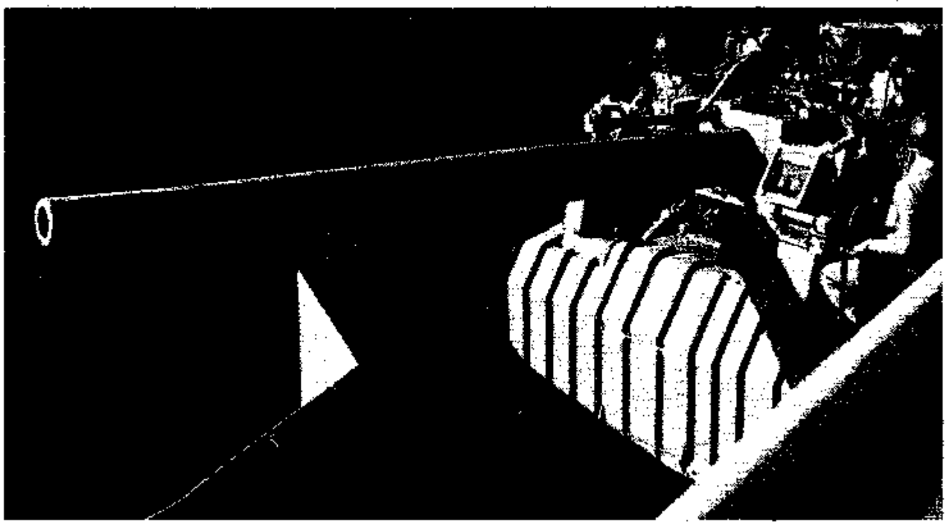
(a) Enclosed single mount with ammunition-handling room below. Originally on destroyers, destroyer escorts and auxiliaries. Now mainly found on auxiliary vessels of the US Navy, these single mounts are also the main surface armament of the *'Lepanto'* class destroyers and *'Legazpi'* class frigates of the Spanish Navy.

(b) Open single mount with ammunition-handling room below. Auxiliary vessels.

(c) Open single mount without ammunition hoists or handling room. Converted merchant vessels.

In performance there is essentially no difference between the first two of these and one gun of the enclosed twin mounting. The third arrangement is necessarily less efficient in terms of ammunition handling; but otherwise the gun characteristics are the same.

Enclosed mounting of a 5-inch 38-calibre gun on USS Brooke (US Navy photograph)



A 5-inch 38-calibre gun in an open mounting on the aircraft carrier USS Kearsarge (US Navy Photograph)

6093.203
SINGLE 5-inch 54-CALIBRE GUN MOUNTING MARK 39

This gun mounting is an intermediate stage between the 5in/38 mountings (**6026.203** and **6092.203**) and the 5in/54 Mark 42 mountings (**6027.203, 6028.203 and 6029.203**). It can be regarded as a 5in/38 single enclosed mounting Mark 30 with the Mark 12 38 calibre gun replaced by a Mark 16b54 calibre gun. This gun fires a heavier shell (about 32 kg instead of about 25 kg) with a slightly higher muzzle velocity and thus a longer range.

It may be noted that in this mounting an amplidyne all-electric power drive is used, whereas in both the 5in/38 mountings and the 5in/54 Mark 42 mountings the drive is electro/hydraulic.

STATUS:

Operational as a single enclosed mounting in "Midway" class aircraft carriers.

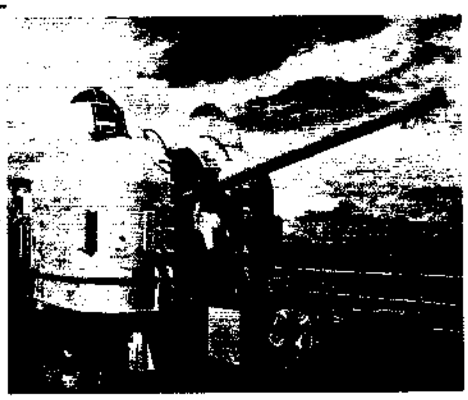
6027.203
SINGLE 5-inch 54 CALIBRE GUN MOUNTING MARK 42

This widely-adopted gun mounting had several advantages over both the 5-inch 38 calibre mountings and the 5-inch 54 calibre Mark 39 mounting (**6093.203**). It uses the Mark 18 54-calibre gun, and it is capable of very much higher rates of fire. The following description applies largely to Mod 7 which is the most widely used operationally of the earlier versions.

DESCRIPTION:

Mark 42 Mod 7 is a dual-purpose single enclosed mounting of the base-ring type fitted with automatic ammunition feed mechanisms. Driven by electric-hydraulic power units, it can be operated in local or automatic control.

The gun housing slide and breech mechanism are quite different from those of the semi-automatic 5-inch 54-calibre and 5-inch 38-calibre designs, as also is the ammunition feed system. The latter involves manual operations only in loading the cylindrical, power-driven loading drums that store complete rounds of ammunition and use them to feed the hoists. All subsequent operations are performed mechanically and as a result the single gun can achieve a continuous firing rate equal to that achieved only in short bursts by an expert crew on the two guns of the 5-inch 38-calibre Mark 32 mounting. A further obvious advantage is the reduction in the number of men required to man the gun. Crew for the Mark 42 is 14 total of whom 4 are on the mounting.



5-inch 54-calibre Mark 42 gun on USS John King (Official US Navy photograph)

Projectile weight is about 32 kg, muzzle velocity about 810 m/sec, range against surface targets about 24 km (about 13 nm) and ceiling (at 85° elevation) about 13,600 metres. Weight of complete turret is some 60 tons.

STATUS:

Operational in ships of the US Navy and elsewhere. To be mounted on the new "Andalucia" class frigates of the Spanish Navy.

6076.203
MODIFIED SINGLE 5-inch 54 CALIBRE GUN MOUNTING MARK 42

In some installations of the Mk 42 5-inch 54 calibre gun mount the starboard "bubble" or "frog-eye" on the mount has been removed. This dome is normally used for local anti-aircraft control; the port dome, which is retained in these installations, is for local anti-surface control.

6028.203
SINGLE 5-inch 54 CALIBRE GUN MOUNTING MARK 42 (Lightweight Mod 9)

DESCRIPTION:

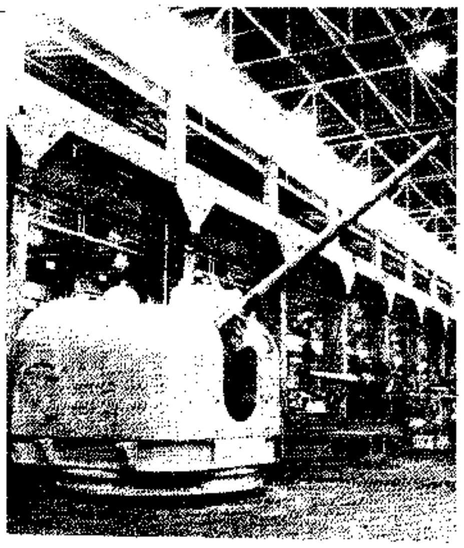
Functionally similar to the Mark 42 Mod 7 gun mount described above, the Mark 42 Mod 9 is an improved design featuring lower mount weight (58,700 kg), nearly 10% lower power consumption and a smaller crew requirement. State-of-the-art improvements incorporated included replacement of all electronic components of the earlier mount by solid-state devices. Only two men are needed on the mount as against four for the Mod 7, and the total crew requirement is 12 men instead of 14. The only respect in which the Mod 7 performance is known to be superior is that of elevation acceleration (60°/sec² against 40°/sec²).

STATUS:

51 units of the above-decks portion of the mount were manufactured by FMC/NOD and supplied for use on DE-1052 class ships. The below-decks portion was produced by the US Navy Naval Ordnance Station, Louisville.

MANUFACTURER:

FMC Corporation, Northern Ordnance Division, Minneapolis, Minn. 55421.



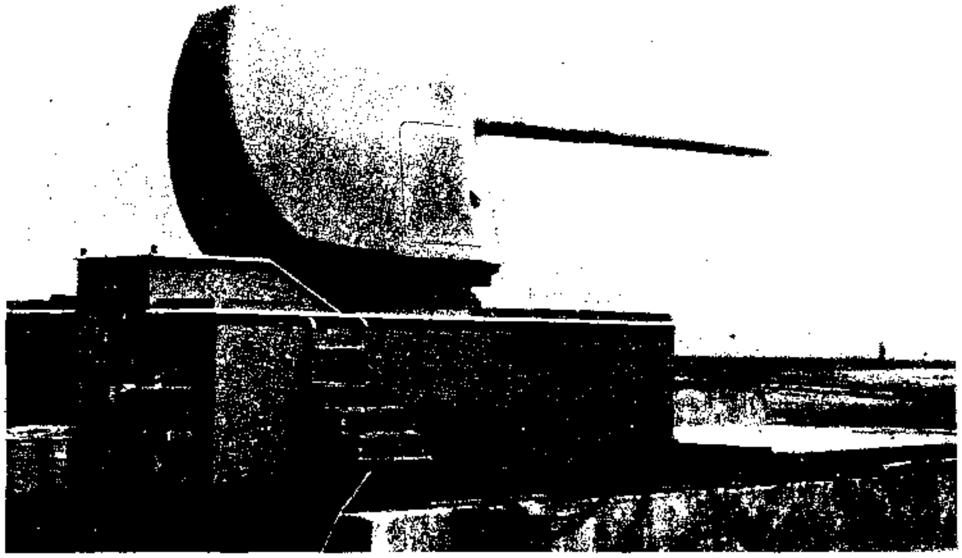
Lightweight (Mod 9) version of the 5-inch 54-calibre gun mounting Mk 42 in production

6029.203
SINGLE 5-inch 54 CALIBRE LIGHTWEIGHT AUTOMATIC GUN MOUNTING MARK 45

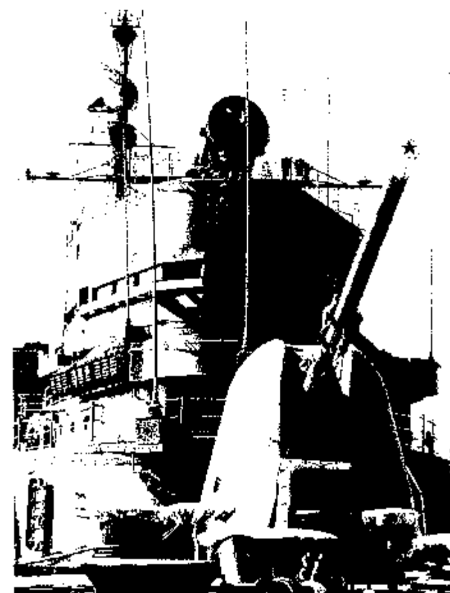
DESCRIPTION:

This completely new gun mounting represents a major step forward in medium calibre ordnance for the US Navy. It has been designed primarily for installation in new ships and was required to embody all relevant improvements developed over some 30 years since the 5-inch/38 was first introduced (**6026.203**). It was also required to be light, easily maintained and exceptionally reliable. The result is a weapon which requires only one-third of the crew of a 5-inch/38 and with which a single man in a control centre can fire a drum load of 20 shells without help.

Specifically, the major differences in characteristics between the Mark 42 (**6027.203**) and Mark 45 mountings are:



Side elevation of the Mark 45 gun being test-fired



5-inch 54 calibre Mark 45 lightweight gun mount on USS Norton Sound

Mount weight: reduced from 60 tons to 25 tons
Crew: reduced from 14 to 6
Crew on mounting: reduced from 2 to 0
Maximum elevation: reduced from 85° to 65°
Rate of fire: reduced from 40 rounds/min to 20
Ready service rounds: reduced from 40 to 20

The gun will be used with the lightweight Mark 86 GFCS

DEVELOPMENT AND PROCUREMENT:

Development of the new weapon started in 1964 on a contract placed with the Northern Ordnance Division of the FMC corporation. Initial production was by FMC/NOD, who continue to make the mounting, and General Electric Company Ordnance Systems have been brought in as a second source.

FMC/NOD were also the developers and are understood to be the sole manufacturers of the Mark 6 Ammunition Hoist, which is an integral part of the Mark 45 installations on DLGN-36 and DD-963 ships.

Gun barrels are produced by US Government Ordnance factories and are installed in the mount after it has been installed in the ship.

STATUS:

Deliveries of complete production units, less barrels, for installation on LHA, DLGN-36 and DD-963 class ships began in August, 1971, and are continuing; and the mount is now operational.

6030.203
3-inch 50 CALIBRE GUN MOUNTING MARKS 27, 33 and 34

DESCRIPTION

These 3-inch (76 mm) 50 calibre gun mounts are primarily intended for air defence but can be used also against surface targets. Planned during the Second World War but not completed in time for combat use in that conflict, the mounts have since proved themselves so effective that they have virtually displaced their predecessors – 40 mm twin and quadruple mounts – on combat vessels.

Mks 27 and 33 are twin mounts and Mk 34 a single. Mks 27 and 33 are identical in almost all respects, the main difference being in the slide. All marks use the same gun and similar backing mechanisms, except that in the twin mounts the assemblies are of opposite hand. Some models of the Mk 33 are enclosed twin mounts with an aluminium or fibreglass reinforced plastic (FRP) shield, and others again are twins with modifications for installation of a fire control radar antenna. The Mk 34 mount is an open single with a right-hand slide and loader assembly. Some models of the Mk 34 also are FRP shielded. Mount weights are in the region of 32,000 lb (14,500 kg) for the twins and 17,000 lb (7,700 kg) for the Mk 34.

Horizontal range is about 13 km and targets can be engaged at heights of more than 9,000 metres. Projectile weight is approximately 6 kg and the design rate of fire is 45 rounds per barrel per minute – although it is believed that higher rates can be achieved.

STATUS:

Operational.

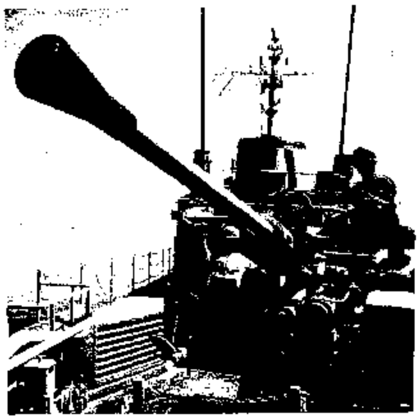
A single mounting of the 3-inch 50-calibre gun (US Navy photograph)

A 3-inch 50 calibre twin mounting (US Navy Photograph)

6031.203
40 mm ANTI-AIRCRAFT GUN MOUNTINGS

DESCRIPTION:

There are both single, twin and quadruple barrelled versions of the 40 mm automatic recoil operated gun. The gun has a range of approx 5,000 metres and a rate of fire of 160 rounds per minute. Most mounts can be either locally or remotely controlled, and are power operated, with emergency hand operation. The gun is derived from the Bofors design and the accompanying photograph shows a single barrel mount.



A 40-mm single mount on the USS Asheville (US Navy photograph)

6034.203
20 mm GUN MOUNTING MARK 56

DESCRIPTION:

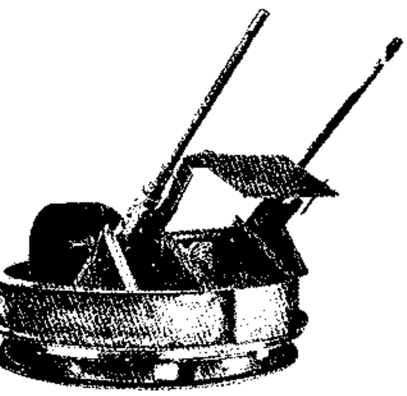
Colt's gun mount Mk 56 Mod 0 is available either as a twin 0.50 calibre M2H8 machine gun mount or as a combined 0.50 calibre and Mk 16 20 mm automatic gun. Without guns the mount weighs 166 kg and stands 50 cm above the deck. It can be trained in azimuth through 360° and in elevation from −15° to +65°. Ammunition capacity is 500 rounds for 0.50 calibre guns and 200 rounds for 20 mm guns.

The .50 inch (13 mm) machine gun is an air cooled, belt fed, recoil operated machine gun used in small craft. It has a range of approximately 7,000 yards (6.4 km) and a rate of fire of 450 rounds per minute. The barrel can be quickly exchanged without dismantling other parts of the weapon.

The 20 mm rapid fire gun is a 70 calibre magazine loaded machine gun type anti-aircraft gun. It is manually aimed and used as a close range defence weapon. The rate of fire is 850 rounds per minute and the range is 4,800 yards (4.65 km). The gun and mechanism weigh 150 lbs (68 kg).

MANUFACTURER:

Colt's Firearms Division, Colt Industries, Hartford, Conn.



Colt Mk 56 Mounting

2836.203
20 mm THREE BARREL DECK MOUNT

DESCRIPTION:

Designed for installation on a wide range of seagoing and riverine craft, this three-barrel 20 mm gun can provide a small vessel with very substantial fire-power.

The system comprises an M197 three-barrel 20 mm gun and ancillary equipment mounted on a US Navy Mk 10 stand. The gun and its associated delinking feeder (M-89) are currently in use by the USMC in helicopters and in US naval aircraft.

The M197 weapon is electrically operated and power for this is supplied by a battery mounted on the gun stand. Twenty complements of ammunition can be fired without battery recharging: the battery can conveniently be connected to a main power source to provide a 28V trickle feed, thus maintaining the battery in a charged condition.

The three barrel gun is derived from the six-barrel M-61 (Vulcan) gun (**5547.103**) and has alternative rates of fire of 600 and 1,200 rounds/min. The M-89 delinking feeder includes a declutching arrangement which, when the trigger is released, automatically stops the supply of ammunition to the gun but permits the gun to continue firing long enough to clear the barrels.

Pintle Mounting

The Mk 10 gun mount provides convenient room for the installation of the 300-round ammunition can behind the right-hand shield – the battery and control box being mounted behind the other half. The M-197 gun can, however, also be pintle-mounted, in which case there is no obvious location for the ammunition box. The ammunition feed system, however, permits the ammunition box to the gun by means of a flexible chute so that the box can be located in any convenient position near the gun. In addition, a larger ammunition box may be used if desired.

CHARACTERISTICS:
Deck-mounted on Mk 10 mount:
Weapon: M-197 20 mm three barrels
Elevation: −15° to +75°
Traverse: unlimited
MV: 1,030 m/sec
Dispersion: 80% in 8 mil circle
Rate of fire: 600 or 1,200 rounds/min
Ammunition: M-50 series
Feed: XM-89
Ready rounds: 300
Battery fireout capability: 6,000 rounds
Weight: (without ammunition) 500 kg approx
MANUFACTURER:
General Electric, Aircraft Equipment Division, Burlington, Vermont, USA.

2851.203
20 mm VULCAN GUN (NAVAL APPLICATION)
DESCRIPTION:
The Vulcan six-barrelled 20 mm anti-aircraft cannon has been established in the US Army for some years (see **2850.131** and **5547.103**). Recently, however, the possibility of using its considerable fire-power to provide a "last ditch" defence for ships attached by cruise missiles has been considered; this consideration has resulted in the Vulcan/Phalanx system.

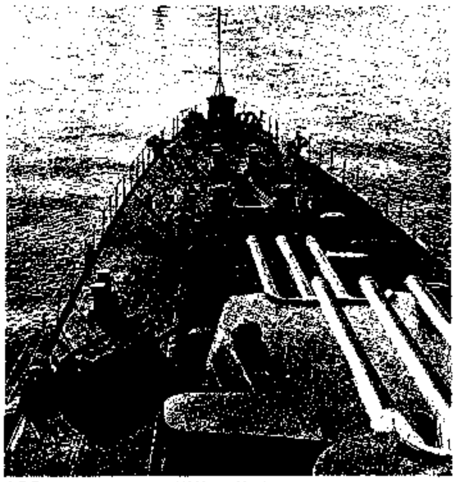
All available information on the radar-plus-computer-plus-gun system is set out in entry number (**2543.231**).

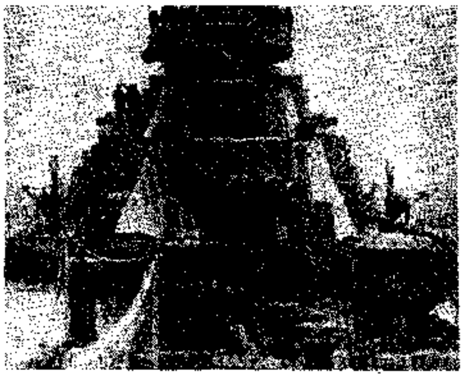
MANUFACTURER:
General Electric, Aircraft Equipment Division, Burlington, Vermont, USA.

THE UNION OF SOVIET SOCIALIST REPUBLICS

6037.203
TRIPLE 180 mm GUN MOUNTING
DESCRIPTION:
In the Russian Navy, as in most others, big guns are nearing the end of their service life. The 180 mm gun is now the largest carried by Russian ships (and only in the US and Spanish Navies are larger guns to be found) and even this is restricted to the two surviving members, *Kirov* and *Slava* of the *Kirov* class cruisers. Both ships were launched before the Second World War, although *Slava* (formerly *Molotov*) was not completed until 1944.

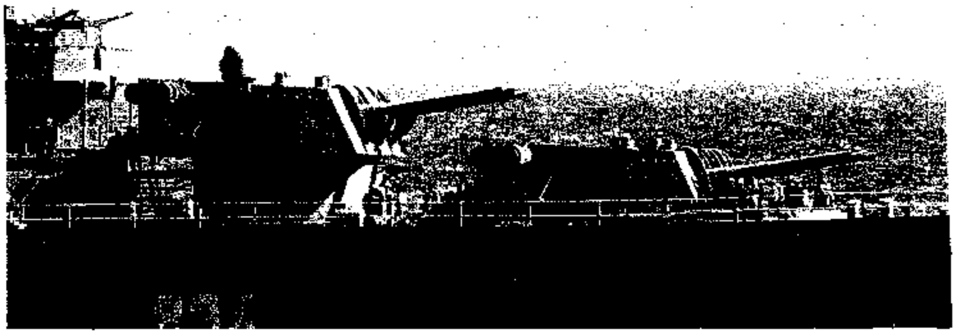
Each cruiser carries 9 of the 180 mm guns in three triple mountings. The three guns in each mounting are mounted in a single sleeve and are thus not capable of individual elevation. Maximum elevation is 40 degrees. The guns are semi-automatic, 57 calibres long and can fire 6 rounds per minute. Muzzle velocity is 920 m/sec, projectile weight about 100 kg and range about 35 km.

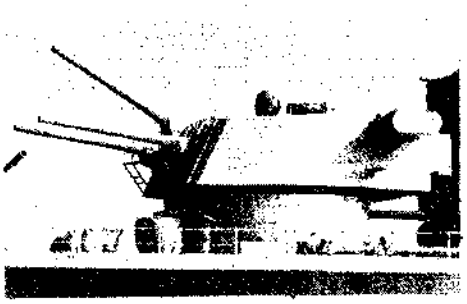

180 mm guns on a "Kirov" class cruiser (Novosti)


The forward 180 mm guns of the cruiser Slava

6038.203
TRIPLE 152 mm GUN MOUNTING
DESCRIPTION:
These guns are in service with several of the older cruisers of the Russian fleet. The "Sverdlov" class cruisers each carrying 12 guns in four triple mountings, except for the *Dzerjinski* which has had one of its turrets replaced by a launcher for the SAM-2 Guideline missile (**2943.231**). The older "Tchapaev" class cruisers also carry four triple turrets.

Guns in the turrets are mounted in separate sleeves, thus permitting individual elevation to at least 50 degrees. Projectile weight is believed to be about 50 kg and muzzle velocity 915 m/sec so that maximum range is probably in the region of 27 km. The gun is 50 calibres long, semi-automatic and can fire 10 rounds per minute. An 8-metre range-finder is incorporated in each turret.


The 152 mm triple turrets of the "Sverdlov" class cruiser Alexsander Suvorov *photographed in the Philippine Sea during the Soviet worldwide exercise* Okean (US Navy Photograph)

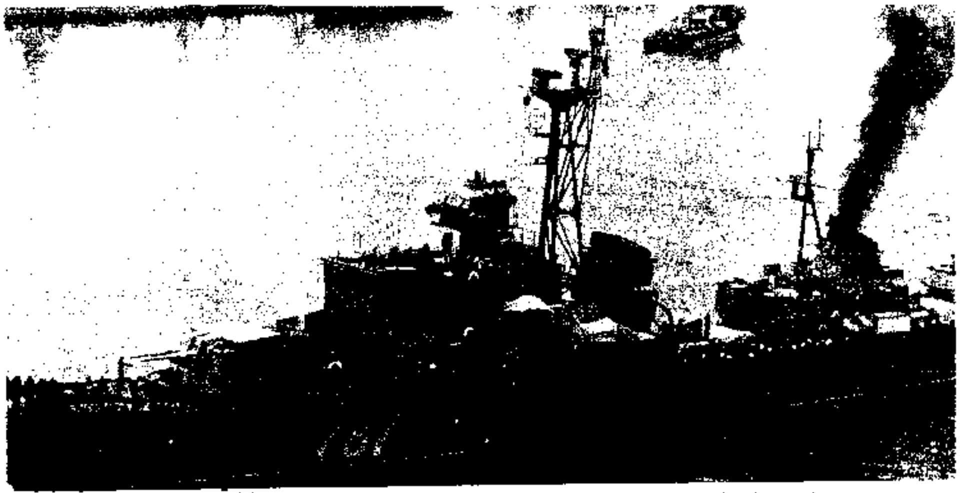

Another view of the 152 mm guns showing independent laying


The "Sverdlov" class cruiser Mikhail Kutuzov *with its four triple 152 mm gunmountings. Note also the three starboard twin mountings for the ship's 100 mm guns, the port and starboard stabilised directors for these guns just aft of the forward funnel and the large director and tandem-mounted 9-metre range finders amidships aft of the after funnel. A similar director and range finder assembly is mounted on the control tower*

6039.203
TWIN 130 mm GUN MOUNTING
DESCRIPTION:

These gun mountings are to be found only on the older (unmodified) "Skory" class destroyers – including those supplied to Indonesia and to Poland. These vessels carry two twin mountings.

It is believed that the gun is 50 calibres long and fires a 27 kg shell with a muzzle velocity of 875 m/sec. The mountings are semi-automatic and a rate of fire of 10 rounds per minute can be achieved. Range is about 25 km. The 130 mm guns of the modified "Skory" class destroyers are housed in twin mountings of somewhat different design and it is believed that these mountings are the same as those of the "Tallin" and "Kotlin" class destroyers.

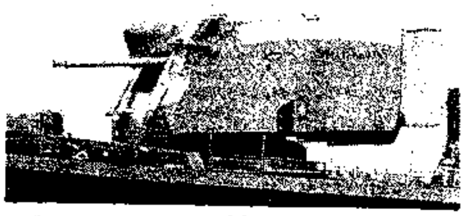


Twin 130 mm guns mounted on the "Skory" class destroyer Svobodnyi

6040.203
TWIN 130 mm DUAL-PURPOSE GUN MOUNTING
DESCRIPTION:

It is believed that this mounting is common to the modified "Skory" class and the "Tallin" and "Kotlin" class destroyers (but certainly not the modified "Kotlin" class ships that carry surface-to-air missiles).

On these vessels, assuming that all the installations are indeed similar, the 130 mm guns, in two twin turrets including firing directors are fully stabilised. The installation on the *Neustrashimyi* (or *Nastoichvyi* – opinions differ) is indeed believed to be the first of its kind on a ship of destroyer size. The guns are dual-purpose, semi-automatic and are believed to be 58 calibres long and to fire a 27 kg projectile at 10 rounds/min with a muzzle velocity of 875 m/sec. The two guns in the mounting can be independently laid and can be elevated to 70°. They are used with "Wasphead" stabilised directors with radar.



Fully stabilised twin 130 mm dual purpose gun mounting

6042.203
TWIN 100 mm DUAL-PURPOSE GUN MOUNTING
DESCRIPTION:

Guns of this type are in service with the Russian Navy on the "Sverdlov" class cruisers (including the *Dzerjinski*) and the "Tchapaev" class cruisers, on which they are associated with "Wackeltopf" stabilised directors with radar.

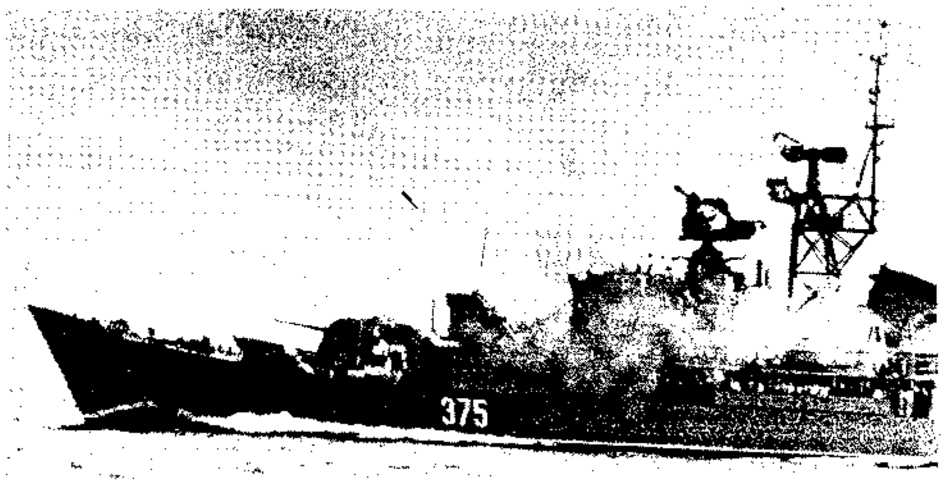
These guns are of more modern type than the single 100 mm gun fitted on the "Kirov" class cruiser and the "Kola" and "Riga" class destroyers (**6041.203**). They are reported as being capable of firing their 16 kg projectile with a muzzle velocity of 900 m/sec at 20 rounds/min. Maximum surface range is understood to be 18 km and maximum AA engagement height 12,000 metres (at 80° elevation). Barrel length is 60 calibres. The turret is stabilised and has been said to weigh 35 tons. It is believed that the trunk of the turret extends downwards for at least one deck and contains the ammunition hoist.

Stabilised twin mounting for 100 mm dual-purpose guns on a cruiser. The top of the fire director can be seen to the rear of the gun mounting

6041.203
SINGLE 100 mm DUAL-PURPOSE GUN MOUNTING
DESCRIPTION:

This gun mounting is to be found on the two "Kirov" class cruisers, on the many "Riga" and "Kola" class destroyers that are to be found in the navies of both Russia and its client countries, and on the "Don" class support ships.

These guns are all believed to be the 1947 model, to be 56 calibres in length and to fire a 13.5 kg projectile with a muzzle velocity of 850 m/sec. Surface range is believed to be some 16 km and maximum AA engagement height 6,000 metres. They are manually operated and obsolescent.



Anti-submarine rockets being fired from a "Riga" class destroyer. Two single 100 mm dual-purpose gun mountings can be seen. Note the elevation angle of the gun nearer to the rocket launcher (Novosti)

6043.203
SINGLE 85 mm DUAL-PURPOSE GUN MOUNTING

Fitted on some of the "Kronstadt" class coastal patrol vessels this gun may be presumed to be obsolescent. It has been replaced on many of these vessels by weapons of smaller calibre.

The guns are 52 calibres long and semi-automatic. Maximum range is about 15 km, the muzzle velocity being 800 m/sec. Rate of fire is 10 rounds/min. Maximum elevation is 75°.

2865.203
TWIN 85 mm AA GUN MOUNTING

Description:

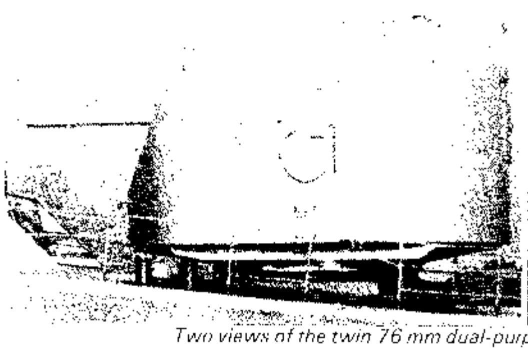
This is an elderly semi-automatic heavy anti-aircraft weapon believed to be installed now only in the "Skory" class destroyers. Barrel length is about 52 calibres, muzzle velocity about 800 m/sec. maximum range and height about 10,000 m and 5,000 m respectively. Maximum barrel elevation is 75°. Rate of fire about 15 rounds/min.

6044.203
TWIN 76 mm DUAL-PURPOSE GUN MOUNTING

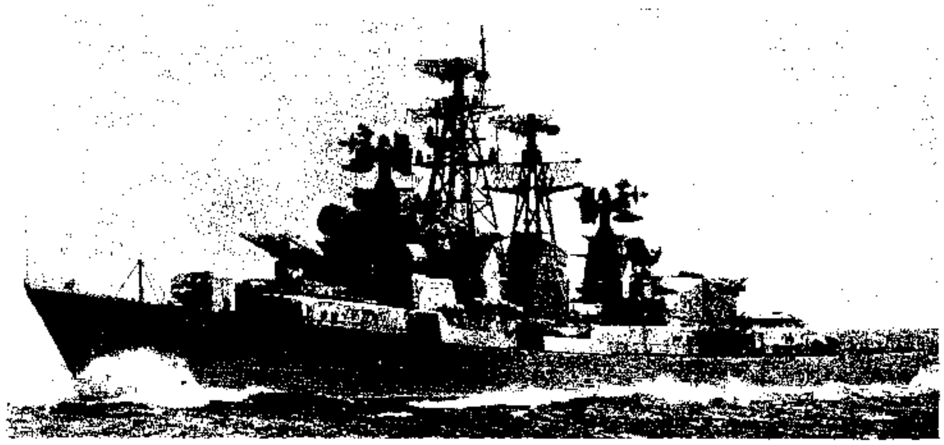
Description:

This is a relatively modern weapon and is fitted to the "Kynda" class guided missile cruisers, on the "Kashin" class guided missile destroyers and on the "Mivka" and "Petia" class.

The 60 calibre gun can be elevated to about 85°; and this with a muzzle velocity of about 900 m/sec. means that air targets can be engaged at slant ranges up to 14,000 m. Maximum range is 15 km. Rate of fire is said to be 60 rounds/min




Two views of the twin 76 mm dual-purpose gun mounting



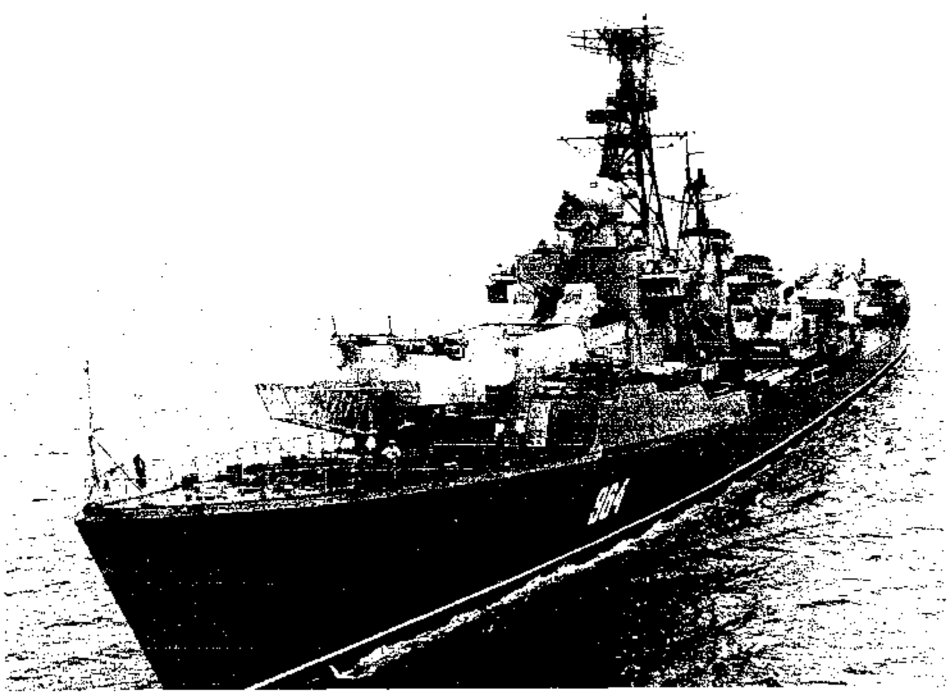
"Kashin" class guided missile armed destroyer with twin 76 mm guns mounted forward of the Goa missile launcher

6047.203
QUADRUPLE 57 mm AA GUN MOUNTINGS

Description:

In the "Kanin" and "Krupny" class destroyers and the "Lama" class supply ships quadruple 57 mm mountings are installed. The guns are arranged as two pairs mounted vertically one above the other and it is believed that the pairs are essentially similar to the twin 57 mm guns described below, except that the barrels of the quad-mounted guns do not have muzzle brakes.

The fire control radar for these guns is described in **1325.253**.



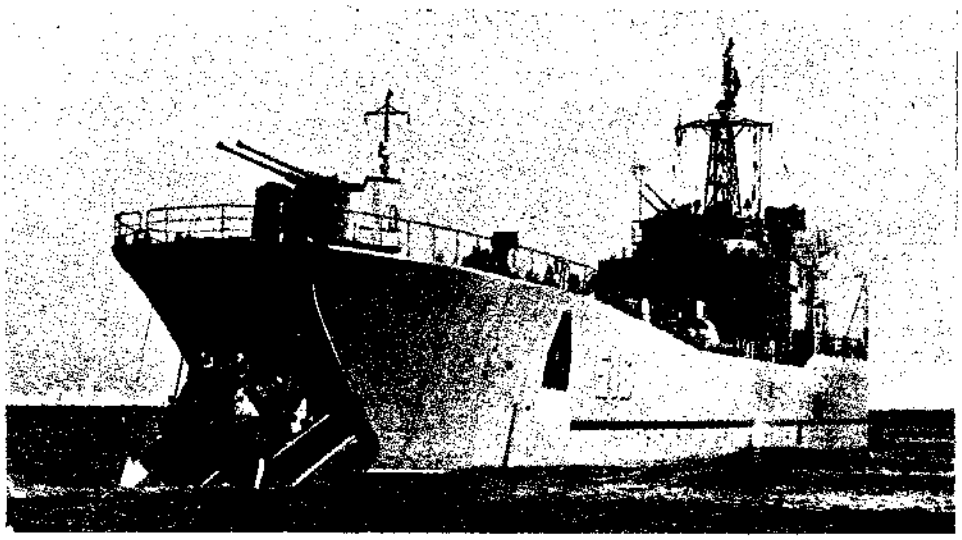
The "Krupny" class guided missile armed destroyer Gnevny. *Two of the four quadruple 57 mm AA gun mountings can be seen here together with the forward director and fire control radar. Note also the forward Strela launcher and hangar and the port 16 barrel A/S rocket launcher aft of hangar.* (UK Ministry of Defence. Official photograph)

6046.203
TWIN 57 mm AA GUN MOUNTINGS

Description:

Twin 57 mm AA guns are fitted to many of the more modern or recently modernised Russian ships. The guns have 70-calibre barrels with muzzle brakes and a rate of fire of some 120 rounds/min/barrel is believed to be possible. Muzzle velocity is about 950 m/sec. vertical range is believed to be about 6,000 metres and horizontal range about 9,000 metres; the weight of the shell is about 2.8 kg.

Guns of this type are installed in "T-58", "Don", "Lama II", "Oskol", "Tovba", "MP-8" and "Alligator" classes of ship. Although primarily AA weapons, the 57 mm guns are in some cases the sole armament of a ship and must therefore be intended for use in a dual-purpose role.



Twin 57 mm AA guns on "Alligator" class LST (Novosti)

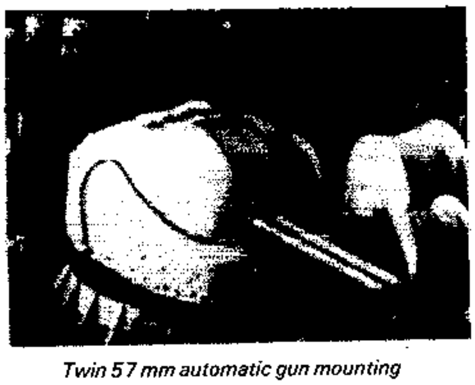
Twin 57 mm AA guns. (Novosti)

2869.203
TWIN 57 mm AUTOMATIC AA GUN MOUNTING

DESCRIPTION:

Several of the most modern classes of Russian ships are equipped with fully-enclosed, fully-automatic 57 mm guns in twin mountings. With 80-calibre barrels and muzzle velocities around 1,000 m/sec, these guns have maximum horizontal and vertical ranges of some 12,000 m and 5,000 m respectively. Rate of fire is believed to be 120 rounds/min/barrel. Maximum elevation is around 85°.

Guns of this type are found in the "Moskva", "Kresta",, "Grisha", "Nanuchka", "Poti", "Ugra" and "Chilikin" classes. Radar control is normally by Muff Cob (**1611.253**).



Twin 57 mm automatic gun mounting

Twin 57 mm automatic gun mounting

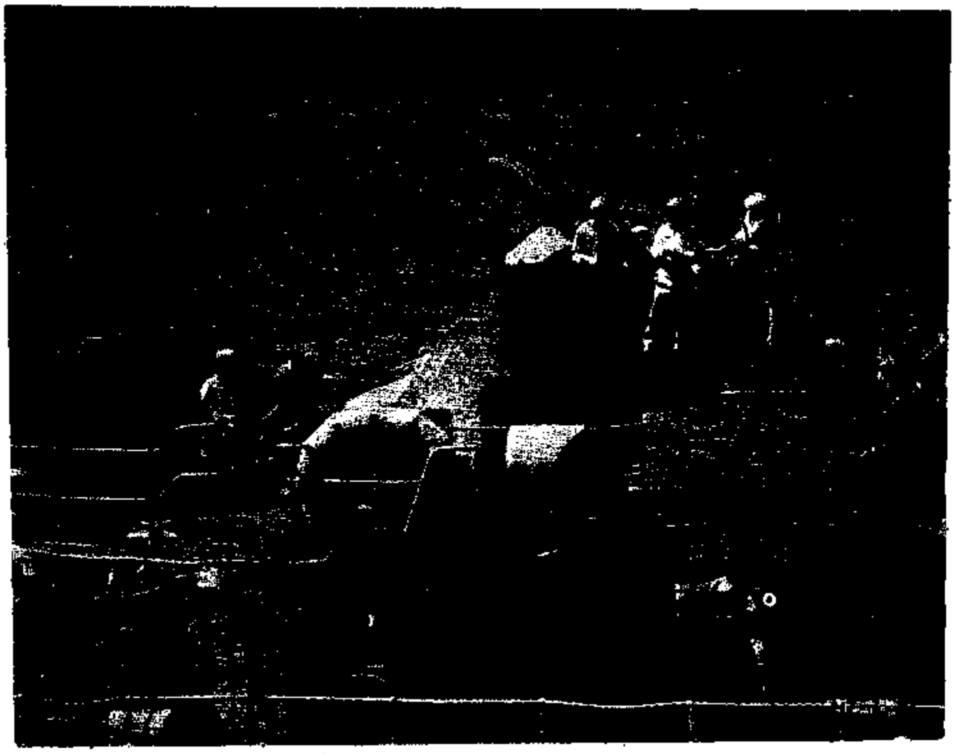
6045.203
SINGLE 57 mm DUAL-PURPOSE GUN MOUNTING
DESCRIPTION:

This 57 mm gun is fitted only to the "Sasha" class coastal minesweepers and the modified "Skory" class destroyers. It is believed that the gun performance is the same as that of the twin-mounted 57 mm gun described in entry **6046.203** but the gun barrel is not fitted with a muzzle brake.

6048.203
QUADRUPLE 45 mm AA GUN MOUNTS

These mounts are very similar in appearance to the quadruple 57 mm AA gun mounts described above. They are fitted to some of the older destroyers of the fleet – the "Kildin", "Kotlin" (unmodified) and "Tallin" classes.

Semi-automatic and with an 85-calibre barrel, each gun can fire about 160 rounds/ min with a muzzle velocity of about 1,000 m/sec and vertical and horizontal ranges of some 7,000 m and 9,000 m.



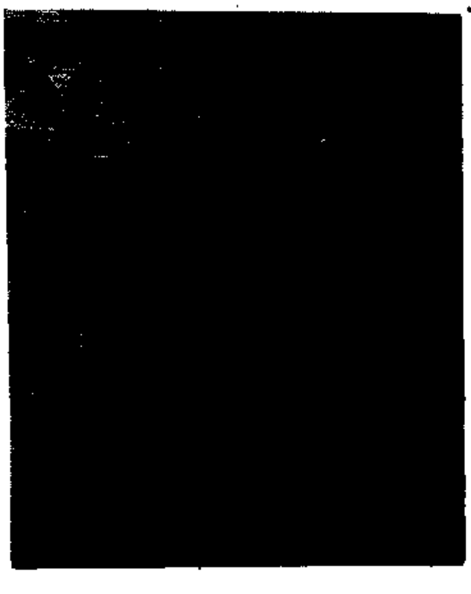
Quadruple 47 mm 85 calibre AA gun mounting on a "Kotlin" class destroyer photographed during the Okean *exercise* (US Navy Photograph)

2870.203
TWIN 37 mm AA GUN MOUNTINGS
DESCRIPTION:

Twin 63-calibre AA mountings of various types are found on many of the older cruisers, destroyers and auxiliaries of the Russian Navy. The 37 mm AA calibre was first introduced for naval use, adapted from the army weapon in 1943, but the twin mountings date from some five years later.

With a muzzle velocity of some 850 m/sec the guns have a range of around 4,000 m. Rate of fire is believed to be about 130 rounds barrel/ minute.

Twin 37 mm AA guns (Tass)



2883.203
SINGLE 37 mm AA GUN MOUNTING
DESCRIPTION:

Derived from an army weapon of the same calibre this gun was introduced for naval use in 1943 and is to be found in open mountings on the older "Skory" class destroyers, and on "Kronstadt" class submarine chasers and in turret mountings on T-301 class coastal minesweepers.

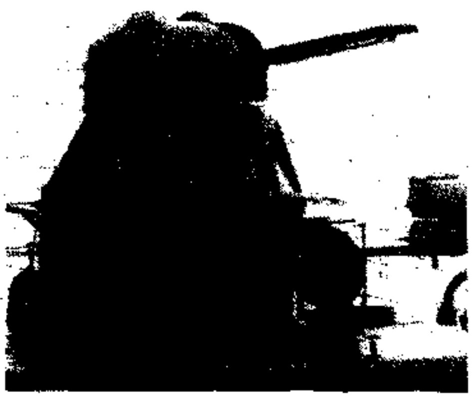
Characteristics of the gun are believed to be substantially the same as those given for the twin 37 mm mountings in entry **2870.203**.

Single 37 mm AA mountings

2896.203
TWIN 30 mm AA GUN MOUNTING
DESCRIPTION:

Widely fitted in missile boats and other small craft, this is a fully automatic remote-controlled weapon. Barrel length is 65 calibres, muzzle velocity around 1,000 m/sec, range about 3-4,000 m and rate of fire around 500 rounds/minute/barrel. Maximum elevation is about 85°.

The gun was first introduced in 1960. It is most commonly associated with the Drum Tilt fire control radar (**1330.253**) or more rarely with Muff Cob (**1611.252**).

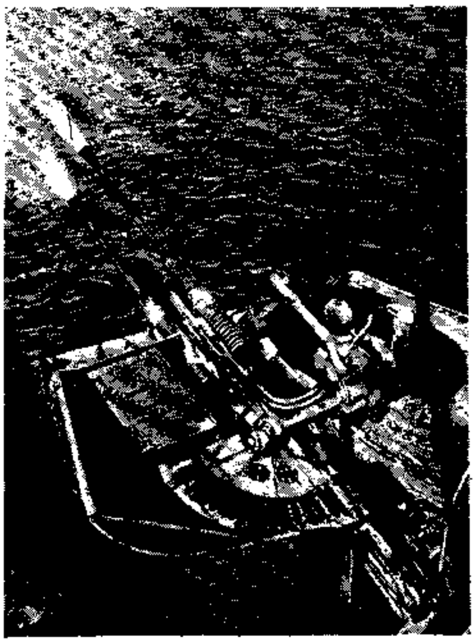


Twin fully-automatic 30 mm AA mounting as mounted on missile boats and other small vessels

2897.203
TWIN 25 mm AA GUN MOUNTINGS
DESCRIPTION:

LAA guns of this type are mounted in many of the smaller ships of the Russian Navy. The two guns are mounted vertically one above the other, have a barrel length of 70 calibres, a muzzle velocity of about 900 m/sec, a range of some 4,000 m and can fire about 350 rounds/minute/barrel. Elevation capability is about 88°.

This enclosed twin mounting is installed in a BK-class gunboat

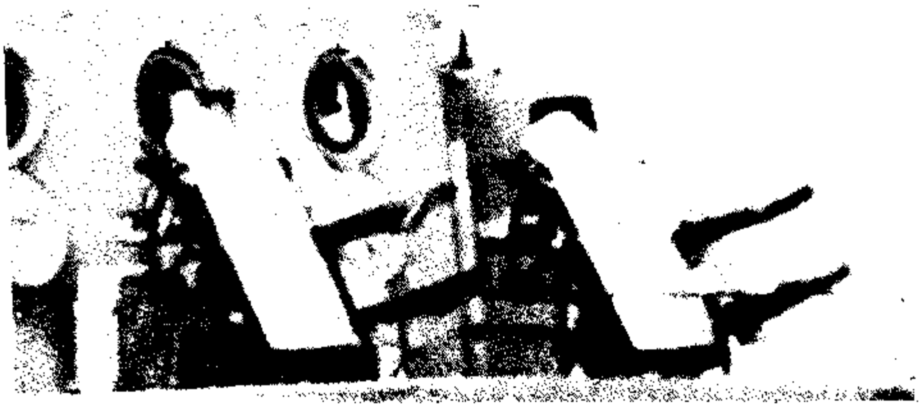


Twin 25 mm AA guns in open mounting

Modern semi-enclosed twin 25 mm gun mounting used on submarine chasers and similar vessels

2898.203
TWIN MG MOUNTINGS
DESCRIPTION:

Twin MG mountings are used for AA defence on many small Russian ships – especially the older ones. Typical are the twin 12.7 mm mountings on a "Kronstadt" class submarine chaser illustrated here.



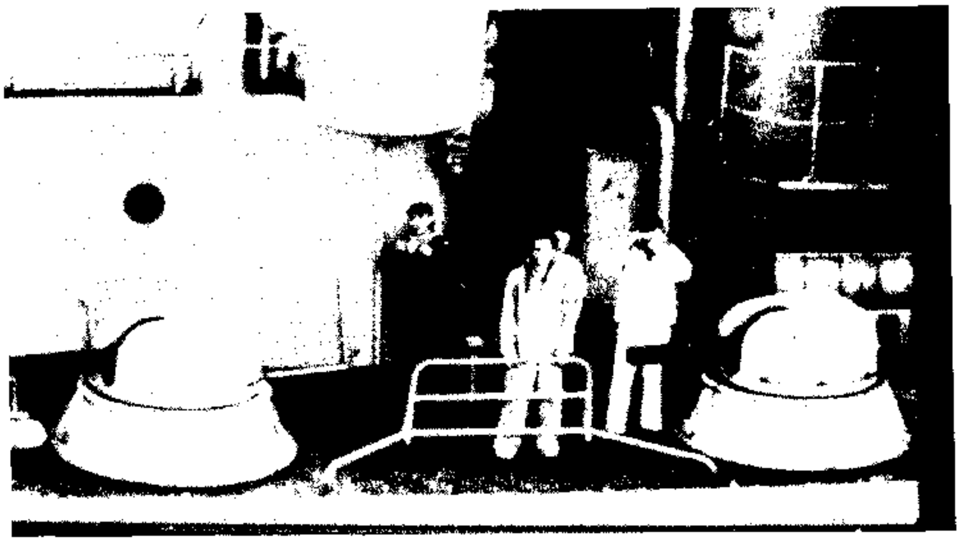
Twin 12.7 mm AA MGs on a "Kronstadt" class submarine chaser

2973.203
CLOSE-IN WEAPON SYSTEM
DESCRIPTION:

It was first thought that the pairs of small barbette mountings abaft the SS-N-10 missile launchers on the "Kresta II" class cruisers of the Russian Navy were twin 30 mm gun-mountings similar to but more modern than those described in **2896.203** above.

It now seems possible, however, that they are in fact a more sophisticated device intended as a close-in weapon system or "last-ditch" anti-missile system, similar in concept – but not in execution – to the Vulcan-Phalanx system (**2543.231**) of the US Navy.

No details of calibre or performance are available.



Barbette mountings on Kresta II

2899.203
140 mm ROCKET LAUNCHERS

DESCRIPTION.

For the past thirty years and more the Russian Army has been using and arranging for the development of a wide range of unguided barrage rockets (**5555.103**). It is not surprising, therefore, that the Russian Navy should also use these weapons: indeed it is surprising that they have not made greater use of them.

So far as is known at present the only confirmed installation is on the "Polnocny" class landing ship. This carries a trainable launcher with a capacity for 18 rounds of 140 mm rockets. These are credited with a range of some 9 km.

2991.203
SAN-4 UNGUIDED MISSILE SYSTEM

DESCRIPTION

A note on this new missile system is included here as well as in Section 1 (**2990.231**) because it is not definitely known whether or not the SAN-4 missiles are guided.

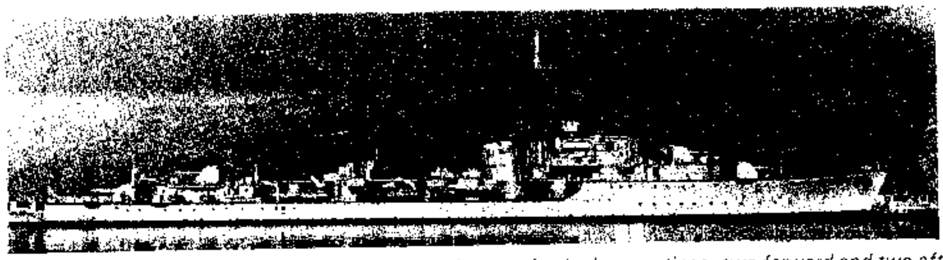
One possibility appears to be that the weapon comprises a fast reaction launcher assembly, which is capable of rapidly launching a large salvo of relatively small unguided rockets in the direction of an attacking aircraft or missile. Those who support this view suggest that the launcher assembly is installed below deck and can be moved up bodily when the system is brought into action. An argument in favour of this view would seem to be the advantage of being able to reload such a launcher under cover – possibly even by exchanging complete pre-load missile containers; an operation which it would be inconvenient to perform under fire on deck.

Until some pictures showing more than the top (if such it be) of the launcher are available, however, the true nature of this system must remain in doubt.

YUGOSLAVIA

6079.203
SINGLE 120 mm GUN MOUNTING

These guns are installed in the ex-British "W" class destroyers *Kotor* and *Pula*. The ships were refitted in 1956-59 but it seems possible that the 120 mm guns are Vickers 4.7 in 50-calibre weapons of the 1931 pattern. See also entry number **6081.203** above (Argentina).



The destroyer Pula *The four 120 mm guns can be seen in single mountings, two forward and two aft*
(Yugoslavian Navy Official Photograph)

SHIPBORNE ANTI-SUBMARINE WEAPONS

6095.203
SHIPBORNE ANTI-SUBMARINE WEAPONS – INTRODUCTION

Many ships nowadays carry a considerable variety of ASW weapons and systems. This brief survey, which is indicative rather than exhaustive, deals with the more important categories of shipborne weapons: systems are covered in Section 1 and the following notes contain references to entries in that section.

A/S Torpedoes

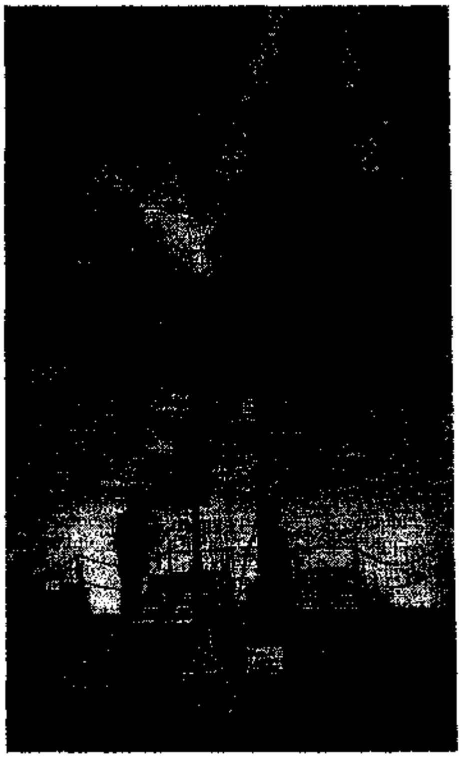
The torpedo is a major anti-submarine weapon. It may be launched directly from a torpedo tube on a ship, from a drone or missile launched from a ship, or from a manned aircraft or helicopter. All available information on torpedoes will be found in Section 1.

Drones and Missiles

Drone torpedo-launchers and torpedo-carrying missiles are also dealt with in Section 1. Their names and reference data are listed below.

Name	*Entry No.*	*Country*
Asroc	**6001.241**	USA
Dash	**2550.341**	USA
Ikara	**6002.241**	Australia
Malafon	**1179.241**	France

Of these it should be noted that Asroc has a dual role – as a carrier of either an A/S torpedo or a depth charge. The submarine-launched missile Subroc (**1128.441**) is not at present a torpedo carrier. The nature of the large Russian anti-submarine rocket (**6097.241**) is not known.



Depth charge launching from Russian ship (Novosti)

Quintuple trainable torpedo launcher on a Russian cruiser

The Italian frigate Cigno *with Menon three-barrelled depth charge launcher aft of the twin 76/62 guns*

Depth Charges

Relatively simple cylindrical depth charges that can be rolled or catapulted into the sea are the longest-established anti-submarine weapons: they were first used by the Royal Navy in the First World War. They are time-fused and have a low sinking rate – thus giving the launching vessel time to get clear. They are still used extensively by many navies: a typical weight of the depth charge is 150 kg and launcher can project the charge up to about 150 metres.

Depth Charge Mortars

Towards the end of the Second World War a more streamlined type of depth charge with a higher rate of sinking was introduced by the US Navy. The higher sinking rate makes it necessary to project the charge to a greater distance from the launching vessel and for this purpose a mortar is used. Such mortars have been developed in several countries, Squid (**6007.241**) and Limbo (**6008.241**) in the UK being two examples and the Italian Menon being a third. The Menon launcher, which exists in three-barrelled and six-barrelled forms, is notable for the length of its tubes: the three-barrelled mortar can be seen aft of the twin 76/62 guns on the frigate *Cigno*. It has a range of about 1,500 metres compared with 350-1,000 metres for the two British devices. A single-barrel mortar is fitted on some Italian frigates and corvettes. This is said to have a range of about 1,000 metres and a rate of fire of 15 DCs/minute.

Another weapon in this category is the French 4-barrelled mortar. This is mounted in a turret and is automatically loaded. It fires a heavier projectile and has a longer range (about 2,750 m) than any of the others. All these mortars fire 12-inch (305 mm) depth charges.

It is believed that the Russian Navy has not adopted the streamlined form of depth charge. They do, however, use depth charge mortars, but it is thought possible that they use compressed air to propel the charge whereas other countries use an explosive cartridge.

Nuclear Depth Charges

Also introduced by the US Navy is the nuclear depth charge. To take this clear of the launch vessel a rocket is required, and these depth charges have so far been associated only with Asroc (**6001.241**) and Subroc (**1128.441**).

Multiple Short-range Rocket Launchers

Another American innovation of the Second World War was the multiple launcher for small (c. 25 kg) rockets with impact fuses. Devices of this nature are widely used by many navies and are commonly known by the name Hedgehog, which was applied to the first US 24-rocket launcher, even though they may not be of identical design. The American Hedgehog has a range of about 350 metres: a smaller 8-rocket device known as Mousetrap has a range of about 200 metres.

Medium Range Rocket Launchers

One of the most widely adopted developments of the years since the Second World War has been the medium-range (200-600 metres) anti-submarine rocket launcher. Brief details of the French system (**2057.241**) and the Swedish system (**6021.241**) on which the French system is based, are given in earlier pages; and although it differs in some important respects from these systems the Norwegian Terne system (**6022.241**) is in this general weapon category. The US Navy has also developed systems of this kind, the current one being known as Weapon Alfa – successor to Weapon Able. Many such developments have also taken place in recent years in Russia.

The next two entries give details of the widely-used Swedish Bofors 4-tube launcher and the more recent 2-tube launcher. The final entries in this section give a little information concerning Russian developments.

MANUFACTURERS:

Many weapons in this group are made at government establishments or in circumstances which prevent disclosure of manufacturers' or contractors' names. The following list names some commercial manufacturers known to have been involved – but again it is certainly not exhaustive.

Torpedoes:
France: CIT-Alcatel
Germany: AEG
Italy: Whitehead Moto Fides
UK: GEC-Marconi, Plessey, Vickers
USA: Gould (formerly Clevite), Northrop, Westinghouse

Drones and missiles:
France: Latécoère
UK: BAC, Hawker Siddeley
USA: Goodyear, Gyrodyne, Honeywell

A/S Mortars and Rockets:
France: Creusot-Loire
Italy: Whitehead Moto Fides
Japan: Mitsubishi
Sweden: Bofors

SWEDEN

2369.203
SHIPBORNE 4-TUBE ANTI-SUBMARINE ROCKET LAUNCHER

The Bofors 375 mm 4-tube anti submarine rocket launcher is electro-hydraulically driven, has an integral fixed-structure loading hoist with a rotatable rocket table and is remotely controlled.

In an emergency the launcher can be hand laid using a follow the-pointer device and the hoist can be hand operated. Otherwise remotely controlled electro-hydraulic laying machinery is used. Fuse setting is with the rocket in the tube. The rocket table holds 8 rounds. Reload time for four rockets is three minutes, and the minimum interval between firings is one second. Minimum manning complement is four men.

STATUS:

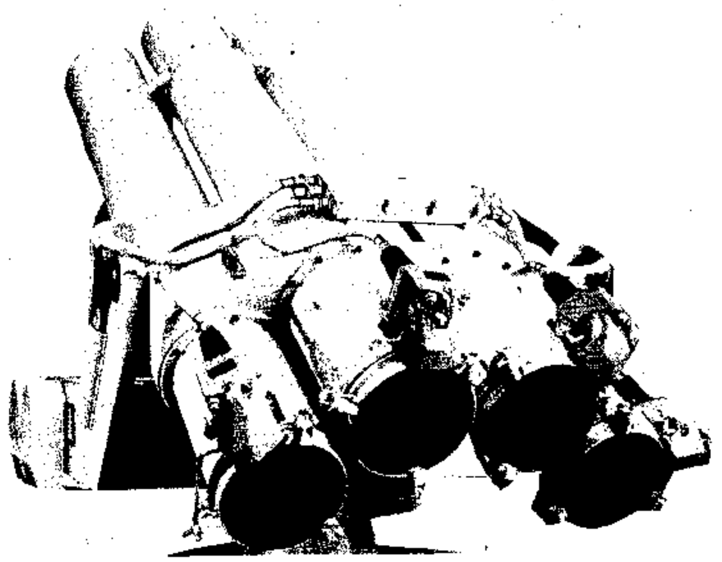
Design was started in 1948 and the launcher first went into service with the Royal Netherlands Navy – who had initiated the work – in 1954. Since then it has been supplied to the Argentine, Colombia, France, Germany, Japan, Portugal and Sweden.

CHARACTERISTICS:

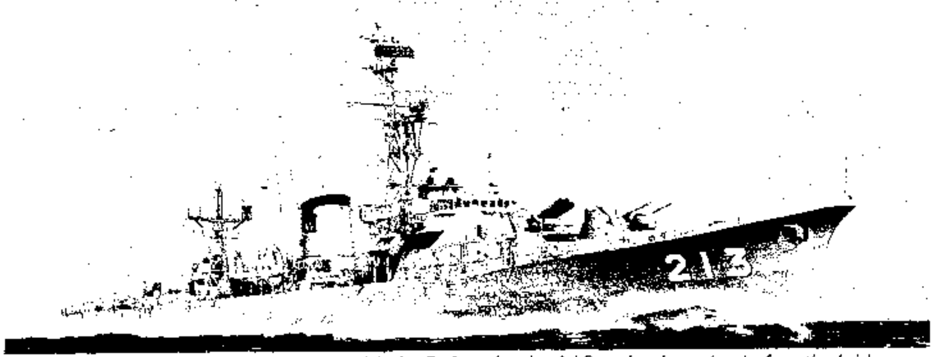
Weight, excluding rockets and flame guard: 7.3 tons
Traversing speed: 18 deg/sec
Elevating speed: 18 deg/sec
Traverse limits: +130 deg
Elevation limits: +15 to +90 deg
Power supplies: 440 V 3-phase 60 Hz
Power consumption: Loading: 6 kW
Tracking: 6 kW

MANUFACTURER:

AB Bofors, Bofors, Sweden.



Bofors 4-tube anti-submarine rocket launcher



Mogami-class Japanese frigate with the Bofors 4-tube A/S rocket launcher before the bridge. The launcher is built under licence in Japan by Mitsubishi H.I.

2368.203
SHIPBORNE 2-TUBE ANTI-SUBMARINE ROCKET LAUNCHER

This is a new Bofors rocket launcher with two launching tubes, which is currently at an advanced development stage. It has an integral motor-driven twin hoist for loading both tubes at once, and a rotating loading table. The laying mechanism is electro-hydraulic with choice of local or remote operation. Fuse setting is with the rocket in the tube. The rocket table holds four rounds and the total number of rockets in the operating room is 24. The shortest time between successive firings is one second; the time for firing six ready rockets (four on the table and two in the tubes) is one minute; and the firing rate for continuous fire is two rockets every 45 seconds – or, with an automatic loading device, one two-round salvo every 20 seconds. Minimum manning complement is three men.

CHARACTERISTICS:

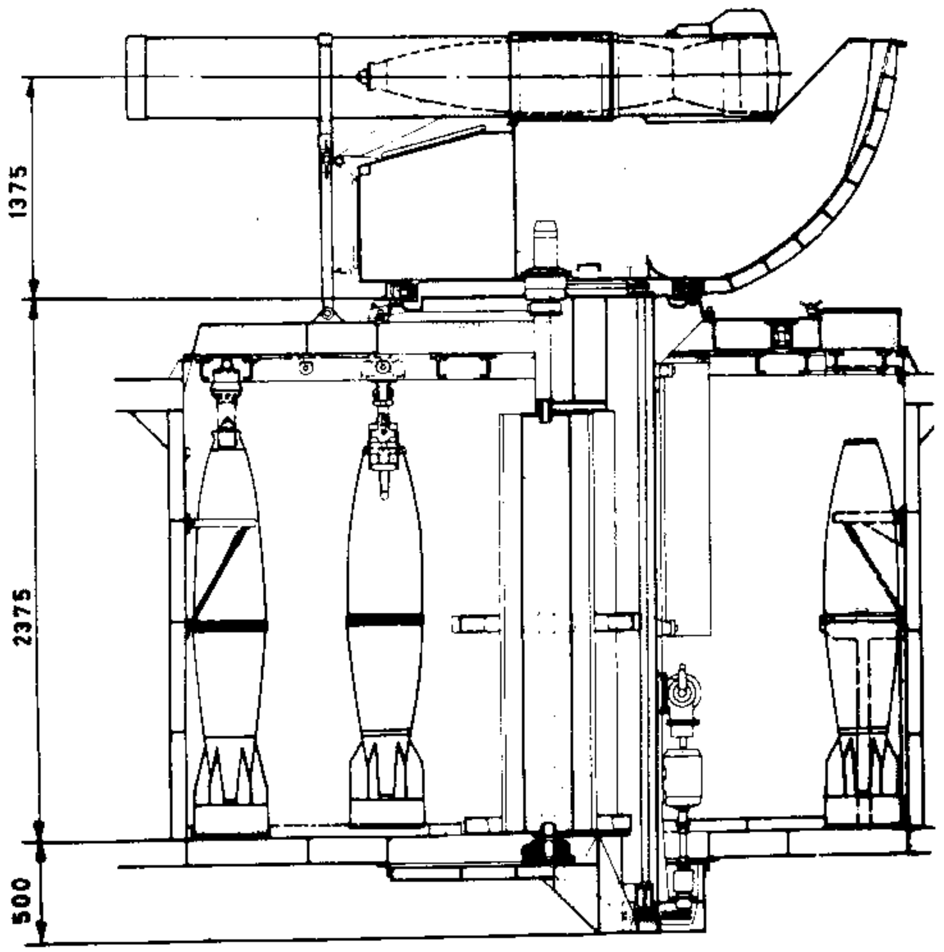
Weight, excluding rockets but including flame guard and deck plate: 3.2 tons
Traversing speed: 30 deg/sec
Elevating speed: 30 deg/sec
Traverse limits: Unlimited
Elevation limits: (Mechanical) 0 to +90 deg
Elevation limits: (For firing): 0 to +60 deg
Power supplies: 440 V 3-phase 60 Hz
Power consumption: (Mean, during tracking): 4 kW

STATUS:

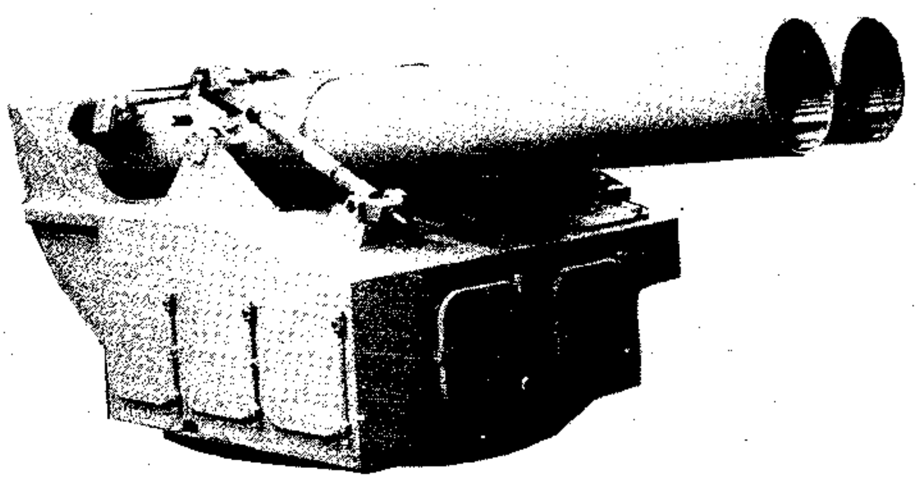
In production

MANUFACTURER:

AB Bofors, Bofors, Sweden.



Arrangement of Bofors 2 tube anti submarine rocket launcher



Bofors 2-tube anti-submarine rocket launcher

THE UNION OF SOVIET SOCIALIST REPUBLICS

6096.203
RUSSIAN ANTI-SUBMARINE ROCKET LAUNCHERS

As noted earlier in this section the Russians do not appear to have adopted the streamlined depth charge of the kind introduced by the Americans in the 1940s. Instead they appear to have leap-frogged a development stage and proceeded directly from the slow-sinking depth-charge to the medium range anti-submarine rocket.

The development of this type of weapon by the Russians was first noticed by outside observers around 1960. The earliest installation appears to have a small (150 cm long) twin launcher for rockets with a range of 6-800 m. This is found on the old "Kola" class destroyer escorts, and "Kronstadt" class submarine chasers. More recently a range of more powerful weapons has been introduced: these are described in the entries below.

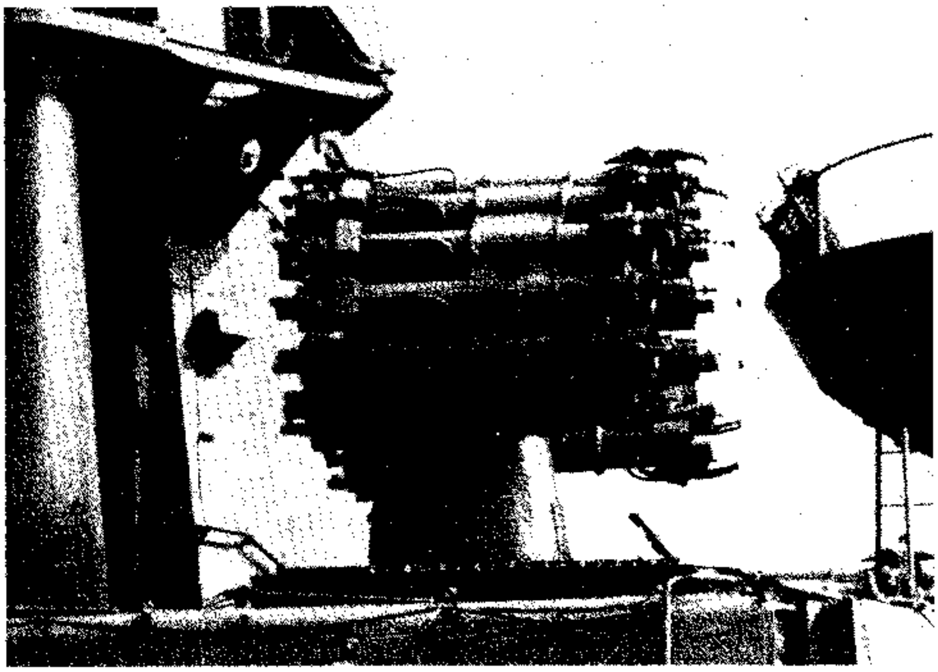
2902.203
250 mm ANTI-SUBMARINE ROCKET LAUNCHERS

DESCRIPTION:

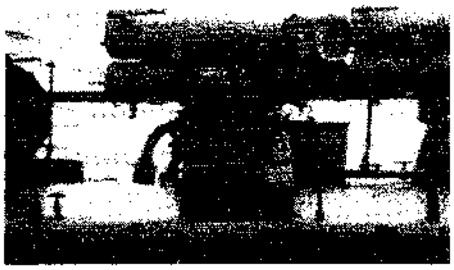
Three different types of mounting for 250 mm calibre anti-submarine rockets have been observed; and, according to one source, the performance of rockets launched from one of these – the earliest in service – is inferior to that of rockets launched from the other two.

This "inferior" model is the five-barrel launcher illustrated here. It can also be seen in action in the picture accompanying entry **6041.203**. The range of these rockets is said to be some 1,800 m; launch tube length is 180 cm – as also is that of the other two launchers.

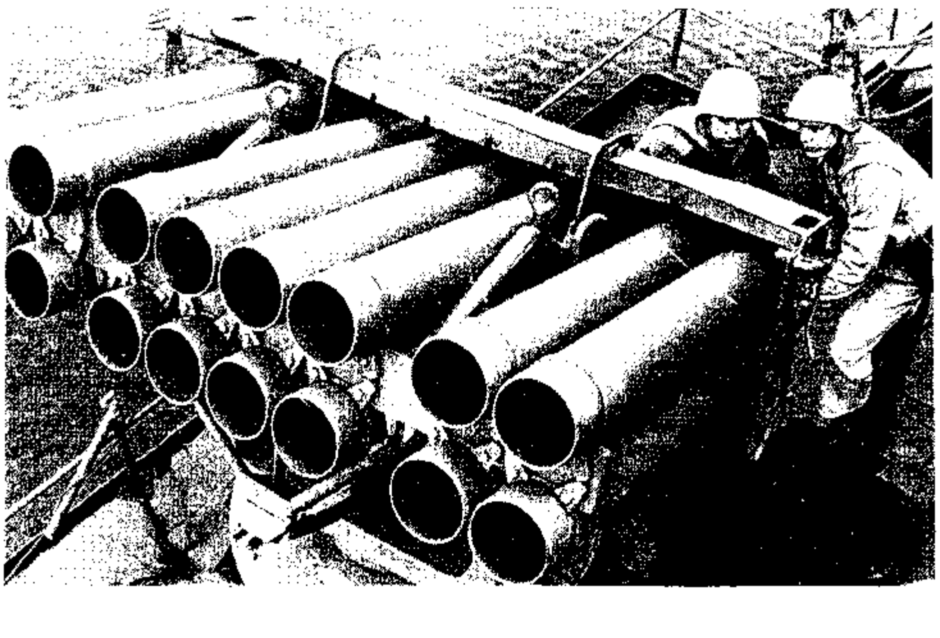
The more recent models are the 12-barrel and 16-barrel launchers illustrated here. Range of rockets launched from these launchers is said to be about 2,500 m.



12-barrel rocket launcher



5-barrel rocket launcher



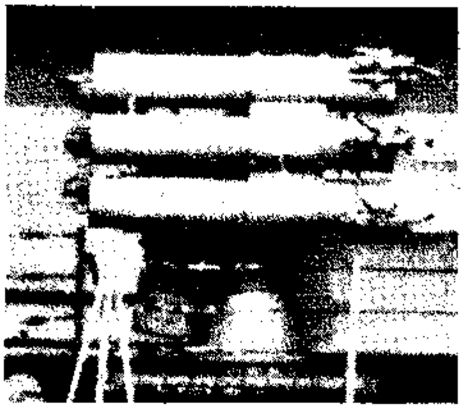
16-barrel AS rocket launcher. The Russian caption to this picture describes the weapon as a "jet-propelled depth charge thrower" (Tass)

2903.203
300 mm ANTI-SUBMARINE ROCKET LAUNCHERS

Description:

These long-range anti-submarine rocket launchers have been reported in two slightly different forms. Both are six-barrel pedestal-mounted remote-controlled mechanisms; but in one the two columns of three barrels are parallel whereas in the other the top two barrels are closer together than the other two pairs.

The range of the rockets used with these launchers has been reported as 4,500 m. If correct, this figure compares favourably with that of anti-submarine rockets currently used by NATO and neutral nations – except, of course, for ASROC.



6-barrel rocket launcher

AIRCRAFT ARMAMENT

FRANCE

1274.303
68 mm SNEB ROCKET

DESCRIPTION:

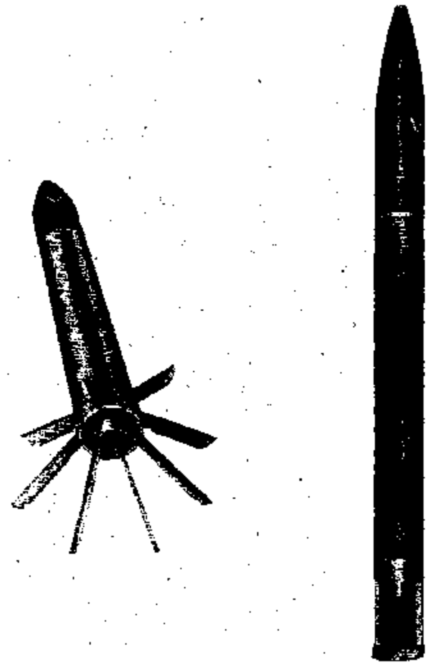
The 68 mm SNEB rocket has been developed as an air-to-ground and air-to-air weapon for subsonic and supersonic interceptor and ground attack aircraft.

The rocket is unguided and is stabilised in flight by eight folding fins. It is carried and fired from a conventional multi-tube launcher. The rocket motor gas is used to actuate the fin opening as the rocket leaves the launcher tube. In flight the fins are locked in the extended position. Fin stabilisation is supplemented by additional spinning of the rocket-flight, initially at a rate of about 30 revolutions per second. This spin is introduced by chamfering of the fin leading edges.

A variety of launchers are available for use with these rockets, for example MATRA launchers M116, M122, M150 and JL100.

Type	Length mm	Weight kg	Warhead kg	Warhead type	Velocity **m/sec	Role
250	911	5.05	1.8	Smoke	600	Practice
251P	834	4.3	1.05	Blast	800	Air-to-air
252	826	4.3	0.8	Inert*	—	Air-to-ground practice
253	911	5.05	1.8	Hollow charge and Fragmentation	600	Air-to-ground against armoured vehicles and personnel
256P	911	6.25	3.0	Fragmentation	450	Air-to-ground

*Inert warheads are available to simulate all types of operational warhead.
**Maximum velocity increment reached by rocket to be added to launching aircraft speed.



SNEB 68 mm aircraft rockets

STATUS:

In production and in service with the Royal Air Force and other air forces. Aircraft types fitted include: Mirage 3, F1 and 5, Fouga, SMB2, Mystère IV, Paris, Broussard, Ouragon, Mistral, Etendard, Milirole, Vautour, T6, T28, F84, F86, Corsair, Skyraider, G91, MB 326, Skyhawk, F-5, Phantom, HF 24, Hunter, Strikemaster, Lightning, Canberra, Buccaneer, Harrier, Jaguar.

MANUFACTURER:

Thomson-Brandt, Branche Armement et Méchanique Générale, 52, avenue des Champs-Elysées, 75008 Paris, France.

1281.303
MATRA 30 mm GUN PODS

DESCRIPTION:

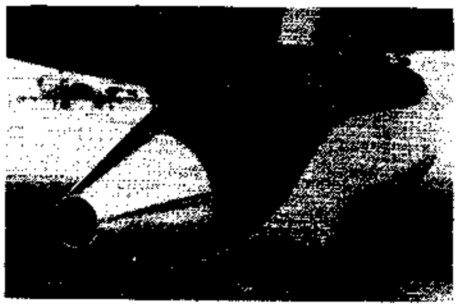
The MATRA gun pods carry a single 30 mm aircraft cannon, either DEFA type 552 or 553 or the British ADEN Mk 4. The DEFA 553 pod carries up to 400 rounds. The pod is designed to be used on subsonic or supersonic aircraft up to Mach 2 and may be fired to Mach 1.6. It is carried on standard external store racks which may be equipped for stores having twin-lug mountings at 356 mm (14 in) or 762 mm (30 in) centres.

The pod has a cylindrical body with nose and tail fairings. The 30 mm gun is mounted coaxially in the pod and is fed by standard linked ammunition contained in a rectangular cannister behind the gun. The aft compartment of the pod forms a container for spent cartridge cases which are not ejected overboard. Ammunition links are retained in the centre section of the pod. Both guns use similar electrically fired ammunition. The DEFA pod has provision for in-flight gun cocking or arming by an electrically fired pyrotechnic cartridge.

Ram air intakes are provided to purge the pod of gun gas. A shock damper is fitted to reduce the peak recoil loads transmitted to the aircraft, so that the pod is suitable for mounting on light tactical aircraft when required.

STATUS:

MATRA 30 mm gun pods have been installed on a variety of tactical aircraft including Mirage III, Macchi 326, SAAB 60 aircraft. The SA 10 pod is in service in Sweden on SAAB 105 aircraft and it will also be carried by the Viggen.



Latest version of Matra 30 mm gun pod, housing Type 553 DEFA cannon

MANUFACTURER:

SA Engins Matra, Avenue Louis Bregeut, Velizy-Villacoublay, 78-France.

1273.303
30 mm AIRCRAFT GUN DEFA 553

DEVELOPMENT:

The DEFA 553 30 mm aircraft cannon is a direct development of the DEFA 552. Its performance is similar to the 552 but design modifications have been made to improve service life and facilitate installation. A new barrel in nitro-chrome steel is used with a muzzle device to reduce muzzle pressure. Other changes have been made to simplify installation and the DEFA 553 weapon will now accept ammunition feed from either side without modification.

Other features, including in-flight recocking, correspond to the DEFA 552 model, and the same ammunition is used.

The electric control unit for the DEFA 553 provides the following facilities:

"OFF" – Firing of the gun completely inhibited.

"Continuous fire" – not normally used in action.

"0.5 second" – maximum continuous burst length 0.5 second.

"1 second" – maximum continuous burst length 1 second.

In twin installations a unit is needed for each gun and an additional control and junction box providing:

Position 1 – both guns inhibited.

Position 2 – continuous fire, both guns.

Position 3 – both guns in burst lengths (which may be different) set into each individual control unit.

Position 4 – gun camera switched on.

STATUS:

The cannon DEFA 553 is in production. It equips the Mirage F1 and Jaguar, and its use on the Alpha-jet is foreseen.

MANUFACTURER:

Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.

1271.303
30 mm AIRCRAFT GUN DEFA 552A

DESCRIPTION:

The 30 mm DEFA gun is the French development of the German Mauser revolver gun principle and is similar to, and virtually interchangeable with the British ADEN Mk 4. Over 10,000 units have been manufactured and the gun has been proved in combat in a number of theatres. Since 1971, a long-life version has been developed, called Canon Automatique de 30 mm, 550-F2A (DEFA 552A) which replaces the gun type 552, with which it is directly interchangeable.

The principal characteristics of the DEFA 552 and the DEFA 552A are light weight, a rate of fire of 1,200 rounds per minute and provision for automatic re-cocking in the event of a stoppage. The gun uses 30 mm ammunition developed for the DEFA/ADEN weapons which is available in the usual variety of types – armour piercing, HE incendiary, etc. Belted ammunition may be fed to either side of the gun. Spent cases are ejected from the same side of the weapon as accepts the feed. Links are ejected on the opposite side. The ammunition is electrically ignited.

The DEFA 552 revolver gun incorporates safety devices to ensure that firing is impossible unless the cartridge is in the firing position and the control slide, which carries the round firing contact, is in the forward position. In operation the whole gun recoils about 12 mm. On the ground a special device is used to cock the gun by hand. A single pyrotechnic cartridge is provided for automatic recocking during firing if a stoppage should occur.

STATUS:

The DEFA 552 and DEFA 552A cannon is in service with the French Air Force, the Israeli Air Force and others throughout the world. Two 552s are standard equipment on all Mirage III and Mirage V aircraft.

MANUFACTURER

Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.

1275.303
AIRCRAFT GUN 20 mm M.621

DESCRIPTION:

The Type 621 20 mm cannon is a versatile weapon developed in France by Manufacture Nationale d'Armes de Tulle, the national armaments factory. The weapon is particularly suitable for helicopter mounting because of its light weight and low recoil forces.

The Type 621 utilises 20 mm ammunition which is interchangeable with the US M.56 series used in Vulcan cannon. It is electrically ignited and a full range of types is available – armour piercing, incendiary, and fragmentation. Steel and brass cartridge case versions are manufactured. On firing, cases and links are ejected from the gun either downward or to the side according to installation.

Provision is made for left or right hand belt feed, and for special application ammunition of different types can be fed to each side of the gun and selected at will by the gunner. The rate of fire is either 300 or 740 rounds per minute. Provision can also be made for firing single shots.

Initial cocking of the gun is by cable, but provision is made for automatic recocking by pyrotechnic cartridge. This is available once only and is automatically triggered after a 0.3 second delay in firing. While firing the whole gun mechanism including the barrel recoils, sliding on guide rails which are part of the mount cradle.

A variety of accessories and mountings are available to adapt the M.621 to different applications. For helicopters a pintle mount is used with shields for the gunner, chutes for spent cases and links and a reflector sight mounted above the breech mechanism. In applications where minimum recoil force is essential, a muzzle brake can be fitted in place of the flash eliminator. By this means, and using a shock absorbing mounting, the average recoil force can be reduced from 400 kg to 250 kg.

CHARACTERISTICS:

Calibre: 20 mm
Gun weight: 47 kg
Muzzle velocity: 980-1,030 metres/second
Rate of fire: 740 or 300 rounds per minute
Accuracy: 80% rounds inside 2 mils (hard gun mount)
Length: 2,207 mm
Round weight: .32 kg
Projectile weight: 0.1 kg
Range*: over 1,500 metres
Average recoil force: 400 kg
*gun stationary

STATUS:

The M.621 is in production in France. Trial installations have been made in Alouette III and other helicopters. The 20 mm M.621 is also used in ground applications.

MANUFACTURER:

Groupement Industriel des Armements Terrestres (GIAT), 10, Place Georges Clémenceau, 92211-Saint-Cloud, France.

1509.303
GIBOULEE DISPENSER

DESCRIPTION:

Giboulée is a bomblet dispensing system developed in France by Thomson-Brandt in co-operation with Engins Matra and La Technique Electronique. Thomson-Brandt are the prime contractors responsible for the system with Matra contributing the container and installation design and La Technique Electronique the control units and timing system for the dispensing tubes.

Giboulée, in common with other similar systems, has been developed to increase the effectiveness of low altitude attacks on vehicles including tanks. The system consists of 12 or 24 launching tubes each of 50 mm bore contained in a streamlined pod for under-wing or under-fuselage mounting. Each tube carries five projectiles which are launched rearward successively initiated by a timing system. The tubes are aligned in azimuth at different angles to the pod axis and the effect of this aiming in azimuth and the forward speed of the aircraft is to distribute the bomblets uniformly in the target area. The launch velocity is 230 m/sec (450 kt) and should be matched by the aircraft speed if maximum effectiveness is to be achieved.

In typical conditions using a ventral pod having 24 tubes, each with five bomblets, the area covered is 100 m long by 20 m wide, the impact points of the bomblets being distributed on a rectangular mesh 4 m by 3.3 m. This high-density of distribution is optimum for the anti tank role. For anti-personnel use the pilot may operate a switch to lengthen the interval between successive bomblet firing so as to increase the size of the ground pattern by about four times to give impact points distributed over an area 300 m by 20 m.

Each bomblet weighs 0.7 kg and contains 100 gm of explosive. They are fitted with rear stabilising surfaces in the form of drag vanes attached to a closed end cap. This cap is coupled to the body of the projectile by a coil spring which deploys on launch. By these means the bomblet assumes a vertical attitude a few metres behind the point of launch and it falls to strike the ground or its target with zero forward speed.

Each bomblet is armed 1 second after launch and is fused to explode on impact. For the anti-tank role hollow charge bomblets are used which are capable of penetrating 250 mm of steel. Fragmentation bomblets are used for the anti-personnel role or for attack on soft skinned vehicles. Practice bomblets are also available either inert or fitted with flash charges to indicate impact.

The pilot's control box for Giboulée provides for the selection of anti-tank or anti-personnel patterns, the jettison of charges unarmed and to fire missiles with a time delay. This delay can be either 0.33 sec after the target has passed below the nose of the attacking aircraft or can be pre-set to a value corresponding with pre-determined launch conditions for a dive attack. The pilot also has the option to make two attacks, each with half his total bomblet load.

Specification:
Giboulée pod: Rectangular cross section with rounded corners and nose fairing
Size: 400 × 700 × 3,850 mm long
Weight: 490 kg
No. of tubes: 24
No. of bomblets: 120

STATUS:

Development initiated in 1966. Giboulée is due to enter service in France shortly on Mirage 4, Jaguar and F1 aircraft.

PRIME CONTRACTOR:

Thomson-Brandt Branche Armement et Mécanique Générale, 52 avenue des Champs-Elysées, 75008 Paris, France.

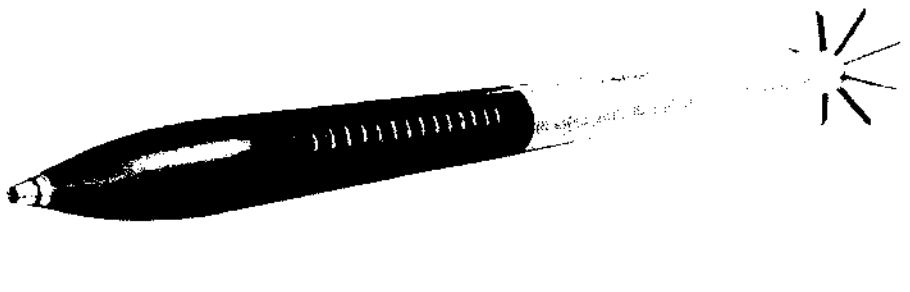
1510.303
THOMSON-BRANDT 100 mm AIRCRAFT ROCKET

DESCRIPTION:

The 100 mm Hotchkiss Brandt aircraft rocket has been designed as a larger calibre, longer range and higher lethality alternative to the well known 68 mm SNEB rocket. The principles of the 68 mm design including the stabilising system and warhead have been followed in this new design. A six tube launcher has been developed by Matra and is referred to in entry **1511.393**. Six versions of the 100 mm rocket have been developed, the only difference between them being the warhead type. All versions have the same dimensions, weight and ballistic properties.

CHARACTERISTICS

Calibre: 100 mm



Thomson-Brandt 100 mm aircraft rocket

Length: 2,480 mm
Weight: 38 kg
Warhead weight: 14 kg
Velocity: 760 m/sec gain over launch velocity
Typical firing range: 2,000 3,000 m
Time of flight to 2,500 m at launch velocity of

276 m sec (500 kt): 3 sec
Dispersion: Standard error 2 milliradian
Warhead:
EAP: General purpose fragmentation
ECC: Hollow charge armour piercing penetration 600 mm armour
ESP: Semi-AP hard cone – penetration 150 mm armour
DEM: Demolition, delayed action fuse, armour penetration 60 mm, sand – 5 m, concrete – 0.3 m
LUM: Flare, 60 second burning time, 750,000 candlepower
IN: Inert

STATUS:
Under development.

MANUFACTURER:
Thomson Brandt, Branche Armement et Méchanique Générale, 52, avenue des Champs-Elysées, 75008 Paris, France.

1599.393
ALKAN TYPE PM3 BOMB RACK

DESCRIPTION:
The PM3 bomb rack manufactured by Alkan is intended for tandem ejection of two stores fitted with 14-inch lugs and a maximum of 500 kg weight. The rack has a forward and trailing carrying section, each of which has a pyrotechnic ejector Alkan Type 257 and a twin fusing unit mechanically linked to the ejector. Each ejector contains a check device to ensure proper engagement of the store. Two pyrotechnic initiators type 28 are electrically activated to provide power for unlocking and ejection.

STATUS:
Installed in Mirage III and M5 aircraft.

MANUFACTURER:
Alkan & Cie, Rue d'Yerres, 94-Valenton, France.

Alkan type PM3 bomb rack

1598.393
ALKAN TYPE 65 BOMB-RACK ADAPTOR

DESCRIPTION
In order to use pylons, originally designed for large bombs, to be used for small bombs, Alkan have developed the Type 65 adaptor in which three small active or practice stores can be held. Three suspension rings give attachment to any rack or pylon with 14 inch (355.5 mm) lug spacing. There are three types of release mechanism; an electro-mechanical unit in which the bomb is released in free fall by an electrical impulse, a pyrotechnic unit in which the bomb is ejected, and the third type is a clamp for ringless bombs where an ejector opens the clamp and ejects the bomb. The weight of the adaptor is from 32 to 40 kg, according to ancillary fittings.

MANUFACTURER:
Alkan & Cie, Rue d'Yerres, 94-Valenton, France.

Alkan type 65 bomb rack adaptor

7503.393
ALKAN TYPE 500-OM BOMB RACK

DESCRIPTION:
Capable of carrying numerous types of bombs, as well as various packs, tanks, containers, cartridge launchers, and adaptors for bombs or missiles, its installation on the aircraft is simple, consisting of four mounting bolts.

Electro-mechanical stores release is initiated through the aircraft electrical system (24 V DC).

A special version may be adapted for rocket launching. The rocket carrying centre section can be housed in the tail end of the bomb rack so that rocket launching may be followed up immediately with a bombing mission, or vice versa, without any need to return to base in between.

Weight of the bomb rack ranges from 21 to 34 kg depending on the version.

MANUFACTURER:
Alkan & Cie, Rue d'Yerres, 94-Valenton.

7504.393
TYPE 10B SONO-BUOY ADAPTOR

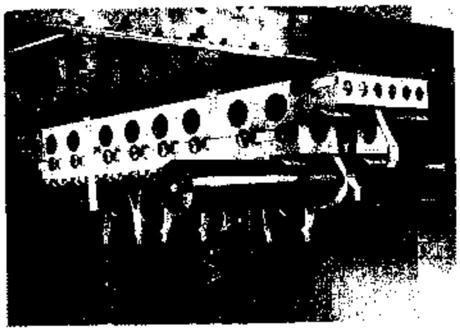
DESCRIPTION:
Intended for the carrying and the releasing of 10 omnidirectional sono-buoys. It is mounted in the bomb-bay of the Breguet 1150 "Atlantic".

It features a rigid light alloy framework fitted with 10 independent and similar carrying and releasing devices: each of these includes two sets of fixed pads for accommodating a buoy and used as rests; a strap which retains the buoy when in the latched position; adjustable in height, with respect to the pads, through an individual handwheel, which provides for the shimming of the buoy against its rests: an electro-magnetic release unit, which is cocked prior to the positioning of the buoy causes the strap to be unlatched, and the buoy to be released: a store-loaded indicator.

The release sequence of the buoys can be selected in flight and is reported through a signalling device.

Sono-buoy adaptor frameworks are produced for different types of aircraft or for different sono-buoys numbers, dimensions and shapes.

MANUFACTURER
Alkan & Cie, Rue d'Yerres, 94-Valenton.



Type 10B sono-buoy adaptor

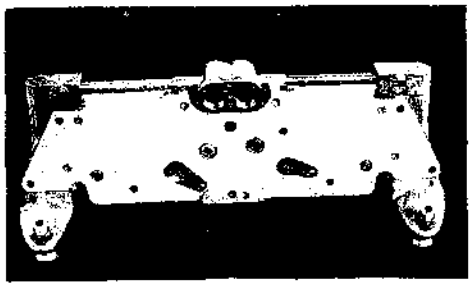
1600.393
ALKAN STORES EJECTORS

DESCRIPTION:
Despite differences which may appear in their design, configuration and performance, all Alkan ejectors are based on the same principle and have the same basic function. They rely upon pyrotechnic devices to power the release and ejection mechanisms. Pyrotechnic energy is transmitted to two pistons, the purpose of which is to eject the stores at the same time as they are released. The thrust on each piston can be adjusted to ensure correct attitude at the initiation of the store trajectory. Ejectors can be fitted with retractable pistons, thereby significantly reducing the drag of the unit. All components of the pyrotechnic device are designed for easy removal and maintenance.

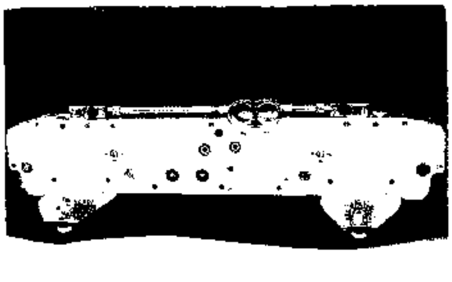
Integral construction has been adopted, and each unit consists of two half-shells machined from the solid metal, ensuring maximum rigidity. The mechanical assembly is attached to one half of the shell and the other forms a quickly removed inspection and maintenance cover for the ejector mechanism. Locking and unlocking of the actuators are affected by a special toggle joint which is designed to eliminated the need for excessive force due to the weight of the stores attached to the hooks. As a result, the mechanism operation is quite safe and almost independent of the stresses applied to the hooks. The manual locking and release controls are separated so that inadvertant unlocking cannot occur. Additionally, safety pins are provided for visual safety checking.

It is noted that all Alkan ejectors are designed so that the arming devices of the fuse arming wires included or associated with the ejectors are mechanically locked in the closed position when the hooks are closed and loaded.

The Alkan ejectors are delivered with or without sway braces with store pads which can accommodate stores from 180 to 680 mm diameter. Specific ejectors are fitted with two pairs of hooks, all interlinked, thus enabling the ejector to accept stores which have twin suspension at 14-in or 30-in centres.



Alkan Type 105 Ejector

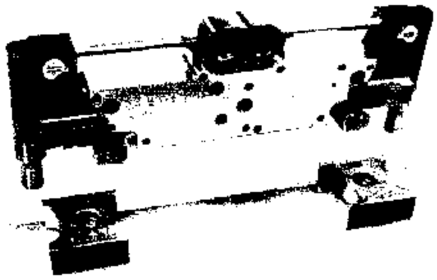


Alkan Type 115 Ejector

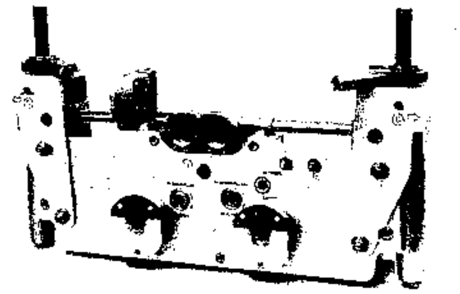
The new generation Alkan ejectors, Type 132 and Type 145, have been designed to solve the problem of store diameter, and are equipped with double hooks and a store chocking system consisting of four independent spring-loaded wedges. The double hooks engage special saddle adapters attached to the store, and the spring-loaded wedges bear upon the upper surface of the saddle adapters to take up all clearance as the hooks are closed. As a result of the elimination of the crutch arms, these new ejectors have low drag, and are designated Minimum Drag Ejectors. The adjacent table summaries the various versions.

MANUFACTURER:

Société R. Alkan and Co, Rue du 8 mai 1945, 94460-Valenton, France.

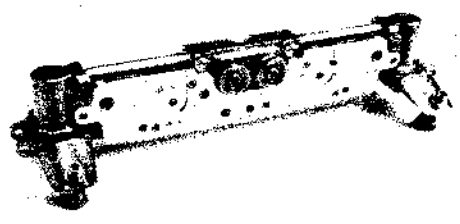


Alkan Type 132 Ejector



Alkan Type 101 Ejector

Alkan Type 145 Ejector



Alkan Type 165 Ejector

ALKAN TWIN-SUSPENSION EJECTORS

Alkan Twin Suspension	Conventional Ejectors				Minimum Drag Ejectors	
Ejectors	101 (1)	105	115	165 (2)	132	145
Fusing unit control	included	associated	associated	associated	included	included
Transfer/signalisation	included	associated	associated	associated	included	included
Store chocking	crutch arms with pads	crutch arms with pads	crutch arms with pads	crutch arms	chocking wedges	chocking wedges
Store suspension devices and interval	2 lugs 14 in	2 lugs 14 in	2 lugs 14 in or 2 lugs 30 in	2 lugs 14 in	2 saddles 14 in	2 saddles 14in 2 saddles 30 in
Store diameters	according to adaptor	200 to 480	120 to 680	200 to 485	no limit	no limit
Ultimate load per hook in daN.	10,000	13,000	10,600 (14 in) 20,200 (30 in)	1,200		
or rolling moments in m.daN.					3,000	3,000 (14 in) 4,000 (30 in)
Weight (in Kg)	8.8	9.7	19.2	7	9.2	26.5

(1) Specially designed for the Marcel Dassault fuel tank-bomb carrier RPK

(2) Specially designed for adaptors, can also be used as releaser, Height 88 mm, width 46 mm, length 522 mm.

1514.393

MATRA TYPE 200 BOMB RETARDING SYSTEM

DESCRIPTION:

The MATRA Type 200 bomb retarding system was approved for use by the French Air Force in 1964. It can be used with SAMP made 250 and 400 kg GP bombs. The equipment consists of a cruciform nylon parachute packed into a container within the tail of the bomb, together with the appropriate fusing equipment according to the mission being flown and the characteristics of the retarding system. In typical operations the bomb is released at an altitude of about 30 m (100 ft) at a forward speed of between 400 and 600 kt. The bomb will then hit its target, exploding on impact, at a time when the attacking aircraft is about 480 m (1500 ft) ahead of the explosion. This ensures complete safety for the attacker. Provision can be made before loading the weapon on to the aircraft to adjust the fuse operation for different release conditions.

Matra retarded bomb immediately after release

Comprehensive safety provisions are made in the MATRA 200 system. The parachute is locked to the bomb body only after release has taken place, so that should the parachute deploy while the weapon is still being carried by the aircraft it will pull away before dangerous turning moments are built up by the drag of the 'chute'. Similarly the parachute does not open until it is well clear of the aircraft. Provision is also made for the parachute to rotate with respect to the bomb while it is in flight eliminating the possibility of parachute twist.

Nose and tail fuses are fitted with the retarding mechanism. These normally operate in the 'instantaneous' mode unless safety requirements are not met, i.e. when parachute functioning, release altitude and release speed are all correct. If safety requirements are not met then there is a danger that the attacking aircraft will be damaged by the bomb explosion, and the fuse is automatically set to operate after a delay of 15 seconds. Provision is made within the fuse to prevent inadvertent instantaneous explosion in the case of a richochet when conditions required for normal operation have not been met and the system is operating within 15 seconds delay.

STATUS
In production and in service with the French and other Air Forces.

MANUFACTURER:
Engins MATRA, BP No. 1, Avenue Louis Breguet, 78-Velizy, France.

7507.393
ALKAN UNIVERSAL ADAPTOR TYPE F.1

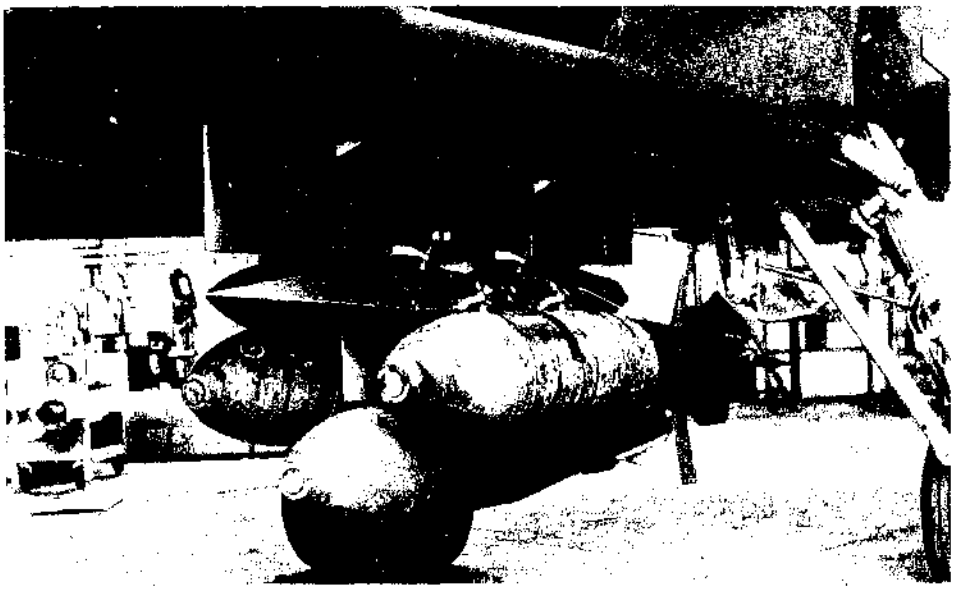
DESCRIPTION:
It can be hooked under bomb-releasers fitted with 14 inch spaced lugs (NATO type 500) or 30 inch spaced lugs (NATO type 1,000) and consists of a two-post streamlined main chassis and a removable lower bomb-release, which permits the carrying and shot-by-shot releasing of two or three stores (bombs, rocket-launchers) depending upon the case.

Each carrying and ejection system features an Alkan pyrotechnic ejector type 105, intended for the carrying of stores fitted with 14-inch spaced lugs; two Alkan fusing unit electrical devices type SL 60, which are mechanically locked when the ejector is on the "ARMED" position; signalling and firing transfer devices which are controlled by the ejectors and permit the stores to be ejected according to a preselected order; and a safety pin.

The electrical supply is normally made through a connector which is positioned according to NATO standards. The rocket-launchers which can be laterally positioned are normally fed through a pull-off connector located on each post.

Access to all the services of the adaptor and its ejectors is from the outside.

MANUFACTURER:
Alkan & Cie, Rue d'Yerres, 94-Valenton, France.



Alkan universal adaptor Type F1 on Jaguar aircraft and carrying three 250 kg bombs

MAIN DETAILS

	2 Posts	3 Posts
Length	2,150 mm	1,250 mm
Width	444 mm	444 mm
Height	184 mm	354 mm
Allowable stores		
Diameters	200 to 480 mm	200 to 360 mm
Typical loads	2 × 1,000 lb	3 × 500 lb

7508.393
JAGUAR & MIRAGE F1 WEAPON PYLONS

DESCRIPTION:
The five pylons developed by Alkan for the armament of the Jaguar are of three types, depending on their location on the aircraft: 1. one central pylon, under the fuselage; 2. two inboard pylons, under the wing; 3. two outboard pylons, under the wing.

These carry heavy stores such as bombs, rocket-launchers, tanks, various adaptors and containers.

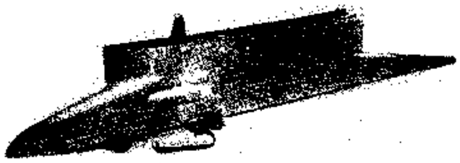
The fixed pylons are built from two light-alloy integrated-structure shells and they are fitted with an Alkan pyrotechnic ejector of the same structure and featuring two embodied crutches.

The pylons accommodate the whole electrical system as well as the fusing unit devices, the latter remaining locked when the ejector hooks are closed, due to a linkage with the ejector mechanism. They feature "adaptor" and "rocket-launcher" connectors.

The central and inboard pylon accommodate an ejector type 115 with two sets of hooks (14-inch and 30-inch spaced). They are intended for stores up to 1,000 kg in the normal operational utilisation of modern aircraft. In addition, they feature a transfer and signalling electrical system which is mechanically controlled by the ejector mechanism, and the services for the fuel cross-feed.

The outboard pylons accommodate an ejector type 105 with one set of 14-inch spaced hooks, and they are intended for stores up to 500 kg. A similar set of pylons and ejectors of the same design has been developed by Alkan and Company for the Mirage F1

MANUFACTURER:
Alkan & Cie, Rue d'Yerres, 94-Valenton, France.

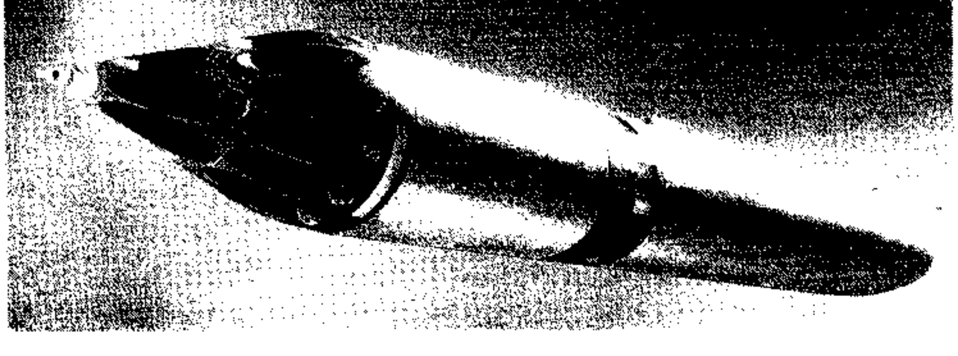


Alkan inboard pylon for Mirage F1, showing external and internal arrangement

1511.393
MATRA UNGUIDED AIRCRAFT ROCKET LAUNCHERS

DESCRIPTION:
The MATRA company in France have specialised in the design and manufacture of unguided aircraft rocket launchers. All calibres including the British 2 in rocket are catered for and Matra launchers are in widespread use. They have been adopted by NATO and are manufactured under licence in a number of countries.

Although the range of the launchers is wide they all embody similar design principles. The construction is in the form of a faired tube which, when charged with rockets, forms an aerodynamically smooth pod for external carriage under the wings or fuselage of fighter aircraft at high and low altitude. Provision is made to insulate the rocket pro-



Matra 100 mm Rocket Launcher

pulsion motors from thermal effects. Comprehensive safety provisions are built in to the electrical rocket firing systems.

Recent developments include a series of expendable launchers which are used once only and then jettisoned. Further flexibility is provided by launchers combined with an external fuel tank.

STATUS:

In production and in service with a large number of air forces. UK requirements are met by manufacture to Matra designs by Thomas French & Sons (Engineering) Ltd.

MANUFACTURERS:

SA Engins Matra, Avenue Louis Breguet, 78-Velizy Villacoublay, France.

Thomas French and Sons (Engineering) Ltd, 59 St James's Street, London SW1.

Matra LR 100 rocket launcher in use on RAF Phantom

1683.393

ALKAN CARTRIDGE LAUNCHERS

DESCRIPTION:

The Alkan company produces a range of launchers for the carriage and launching of 40 mm and 74 mm diameter cartridges of various types, such as flare, photo-flash, anti-personnel, chaff etc. Others are produced for the use of 45 mm or 1.75 inch diameter target illumination flares. These launchers consist essentially of a chassis supporting a breech, a relay unit, and a number of magazines containing the cartridges or flares. These components are disposed so that the overall equipment can be configured for either integral construction with the airframe or for mounting on aircraft stores pylons. Typical examples are shown in the accompanying illustrations.

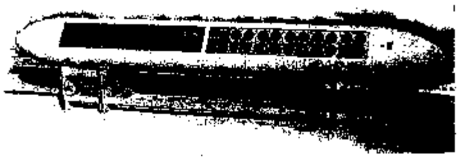
Designed for mounting on aircraft weapon pylons, the Type 501 is intended for NATO standard 14 inch spaced hooks. The central part of the body carries the suspension system, and there are three positions providing for central, and 12 degrees left or right tilt to give increased lateral ground cover. This central part houses the single magazine for 28 cartridges. A Type T 30 distribution box is located in the front container shell and this can incorporate a ground-adjustable sequential timer for various firing sequences. Contact pins for the cartridge firing lines are located on the flat bottom part of the body along with the ground test connector. A safety switch, ground locked with a safety pin, is actuated at take-off by the airstream.

STATUS:

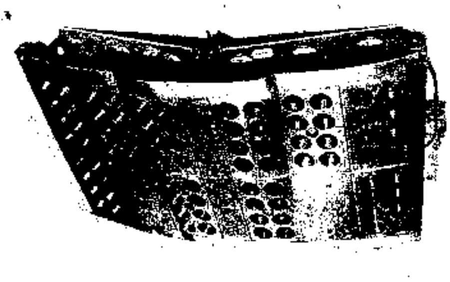
In production in various models for many types of French and other national air forces.

MANUFACTURER:

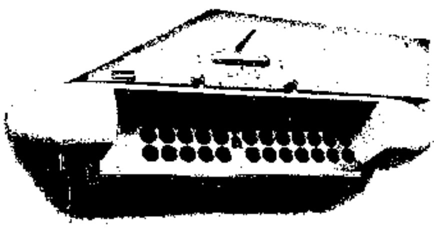
Société R Alkan et Cie, Rue du 8 mai 1945, 94460-Valenton, France.



Alkan Type LC III cartridge launcher as used on Etendard



Alkan Type 80-74 flare launcher for Mirage III



Alkan Type 501 cartridge launcher

1682.393

ALKAN ASW AIRCRAFT ARMAMENT EQUIPMENT

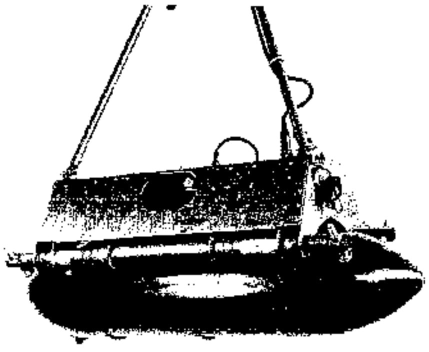
DESCRIPTION:

Alkan Torpedo Racks Types 541 and 542 are designed for anti-submarine warfare and specially for mounting on a vertical frame, as for example on a helicopter, by means of tension rods. The Type 541 can carry a 1,200 lb torpedo, and the Type 542 is intended to carry two of 600 lb each. A sealed electrical system and other measures enable the equipment to withstand sea water immersion. The racks are provided with one or two, as appropriate, release units Type 540. Both versions of the complete torpedo rack are shown in the accompanying illustrations.

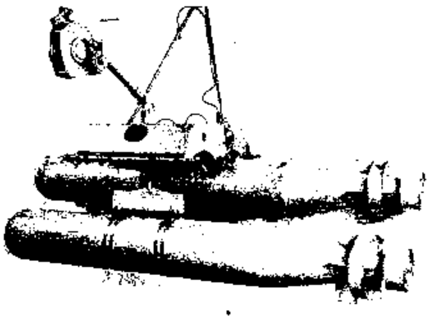
The Alkan Type J SD launcher is used for the deployment of sonar explosive sound generators for ASW operations by aircraft. The unit consists of a light alloy chassis, a number of launcher mechanisms and magazines, and a control panel. Up to 24 generators of American or French pattern can be carried. Each launcher incorporates a perforation system, which in the case of French stores allows either of two burst depths to be selected at the control panel. This equipment is fitted to the Breguet 1050 Atlantic maritime aircraft.

MANUFACTURER

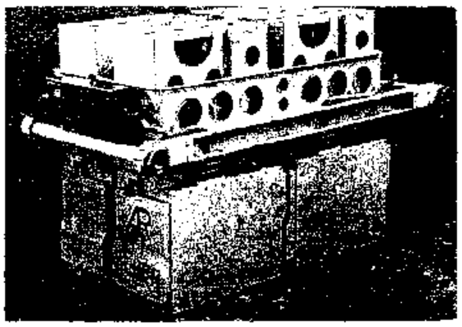
Société R Alkan et Cie, Rue du 8 mai 1945, 94460-Valenton, France.



Alkan Type 541 torpedo rack



Alkan Type 542 torpedo rack



Alkan sound-bomb dispenser unit as fitted to Atlantic maritime aircraft

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GERMANY (FEDERAL REPUBLIC)

1512.303

STREUWAFFEN

DESCRIPTION

The Federal Republic of Germany, like Great Britain, France and the US is developing airborne bomblet dispensing systems. One consists of a streamlined pod containing 19 launcher tubes which contain 409 0.5 kg bomblets. Each bomblet is equipped with six spring loaded stabilising fins and the whole load can be ejected in a short interval so that a high density can be achieved on the ground. References have been made to this weapon under the name Dragon Seed. The bomblet pod is equipped with standard weapon suspension lugs and is compatible with all Luftwaffe tactical aircraft.

ITALY

1696.393
2 IN ARF/8M2 ROCKET

DESCRIPTION:

The 2-in ARF/8M2 air-to-ground rocket is an intermediate weapon system between machine gun and 2.75 in rockets, developed in order to provide efficient action by aircraft and helicopters, with a single weapon system, against small defence posts, scattered troops, surface transportation and general hard targets.

The main characteristics of this system are the following:

Low weight, such as the total number of rounds per aircraft or helicopter is substantially increased (120 rockets for a total weight, including launchers, of less than 700 kg).

Excellent accuracy, obtained with a special patented free rotating folded fin assembly which opening (by the action of an elastic, inertial and aerodynamic system) is completed 25 ms after firing and with free spinning, induced by gas deflectors in the nozzle, of the rocket body on its longitudinal axis.

Different types of warheads (HEI, high explosive incendiary, or API, armour piercing incendiary) assure firing efficiency against varied ground targets, whether protected or otherwise.

The following three different launchers (developed and manufactured by SIMPRES), fitted beneath the wings in sets of 2 or 4, can be used:

a) 7 rounds, for training;

SPECIFICATIONS:

Rockets	HEI Warhead		API Warhead
Diameter:		51 mm	
Length:	927 mm		1,002 mm
Weight:	3,567 kg		3,792 kg
Combustion time: (−30°C to +50°C)		1.1 ± 0.1 sec	
Total impulse: (−30°C to +50°C)		220 ± 6 kg/sec	
Max pressure:		120 kg/cm^2	
Burn out velocity:		700 m/s	
Time to target at 1,000 m/s:		2.15 ± 0.05	
Average dispersal:		10 mils	
Launchers:	25 rounds		30 rounds
Outside diameter:	39.5 cm		39 cm
Max length (in flight):	204 cm		180 cm
Weight without rockets	46 kg		73 kg
Weight in flight configuration (HEI rockets):	135 kg		165 kg

b) 25 rounds, for fighting, reusable for up to 10 missions;
c) 30 rounds, for fighting, reusable for up to 100 missions.

Inert warheads are available.

Four fins are folded within the diameter enabling the rocket to be fired from a tubular launcher.

STATUS:

In production and in service with the Italian Air Force and other air forces.

MANUFACTURER:

SNIA Viscosa, Defense and Aerospace Division, Via Lombardia 31, 00187 Rome, Italy.

SPAIN

1839.303
CASA TYPE 06.070 ROCKET LAUNCHER

DESCRIPTION:

This reusable rocket-launcher is designed to carry and launch six FFAR 2.75" 170 mm or six INTA S-11 rockets. It can be installed in any pylon type provided with the standard NATO suspension system (14"). Basic and low-drag versions are produced.

OPERATION:

Rocket firing is by means of an electronic intervalometer incorporated in the rocket-launcher. Single rocket firing or ripple firing is selected by the pilot in the cockpit or by adjusting the mode selector incorporated in the launcher. Rate of fire according to a firing interval of 30 milliseconds (The intervalometer can be adjusted for a different firing rate upon request).

DIMENSIONS:

Basic Model:
Length: 1.24 m
Diameter: 25 cm
Weight (Empty): 14.8 kg
Weight (Loaded): 63.6 kg

Low Drag Model:
Length: 1.9 m
Diameter: 25 cm
Weight (Empty): 17.8 kg
Weight (Loaded): 66.6 kg

CASA 06.070 Launcher

MANUFACTURER:

Construcciones Aeronauticas SA, Rey Francisco 4, Madrid-8, Spain.

1840.303
CASA TYPE 18.037 ROCKET LAUNCHER

DESCRIPTION:

This re-usable rocket-launcher is designed to carry and launch 18 INTA S9 37 mm rockets. It can be installed in any pylon type provided with the standard NATO suspension system (14"). Basic and low-drag models are produced.

OPERATION:

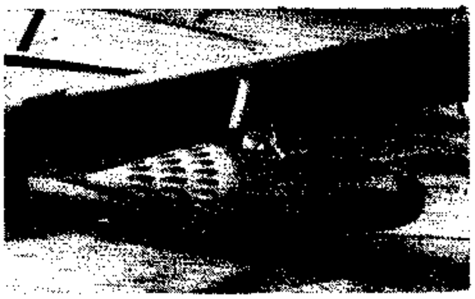
Rocket firing is by means of an electronic intervalometer incorporated in the rocket-launcher. Single rocket firing or ripple firing is selected by the pilot in the cockpit or can be adjusted by the mode selector incorporated in the launcher. Rate of fire according to a firing interval of 30 miliseconds (The intervalometer can be adjusted for a different firing rate upon request).

DIMENSIONS:

Basic Model:
Length: 1.24 m
Diameter: 25 cm
Weight (Empty): 15.7 kg
Weight (Loaded): 35 kg
Low-Drag Model:
Length: 1.9 m
Diameter: 25 cm
Weight (Empty): 19.3 kg
Weight (Loaded): 38.6 kg

MANUFACTURER:

Construcciones Aeronauticas SA, Rey Francisco 4, Madrid-8, Spain.



CASA Rocket Launcher type 18.037

1841.303
CASA TYPE 18.070 ROCKET LAUNCHER

DESCRIPTION:

This reusable rocket-launcher is designed to carry and launch 18 FFAR 2.75" (70 mm) or 18 INTA S11 rockets. It can be installed in any pylon type provided with the standard NATO suspension system (14"). Basic and low-drag versions are produced.

OPERATION:

Rocket firing is by means of an electronic intervalometer incorporated in the rocket launcher. Single rocket firing or ripple firing can be selected by the pilot in the cockpit or by adjusting the mode selector incorporated in the launcher. Rate of fire according to a firing interval of 30 miliseconds (The intervalometer can be adjusted for a different firing rate upon request).

DIMENSIONS:

Basic Model:
Length: 1.24 m
Diameter: 40 cm
Weight (Empty): 37.3 kg
Weight (Loaded): 183.8 kg
Low-Drag Model:
Length: 2.27 m

CASA 18.070 Launcher

Diameter: 40 cm
Weight (Empty): 46.8 kg
Weight (Loaded): 193.3 kg

MANUFACTURER:
Construcciones Aeronauticas SA, Rey Francisco 4, Madrid-8, Spain.

1842.303
CASA TYPE 54.037 ROCKET LAUNCHER
DESCRIPTION:
This reusable rocket-launcher is designed to carry and launch 54 INTA S9 37 mm rockets. It can be installed in any pylon type with standard NATO suspension system (14"). Basic and low-drag versions are produced.
OPERATION:
Rocket firing by means of an electronic intervalometer incorporated in the rocket-launcher. Single rocket firing or ripple firing can be selected either by the pilot in the cockpit or by adjusting the mode selector incorporated in the launcher. Rate of fire according to a firing interval of 20 miliseconds (The intervalometer can be adjusted for a different firing rate upon request).

DIMENSIONS:
Basic Model:
Length: 1.24 m
Diameter: 40 cm
Weight (Empty): 39.5 kg
Weight (Loaded): 97.5 kg
Low-Drag Model:
Length: 2.27 m
Diameter: 40 cm
Weight (Empty): 49 kg
Weight (Loaded): 107 kg
MANUFACTURER:
Construcciones Aeronauticas SA, Rey Francisco 4, Madrid-8, Spain.


CASA 54.037 Launcher

1843.303
LANCO RC-06-100
DESCRIPTION:
This re-usable unit is designed to carry and fire six heavy 100 mm INTA S 12 rockets. It can be fitted to any aircraft with 14" and 30" NATO attachments. The conversion from 14" to 30" is carried out by changing the position of the rear attachment.
OPERATION:
Rocket firing is controlled by an electronic intervalometer incorporated to the launcher. Single rocket firing or continuous ripple firing can be selected by the pilot or set in on the ground if this unit is not available. The firing sequence can be controlled between 20 and 70 ms by adjusting the intervalometer without removing it from the rocket-launcher.

DIMENSIONS:
Length: 3.4 m approx
Weight (Empty): 100 kg
Weight (Loaded): 460 kg

MANUFACTURER:
Construcciones Aeronauticas SA, Rey Francisco 4, Madrid-8, Spain.


LANC RC-06-100

1601.393
CASA 04.080 ROCKET RACK LAUNCHER
DESCRIPTION:
The CASA 04.080 rack launcher carries four 80 mm Oerlikon rockets and is designed for light aircraft and helicopters. It may be pylon mounted, either using the AH 039220 pylon or others with NATO attachments. The firing rate is controlled electrically and can be adjusted from 20 to 50 milliseconds. The launcher is also available in the CASA 04057/080 version to carry and fire either four 57 mm (2.25 inch) rockets or four 80 mm Oerlikon rockets.
MANUFACTURER:
Construcciones Aeronauticas SA, Rey Francisco 4, Madrid-8, Spain.


CASA 04.080 rocket rack launcher

1603.393
CASA AH 039220 UNIVERSAL PYLON
DESCRIPTION:
The universal pylon produced by CASA can be used to attach honeycomb or rack launchers or machine-gun or bomb pods. The body has a main section, attached to the aircraft by four screws, and a forward fairing mounted by one screw. The forward fairing contains accessible electrical ejector and firing circuits. A detachable yoke at the trailing end provides for long weapons which might otherwise meet the trailing edge of the aircraft wing. Ejector hooks are located at the standard NATO distance of 14 inches.

MANUFACTURER:
Construcciones Aeronauticas SA, Rey Francisco 4, Madrid-8, Spain.

SWEDEN

7514.393
VIRGO 120KG FRAGMENTATION BOMB
DESCRIPTION:
The bomb is intended for use against targets such as landing craft, aircraft on the ground, anti-aircraft weapons, field artillery, un-armoured and light armoured vehicles etc, and as an anti-personnel bomb against troops in the open or behind light cover. It is designed to give a large number of fragments of a predetermined size and weight and with high striking velocity.
For the low level attack a brake parachute can be fitted which will retard the bomb sufficiently to give the aircraft enough lead to be safe at the time of burst.
The bomb is designed for supersonic speeds and has therefore protection against aerodynamic heating.
The fusing system consists of an impact nose fuse which can be combined with a proximity fuse which is interchangeable with the brake parachute, for air burst.

DATA

Bomb:
Length overall:
Nose fuse and parachute fitted: 1,541 mm
Nose fuse and proximity fuse fitted: 1,582 mm
Diameter of body, maximum: 214 mm
Fin span: 368 mm
Total weight of prepared bomb, maximum: 123 kg
Charge: RDX/TNT
Weight of charge: 30 kg
Position of lug from nose end (nose fuse fitted): 743 mm
Centre of gravity from nose end (nose fuse fitted): 736 mm
Position of contact plug in front of lug: 49 mm

Nose Fuse:
Length overall: 591 mm
Diameter (main body): 64 mm
Weight: 1.9 kg
Arming delay time: 4.3 s
Proximity Fuse:
Length overall: 287 mm
Diameter: 98 mm
Weight: 2.3 kg
Brake Parachute:
Container:
Length overall: 290 mm
Diameter: 89 mm
Weight: 1.2 kg
Parachute diameter, opened: 530 mm

The use of a proximity fuse substantially increases the size of the effective lethal area.
The system consists of a VIRGO 120 kg fragmentation bomb, VIRGO nose fuse, VIRGO brake parachute and VIRGO proximity fuse. The bomb and the nose fuse are always used together, either

alone (not low-flying attack) or with brake parachute (low-flying attack) alternatively proximity fuse (not low-flying attack).

The delivery units are separately packed in cases with one bomb (four bombs make a load unit on a loading pallet), 12 nose fuses, 12 brake parachutes, or 12 proximity fuses.

OPERATION:

The bomb has two separate initiation systems with joint arming function. The Impact Initiation System in the front of the nose fuse consists of a hammer primer, a detonator, and a front exploder and is always in action after release, giving an instantaneous impact burst.

The Proximity Fuse Initiation System in the middle and the rear of the bomb consists of a proximity fuse, an electric detonator, and a rear exploder and is in action only when the proximity fuse is adapted, giving an air burst 5-20 metres over the target or the ground.

The safety system has the following functions:

Ground transport safety means (in addition to air transport safety) that the nose fuse and the proximity fuse are kept separate from the bomb and that the transport safety device is blocked.

Air transport safety ensures that the arming of the nose fuse is blocked when the bomb hangs in its suspension lug. Should arming of the nose fuse begin during air transport, the nose fuse will lock the transport safety device in secured (partially armed) position.

Trajectory safety prevents the nose fuse arming until 4.3 seconds after release.

Brake safety (applies only to bomb with brake parachute) ensures that the arming of the nose fuse will be blocked if the tractive force of the brake parachute fails to reach a predetermined level within the trajectory safety time.

DEVELOPMENT:

First design study was completed in 1956; and was type-tested 1958-61. Production started in 1961 and it went into service with the Royal Swedish Air Force in 1963.

STATUS:

Designed for A32 Lansen and adaptable for A35 Draken and AJ37 Viggen attack aircraft, the Royal Swedish Air Force are the only known users.

MANUFACTURERS:

Förenade Fabriksversken, Fack, S-631 87 Eskilstuna 1, Sweden.

1513.303

135 mm BOFORS AIR TO GROUND ROCKET SYSTEM

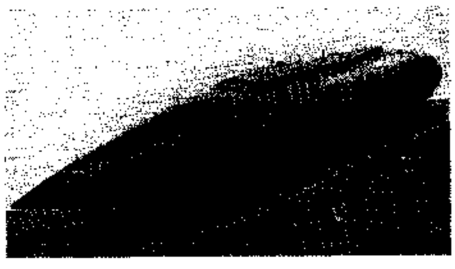
DESCRIPTION:

The 135 mm air to ground rocket system manufactured by AB Bofors is intended as part of a range of armament developed for the Saab AJ37 Viggen. It consists of a rocket launcher carrying six rockets which are salvo-fired from a built in firing pulse generator after initiation of the sequence by the pilot. The launcher is designed to give thermal protection to the rockets during high and low altitude flight at supersonic speeds; it is also a low drag design. Standard NATO type suspension lugs can be provided so that the 135 mm rocket system is compatible with a large range of tactical aircraft.

The rockets themselves can be fitted with either of two types of warhead, a general purpose one and an armour piercing fragmentation head. Further variations are possible as a choice of three fuses is available – instantaneous or delayed action, sensitive direct action fuse or electronic proximity (VT) fuse. The rocket motors give high velocity and low dispersion, leading to a time of flight of about 3½ seconds to 2,000 metres slant range in typical launching conditions.

CHARACTERISTICS:

Total weight with 6 rockets: approx 400 kg
Empty weight: 125 kg
Length: 3,226 mm
Diameter: 486 mm
Firing interval in salvo: 0.1 sec
Specification: 135 mm Rocket
Weight of rocket motor: 25 kg
Burning time: 2.0 sec



Bofors 135 mm Rocket Launcher

Velocity all-burnt: 600 m/sec
Warhead weight – GP: 19.5 kg
Warhead weight – AP Frag: 175 kg
Warhead charge weight – GP: 3.7 kg
Warhead charge weight – AP Frag: 5.0 kg

1684.393

SAAB EJECTOR RELEASE UNIT ULM-1

DESCRIPTION:

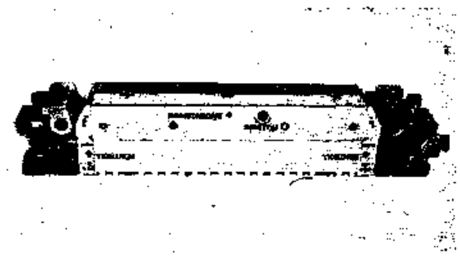
The ULM-1 Ejector Release Unit (ERU) is intended for heavy missiles, drop tanks, gun pods, bombs etc, with two T-lugs for suspension. The lug-matching hooks on the ERU are located according to NATO standard spacing at 30-inch centres. Pre-stressing devices and bomb supports are not needed as the T-lugs are secured by spring-loaded wedges. The power for opening the lock is derived from two powder cartridges in the upper centre. The cartridges also power the two ejectors, outside the hooks, thus ensuring positive separation of the load.

The ULM-1 is designed with a facility for variable pitch control by means of a ground-set orifice feature. The orifices can be in either open or closed positions, enabling the total thrust to be exerted on either the forward or the aft ejector. With both orifices open, each ejector receives equal thrust. On the ground, release of the store or opening of the lock is effected with a standard spanner, which can be applied on both sides of the ERU. After the ejectors have pushed the store clear, they return to their initial positions automatically by means of strong return springs.

To ensure that the hooks are in their correct positions and the linkage system in a locked state when the ERU is carrying a load, a dowel is placed through the check holes. For security locking, the dowel is placed into a security locking through hole. Two switches, separate from the ERU mechanism, are incorporated to sense if the ERU is carrying a load or not, and these switches are in the cartridge firing circuit so that no firing can take place if the ERU is not loaded.

DEVELOPMENT:

The ULM-1 ERU was developed by Saab-Scania under licence from the McDonnell-Douglas Aircraft Corporation.



Saab ejector release unit ULM-1

STATUS:

In full production for the Saab 37 Viggen multi-purpose STOL combat aircraft.

MANUFACTURER:

Saab-Scania, Datasaab Division, Jönköping, Sweden.

1685.393

SAAB BOMB LOCK ULM-3

DESCRIPTION:

The ULM-3 bomb lock is intended for bombs with a single suspension fitting and a normal weight of 120 kg. The bomb is secured in position by pre-stressing. The pre-stressing devices are not integrated in the lock, but form part of the carriage. The hook is designed for lug bolts as specified in Mil Standard A-8591 C, 1,000-lb weight class.

The power source for opening the lock is a powder cartridge, mounted on the upper side of the lock. The cartridge also powers two ejectors, one in front of and the other behind the hook, for positive separation of the bomb. The bomb lock is designed with a facility for variable pitch by means of a ground-set orifice feature. The throttling is such that a maximum of two-thirds of the total thrust can be obtained at the forward ejector with the remaining third at the aft ejector, and vice versa. Opening of the lock on the ground is by means of a spanner, and security locking is effected by a standard 8 mm diameter pin. Accidental firing does not effect the functioning of the lock or the removal of the safety pin.

The linkage system in the bomb lock operates, simultaneously with the hook, a pair of miniature switches, one of which indicates Open or Closed Hook to the pilot, and the other arms the bomb as the hook is opening. The unit is designed for a minimum of 250 firings without major overhaul, and it is stressed to permit a minimum of 1,000 flight hours in the loaded condition.

DEVELOPMENT:

Development was undertaken in connection with the Saab 37 Viggen combat aircraft programme.

STATUS:

Entering production for the Saab Viggen combat aircraft.

Saab bomb lock ULM-3

MANUFACTURER:

Saab-Scania, Datasaab Division, Jönköping, Sweden.

SWITZERLAND

1263.303
HISPANO OERLIKON SURA 80 mm AIRCRAFT ROCKET

DESCRIPTION:

The Hispano Oerlikon SURA aircraft rocket has been developed primarily for ground attack purposes. It is of 80 mm calibre, carries a warhead of weight 3 kg and under typical conditions is fired when the aircraft-to-target range is about 1,000 metres.

The fin assembly is a sliding fit on the rocket body and has a double function. Before firing the assembly acts as the front suspension, engaging with the front suspension lugs on the aircraft underwing rail. Lower rockets in the same cluster can also be engaged by means of the fin slots and by an additional integral suspension ring located forward of the main fin ring.

The rockets are electrically fired and on firing the sliding fit fin ring acts as a guide until it is met by the rear cone of the motor. It is then carried on with the rocket stabilising it in flight.

Incendiary/blast, hollow charge armour piercing, fragmenting and inert practice warheads are available.

Specification:

Different warheads have slightly different lengths.

Typical characteristics are:

Rocket Type: SURA Type US
Calibre: 80 mm
Length: 1,060 mm
Total weight: 11 kg
Weight of warhead: 3 kg
Weight of propellant: 3 kg
Typical range: 1,000 metres
Accuracy: 50% of shots within 10 mils approximately

STATUS:

SURA rockets are in service with many air forces throughout the world. Successful installations have been made on numerous aircraft including Hunter, Fiat G 91, BAC Jet Provost/Strikemaster, F86.

MANUFACTURER:

Machine Tool Works, Oerlikon-Bührle Ltd, CH 8050, Zürich, Switzerland.

Oerlikon 8 cm rocket launcher for helicopters

Hispano Oerlikon 80 mm SURA rockets on BAC Strikemaster

1269.303
OERLIKON 30 mm GUN TYPE KCA 304RK

DESCRIPTION:

The aircraft gun type KCA is of 30 mm calibre and has been developed by Oerlikon, Switzerland. The weapon is a further example of the development of the Mauser revolver principle which has been almost universally adopted for single barrel aircraft cannon since the end of World War II.

The KCA differs, however, from almost all comparable guns in the present generation in using a new design of ammunition in which the ratio of propellant charge to projectile weight is over 2 : 1 whereas in most other guns, the ratio is likely to be 3 : 2. In addition the KCA ammunition has a higher projectile weight than other 30 mm types.

As a result of these factors and lightweight design of the moving parts of the weapons a firing rate of 1,350 rounds per minute is obtained and a muzzle velocity of over 1,000 metres per second. The weapon is therefore well suited to ground attack as well as air-to-air engagements, and for the former role a long gun range is required to give the attacker a wide firing bracket.

The Oerlikon KCA has a four chamber revolver mechanism so that before firing the gun mechanism has to be cycled three times to charge all chambers. This can be done in the air by electrically fired pyrotechnic cartridges. A total of 12 of these cartridges is provided and the remainder can be used to clear stoppages should they occur.

Ammunition for the KCA is available in a range of types, TP, HEI, SAPHEI and AP. Both steel and aluminium cased shells have been developed.

CHARACTERISTICS:

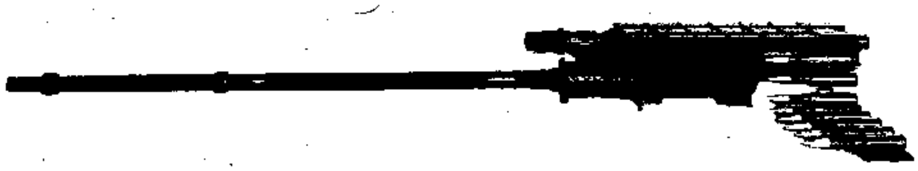
Calibre: 30 mm
Gun weight: 125 kg
Muzzle velocity: 1,050 metres/sec
Rate of fire: 1,350 rounds/minute
Accuracy: 50% rounds inside 5 mils
Length of gun: 2,690 mm
Round weight: 0.700 kg
Projectile weight: 0.360 kg
Range*: over 2,000 metres
*gun stationary

STATUS:

The Oerlikon KCA is in pre-series production, and is under consideration for various aircraft.

MANUFACTURER:

Machine Tool Works Oerlikon-Bührle Ltd, CH 8050, Zürich, Switzerland.



Oerlikon Type KCA 30 mm aircraft gun

1272.303
HISPANO OERLIKON 20 mm TACTICAL AIR ARMAMENT

DESCRIPTION:

Two types of 20 mm calibre aircraft cannon were manufactured by Hispano Suiza in Switzerland and by their UK company, British Manufacture and Research Co Ltd of Grantham, Lincolnshire. Both types, the 20 mm Mk 5 and 20 mm Mk 2* are similar and are derived from the original Hispano type 404 weapon. The Mk 5 model is lighter in weight than the Mk 2* and has a higher rate of fire. Although no longer part of the Company's programme, this weapon remains in extensive service in many parts of the world.

A wide range of 20 mm ammunition types is available including armour piercing, tracer, ball and HE incendiary. Different types of fuses are also available. The round has a brass case and is percussion fired. Ammunition is normally supplied in 60 round belts or as individually packed rounds.

A wide variety of tools and accessories are available for 20 mm Mk 2* and Mk 5 guns.

Specification: 20 mm Mk 5 gun
Calibre: 20 mm
Gun weight with feed: 42 kg
Muzzle velocity: 850 metres/sec
Rate of fire: 580-640 rounds/minute
Length of gun: 2,052 mm
Round weight: .1367 kg
Projectile weight: .138 kg
Range*: 1,600 metres to velocity 300 metres sec
*gun stationary

STATUS:

Hispano 20 mm aircraft cannon are in service with the Royal Air Force, Royal Navy and over 30 other air forces. RAF Canberra and Shackleton aircraft have Hispano 20 mm armament. Over 98,000 20 mm guns of all types have been made in the UK alone.

MANUFACTURERS:

Machine Tool Works, Oerlikon-Bührle Ltd, CH 8050, Zürich, Switzerland.

British Manufacture & Research Co Ltd, Springfield Road, Grantham, Lincolnshire, England.

THE UNITED KINGDOM

1277.303
CLUSTER BOMB NO. 1 Mk 1 (BL 755)
DESCRIPTION:

BL 755 has been developed to meet a requirement for a weapon that will yield a high kill probability against a range of small hard and soft targets encountered in the battlefield and immediate tactical area. Because of the efficiency of modern surface-to-air weapon systems it is operationally necessary for air-to-ground attacks in support of ground forces to be carried out at very low level. Any other form of attack necessitates prolonged exposure to the enemy ground defences and negates any element of surprise. This will result in unacceptable losses to the attacking aircraft.

To compensate for the aiming errors inherent in low level attack, BL 755 covers the target area with a pattern of bomblets, the dimensions of which are proportional to the aiming errors. The dual function bomblets are effective against armoured and soft-skinned vehicles, parked aircraft and personnel and are distributed evenly within the pattern.

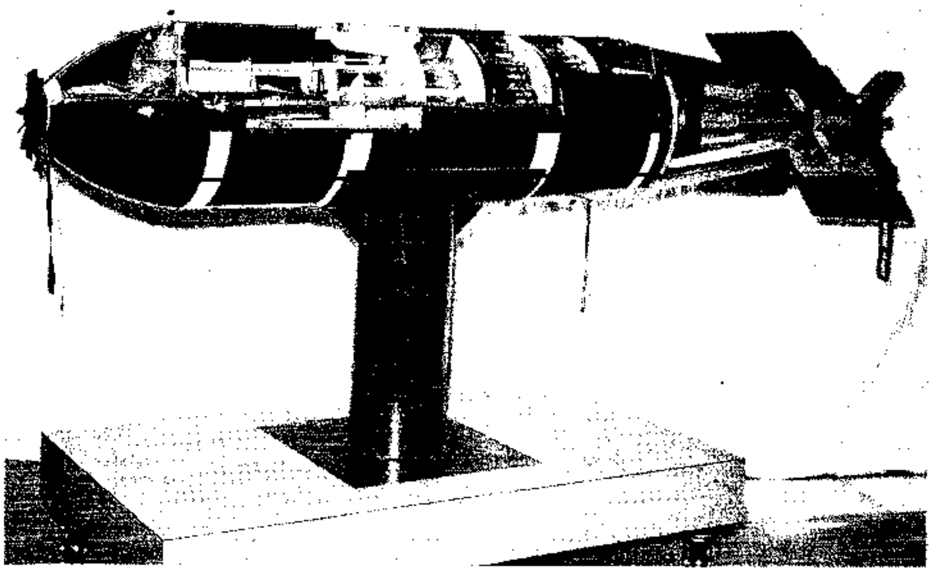
BL 755 is compatible with current and future strike aircraft. It can be carried in a bomb-bay or externally with twin 14 inch or single suspension. It can be delivered using a simple or sophisticated sighting system. It is immune from electronic countermeasures and incorporates a safety mechanism which provides protection for the aircraft during carriage and release and the deployment of bomblets.

Studies and evaluations have shown that BL 755 is many times more effective against typical battlefield targets than either single or small sticks of high explosive bombs.

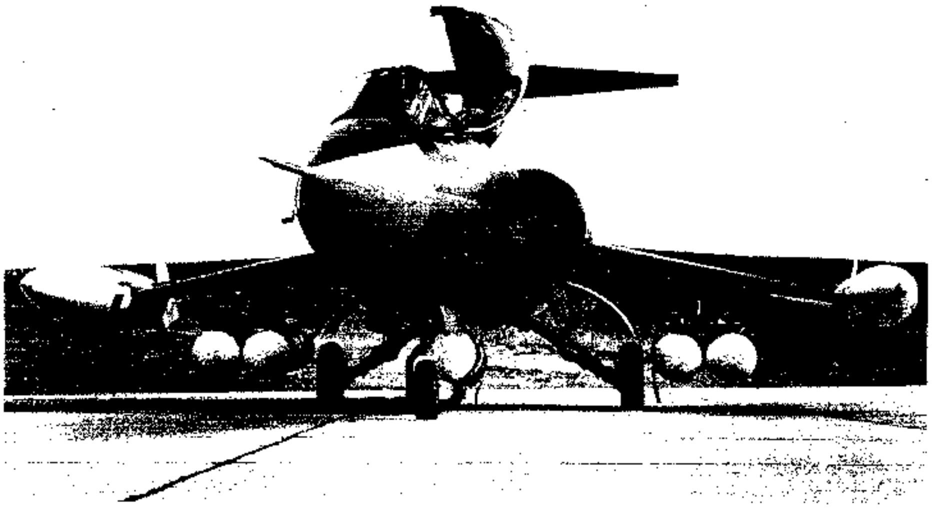
CHARACTERISTICS:
Weight: 272 kg
Length: 2,436 mm
Diameter: 419 mm
Fin span: 566 mm
Suspension: Twin lug at 356 mm spacing or single lug

STATUS:
The Cluster Bomb (BL 755) is in service with the Royal Air Force and is being supplied to at least five countries within NATO

MANUFACTURERS:
Co-ordinating Design Authority:
Hunting Engineering Ltd, Reddings Wood, Ampthill, Bedfordshire
Production:
Directorate of Ammunition Production, Ministry of Defence.



Cutaway view of the 600 lb No 1 Mk 1 Cluster Bomb, BL 755. At the front is the air arming vane. In the nose cone are the Safety Arming and Functioning Unit and the breech assembly for initiating the gas system used for skin stripping and bomblet ejection. The central section houses the payload of 147 bomblets



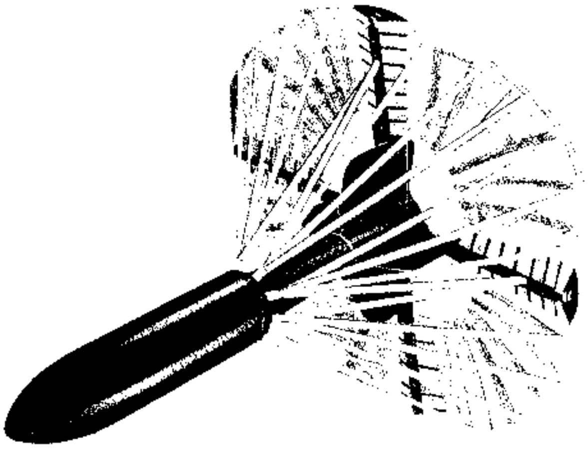
F-104 Starfighter armed with five BL 755 cluster bombs

1267.393
BRITISH BOMB RETARDING SYSTEM
DESCRIPTION:

The British bomb retarding system was developed in UK by Hunting Engineering Ltd. The retarder is incorporated in a special bomb-tail assembly which can be readily applied to a wide range of existing ballistic bombs.

The Retarding Tail with its associated fuse has been designed to overcome the problem of low altitude attack. If a conventional bomb is used from low altitudes it is likely that the separation of the attacking aircraft from the bursting of the bomb will be small enough to endanger the attacking aircraft. The purpose of the Retarding Tail is to decelerate or retard the bomb after release, and allow the aircraft to reach a safe separation distance before the bomb impacts and explodes. Conventional delayed action bombs, if used in this way, are liable to ricochet and to miss their targets.

The Retarding Tail utilises a combination of a ribbon parachute and air brakes retarder arms formed from the structure of the tail. This technique has the advantages of providing very high



Hunting Engineering Bomb Retarder fully deployed drag after a closely predictable time delay, essential for accurate control of bomb stick spacing leading to improved probability of target destruction.

The basic structure of the retarder tail consists of a base ring made in forged steel in which are incorporated eight securing pads for attaching the tail to the bomb. The steel inner cone is welded to the base ring and at the aft end carries the one-piece fin casting in light alloy. This casting is riveted to the steel inner cone. The four retarder arms consist of spines carrying the outer skin sections. The spines pivot at the root of the fins and when extended form four airbrakes. When closed the skin sections form the tail cone.

The design incorporates various safety measures which ensure that at no time does the bomb constitute an unacceptable hazard to the aircraft during carriage or after release.

A timer mechanism which controls the operation of the unit is housed within the inner cone. As the bomb is released from the aircraft this timer is initiated by a lanyard. After a short interval to allow the bomb to fall clear of the aircraft the timer triggers the release of the retarder arms. These arms are forced into the airstream by a spring and then aerodynamic forces extend them to the fully open position. The energy released in this operation is absorbed by a tear-webbing shock absorbing device.

At the base of the tail couplings are provided to connect with the tail fuse of the bomb, so that the arming of the latter is controlled by the action of the retarding tail mechanism.

While being carried aboard the aircraft Retarding Tail bombs resemble conventional fixed fin types. The fins are provided to stabilise the bomb aerodynamically immediately after release. In the event of the bomb being jettisoned the retarding tail is not operated and neither is the fuse armed. Retarded bombs can be carried externally or internally in subsonic or supersonic aircraft.

SPECIFICATIONS:

Bomb Retarder Tail Type 117

This tail is 1,003 mm long and 584 mm span. It was developed initially for use with British 1,000 lb HE medium capacity Mk 6 and 9 19 series bombs. Two types of tail – Mk 3 and Mk 4 are available. The Mk 3 with a tail fin span of 584 mm is suitable for external carriage whilst the Mk 4 with a tail fin span of 419 mm is suitable for both external and internal bomb carriage.

Bomb Retarder Tail Type 118

This tail is 970 mm long and 465 mm span. It was originally designed for use with the British 540 lb HE medium capacity bomb.

Adaptors are available to couple type 117 and 118 retarding tails to many other types of HE bombs, including the principal US types such as Mk 82 and 83, M.64, M.65 and M.117 types.

Both types of retarder are designed for a shelf life of at least 5 years without attention.

STATUS:

The Retarding System is in service with the Royal Air Force and is being supplied to air forces overseas.

MANUFACTURERS

Hunting Engineering Ltd, Reddings Wood, Ampthill, Bedfordshire, England.

1845.393 WESTLAND/FRAZER NASH HIGH STRENGTH MACE

DESCRIPTION.

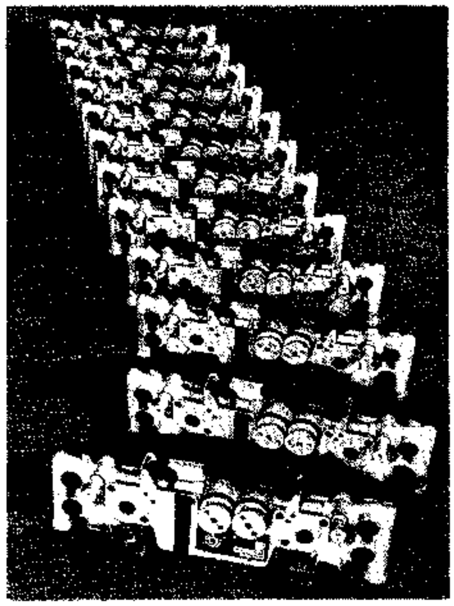
The Ejector Release Unit (ERU) is in the form of a beam with the operating mechanism, breech etc. sandwiched between a pair of sideplates, one a baseplate and the other a closure plate. Their sideplates terminate in two identical gas operated ejector ram assemblies which also carry the store retaining jaws and also incorporate integral wedge systems conforming to the crutchless form of store retention.

The jaws are designed to suit the recommended STANAG saddle lugs which are mounted on the store at 14 inch (355.6 mm) centres. The jaws are connected to the locking wedges by spring links so that when the jaws are engaged with the saddles the wedges are forced into the clearance between the abutments on the ram cases and the surface of the saddle lugs. This effectively "locks" the store to the ERU preventing any sway or pitch. Spigots are incorporated in the base of both ram case forgings to control yaw and fore and aft movement of the store.

The jaws are linked by connecting rods to a central operating toggle which, when turned on its axis, withdraws or engages the jaws. The linkage forms a geometric lock comprising an "over-centre" system which is maintained in both and locked and unlocked positions by a compression spring coaxial with a rod suspended between a projection on the breech and one arm of the linkage. In the locked position this rod is at the limit of its travel and so maintains the overcentre attitude, thus preventing the toggle turning. The release is achieved by a gas operated plunger which drives the toggle round so that the line of action of the spring, on its rod, now swings above the toggle pivot, reversing the sense of the geometric lock and maintaining it in the unlocked position with the jaws retracted from the bomb lugs. The design of the mechanism is such that the weight of the store tends to intensify the geometric lock in the loaded position, and, when released, to contribute a positive force to open the mechanism and prevent any possible "hang-up".

The plunger which operates the mechanism is housed in a cylinder bored in the breech block which forms the central unit of the gas system. The plunger is held in position by a screw cap and a spring. In operation the gases enter the cylinder at the upper end, via internal porting leading from the combustion chambers, and forces the plunger down against the spring, tripping the geometric lock and retracting the jaws. The combustion chambers are twin receptacles bored in the breech block and threaded to receive the cartridge holders. These are inter-connected internally such that they both feed the gas system to ensure that if only one cartridge fires from electrical initiation the other will ignite sympathetically.

Internal ports lead from the combustion chambers fore and aft to the gas tubes which conduct the gases, on firing, to the ejector ram assemblies via interchangeable throttles housed in the inlets to the ram cylinders. These throttles are "plug-in" units drilled with a gas port of some pre-determined diameter to govern the amount of gas entering the ram. By interchanging throttles with different orifice diameters the thrust of the rams can be adjusted to suit a limiting aircraft reaction, or by installing throttles of differing bore sizes at the forward and aft rams a differential thrust can be obtained to vary the attitude of launching of the store. These throttles can also be supplied with ports drilled to exhaust the gas directly to atmosphere so that the rams are inoperative when a free-fall gravity drop is required.



High-strength 14-in MACE ejector release units for the MRCA

STATUS:

Following the Panavia 'Intent to Purchase' notification issued in March 1973, development testing continued through 1973 to qualification of units to production standard in early 1974. Design was in accordance with a Panavia Specification to meet the requirements of the Multi-Role Combat Aircraft for which the unit will be produced.

MANUFACTURER:

Sandall Precision Company Ltd, Watling Street, Milton Keynes, MK1 1ES, England. Member of the Westland Group.

1604.393 ML CARRIER BOMB LIGHT STORES NO. 200

DESCRIPTION:

The ML Aviation Carrier Bomb Light Stores No. 200 (CBLS 200) is an aerodynamically faired Carrier combining maximum strength and stiffness with minimum weight. It was developed from experience gained with the earlier CBLS 100. Carrier to aircraft suspension is via lug pockets for single NATO twin 14 inch and NATO twin 30 inch suspension. CBLS 200 is equipped with four ML ERU 122 EX permitting the carriage of four stores each up to 103 mm diameter and 750 mm long. All stores are ejected vertically. CBLS 200 has the facility to accept clip on side pannier rocket launchers for four SNEB 68 mm or FFAR 2.75 inch rockets.

Specifications:

Overall length: 2,464 mm

Diameter: 423 mm

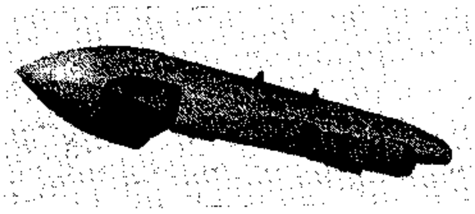
Weight less Stores and Rocket Panniers: 53.5 kg

Weight with Rocket Panniers but less Stores and Rockets: 78.0 kg

Suspension: (a) Single Lug. (b) Twin Lugs at 14 inches (NATO). (c) Twin Lugs at 30 inches (NATO).

STATUS:

CBLS 200 is in production for seven Air Forces for use on a large number of in-service aircraft types ranging from Hunter to Phantom. It has also been adopted for aircraft now under development both in the UK and overseas.



ML Carrier bomb light stores No 200 with rocket panniers

MANUFACTURER:

ML Aviation Company Limited, White Waltham Aerodrome, Maidenhead, Berkshire, England.

1264.393
ML AVIATION LIGHT WEIGHT LOW-DRAG TWIN STORE CARRIER

DESCRIPTION:

This carrier is designed to increase the capacity of a normal single external weapon station so that two stores can be carried. It is designed for use on wing or fuselage stations and incorporates two ML Ejector Release Units No 119 Mk 1. All the necessary fusing services for a full range of modern conventional stores are incorporated in the carrier which can be supplied with auto-selection or pilot selection electrical wiring according to requirements. Typical weapons used with this carrier are 250 kg HE bombs or rocket launchers.

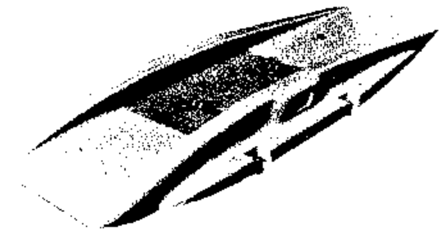
The carrier consists basically of a main spar and baseplate machined from stretched light alloy plate. Raised lugs on the sides of the main spar form the attachment points for the two ejector release units. Lightweight fairings are fitted over the main structure to minimise the aerodynamic drag of the carrier.

Twin lugs at the standard 14-inch (355.6 mm) centres are provided for mounting the carrier on any standard weapon pylon. If desired the carrier suspension can be offset from the centre line by 57 mm to either side, to adjust rolling moments or to increase store-to-aircraft clearance. Adaptors are available to use this carrier with single lug type store suspension or to the 762 mm centres type.

STATUS:

The ML lightweight low drag twin store carrier is in production for Harrier, F.104 and Hunter aircraft

Specification:
Carrier weight, including 2 × ERU 119: 37 kg
Length overall: 1,638 mm
Width overall: 655 mm
Depth overall: 146 mm



ML aviation light weight low drag twin store carrier

Max store diameter: 420 mm
Max store weight: 500 kg
Max speed: Mach 0.95

MANUFACTURER:

ML Aviation Co Ltd, White Waltham Aerodrome, Maidenhead, Berkshire, England.

1515.393
ML LIGHTWEIGHT TWINSTORE CARRIER (HIGH STRENGTH)

DESCRIPTION:

The High Strength Two Store Carrier is a direct development of the Lightweight Low Drag twin store carrier. It has been introduced to cater for the increased aerodynamic loads on new aircraft. It is mechanically, electrically and operationally interchangeable with the earlier model.

High strength version of ML lightweight twin store carrier

1282.393
ML BOMB CARRIER UNIVERSAL TWO STORE

DESCRIPTION:

The ML Bomb Carrier Universal Two Store is designed for internal installation in Canberra aircraft. It is specially suitable for the carriage of retarded or conventional bombs. The basic structure comprises a single central spine of light alloy tube with outriggers to support the two release units. A stressed base plate carries the auto-selector and other electrical services.

In its standard form the carrier is provided with two ML Ejector Release Units No 119 Mk 1 which mate with any store having twin suspension lugs at the standard NATO spacing of 356 mm.

The carrier will accept a wide range of conventional stores in current use. Adaptors are available to extend the role of the carrier to carry single lug bombs such as the UK 1,000 lb Mk 6, 9, 11 and 12. Aerodynamic fairings are also available for external fitting of the carrier to a standard weapon pylon.

STATUS:

The Carrier Universal is in service with the Royal Air Force and with overseas Air Forces. It is in production.

Specification:

Overall dimensions of the ML Carrier Universal Two Store with Canberra adaptors:

Length: 818 mm
Width: 610 mm
Depth: 265 mm
Maximum store diameter: 420 mm
Store centre to centre spacing: 445 mm
Typical store load: 2 × 1,000 lb HE bomb Mk 10

MANUFACTURER:

ML Aviation Company Limited, White Waltham Aerodrome, Maidenhead, Berkshire, England.

7513.393
EJECTOR RELEASE UNIT No 119

DESCRIPTION:

A double-hook, positive lock release mechanism and two cartridge operated variable thrust ejector rams enable the thrust and pitch attitude of ejection to be adjusted to suit the store. This small, lightweight release is designed for suspension between two sideplates, as in a wing pylon, for use with conventional stores. The locking and release mechanism is mounted between two identical forged steel ejector ram barrels incorporating crutching arms and mounting lugs. The cartridges are housed in a central breech and, when fired, the gases are transmitted to the two ejectors. Readily interchangeable throttles enable the ram characteristics to be adapted to the role.

EJECTOR RELEASE UNIT No. 119 JN

A further development of the ERU No. 119 has been developed designated the ERU No. 119 JN. This has been delivered to the Japan Self Defence Force for use on their new XT2 aircraft. This variant is stronger than the ERU No. 119 and gives the following performance:

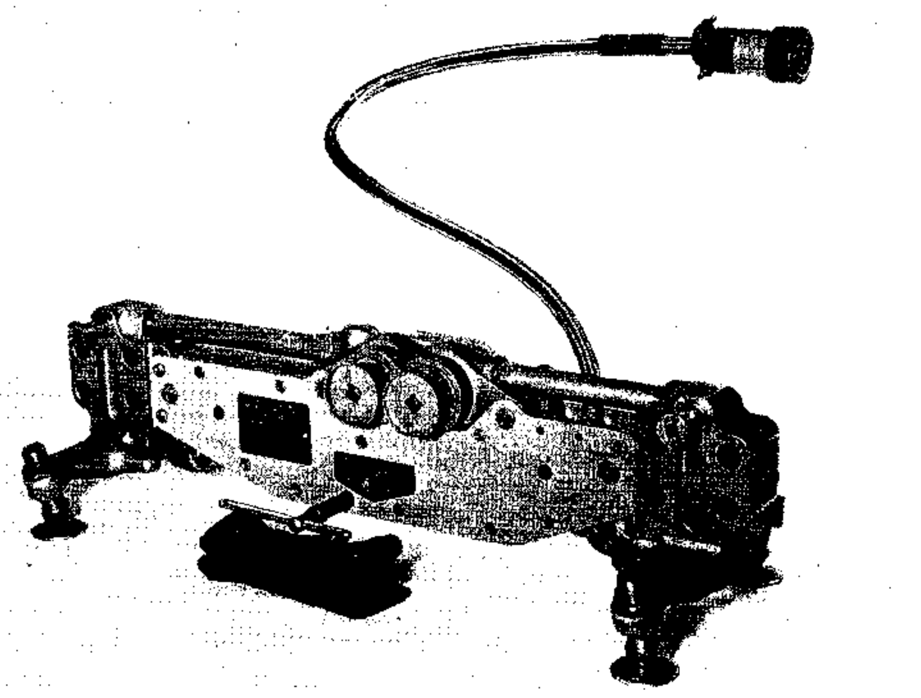
Ultimate Hook Load 13,608 kg
Ultimate Crutch Arm Load 7,711 kg
Ultimate Yaw Moment 2,560 kg/m

Mechanically the ERU No. 119 JN is interchangeable with the other models in the series.

EJECTOR RELEASE UNIT No. 119 SN:

This is a modified version of the ERU No. 119 Mk 1 and is designed to take increased loading. It differs from the standard unit in three ways:

1. Strengthened barrel and crutch arm assembly end forgings provided with larger diameter mounting holes to take larger bolts.
2. Strengthened hooks, connecting rods and pivot pins.



Ejector Release Unit No. 119 SN, specially developed by ML Aviation Company for the Royal Danish Air Force, Draken Aircraft

3. Rad-haz filters deleted from the firing circuit. All electrical connections through a single connector terminating in standard 11 pin plug (MS 3116-1811P).

In all other respects the ERU 119 SN is identical with the ERU 119 Mk 1.

EJECTOR RELEASE UNIT 120 Mk 1:

This has been designed to carry the latest stores and multi-weapon carriers on the latest types of aircraft and is suitable for suspension in a wing pylon or a bomb bay. It is provided with two sets of suspension hooks to accommodate stores fitted with bomb lugs at either 14-inch centres or at 30-inch centres. The positive lock and release mechanism for both pairs of hooks are mounted between two forged steel ejector ram barrels incorporating crutching arms and mounting holes.

The unit is operated by gas pressure from a central breech containing two cartridges. When fired the rapidly expanding gases are transmitted to an actuator piston which first unlocks the hook mechanism and thence, via a variable throttle system, to each of the ejector rams which thrust the store off. Readily interchangeable throttles enable the ram characteristics to be adapted to the role.

STATUS:

Aircraft using the ERU No. 119 include Harrier, Lightning Mk 53, BAC Strikemaster, Phantoms, and Jaguars, export Canberras, Drakens, XT2, and F-104. It is used by 18 nations, and the production rate has recently been increased.

Performance:

Typical performance at 15°C with 1 g assisting:

With reaction limited to 4,540 kg:

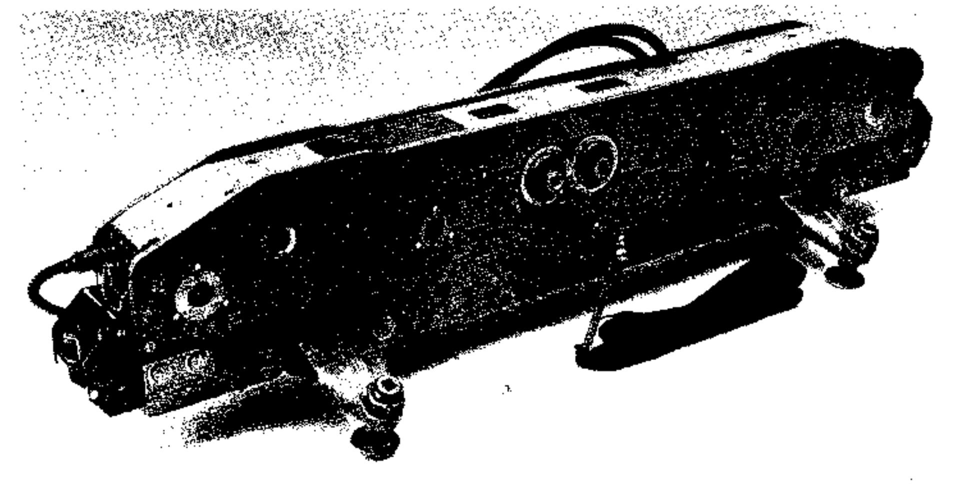
Store weight 952 kg, Ejected velocity 8.4 metres/sec

Store weight 454 kg, Ejected Velocity 3.0 metres/sec

Store weight 66 kg, Ejected velocity 8.0 metres/sec

With reaction limited to 2,380 kg:

Store weight 286 kg, Ejected velocity 3.0 metres/sec



ML Aviation Ejector Release Unit No. 120, Mk 1. The Unit is provided with two sets of suspension hooks to accommodate stores fitted with bomb lugs at either 14 in (35.6 cm) or 30 in (76.2 cm) inch centres

Temperature range (without cartridge): −60°C to +150°C

Strength Data:

Ultimate hook load: 10,900 kg per hook

Ultimate crutch arm load: 6,350 kg per crutch arm

Ultimate yaw moment: 2,040 kg/metres

Weight of unit complete with cartridge holders and throttles: 7½ kg

MANUFACTURERS:

ML Aviation, White Waltham Aerodrome, Maidenhead, Berks, England.

1516.393

ML No 123 ERU MACE

DESCRIPTION:

Ejector Release Unit MACE (Minimum Area Crutchless Ejector) has been developed and introduced to eliminate the drag effects of the sway brace method of carrying aircraft stores on pylon and multi-store carrier installations. It eliminates the necessity to torque-tighten the sway brace screws, thereby reducing aircraft reloading time.

Two double hooks engage NATO saddle adaptors attached to each of the standard 14 inch NATO lug pockets. The hooks are operated and locked by a simple toggle mechanism similar to that used on other ML Ejector Release Units. Spring-loaded devices housed at each side of the end barrel forgings, engage with the upper surface of the saddle adaptors and automatically take up all clearance as the hooks close, when loading the store.

This combination gives complete structural integrity for flight carriage of the stores. Down loads are taken by the hooks, and up loads, due to rolling moments, are taken by compression across the saddle. Yaw moments, and fore and aft loads are taken by spigots engaging the saddle adaptors. The geometry of the design ensures that both 'up' and 'down' loads are spaced at similar distances to those used in the conventional sway brace method, and the total system is designed to give a greater rigidity of carriage.

The ejector system is similar to the ML Ejector Release No. 119 Mk 1 and uses two standard NATO cartridges.

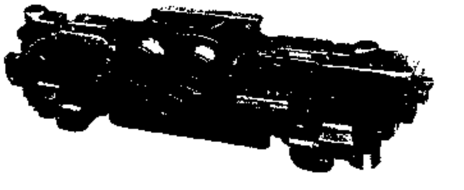
Performance:

With reaction limited to 44.5 KN (10,000 lb.f).

Store weight: 535 kg (1,180 lb) Ejected velocity 3.3 m/s (10.8 ft/s)

Temperature range (without cartridge): −60°C to +150°C

Weight: Unit complete with cartridge holders and throttles 8.2 kg (18.1 lb)



ML Ejector Release Unit MACE

Main Dimensions:

Overall Length: 428 mm (16.85 in)

Overall Height: 135 mm (5.31 in)

Overall Width: 78 mm (3.07 in)

Mounting Width: 50 mm (1.97 in)

MANUFACTURER:

ML Aviation Company Limited, White Waltham Aerodrome, Maidenhead, Berkshire, England.

1680.393

MILES FREE FALL MACE

DESCRIPTION:

The Minimum Area Crutchless Equipment (MACE) is the modern method of carrying and releasing weapons and other stores from aircraft. It is used with a new type of lug on the weapon and, by providing what is effectively four-point suspension, eliminates the need for conventional crutches (sway braces) and provides a light, compact unit.

The unit consists of two dual (two-tongued) pivotted hooks controlled by a simple linkage mechanism. The weapon is raised to the unit locked in place by a single operation of a cocking tool (which also cocks the release actuator) and is maintained there by a release lever. A ground safety pin is provided.

The actuator is a well proven, electrically operated, spring stored energy device which provides a powerful thrust on initiation to trip the release lever and release the mechanism under all conditions. Duplication is provided to meet Service requirements.

Spring loaded wedges interposed between the store lug and the Release Unit base plate provide automatic and progressive take-up of tolerance in the attachment of the store to the unit without inhibiting store release in any way.

A bomb Release Safety Lock can be provided within the overall envelope of the unit if required. The complete equipment has been designed to meet the very difficult environment of naval helicopter operation.

Specification:

Length: 417 mm

Width: 80 mm

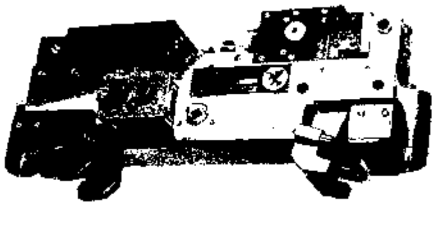
Depth: 150 mm

Total weight: Without BRSL 6.8 kg. With BRSL 7.8 kg

Operating voltage: 18 V to 28.5 V dc pulse not less than 14 ms

Maximum Store Weight: In excess of 450 kg

Ambient Temperature Range: −60°C to +135°C



Miles Free fall MACE

STATUS:

In development for UK Ministry of Defence.

MANUFACTURER:

F. G. Miles Engineering Ltd, Old Shoreham Road, Shoreham-by-Sea, Sussex BN4 5FL, England.

1681.393

MILES CARRIER BOMB LIGHT STORES

DESCRIPTION:

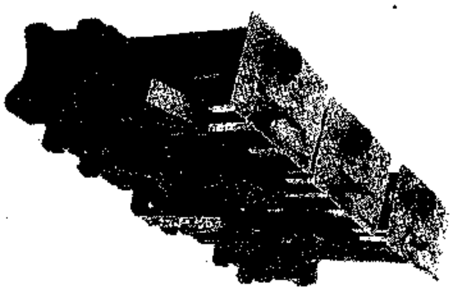
The crutchless principle for carriage and release of stores is also the basis of a new generation of Light Stores Carriers produced by Miles. The basis is a free fall modular release unit, EMRU No 21, which is so designed that by combining units together 3 store carriers, CBLS No 105, and 4-store carriers, CBLS No 104, or other combinations can be built up. Provision is made for unit selection, fusing and store-on-station indication.

The units are designed for current and future flares, markers and other light stores of up to 22.7 kg in weight, 914 mm in length and diameter varying between 77 and 127 mm. They will carry and release, or jettison, stores at all heights up to 4,570 metres, at speeds of 0 to 250 kts and function within the temperature range −60°C to +90°C.

The EMRU is operated electrically by the same Stored Energy Actuator (SEA) which is used on the EMRU No 22. Stores, for carriage on this unit, need a special lug which is simply attached to existing stores by bands. Four hooks engage with this lug and a spring loaded wedge system provides automatic and progressive take up of any tolerance in attachment of the store without inhibiting its release.

Loading of stores on to the carrier is quick and simple. The unit is cocked by means of a cocking lever at the rear of the unit, the store is raised against the unit and pressed against a small platform between the hooks which then close over the lug. A Safety Pin and Manual Release are provided for use on the ground.

SPECIFICATION FOR THE EMRU No 21:
Length: 280 mm
Width: 197 mm
Depth: 113 mm
Weight: 3.5 kg
Operating Voltage: 18 V to 28.5 V DC continuous or pulsed (14 m Sec Min)
Maximum Store Weight: 22.7 kg
Maximum Store Size: Length 914 mm, Diameter 77 to 127 mm
Operating Temperature Range: −60°C to +90°C
STATUS:
In development for UK Ministry of Defence.
MANUFACTURER:
F. G. Miles Engineering Ltd, Riverbank Works, Old Shoreham Road, Shoreham-by-Sea, Sussex, BN4 5FL, England.



Carrier Bomb Light Stores No 104

1266.393
MILES WEAPON RELEASE EQUIPMENT
EMRU No 20 Mks 1-4

The Miles Electro Magnetic Release Units (EMRU) No 20 were designed basically for free fall release and electro-mechanical operation. They are twin hook types with suspension centres at the NATO Standard of 14 ins (356 mm). The normal method of release is through an electrically operated spring stored energy unit, Solenoid Unit Type 1000, but a Cartridge Unit Type 2000 can be fitted in its place if cartridge operation is desired.

The system is intrinsically safe and reliable but for some applications an independent Bomb Release Safety Lock (BRSL) may be called for. The requirement is met by fitting a Miles Actuator MAL 19. When these are fitted a store-on-station switch is also used to indicate when a weapon is in place.

Two basic types of EMRU No 20 are manufactured – one type having a stainless steel body and the other, a lightweight version, with aluminium alloy body. All units are similar in appearance and have the same dimensions.

In operation, each suspension hook is independently latched; thus meeting NATO requirements. When the unit is cocked the hooks are closed and held so by a linkage mechanism consisting of a system of jointed struts maintained by a sear in a near straight condition. The sear is released by the action of the solenoid or cartridge, the strut system collapses and the hooks open. The possibility of a hang-up is eliminated by positive displacement of a strut joint when the sear is released.

Although basically free fall units a bolt-on ejector pack has been developed.

STATUS:
EMRU No 20 is in production. The Mk 1 and Mk 2 units are used on Nimrod aircraft, whilst the Mks 3 and 4 are in service on Wessex, Wasp and Sea King Naval Helicopters.
MANUFACTURER:
F. G. Miles Engineering Ltd, Riverbank Works, Old Shoreham Road, Shoreham-by-Sea, Sussex, BN4 5FL, England.

SPECIFICATION:

Release Unit Designation:	**EMRU** No. 20 Mks 1 & 2	**EMRU** No. 20 Mks 3 & 4
Normal Store Weight:	680 kg	454 kg
Ultimate Load:	27,700 kg	11,350 kg
Body Material:	Stainless Steel	Aluminium Alloy
Weight:	8 kg (Mk 2)	4.7 kg (Mk 4)
Bomb Release Safety Lock:	MAL 19 (Mk 1 only)	MAL 19 (Mk 3 only)
Length:	All types	542 mm
Width:		71 mm (no BRSL)
Depth:		138 mm (no BRSL)
Store Suspension Centres:	All types	355.6 mm (14 in)
Operating Voltage Range:	18V to 28.5V DC continuous or pulsed (14 mSec min)	
Operating Temperature Range:	All types	−60°C to +150°C

Miles EMRU No 20 Mk 3 fitted with MAL 19 actuator store-on-station switch

1844.393
EMRU No 22
DESCRIPTION:

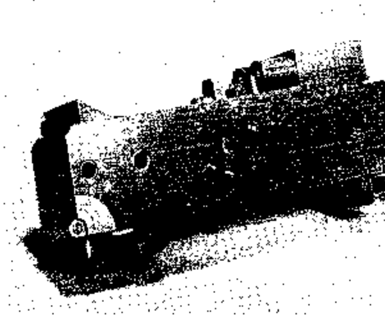
The Miles EMRU No 22 is the first of the new generation of free-fall crutchless release unit for the carriage and release of weapons and other stores from aircraft. The unit requires a new type of lug on the weapon and, by providing what is effectively self-adjusting four point suspension, the need for conventional crutches (sway braces) is eliminated. There is an overall weight saving in installation and the loading of stores is easier and quicker.

The EMRU is operated electrically by a well proven spring Stored Energy Actuator (SEA). This is a hermetically sealed device consisting of a spring loaded plunger held, when cocked, in a compressed state by a rotary solenoid operated lock unaffected by mechanical forces and responding only to a specific voltage. Duplication is provided to meet Service requirements.

The EMRU No 22 consists of two dual (two tongued) pivotted hooks in a frame controlled by a simple linkage mechanism. The mechanism and SEA are cocked by turning a cocking tool anticlockwise, the weapon is raised to the cocked unit and locked into place by turning the cocking tool clockwise. The mechanism is held mechanically in place by a release lever and a safety pin is provided to meet ground safety requirements. Spring loaded wedges in the base of the unit provide automatic and progressive take up of any tolerance in the attachment of the store without inhibiting store release in any way.

A Bomb Release Safety Lock (BRSL) can be provided within the overall envelope of the unit, if required. This is the Miles Actuator MAL 19. The complete equipment has been designed to meet the very difficult environment of naval helicopter operations.

Specification:
Length: 420 mm
Width: 80 mm
Depth: 164 mm
Total Weight: 7.25 kg without BRSL
8.07 kg with BRSL
Operating Voltage Range: 18V to 28.5V DC continuous or pulsed (14 m Sec min)
Maximum Store weight: In excess of 450 kg



Miles EMRU No 22

Ambient Temperature Range: −60°C to −135°C
STATUS:
In development for UK Ministry of Defence.
MANUFACTURER:
F. G. Miles Engineering Ltd, Riverbank Works, Old Shoreham Road, Shoreham-by-Sea, Sussex, BN4 5FL, England.

1265.393
ML CARRIER BOMB LIGHT STORES No 100
DESCRIPTION

The ML Carrier Bomb Light Stores No 100 is a streamlined faired carrier for adapting standard weapon pylons to the carriage of light stores such as practice bombs. The carrier is provided with pockets for NATO standard twin lugs at 356 mm (14 in) spacing, or UK 30 in spacing lugs or single lug suspension. It enables a maximum of four light stores, to a maximum weight each of 18 kg, to be carried. Each store is suspended from an Ejector Release Unit No 122. Typical loads are four 4 lb (1.8 kg) retarded practice bombs, or two 127 mm (5 in) flares, or two 12.7 kg practice bombs. All stores are ejected vertically by an explosive cartridge contained in the ejector release units.

STATUS:

The Carrier Bomb Light Stores is in production and on order by the Royal Air Force and other Air Forces. It is used with a variety of aircraft including Jaguar, Buccaneer, Harrier, Strikemaster, Hunter, Lightning Mk 53, Phantom and Canberra.

Specification:

Overall length: 2,300 mm

Diameter: 419 mm

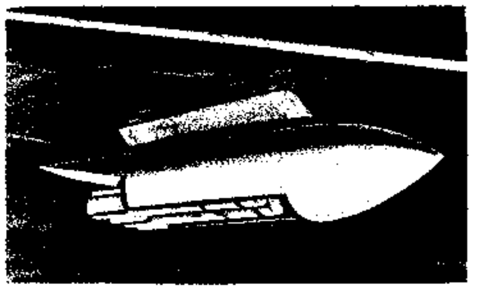
Weight less stores: 34.6 kg

Suspension:

(a) single lug
(b) twin lugs at 356 mm (NATO)
(c) twin lugs at 762 mm

MANUFACTURER:

ML Aviation Co Ltd, White Waltham Aerodrome, Maidenhead, Berkshire, England.



Drawing of ML Carrier Bomb Light Stores No 100 with two 5 in flares loaded

1280.393
ML AVIATION EJECTOR RELEASE UNIT No 122

DESCRIPTION:

The ML Aviation Ejector Release Unit No 122 Mk 2 is designed for use with smaller diameter stores of lightweight such as practice bombs and some types of flares.

The ERU No 122 Mk 2 will accept stores up to a maximum diameter of 127 mm and maximum weight of 25 kg. The store is gripped between jaws and no store suspension lugs are required. The release unit is fired by a single small explosive cartridge: radiation hazard protection is built into the firing circuits. The release unit is fired by a single explosive cartridge. Two versions of the ERU 122 are available.

ERU 122 Mk 2 uses UK cartridge ejector release unit CERU 200.

ERU 122 Ex uses UK CERU 201 or US ARD 863 or similar NATO types.

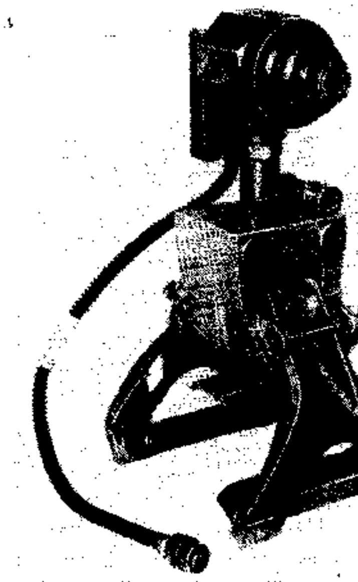
ERU 122 is normally part of the equipment supplied with Carrier Bomb Light Stores No 100 and No 200.

STATUS:

In production for the Royal Air Force, the Royal Navy and eleven overseas countries.

MANUFACTURER:

ML Aviation Co Ltd, White Waltham Aerodrome, Maidenhead, Berks, England.



ML Aviation ejector release unit No 122

1679.393
ML TRIPLE STORE CARRIER

DESCRIPTION:

This carrier is mechanically and electrically interchangeable with the American Triple Ejector Rack (TER) currently used on many aircraft throughout the world.

The ML Triple Store Carrier (TSC) is fitted with three ML ERU 119 thus giving improved ejection velocity, pitch control of stores at release, twin cartridge reliability and increased bomb release speeds. An international range of stores can be carried and released – flares, rocket launchers and bombs (including the Matra type retarded bombs for which reaction points are provided). Full fusing is available for all stores and modern electrical systems are installed.

The ML TSC can be supplied either as new build or, if desired, can be produced by conversion of customer's existing USA TERs.

STATUS:

In production for Phantom and other aircraft.

Specification:

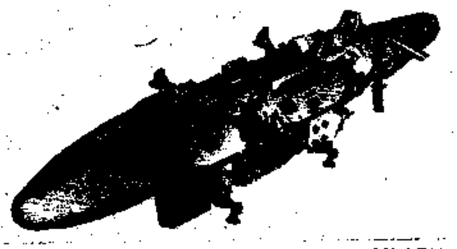
Overall length: 1,697 mm (66.8 inches)

Overall Height: 383.5 (15.14 inches)

Weight (less stores): 68 kg (150 lbs)

MANUFACTURER:

ML Aviation Co Ltd, White Waltham Aerodrome, Maidenhead, Berkshire, England.



ML Triple Stores Carrier fitted with three ML LRU 119

THE UNITED STATES OF AMERICA

1847.303
FUEL-AIR EXPLOSIVE WEAPONS

DESCRIPTION:

Each of the arms of the US Forces, Army, Air Force, Navy, and Marine Corps, is pursuing its own programme of research and development of Fuel-Air Explosive (FAE) munitions of varying types and sizes for differing operational roles. The basic principle consists of creating an aerosol cloud of a fuel-air mixture which is then detonated to achieve an explosive effect as compared with the fire effect produced by Napalm. Specific areas of R and D are concerned with such aspects as ensuring consistency in the size and mixture of the aerosol, means of delivery, and precise control of detonation. Other work is concerned with establishing the best means of achieving different operational objectives. Most of the applications under study are for battlefield operations, two typical examples being the use of FAE weapons against bunkers, fox-holes and similar emplacements, and as a means of explosively clearing mines. Both helicopter launched and high-speed aircraft compatible weapons are being studied, and surface-launched FAE weapons also have been tested.

CBU-55B:

This weapon was used to a relatively limited extent in Vietnam by the US Navy, mostly for defoliation and mine clearance, and is a free-fall cluster-bomb munition. It was deployed on both helicopters and low speed range fixed-wing aircraft. The CBU-55B is in the 500 lb (226 kg) class and each bomb has three 100 lb (45 kg) canisters 53 cm long and 35 cm in diameter. Each canister contains about 72 lb (33 kg) of fuel, and after release from the aircraft the individual canisters separate and are retarded by drogue parachutes as they approach the target. The cloud of fuel/air mixture produced is about 15 metres in diameter and 2.4 metres thick, and blast overpressures of up to 300 psi (210 kg/cm^2) are reported.

The US Army is interested in adapting one of the CUB-55B bomblets, the Blue 73 FAE warhead as the basis of a surface-to-surface FAE weapon for clearing minefields. The vehicle used is the Zuni rocket, a number of which are ripple-fired from a truck-mounted launcher rack. A modified FAU-83 standard mechanical fuse is used to produce varying delays in deployment of the warhead parachutes to achieve an area coverage pattern of FAE detonations.

CBU-72:

The CBU-72 resulted from US Navy modifications to the CBU-55B to suit it for dropping from high-speed jet aircraft. Specific types with which the CBU-72 was used successfully were the A-4 and A-7. Drogue parachutes to retard the individual cannisters were retained and the development of FAE weapons for use with high-speed aircraft, and without parachutes, is a separate project.

HSF-1:

HSF-1 is the designation of the smaller of two high-speed FAE bomb projects being carried out by the USAF. The HSF-1 is a weapon in the 500 lb (226 kg) class while the HSF-II is in the 2000 lb (900 kg) category. The former is projected as an unguided bomb of low cost and intended for carriage on conventional bomb-racks. Specified by USAF Tactical Air Command, the HSF-1 is due to complete advanced development by the end of 1974. If air drops of these models prove successful, full development will then be started.

HSF-II:

HSF-II is the 2000 lb (900 kg) class FAE weapon under development by the USAF. It is intended for use against targets such as parked aircraft, radar vans and similar light, high-value targets. Full-scale dynamic testing was in progress by early 1974 at the US Atomic Energy Commission's Sandia Corporation facility in New Mexico. These tests were concerned with factors such as evaluation of aerosol growth-rates, burst-height requirements, and assessment of the basic efficacy. Full-scale testing is planned for 1975. Guided and un-guided versions of HSF-II may be developed.

MAD FAE:

The US Marine Corps has its own programme for the development of a helicopter-deployed fuel/air explosive system, known as Mass Air Delivery FAE. Aluminium dispenser racks, each holding 12 FAE warheads weighing 136 lb (61.7 kg) each, are hooked to a helicopter's freight hook. Stabilising surfaces are provided to prevent twisting or oscillation of the racks. Single or salvo release of the FAE bombs is possible. Tests have been carried out with CH-46, CH-53, and UH 1 helicopters.

Fuels:

Various fuels have been employed, including ethylene oxide, liquid petroleum, propylene oxide, and methylacetylene propadiene-propane plus butane (MAPP).

DEVELOPMENT:

USN design work on FAE weapons under a government Research, Development, Test and Evaluation programme began in 1966 at China Lake, but this was pre-dated by some six years when the USN exploded its first FAE device at the same site. Navy interest continued from then until the formal programme of 1966. By 1967 there was also USAF and USMC activity, the former service carrying out tests of a 2500 lb (1134 kg) weapon developed under the **Pave Pat** programme. Two versions evolved, Blue 72 and Blue 76 for dropping by A-1 and F-4 aircraft types, respectively. Parachute retarding techniques prevented attainment of the required accuracy, however. The Blue 73 canister used in the CBU-55B had its origins as a ground deployed weapon, when in 1967 they were placed at the edges of minefields and then detonated by remote control for mine clearance. The first USN air-dropped operational FAE weapons (500 lb/226 kg class) were ready in October 1970 and were deployed in Vietnam.

1849.303
GATOR ANTI-TANK WEAPON

DESCRIPTION:

Gator is the designation of a project being conducted by the USAF Armament Development and Test Centre on behalf of the US Army, Navy and Air Force for the development of an air-deliverable anti-tank and anti-personnel mine system. Initial operational capability is planned for 1979. Different types of dispenser to permit delivery by fixed-wing aircraft and helicopters are being evolved, and in early 1974 the ASP (All-altitude Spin Projectile) was under consideration as the main USAF technique for use with fixed-wing aircraft. The US Navy's planned delivery system is known as the Mk 7, and a rotary wing dispenser is being developed for Army helicopters. The mine itself is aerodynamically shaped to spin to aid dispersion and it contains a focused charge intended to penetrate the underside of a tank. It will also have provision for self-destruction after a predetermined interval after deployment to allow friendly forces to pass over seeded areas.

1848.303
HSM – HARD STRUCTURE MUNITIONS

DESCRIPTION:

HSM (Hard Structure Munitions) is the title of a highly classified USAF Armament Development and Test Centre programme directed towards the development of new weapons capable of dealing with difficult hardened targets such as bunkers and command-and-control centres. Among the requirements are low-cost high penetration before release of main energy, high resistance to ricochet, and low-cost (non-nuclear) warhead. The new weapon will also be compatible with USAF standard guidance kits. ADTC hopes to reach the engineering development stage during 1975.

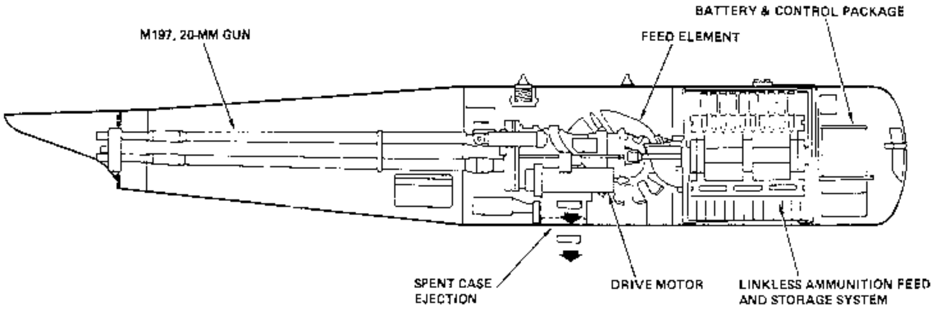
1678.303
GPU-2/A 20 mm LIGHTWEIGHT GUN POD

DESCRIPTION:

The GPU-2/A, 20-mm pod is a lightweight self-contained gun system requiring only a trigger signal from the aircraft. This pod can be mounted on a wide variety of existing helicopters and fixed-wing aircraft by using standard suspension racks. The total system weight when loaded with 300 rounds is less than 600 pounds.

General Electric Company has designed and produced a quantity of prototype GPU-2/A pods for the United States Navy. These systems use the three barrel M197, 20-mm gun which has been in military inventory since 1969. The firing rate for the GPU-2/A is selected at either 750 or 1,500 shots-per-minute. Rounds are fed to the gun through a linkless ammunition storage and feed system. This system maintains positive round control throughout all storage and feed operations.

The design concept of this system has been proven by combat experience with the SUU-11/A Minigun pods. Power for the system is provided by a 32V DC rechargeable nickel cadmium battery located in the aft section. This battery will fire up to three ammunition complements without a recharge. If the aircraft has sufficient power available, provision is made to trickle charge during operation of the aircraft.



GPU-2/A 20 mm lightweight gun pod mechanical arrangement diagram

The pod can be loaded with ammunition while suspended from the aircraft. The storage drum is made accessible by simply removing the aft fairing and swinging the hinged electrical package to one side. A belt of ammunition is attached to a loader mechanism which strips the links and feeds rounds into the storage drum in the proper attitude.

The first maintenance required for the GPU-2/A is at 15,000 rounds. At this time the front track bolts on the gun rotor are retorqued. Barrel life is 15,000 rounds; however, the barrels can be changed within 2 minutes while the pod is still suspended from the aircraft. No special tools are required for maintenance.

CHARACTERISTICS:

Weight: Approx 270 kg
Length: 304 cm
Diameter: 48 cm
Ammunition Capacity: 300 rounds
Rate(s) of fire: 750 or 1,500 shots per min
Gun: 20 mm M197

STATUS:

The GPU-2/A is under evaluation for the US Navy and 21 pods were delivered by early 1973.

MANUFACTURERS:

Aircraft Equipment Division, General Electric, Burlington, Vermont, USA.

1287.303
VULCAN GUN PODS SUU 16/A & SUU 23/A

DESCRIPTION:

These gun pods are of identical size and weight and both incorporate 6-barrel Vulcan 20 mm cannon and ammunition. Designed for installation on standard external store pylons, these pods provide a ready means of greatly increasing the cannon fire power of subsonic and supersonic fighter and ground attack aircraft. The pod mounted Vulcan gun is particularly well suited to the engagement of ground targets from ranges of 700 metres or more. The pods are of aerodynamic shape and attachment to the aircraft is by bomb lugs at standard 760 mm centres (30 in).

Both pods are of similar internal layout, a cylindrical ammunition drum containing 1,200 rounds occupying the rear portion of the pod. A linkless feed system couples this to the gun.

SUU/23A Vulcan 20 mm gun pod with forward fairing removed to show gun installation

The pods differ in the type of Vulcan gun fitted but their performance and hitting power are identical. In the earlier SUU 16/A design the cannon is the standard M61A1 mechanically driven by a ram air turbine. This turbine is mounted on a hinged skin panel of the pod and is lowered into the airstream prior to firing. The use of a ram air turbine restricts the rate of fire at aircraft speeds below 350 knots (650 km/hr). A further consequence of the turbine is that pod drag is somewhat greater than for the SUU 23/A pod in which a self-powered GAU-4 model Vulcan is used. For initial rotation of the GAU-4 gun in the SUU 23/A pod an electric inertia starter is provided.

In operation Vulcan gun pods are aimed using a gunsight or fire control system. During firing spent cartridge cases are ejected overboard and not retained. The gun is cleared automatically after the firing button has been released so that 'cock-off' is eliminated. During the clearing process a small number of live rounds are ejected.

A number of accessories are available to simplify loading, maintenance and testing of the pods.

CHARACTERISTICS:

	Pod SUU 16/A	Pod SUU 23/A
Length:	5.05 m	
Diameter:	560 mm	
Weight with 1,200 rounds:	780 kg	785 kg
Weight empty:	484 kg	489 kg
Boresight adjustment		
Elevation:	± 1 deg	± 1 deg
Azimuth:	± 0.5 deg	± 1 deg

Accuracy: 80% shots inside 8 mil
Rate of fire: 6,000 rounds per minute
Ammunition: 20 mm M 50 series
Power input from aircraft:

at 208 volts 400 Hz		
3 ph	7 amps	10 amps
at 28 volts DC	—	3 amps

STATUS:
Both SUU 16/A and 23/A pods are in service with US forces. They are compatible with a wide range of tactical aircraft including F-100, F-105, F 4, A-4D and F-111. The SUU 23/A pod is in service on Royal Air Force McDonnell Douglas Phantoms.

MANUFACTURERS:
Aircraft Equipment Division, General Electric, Burlington, Vermont 05401, USA.

1270.303
GENERAL ELECTRIC VULCAN 20 mm AIRCRAFT GUN AND LINKLESS FEED SYSTEM

DESCRIPTION

The General Electric M61A1 Vulcan aircraft cannon is of 20 mm calibre and employs the multi-barrel principle first used by Dr Gatling. The Vulcan is the standard USAF aircraft gun and is increasingly being used by the USN.

The gun has a rotary action and in the M61A1 is externally powered from the aircraft hydraulic or electric supply. A self-powered version, the GAU 4 is similar in all respects except that barrel rotation and operation of the action is derived from gun gas bled from four of the six barrels.

The outstanding features of the Vulcan are its high rate of fire, normally 6,000 rounds per minute, the high muzzle velocity of about 1,036 metres per second and the exceptional reliability by comparison with more conventional weapons.

Ammunition linked into belts has been used with Vulcan guns but feed reliability was poor at the high rates of fire characteristic of the weapon. There are also problems of link disposal. For these reasons in the majority of applications Vulcan cannon are associated with a linkless feed system. There are considerable variations in the detailed layout of gun and feed systems in service as each is tailored to the particular requirements of the aircraft installation. The essential elements are the M61A1 or GAU 4 gun, the linkless feed ammunition chutes which contain the ammunition conveyor, the cylindrical ammunition cannister and the drive power coupling between the gun and the ammunition drum.

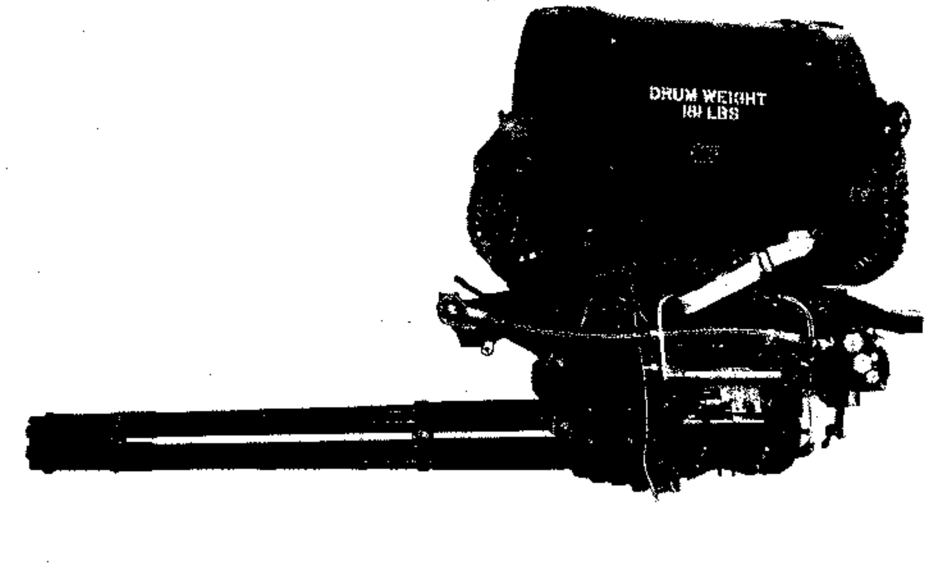
THE GUN:

The Vulcan gun has six rifled barrels and is externally powered. All barrels are rigidly clamped together and attached to the forward end of the breech rotor which rotates in a stationary housing. The rotor revolves anti-clockwise looking in the direction of fire. Cam followers operate the bolt for each barrel successively chambering, firing and extracting the rounds as the gun rotates. The linear actions needed for these operations are imparted to the followers by an elliptical slot machined in the rotor housing.

The multi-barrel design gives long weapon life by reducing heat dissipation and barrel erosion. A variety of barrel muzzle clamps are available to give different shot dispersion patterns. When the minimum dispersion clamp is in use 80% of shots are within an 8 mil cone.

Standard M 50 series electrically primed ammunition is used which is available in a variety of types – incendiary, armour piercing with and without tracer etc.

The preferred drive source is hydraulic power but drives accepting electrical and mechanical inputs have been developed. At full rate of fire about 20 hp is needed to drive the gun and its associated linkless feed system. In the self-powered variant, the GAU 4, gun gas is bled from four of the six barrels to operate the mechanism by means of a gas piston and drive which is mounted between the barrels ahead of the gun action. The GAU 4 develops sufficient power to operate the feed system. The gun is initiated by an electrically operated inertia starter.



Linkless ammunition feed system and 20 mm M61A1 Vulcan gun for F-4E aircraft

LINKLESS FEED SYSTEM:

Typically the linkless feed ammunition drum carries about 1,000 rounds although smaller drums are used in some installations. Linking the drum to the gun is a single or twin ammunition conveyor belt contained in flexible chuting. With a single link the spent cases are ejected overboard, but in many installations a return conveyor for spent cartridge cases is provided.

The ammunition drum carries the rounds stored between radial partitions. A central rotor in the form of a helical archimedean screw then moves the rounds from the drum into the conveyor in a multi-stage operation.

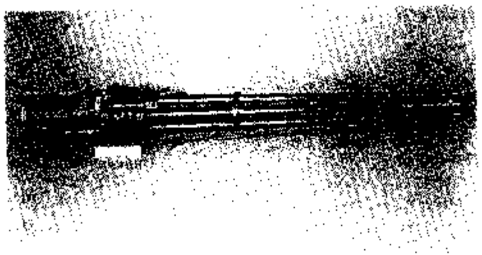
Many accessories and special tools are available for loading and maintaining Vulcan cannon and their feed systems.

Specification:

The self-powered GAU 4 variant of the basic M61A1 Vulcan cannon has virtually identical performance and characteristics, except that it is approximately 5 kg heavier.

Calibre: 20 mm
Weight: 120 kg
Length: 1,875 mm
Recoil Travel: ± 6 mm
Average recoil Force: 1,810 kg
Maximum rate of fire: 6,600 rounds per minute
Time to max rate: 0.3 sec
Stopping time: 0.5 sec
Ammunition: M53, M55AZ, M56A3, etc
Muzzle velocity: 1,036 metres per sec
Round Weight: 0.25 kg
Projectile weight: 0.1 kg
20 mm Linkless Feed System:

The exact specification for the 20 mm linkless feed depends upon aircraft design considerations.



M61A1 Vulcan gun

The data below relates to the installation on the Ling Temco Vought A-7D aircraft which is typical:
Ammunition capacity: 1,020 rounds
Firing rate: 6,000 or 4,000 rounds per minute
Ammunition weight: 114 kg
Feed system weight (less ammunition): 190 kg
Drive system: Shaft coupling to gun hydraulic motor
System type: Double ended – cases retained in drum
Total ammunition chuting length: 4.57 metres

STATUS:

The M61A1 and GAU 4 20 mm Vulcan guns with their associated linkless feed systems are in service with the USAF, the Royal Air Force and with other Air Forces operating F-104 and F-4 aircraft. The weapon and its associated feed are in service on A-7, F-104, F-4, F-111, F-105 and other aircraft. Podded installations are also available and are in service. The Vulcan gun is in production and will be fitted to the F-14 and F-15.

MANUFACTURER:

Aircraft Equipment Division, General Electric, Burlington, Vermont, USA.

1118.303
XM35 ARMAMENT SUBSYSTEM

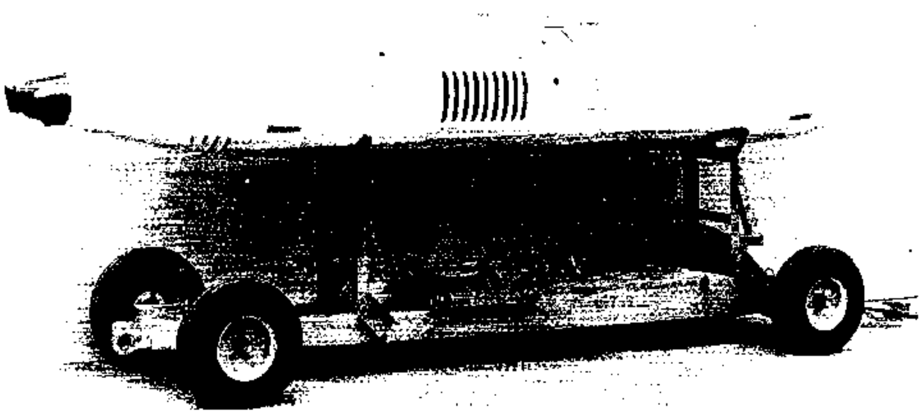
DESCRIPTION:

The XM35 is a fixed mounted armament subsystem located under the left weapon sponson on an AH-1G Helicopter. The system carries one 20 mm automatic gun XM195 a Vulcan type with six barrels. This is a modified M61A1 gun with blast deflectors on the end of 102.6 cm barrels. The 20 mm ammunition is link-fed to the right side of the gun from ammo-containers mounted on the left and right sides of the helicopter outside the aircraft. The weight of the system with ammunition is 530 kg, without ammunition 245 kg. The system carries approximately 950 rounds of ammunition

with a firing rate of 750 ± 100 SPM.
DEVELOPMENT:
The XM35 system was developed by the US Army Weapons Command and the General Electric Company. A production contract was awarded to the General Electric Company in 1968.
STATUS:
US Forces.

1182.303
MK 4 MOD 0 GUN POD

DESCRIPTION:
The Mk 4 Mod 0 Gun Pod is a self-contained and self-powered 20 mm gun system. The pod contains a twin-barrelled 20 mm Mk 11 Mod 5 Gun. The container is a low-drag cylindrical shape with detachable nose and tail cones, that is designed for supersonic flight in fighter and attack type jet and propeller aircraft. Belted ammunition is carried forward from the rotary magazine through dual feed chutes. Expended cases and links are ejected downward from the bottom of the pod at a velocity of 75 feet per second. A salient feature of the gun pod is the instantaneous full rate-of-fire. The pod is equipped with mounting provisions for both 30 inch and 14 inch suspension systems and is normally attached to the aircraft on a standard ejector rack such as the Aero 7A, Aero 27, MAU 9A/A, etc.


Hughes Mk 4 Gun Pod

CHARACTERISTICS:
Primary kill mechanism: Blast fragments, or penetration (depending on whether HEI or API ammunition is used)
Weapon type: Anti-material and anti-personnel
Payload fusing: Contact
Range: 950 m
Firing rate (rpm): 700 or 4,200
Delivery: Strafe
Weight:
Total, loaded: 630 kg
Total, empty: 357 kg
Payload (750 pounds): 269 kg
OPERATION:
The Mk 4 Gun Pod is aimed with either a fixed sight or a fire control system. It is fired by pressing the control stick trigger. Gun reaction time is instantaneous. Delivery is normally made in a shallow dive, 5-30°. Slant range for a "point" target should be 900 m or less. Area targets may be profitably attacked from a longer range because accuracy is not of primary importance. Normal delivery speed is 400 knots but may be at any speed within the performance limits of the aircraft.
STATUS:
The Mk 4 Gun Pod has been flown and fired from the following aircraft: A-4 (1, 2 and 3 pods), F-4 (1 and 3 pods), A-7 (1 and 2 pods), A-6 (1, 2, 3 and 4 pods), OV-10A (1 pod), F-100 (1 and 2 pods), HUS-1 (1 pod).
It entered service in Jan 1966 with the US Navy, for whom it was developed by Hughes. It is also used by the US Marine Corps. Production ceased in 1968 after about 800 units had been delivered. Internal installation of the Mk 11 gun and advanced pod designs are under consideration.
MANUFACTURERS:
Hughes Tool Company, Aircraft Division, Centinela and Teale Streets, Culver City, California 90230, USA.

1183.303
MK 11 MOD 5 GUN

DESCRIPTION:
This weapon is intended for aircraft air-to-ground, air-to-air and ground vehicle installation. Each installation consists of a 20 mm Mk 11 Mod 5 Gun Mechanism and a Mk 2 Mod 1 Loader. The gun mechanism consists of the following major components: receiver assembly, breech assembly, revolver cylinder assembly, and one each Mk 19 Mod 3 and Mk 20 Mod 3 barrel.
The Mk 11 Mod 5 Gun is a twin-barrel, air-cooled, belt-fed, combination gun-gas and recoil-operated automatic weapon firing electrically primed ammunition from an eight-chamber revolver cylinder. The gun is fed by two belts of Mk 6 Links which enter the mechanism on opposite sides of the loader. Belts are simultaneously advanced by a single sprocket within the loader which is driven by the revolver cylinder shaft. The mechanism simultaneously rams two cartridges, fires two cartridges, and ejects two cases which are relinked and ejected from the gun at approximately 100 feet per second.


Mk 11 Mod 5 20 mm gun

CHARACTERISTICS:
General:
Gun Length:
with loader: 199 cm
without loader: 179 cm
Gun Weight:
Gun mechanism: 65.3 kg
Barrels: 23.1 kg
Loader: 20.4 kg
Rate of fire: 4,200 rounds/minute or 700 rounds/minute (other rates available)
Time to rate: Instantaneous (0.003 sec)
Chamber pressure: 4,077 kg/sq cm
System of operation: Recoil, gun-gas boosted
System of locking: Fixed breech revolver principle
System of feeding: Self-feeding through gun-driven sprockets
Method of loading: Gun-gas powered dual rammers
Location of feed opening: Left and right side of loader, 2 belts (top and bottom feed optional)
Location of ejection opening: Rear of loader, 2 openings
Method of charging: Integral, air operated valve
Method of cooling: Air
Recoil distance: 28.5 mm
Distance between barrels: 104.7 mm
Number of chambers in revolver: 8
Belt velocity, average: 1.5 m/sec (each belt)
Ignition system: 120 V – 400 Hz
Barrel length: 143.5 cm
Actual length: 143.5 cm
Effective length: 161.3 cm (including revolver)
Barrel removal: Quick disconnect lever, 60° interrupted threads
Rifling:
Barrel: None (smoothbore system)
Revolver: 8 rifled, replaceable inserts
Number of grooves: 9
Twist: 26°, right hand
Recoil:
Average: 1,134 kg
Peak: Recoil, 3,628 kg. Counter-recoil 2,268 kg
Ammunition: 20 mm Mk 100 series, 20 mm M-50 series
STATUS:
Entered into service with US Navy and US Marine Corps in January 1966. Of 1,600 ordered, 1,270 had been produced at May 1969. It is part of the armament of numerous types of American aircraft.
MANUFACTURERS
Hughes Tool Company, Aircraft Division, Centinela and Teale Streets, Culver City, California 90230, USA.

1119.303
XM156 ARMAMENT MOUNT

DESCRIPTION:
The XM156 multipurpose armament mount is a pair of rack and support assemblies which carry and fire the new, larger capacity XM159C rocket launchers from each side of the UH-1B/C helicopter. Each launcher pod is armed with nineteen 2.75-inch folding-fin aerial rockets. The mount can also accommodate external stores on 14-inch (35.56 cm) bomb rack suspension up to 245 kg on each side. Used with the XM159C rocket launcher the mount has fixed elevation and traverse and is aimed through a fixed reflex type sight. The XM156 can be mounted along with the M5 subsystem on the same aircraft.
STATUS:
US Forces.

1285.303
XM 188 30 mm THREE BARREL AIRCRAFT GUN

DESCRIPTION:

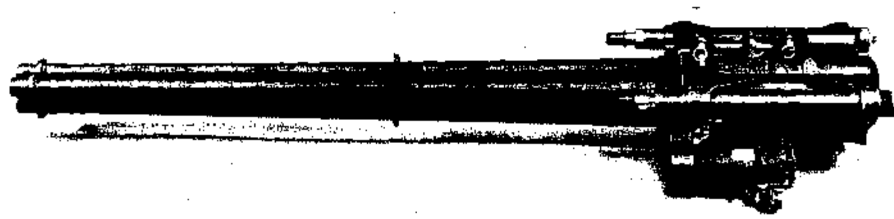
This is a lightweight 30 mm 3-barrel variant of the basic General Electric 20 mm M61A1 Vulcan design.

The gun fires the XM 552 30 mm HEDP round. The firing rate is variable up to 2,000 rounds per minute and ammunition feed is linked by belt or linkless feed system.

In common with other Gatling gun derivatives of the Vulcan series, the 30 mm weapon is externally powered. Hydraulic or electric drives are available. A self-powered variant has been developed.

CHARACTERISTICS:

Calibre: 30 mm
Rate of fire: Up to 2,000 rounds/minute



XM 188 30 mm three barrel aircraft gun

Muzzle velocity: 670 m/sec
No. of barrels: 3
Weight: 68 kg
Length: 1,473 mm
Average recoil force: 605 kg
Accuracy: 80% shots inside 8 mils (1.76 rms)

STATUS:

In prototype development, the gun is used as part of the 20/30 mm Flexible Weapon System.

MANUFACTURERS:

Aircraft Equipment Division, General Electric, Burlington, Vermont, USA.

1120.303
XM140 AUTOMATIC GUN

DESCRIPTION:

The lightweight electrically driven XM140 30 mm automatic gun is specifically designed for attack helicopter gunships. The low recoil force and directional capability of blast diffusion provides feasibility of turret or wing stores mounting peculiar in the US Army's current inventory. The stand-off range of over 3,000 metres, together with the increased kill potential of the dual purpose shape charge, reduces aircraft vulnerability and enhances the operational characteristics against hard and soft targets beyond other weapons now available.

STATUS:

US Army.

1288.303
20/30 mm FLEXIBLE WEAPON SYSTEM

DESCRIPTION:

The General Electric 20/30 mm flexible weapon system has been designed and developed for the Bell Cobra helicopter. It consists of a lightweight turret designed for belly or chin mounting which can be fitted with the GE M 197 20 mm lightweight 3-barrel gun or the equivalent 30 mm gun, GE type XM 188. The turret is interchangeable with the XM 28 turret fitted to the Cobras now in service.

The 20/30 mm turret system consists of a turret, with gun, mounted beneath the nose of the AH-1 helicopter. The sighting station and the controls for aiming and firing the gun are located in the helicopter within easy reach of the gunner. A wide range of gun motion is provided. The gunner directs the gun independently of helicopter altitude, firing from the trigger switches at the sighting station.

If required the gun may be stowed in a pre-set fixed position and used as a fixed aircraft gun, fired by the pilot or co-pilot.

The power controls for training the gun are contained within the turret and operate from the 28 volt DC supply on the helicopter.

The gun servo error signals are processed to give constant overall servo gain throughout the elevation and azimuth angle range.

The optical sight is of the reflector type with the reticle focused at infinity. It is not gyro stabilised. The sighting head is flexibly mounted using a parallel arm linkage. In use it is hand-held and has built-in jump and lead angle compensation.

Ammunition is stored as standard linked belts in three bays. The capacity is 750 rounds of 20 mm or 500 rounds of 30 mm. An electrically powered belt booster is provided to reduce the belt-pull which would otherwise have to be provided by the gun itself. The ammunition is fed to the gun along flexible chutes.

Specification:
Total system weight: about 450 kg
Gun turret mounted: 20 mm M 197 or 30 mm XM 188

20/30 mm Flexible Weapon System installed in helicopter

Azimuth freedom: ± 113 deg
Elevation freedom: + 23 deg to −50 deg
Slewing rates – azimuth: greater than 80 deg/sec
Slewing rates – elevation: greater than 60 deg/sec
Ammunition capacity: 750 rounds 20 mm 500 rounds 30 mm
Reload turn round time: 15 minutes

STATUS:

In 20 mm form the GE Flexible Weapon System is installed and in service with US Marine Corps AH-1J Sea Cobra attack helicopter. The Imperial Iranian Army has ordered an advanced version of the AH 1J fitted with this armament system.

MANUFACTURER:

Aircraft Equipment Division, General Electric, Burlington, Vermont, USA.

1286.303
M 197 20 mm THREE BARREL AIRCRAFT GUN

DESCRIPTION:

The M 197 aircraft gun is a 3-barrel fully automatic gun. It is a lightweight derivation of the 20 mm Vulcan M61A1 six barrelled weapon. The M 197 utilises many of the M61A1 components and has a rate of fire from 400 to 1,500 shots per minute.

Like other guns in the Vulcan series the M 197 needs external power – about 3 hp – for its operation.

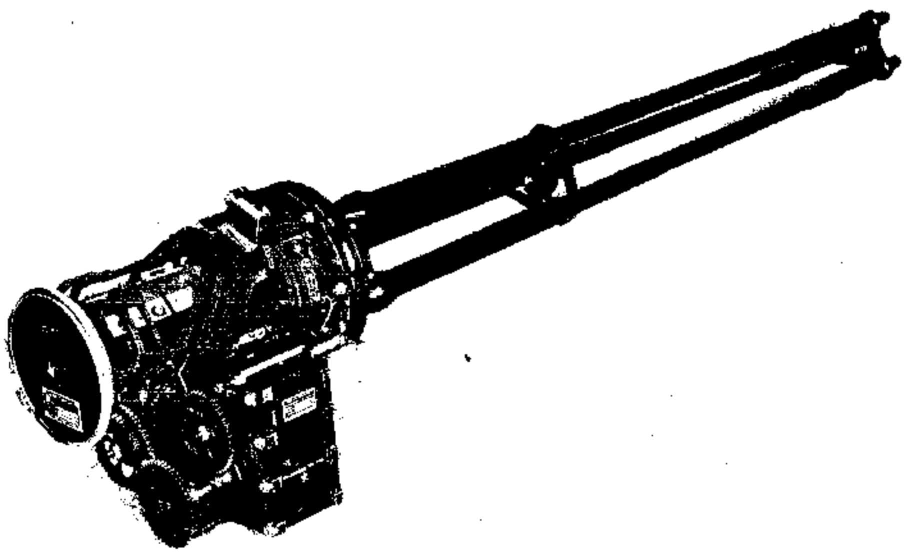
The M 197 fires standard US 20 mm ammunition of the M.50 series. Ammunition can be fed to the gun as a standard linked belt or by a linkless feed system.

Specification:
Calibre: 20 mm
Rate of fire: 400 to 1,500 rounds/minute
Muzzle velocity: 1,036 m/sec
No. of barrels: 3
Weight: 66 kg
Length: 1,892 mm
Average recoil force: 68 kg (at 1,500 rpm)

STATUS:

In production since October 1969 and in service on the USMC Sea Cobra attack helicopter AH-1J and the OV-10A aircraft. The M 197 forms part of the GE Flexible Weapon System and is

used in the GE lightweight gun pod.
MANUFACTURER:
Aircraft Equipment Division, General Electric, Burlington, Vermont, USA.



M 197 20 mm three barrel aircraft gun

1112.303
M21 AIRCRAFT ARMAMENT SYSTEM
DESCRIPTION:
The M21 aircraft armament system is made up of two 7.62 mm M134 machine guns (miniguns) and two M158 pods with seven 2.75-in folding fin rockets each. The system can fire six pairs of rockets in one second or 4,800 rounds of 7.62 mm ammunition a minute. The rocket pods are aimed by manoeuvring the aircraft to which they are fixed. The machine guns, however, traverse 12 degrees inboard to 70 degrees outboard and plus 10 to minus 85 degrees in elevation and depression. When the guns traverse inboard to 12 degrees they operate a limit switch that stops the firing on the inboard pointing gun. The gun on the opposite side then increases its rate of fire from 2,400 to 4,000 SPM, compensating for the non-firing gun. This allows a heavy volume of fire to be placed on the target. Emerson Electric Company is the prime contractor.
STATUS:
American and Italian Forces.

1116.303
XM28 ARMAMENT SYSTEM
DESCRIPTION:
The XM28 armament system includes two M134 7.62 mm machine guns or two XM129 40 mm grenade launchers or one of each, mounted in a powered chin turret under the front of the AH-1G Huey Cobra helicopter. Ammunition is in a special compartment in the forward part of the aircraft and moves to the turret through fixed and flexible chuting. The sight and control panel at the gunner-co-pilot station allows him to train guns or launchers, or both, plus or minus 110 degrees in azimuth and plus 20 degrees to minus 50 degrees of elevation. The pilot can fire weapons in the stowed position. With a full load of ammunition the system weighs from 390 to 395 kg depending upon the combination of weapons carried. Capacity is 4,000 rounds for each machine gun and 300 rounds for each grenade launcher. The system can select 2,000 or 4,000 rounds a minute for the gun and 400 rounds a minute for the launcher. Emerson Electric Company is the prime contractor.
DEVELOPMENT:
Development was carried out jointly by the US Army Weapons Command and Emerson Electric. The latter company is producing the system.
STATUS:
US Forces.

1117.303
XM28E1 ARMAMENT SUBSYSTEM
DESCRIPTION:
The Armament Subsystem XM28E1 is similar to the XM28 except for minor changes in the drive motor, which is a motor with two distinct speeds as opposed to a motor which produces two speeds through use of a control resistor.
STATUS:
US Forces.

1836.303
XM30 AIRCRAFT ARMAMENT SUBSYSTEM
DESCRIPTION:
The XM30 subsystem is a two-gun installation of XM140 30 mm guns, one on each side of the UH-1B helicopter. Ammunition is stored inside the aircraft. The subsystem weighs approx. 1800 pounds (816 kg) when fully loaded. It is capable of firing at a combined rate of approx. 850 rounds per minute.
The guns are remotely controlled and may be fired by the copilot. The pilot can also fire the guns when they are in the fixed forward (stow) position.

1837.303
XM-41 ARMAMENT SUBSYSTEM
DESCRIPTION:
The XM-41 includes an M-60D machine gun, link and brass retainer, ammunition box, and safety harness for the gunner. The system is utilized on the rear ramp of the CH-47 Chinook helicopter. Mechanical stops limit the elevation, depression, and azimuth of the machine gun.

1838.303
XM-59 ARMAMENT SUBSYSTEM
DESCRIPTION.
The XM-59 is basically the M23 pintle mount armament subsystem with the added provision for substituting the AN M2 calibre .50 machine gun for either of the M-60D 7.62 mm machine guns in the left or right cargo compartment doorway of the UH-1D or UH-1H helicopters. The machine guns have a capability of 88° front or backward travel, with 6½° up or 80° downward travel.

1121.303
XM93/XM94 ARMAMENT SUBSYSTEMS
DESCRIPTION:
The XM93 and the XM94 are two similar aircraft armament subsystems employing a common basic mount design to provide pintle-mounted weaponry in the cargo compartment doorways of the UH-1N helicopter. The XM93 designates a GAU 2B/A high rate machine gun subsystem with a 2,000 4,000 SPM rate of fire and controlled from the cockpit only 2,000 SPM rate of fire. The XM94 designates an XM129 40 mm grenade launcher subsystem with a 400 SPM rate of fire. Each subsystem provides two identical pintle installations which can be interchangeably mounted in either the right or left cargo doorway. The system has an elevation of 5.5 degrees, a depression of 70 degrees and an azimuth of 90 degrees forward 70 degrees aft. The weapon can be hand controlled as a flexible pintle installation fixed in a forward attitude and remotely fired by the pilot, or vertically pivoted to a stow position completely inside the aircraft. The system can still fire, even with the engine stopped. The subsystem and individual components are capable of simple, rapid installation or removal. Principal components comprising each subsystem are two each GAU-2B/A or XM129 weapons, pintle mount assemblies, ammunition container and feed assemblies and electrical control boxes. Total weight of the system is 535 kg with a full complement of ammunition.
STATUS:
US Forces.

1111.303
XM18E1 ARMAMENT POD

DESCRIPTION

The Armament Pod XM18E1 is a fixed pod mounted under the weapon sponsons on the AH-1G Huey-Cobra helicopter. It consists of a 7.62 mm machine gun M134 with a 1,500-round, electric driven link ess feed loading system. Gun firing is electrically controlled The 145 kg pod fires at selective rates of 2,000 or 4,000 SPM, powered by a battery and control assembly in the aft portion of pod. This pod is the same as the XM18 except for its redesigned battery and control assembly. It will accept a modification which lets the pod use AC or DC from the aircraft. The pod is 216 cm long, 30.5 cm in diameter and mounts on standard 14-inch (35.36 cm) suspension lugs.

STATUS:
US Forces.

1268.303
MINIGUN POD TYPE SUU 11B/A

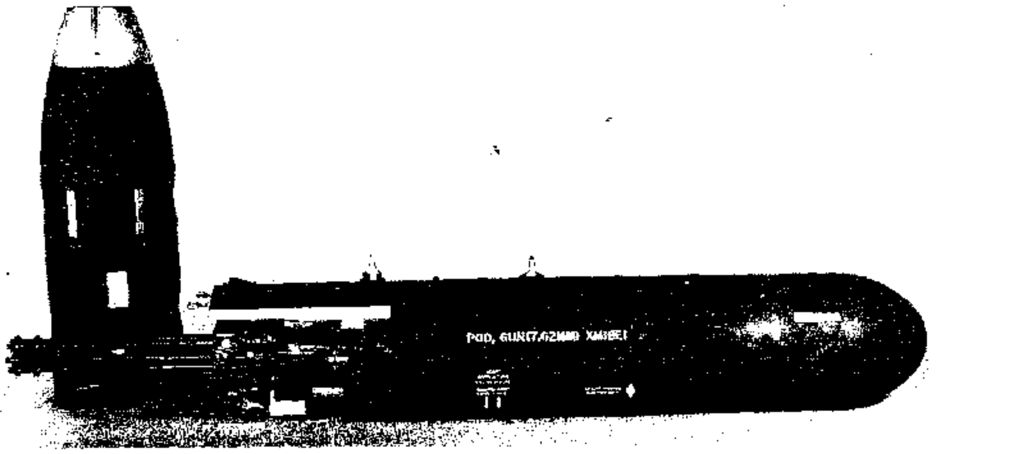
DESCRIPTION:

The General Electric M134/GAU 2B/A Minigun is a 7.62 calibre development of the 20 mm M61 series of "Vulcan" cannons. It has outstanding firepower and the SUU 11B/A pod provides a convenient means of giving its power to any tactical aircraft. The pod is light in weight and small in size and is equipped with standard bomb lugs for attachment to the weapon pylon. The pod can be carried on a wide range of aircraft up to a maximum speed of Mach 1.2.

The gun is mounted in the forward half of the pod and fires through the stainless steel nosecap. The centre section of the pod contains the linkless ammunition feed system. A drum magazine is employed containing 1,500 rounds of standard NATO 7.62 mm ammunition Type M 59, M 80 or M 60. In the rear of the pod is the electrical control package. The linkless feed system is essentially the same as the larger scale one already developed for the Vulcan. In the Minigun pods the feed is single ended and spent cartridge cases are ejected overboard through a port on the bottom of the pod. The ammunition is conveniently loaded from standard belted ammunition using a hand operated de linking loader.

Provision for gun harmonisation is built in to the gun mounting. A screw adjustment provides movement of the gun line through approximately ± ¾ degree. Shot dispersion can be varied to suit operating conditions and target characteristics. At minimum dispersion 80% of shots are within a 6.5 m... included angle.

A similar pod to the SUU 11B/A is used by the US Army under the designation XM 18 E1. This differs only in the power supply requirements and the rates of fire pre-set into the pod.


SUU 11B/a Minigun pod

Specification:
Designation: USAF Minigun Pod SUU 11B/A. US Army Minigun Pod XM 18 E1
Gun: 7.62 Minigun M 134/GAU 2/A
Feed: Linkless type MAU 7
Drive: SUU 11B/A Electric, AC or DC: 28 V at 15 amps or 208 V AC 400 Hz 3-phase 2 amps per phase. XM 18 E1 Electric, 28 V DC 15 amps only
Length: 2,159 mm
Diameter: 305 mm
Weight loaded: 147 kg
Weight empty: 11? kg
Ammunition capacity: 1,500 rounds
Rate of fire: SUU 11B/A 3,000 or 6,000 per minute. XM 18 E1 2,000 or 4,000 rounds per minute
Average recoil force: 136 kg at 6,000 rounds per minute

STATUS:
In production and in service with US and foreign forces.

MANUFACTURER:
Aircraft Equipment Division, General Electric Company, Burlington, Vermont, USA.

1592.303
EMERSON TACTICAL ARMAMENT TURRETS (TAT)

DESCRIPTION:

The Emerson Electric Company developed and manufactures several turret weapon systems which have been used particularly on US helicopters. With the exception of the low-cost, lightweight MINI-TAT version, they are hydraulically powered. TAT 101 has two M60C 7.62 mm MGs, each with a 600 rounds/min firing rate, and the link-belt feed system is within the turret. The fire control system consists of a gunner's sighting station for pointing and tracking the weapons, and a panel containing circuits and controls. The weapons are remotely charged hydraulically. Elevation limits are −15°, −45° and azimuth ± 115° (± 180° modified), both having slew rates of 45°/sec. TAT 102 is of similar type but is for a single M134 7.62 mm lightweight MG. Azimuth coverage is ± 115° (± 180° modified) and elevation + 25°, −50° (−90° modified). Slew rates are higher, azimuth 80°/sec and elevation 60°/sec. Several versions of TAT 102 have been made, the largest and heaviest for the Huey-Cobra helicopter at an overall weight of 115 kg without ammunition.

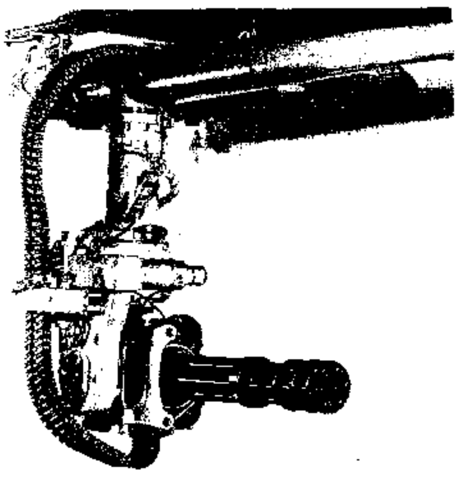
TAT 140 (XM-120) system uses the XM140 30 mm automatic and has similar characteristics to the TAT 102. Overall unloaded weight is 190 kg. TAT 161 20 mm system is intended for M61 type weapons, including M61A1; XM 188 and XM197. Its characteristics are the same as for TAT 101.

EMERSON MINI-TAT

MINI-TAT is a lightweight 7.62 mm weapon system developed to provide flexible, defensive fire for light observation and transport helicopters. Electrically operated on 28 V DC power. Overall weight of the system with US Minigun, minus ammunition, is 86 kg. Fields of fire are + 180° in azimuth and + 6°, −70° in elevation, with high slew rates of 80°/sec in azimuth and elevation.

STATUS:
TAT systems are in service with US Forces. MINI-TAT systems are being supplied to Canada, France and Iran.

MANUFACTURER:
Emerson Electric Co. St Louis, Missouri, USA.


Emerson Electric MINI-TAT with 7.62 mm gun

1115.303
XM27E1 ARMAMENT SYSTEM

DESCRIPTION

The XM27E1 armament subsystem consists of an M134 machine gun (minigun) mounted outside an OH-6A Cayuse helicopter. The gun projects outboard on the left side at the water line and on the centre of gravity. A 2,000 round-load is stored in a single ammunition container and fed to the gun through fixed and flexible chuting. The gun, fixed in azimuth, allows a depression angle of 24 degrees and an elevation angle of 10 degrees. Elevation depression and firing are electrically controlled from the cockpit by the pilot. The sight is an optical beam-splitter type, mechanically linked to the system. Range can be set and changed by the pilot during flight. A two-speed electric motor fires the minigun at 2,000 or 4,000 rounds a minute. The Armament Subsystem XM27E1 is also mounted on the OH-58A helicopter. The only significant difference is the change in elevation and depression angles, which are plus 5½ degrees and minus 20 degrees. Hughes Tool Company is the prime contractor.

STATUS:
US Forces.

1108.303
M5 AIRCRAFT ARMAMENT SYSTEM
DESCRIPTION:

The M5 aircraft armament system is a nose turret mounted M75 40 mm grenade launcher that provides the UH 1B/C helicopter with a limited degree of suppressive fire against ground troops. The system fires 230 rounds per minute with an effective range of 1,500 metres. Capacity is either 150 or 315 rounds, and ammunition is fed through flexible chuting from behind the pilot to the turret. Ball turret mounting allows the launcher a +15 to a −35 degree elevation and a 60 degree right and left traverse. The co-pilot/gunner aims through a reflex type sight. In June 1969 the release for the MWO Kit on the M5 was received. The kit included a lead angle compensator and a rotary ammo-can.

STATUS:
US Forces.

1109.303
XM8 ARMAMENT SUBSYSTEM
DESCRIPTION:

The Armament Subsystem XM8 mounts a 40 mm Grenade Launcher XM129 on the left side below and behind the co-pilot on an OH-6A Helicopter. The system carries 156 rounds (max) of linked 40 mm cartridges. These cartridges are stored in an ammo-container located behind the pilot's seat on top of the subsystem's torque tube assembly. The armament subsystem has a fire rate of 300-450 spm. It weighs 53 kg without ammunition and 107 kg with ammunition. The elevation limits are +10 degrees in elevation and −24 degrees in depression with an elevation control rate of 15-30 degrees per second. The pilot aims the grenade launcher in azimuth by controlling the helicopter.

STATUS:
US Forces.

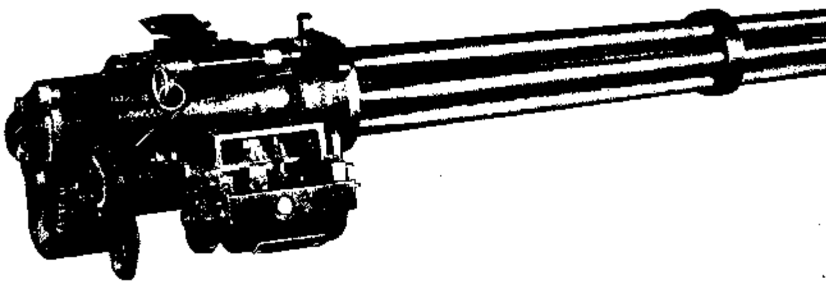
1284.303
XM-214 5.56 mm AUTOMATIC GUN
DESCRIPTION:

The General Electric Company has designed and developed a 5.56 mm automatic gun. The gun design is based on the proven principles of the operational M61A1 20 mm Vulcan Gun and the GAU-2B/A 7.62 mm Minigun. Selectable firing rates are available within the range of 400 to 6,000 shots per minute, permitting optimum engagement of a variety of targets. As few as three rounds to as many as 1,500 rounds can be fired in a single burst. The weapon is a multi-barrelled machine gun externally powered and suitable for aircraft, helicopter or ground vehicle installation. The 5.56 mm M193 (M196 Tracer) round weight is approximately half that of the 7.62 mm round and is the same as is used in the M-16 rifle.

A single, rugged main spring is used for actuation of the firing pins. Elimination of the springs from the individual bolts allows the bolts and entire gun to be simpler, smaller, and lighter.

A de-linking feeder provides a declutching action, which, when the trigger is released, immediately stops the feeding of rounds. The gun continues to fire for a fraction of a second, firing out remaining rounds. This operation automatically clears and 'safes' the gun at the end of each burst. A combination access handle and safing lever separates the main spring from the six gun bolts and provides a positive visual verification of the safe position.

A side-stripping feeder strips and disposes the ammunition links and feeds rounds to the gun.



XM-214 5.56 automatic gun

This feeder permits rapid installation of flexible ammunition belts or ammunition cans. The gun's access cover, bolts and feeder can be removed and installed without tools or timing procedures. Reliability and maintainability of the 5.56 mm gun are expected to be equal to or better than that of the 7.62 mm Minigun.

The power input needed by the gun varies between 0.75 and 3.2 hp according to rate of fire selected. Electric or hydraulic motor drives are available for this purpose. A self-powered propellant gas-driven variant of the minigun has also been developed. For the electric drive a range of nickel-cadmium batteries is available giving a duration of fire up to 80,000 rounds at 1,000 rounds per minute.

Specification:
Calibre: 5.56 mm
Muzzle Velocity: 990 m/sec
Rate of fire: Up to 10,000 rounds/minute
Dispersion: 80% shots within 4 mils
Length: 686 mm
Weight (gun and drive): 15 kg
Recoil force, average: 110 kg (at 10,000 rounds/min)

STATUS:
The XM214 is in prototype development. An XM214 pod has also been designed for aircraft applications.

MANUFACTURERS:
Aircraft Equipment Division, General Electric, Burlington, Vermont, USA.

1846.303
XM230 30 mm CHAIN GUN
DESCRIPTION:

The XM230, also known as the Chain Gun, is a single barrel, externally powered weapon which incorporates a rotating bolt mechanism driven by a simple and reliable chain drive. The entire gun weighs less than 100 pounds (45.3 kg) and will achieve firing rates of 100 to 1,000 shots per minute with minimal design variation. The chain mechanism, together with simplified feeder design and 100 per cent positive round control, assures high reliability at these low and medium rates of fire. Bolt action is such that the gun will handle brass, steel, or aluminium-cased ammunition with equal facility.

The chain drive concept permits a simplified gun cycle which operates safely from an open bolt without requirement for chargers, declutching feeders, or other special devices. Because of its simplicity (180 parts including 52 for recoil adapters), the production cost of the XM230 is expected to be less than half that of competitive weapons.

With the advent of the Advanced Attack Helicopter programme, Hughes considered the 30 mm alternatives which would meet the Army's criteria for performance, reliability, and combat effectiveness yet be consistent with the cost and weight constraints of a lightweight, high-performance helicopter, and initiated development of an externally powered weapon based on state-of-the-art principles. The Chain Gun fired its first shot in April 1973, and in July, the US Army

The Hughes AAH (Advanced Attack Helicopter) includes in its armament the 30 mm Chain Gun. Other features are TOW anti-tank missiles, 2.75 in rockets and Forward Looking Infra-red systems

Armaments Command sponsored a 2,500-round feasibility firing test programme which was successfully completed with the prototype (A Model) gun that September. Although minor mechanical problems were experienced early in this test, the final 1,000 rounds were fired without a stoppage or malfunction. Almost 90 per cent of these last rounds were aluminium cased thereby establishing compatibility of the Chain Gun mechanism with this advanced round of "WECOM 30" ammunition. During subsequent firing tests, the A Model gun demonstrated its capability to fire in any attitude, to fire single shot, and to burst-fire up to 100 rounds at rates approaching 500 shots per minute.

Hughes went on to fabrication of the B Model which incorporates a simplified gearing arrangement which will reduce the total number of gun parts from 128 to 97 and ensure even higher reliability and maintainability. Present plans call for the firing of 50,000 rounds at design rate (500 to 750 SPM) prior to 30 June 1974 in accordance with the Hughes AAH programme schedule.

MANUFACTURER:

Hughes Helicopters and Ordnance Systems, Culver City, California 90230, USA.

1110.303
M16 ARMAMENT SUBSYSTEM

DESCRIPTION:

Armament Sub-system M16 contains two 7.62 mm M60CAL machine guns on each side, also dual, seven round fixed mounted M158 2.5 inch rocket launchers mounted on a UH-1B/C helicopter. Each set of guns is flexible in both elevation and azimuth. Capacity for the machine guns is 6,000 rounds which is link-fed to the left side of each gun. The machine guns shoot 2,000 to 2,600 SPM with a maximum effective range of 1,000 metres. Elevation of the guns is from +11 degrees to −63 degrees while traverse ranges from 12 degrees inboard to 70 degrees outboard. Machine gun firing cuts off electrically or mechanically when guns on a given side of helicopter are in danger of firing into the aircraft.

The rocket launchers M158 have an effective range of 3,000 metres. The pilot aims through a manual reflex sight for both machine guns and rockets. The co-pilot uses a flexible reflex sight for machine guns only. Machine guns cut off while rockets fire.

STATUS:

US Forces.

1113.303
M23 ARMAMENT SUBSYSTEM

DESCRIPTION:

The M23 armament subsystem mounts two M60D machine guns (one in each cargo door) in a UH-1D helicopter to provide suppressive fire against ground troops. The subsystem weighs 95 kg with ammunition. It fires up to a maximum effective range of 1,000 metres through ring sights on the guns. Capacity per gun is 600 rounds and cyclic rate per gun is 550 to 600 rounds a minute. Each gun allows elevation of plus 3.5 degrees forward and plus 6.5 degrees aft and a depression of minus 82 degrees.

STATUS:

US Forces.

1114.303
M24 ARMAMENT SUBSYSTEM

DESCRIPTION:

The Armament Subsystem M24 is similar to Armament Subsystem M23 except that it is mounted on the CH-47A Helicopter and carries 200-round ammunition boxes. One machine gun mounts in the left forward escape hatch, the other across the right forward door.

STATUS:

US Forces.

GROUND RADAR

CHINA (PEOPLE'S REPUBLIC)

2019.153
CHINESE MILITARY RADAR

Little is known of Chinese activities in the military radar field. As with many other military systems the Chinese were almost certainly for many years largely dependent on Russian radar equipment: certainly there can have been little in the way of a legacy from the war years in this area; and with Russian equipment fairly readily available – obsolescent though the available equipment very probably was – it would have been only reasonable for the Chinese to have concentrated their attention on other problems.

Although there is almost certainly still a good deal of operational Russian radar in China, however, it is now believed that they have a substantial radar development programme in hand. It is known that they have constructed a missile early warning system (see also entry **2052.181**); and with respect to these and other radar developments some code names are beginning to emerge from American sources. One of these is the name "Cross Legs" given to a surveillance radar working in the 1,250 MHz band with p.r.f.'s of 300 and 600 Hz – suggesting a maximum range capability of something under 500 km. Another name is "Thin Skin" which is applied to a heightfinder working in the 6,500 MHz band. (H-band in the American military frequency band scale.) Apparently other radars are known to be operating in the American military I-band – i.e. around 9 GHz.

It is perhaps worth noting that these frequency bands are if anything rather more popular for surveillance and height-finding in Western countries than they are in Russia. It would be rash to draw any conclusions from such slender evidence: but it will be interesting to examine this thought in the light of further information which – now that a trickle has occurred – may be expected to be available in quantity before long.

DENMARK

1573.153
POINTER-PORTABLE INDEPENDENT TERMA RADAR

Description:

Pointer is an X-band, light portable surveillance radar offering good accuracy and range performance. It is basically evolved from the smallest of the Terma series of marine navigational radars. It has a number of operational applications, one being as a gap-filler in radar warning systems of countries with extensive coastlines. The manufacturers also produce a PCM (Pulse Coded Modulation) microwave data link system which permits the transmission of radar data in video format from several portable radar sites to a remote central operation centre. The designation of this system is TERALI (Terma Radio Link), and the operating frequency is in the 2.3 to 2.5 GHz band.

The Pointer system consists of three main units: Transmitter/receiver, Display unit, Scanner assembly and radome. The equipment is built and tested to full military specifications for a battlefield environment. It can be prepared for operation by a crew of three in less than 10 minutes.

Characteristics

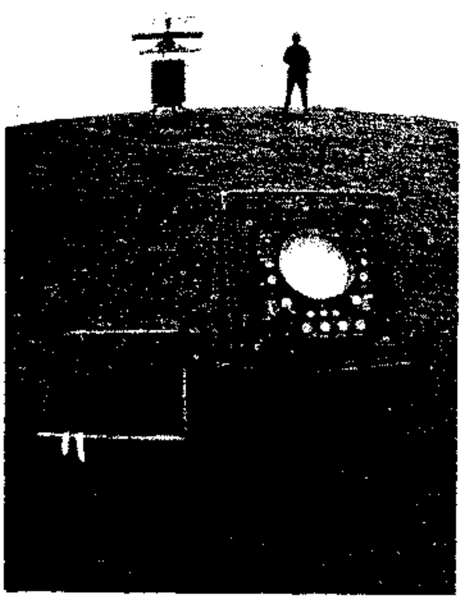
Scanner Unit:
Type: 1.2 metre slotted waveguide.
Horizontal beamwidth: 1.8 deg (3dB)
Vertical beamwidth: 20 deg (3dB)
Gain: 30dB
Transmitter/Receiver:
Frequency: Fixed, 9375 + 30 MHz
Peak Power (nominal): 9kW
IF: 30 MHz
Noise figure: 10 dB
Bandwidth: 3 + 0.5 and 20 – MHz
PRF: 1300 and 2600 Hz
Pulse length: 0.6 and 0.06 microsec.
Display Unit:
CRT Size: 23 cm diameter
Range scales: 5, 10, 20, and 50 km. Variable range marker.

Status:

Development was undertaken in collaboration with the Swedish Army and was completed in 1968. Now in series production. Pointer has been supplied to Sweden, Norway, Finland and Israel.

Manufacturer:

Terma Elektronisk Industri A/S, Finlandsgade 12, 8200 Arhus N, Denmark.



Terma pointer radar system

1574.153
TERMA SPLASH SPOTTING RADAR

Description.

The Terma splash spotting radar is a portable radar designed to indicate the impact or splash of projectiles, such as shells or air-dropped mines.

Tests carried out in co-operation with the Danish Army have indicated the accuracy of the radar to be within +4 metres (distance) and +0.114 degrees in azimuth. Other applications include use as:

(1) Surveillance radar
(2) Radar with Manual Tracking (hand controlled)
(3) Radar with Auto Tracking-Sector Scanning.

The system consists of the following units: Scanner Unit, Receiver-Transmitter Unit, Display Unit, Power Unit, and Control Unit.

Ranges against splash (within the radar horizon):

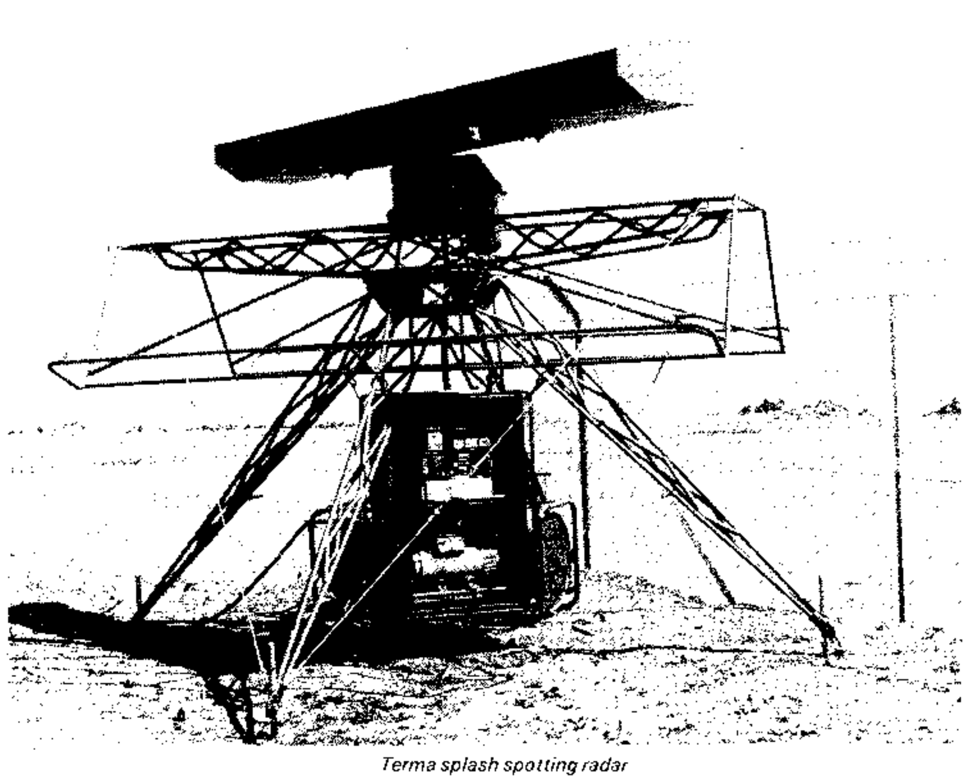
Conventional cylindrical splash:

Diameter	Height	Max. range
0.5m	1 m	10,000 m
1 m	5 m	13,000 m
2 m	7.5 m	16,000 m

Characteristics:

Scanner Unit:
Antenna element: 2.1 m slotted waveguide
Rotation: The scanner is mounted with synchros for the following purposes:

(1) 10 RPM (continuous)
(2) sector scanning 10 degress/sec.
(3) manual operation



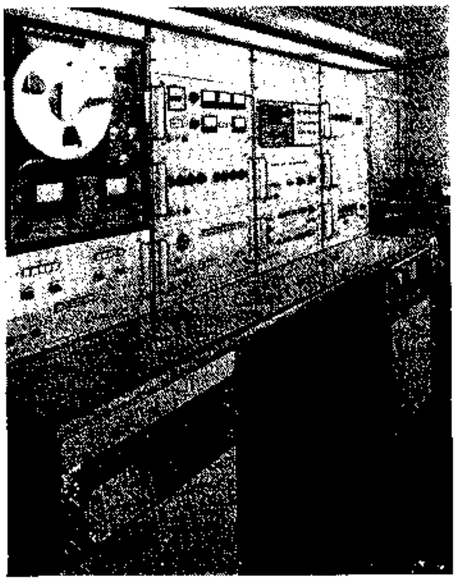
Terma splash spotting radar

Horizontal beamwidth: 1 degree (3dB)
Vertical beamwidth: 20 degrees (3dB)
Standing wave ratio: Less than 1.2
Gain: 34dB
Receiver Transmitter Unit:
Transmitter frequency: Fixed within 9375 ± 30 MHz
PRF: 1000 and 2000 Hz
Pulse length: 0.6 and 0.06 microsec
Peak power: 20 KwkW
Bandwidth: 3 ± 0.5 MHz and 20 + 1 MHz
IF centre frequency: 30 MHz
Noise figure: Less than 11 dB
Display Unit:
Picture size: 30 cm diameter CRT
Range and range rings (km):

Range	1	2.5	5	10	20	40	80
Rings	0.5	0.5	1	2	4	8	10

Accuracy of range rings: Less than 1.5 per cent of range in use
Sweep linearity: Better than 1 per cent
Control Unit:
Digital variable range marker:
A crystal controlled variable range marker generator produces a marker pulse in the range 20 m to 9999 m with a resolution of 10 m. The range marker can also generate a marker of ± 100 m relative to the centre marker. The range is displayed on four digital displays.
A/R Indicator:
The A-indicator is able to display the total radar range selected on an A-sweep selector switch. On the R-indicator a certain area of the total sweep may be selected by means of a delayed sweep which is controlled with a 10-turn potentiometer. The two sweeps are presented on a 13 cm CRT.
B-Indicator:
Range: Following the R-sweep on the A/R indicator
Bearing accuracy of transmission: Better than 0.5 degree
Sector scanning: ± 5 degrees (with linear scanning within ± 3 degrees)
CRT:
10 × 8 inches with internal graticule which is divided into 1-inch squares with 0.2 inch super divisions on the major axes. The CRT can be supplied with amber filter, daylight filter and camera.
STATUS:
The development was completed in 1968 and the splash spotting radar has been delivered to the Swedish armed forces.
MANUFACTURERS:
Terma Elektronisk Industri A/S, Finlandsgade 12, 8200 Arhus N, Denmark.

1577.153
M/532 DOPPLER RADAR:
DESCRIPTION:
The doppler radar M/532 is a CW radar system which includes advanced data processing facilities for continuous velocity measurement of projectiles and rockets. The velocity range is 50-1600 m/sec.
This equipment is particularly well suited for research and development work on shooting ranges.
The doppler radar set consists of: Antenna Unit (Horn Antenna), Transmitter Unit, Data Unit, Test Unit, and Control Unit.
The antenna unit and the transmitter unit are of extremely solid construction, allowing them to be placed where even very high blast conditions arise. The antenna unit includes a transmitting and a receiving antenna, each with a gain greater than 21 dB and a half power beam greater than 12 degrees. This means that the antenna unit is suitable for measurements where the angle between target trajectory and antenna direction changes. Furthermore, it is suitable for measurements with very low antenna elevation because the receiver is equipped with a phase and amplitude correction network for cancellation of reflections from nearby objects on the ground.
The transmitter unit is placed together with the antenna unit so that they look like one unit. The two units can be separated very easily so that it is possible to use the transmitter unit together with a 4.5 degree beamwidth antenna unit.
The transmitting element is a magnetron working at 2.45 GHz and stabilised by a external cavity and by temperature controlling elements. The data unit handles the video signal from the receiver in two filter systems. One processes a certain velocity range, the other is able to follow the target in speed. Then the signal is processed both in analogue and digitally. The digital measurement ensures the highest accuracy. For later data handling the video signal is stored by means of an analogue tape recorder. The output signals from the filters are converted by means of frequency-to-voltage converters in the Analogue Measurement Assembly.
The analogue measurements are recorded by a fast response-UV-recorder. The digital results being a 5-digit velocity and a 6-digit reference time, are fed to a solid-state memory. This type of memory has been chosen for high reliability, speed, and read-in-speed flexibility.
The capacity of the standard memory is 512 measurements, which can be extended to 1024 and further to 2048 measurements. The stored measurements are punched on tape for further data handling in a computer. It is possible to connect a calculating system directly to the memory output and use it together with the tape puncher.
STATUS:
The first M/532 doppler radar was delivered to Norway in 1961. Since then slightly different versions have been delivered to West Germany, Spain, Switzerland, Norway, and Sweden.



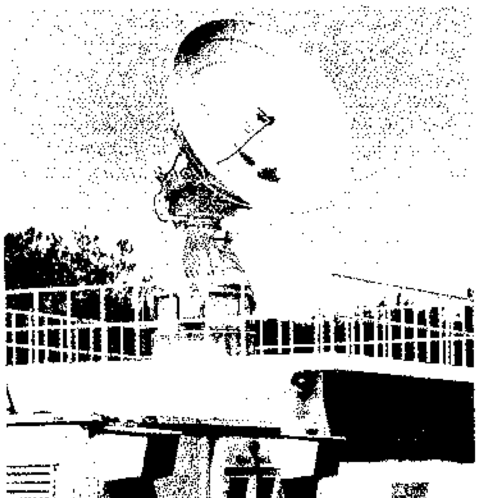
M/532 doppler radar data unit

MANUFACTURERS:
Terma Elektronisk Industri A/S, Finlandsgade 12, 8200 Arhus N, Denmark.

FRANCE

2056.153
ADOUR TRACKING RADAR
DESCRIPTION:
ADOUR (TH.D 1215) is a C-band tracking radar using the conical scanning principle. It is intended for acquisition and automatic tracking and is specifically designed for making measurements in –
1. Flight test centres, for the calibration and evaluation of prototype aircraft, of airborne equipment such as altimeters and autopilots and of ground equipment such as surveillance radar.
2. Rocket and missile test centres and launching centres for measurements relating to missile, sounding rockets and satellite launchers.
In addition, the radar is used at such centres for windfinding and similar measurements.
The turret aerial is of Cassegrain design. Standard polarization is vertical but other polarizations are available. The standard transmitter has a peak power output of 250 kW and is tunable in the band 5450-5825 MHz. The console is large, but can comfortably be operated by one man. Range measurement is digital.
DEVELOPMENT:
Development of this radar followed that of the Aquitaine (**2062.153**) and Béarn (**2065.153**) radars by the same manufacturer. The first set was delivered in 1967.
It is at present installed on French, Swiss, Australian and Brazilian firing test ranges and quantity production has started to meet French needs for export.

CHARACTERISTICS:
Aerial:
Diameter: 3 m
Aerial gain: 42dB
3 dB beamwidth: 1.3°
Sidelobe level: —20 dB
Polarization: Vertical
Optional 3 position polarizer: Vertical, clockwise circular, counterclock-wise circular
Turret and Servos:
Azimuth rotation: Unlimited
Elevation rotation: —15° to +185°
Azimuth servos:
Speed: 1 rd/sec
Acceleration: 4 rd/sec²
Elevation servos:
Speed: 0.6 rd/sec
Acceleration: 3 rd/sec²
Transmitter:
Magnetron tuning range: 5,450-5,825 MHz
Pulse length: 1.7 microsec
Peak power: 250 kW
Optional:
Codable transmitter: Pulse train length variable from 0.25 to 1.7 microsec
Receiver:
Operation modes: 4 (radar; transponder; mixed with radar priority; mixed with transponder priority)
Overall noise figure: (6 dB + 1.5 dB losses) 7.5 dB
Sensitivity (S/N = 0 dB): 136 dB



Adour Tracking Radar TH.D. 1215

Digital Range Measurement:
Maximum Tracking Rate: Better than 14,000 m/sec
Range capability: 4,096
Digital Data Outputs:
Range definition: 2 m (21 digits)
Angular definition: 0.1 mrd (16 digits)
Performance:
Detection range:
On 1 m^2 target (S/N = 0 dB): 170 km
On 50W transponder (aerial gain 0 dB): 9,000 km
Tracking accuracy: (S/N = 20 dB)
Range: 3 m rms
Elevation and azimuth: 0.2 mrd rms (40 sec of arc)
STATUS:
In production
MANUFACTURER:
Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

2060.153
ANTARES HEIGHT-FINDING RADAR

DESCRIPTION:
Under the code name ANTARES (for Antenna Tracking Altitude, Azimuth and Range by Electronic Scan) Thomson-CSF has developed a height-finding radar operating in S-band that can be used for air defence and civil air traffic control purposes. This system is designed mainly to measure the altitude of targets tracked by a 2-D search radar which is associated with it, with a very high accuracy and a high data renewal rate. Antares is an automated system, and all its input or output data are controlled or generated by an automatic digital processing unit. This feature, together with the utilization of electronic scanning in elevation enables the system to satisfy a practically unlimited number of altitude requests.

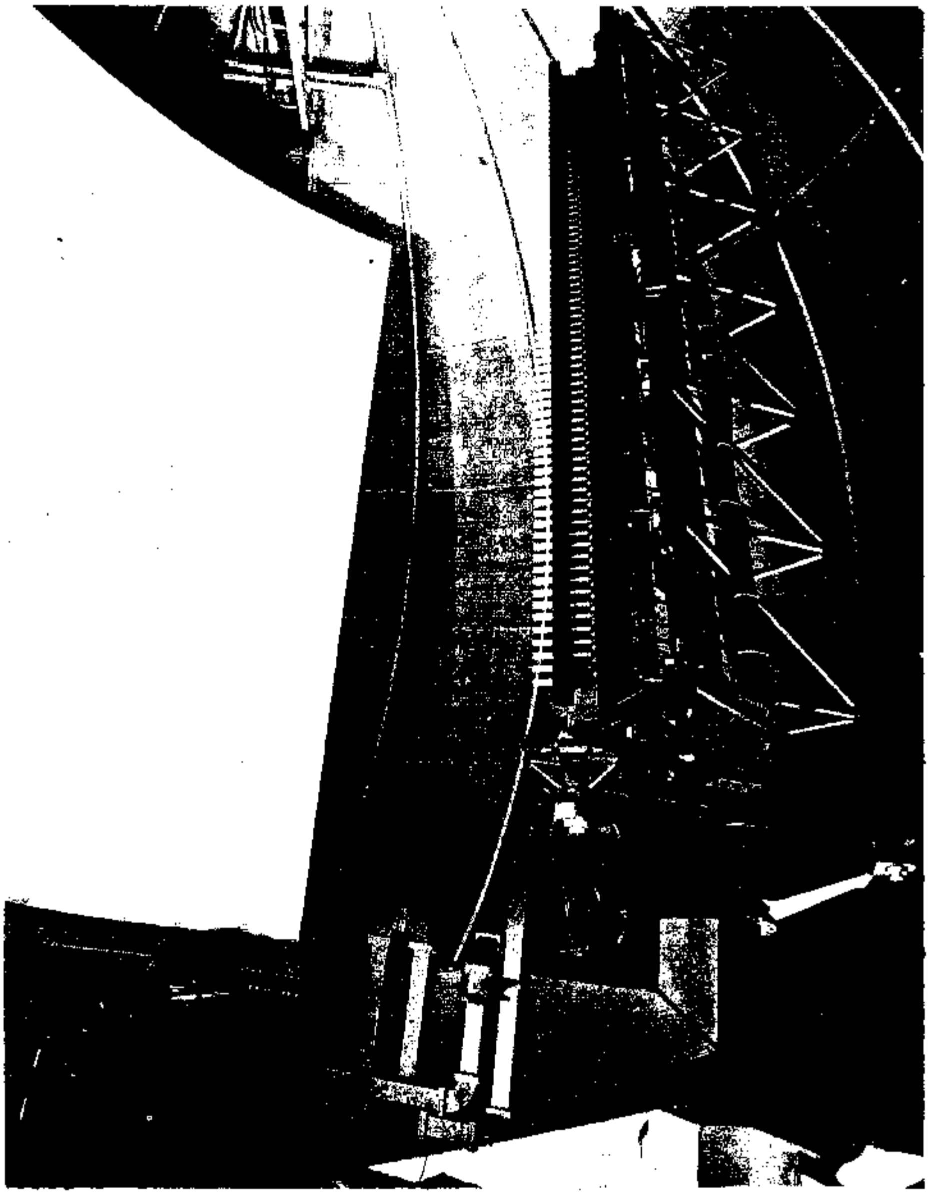
The Antares system consists of a height-finding radar and a processing unit. Principal units of the radar are an antenna under a radome, a servo system for slaving the rotation of the antenna to that of the associated plan radar antenna, three transmitters, three conventional receivers and one angular error measuring receiver.

The antenna is made up of a cylindro-parabolic reflector and a primary feed in the form of an array of elementary feeds radiating circularly polarized waves. The feed is coupled with two waveguides by means of directive couplers which allow mono-pulse operation for angle error measurements. Digital electronic phase-shift networks placed between the elementary feeds and the corresponding directive couplers control the aiming direction of the beams, while focusing in elevation is achieved by the feed array. Owing to the dispersive character of the feed, the use of three different frequencies produces three stacked elevation beams. An antenna computer determines the values of the elementary phase shifts corresponding to the elevation angle ordered by the processing unit.

The transmitter receiver assembly comprises three TH.D.047 transmitter-receivers coupled with the antenna by a single waveguide and one monopulse angle error measurement receiver. The TH.D.047 units are S-band magnetron transmitters delivering a power of 1 MW (peak) – 1 kW (mean). They are modern equipments, fully transistorised (except for the microwave tubes), of small size, and highly reliable. The receiver chains are of the anti-jamming type. The angle error receiver utilizes the phase-comparison amplitude monopulse technique.

The processing unit is a digital computer which controls the beam direction (elevation order sent to the antenna computer), handles the altitude requests coming from the external operations centre, and performs altitude computations.

OPERATION:
Altitude requests from an operations centre outside the system are classified by the processing unit. From the plan-radar data an azimuth-range gate is generated, inside which the height-finding radar performs an elevation search. This search goes on until a "coarse" measurement is obtained (using the three beams). The centre beam is then aimed at the acquired target, and a "fine" measure obtained; the computer converts this elevation value into an altitude and sends the results to the operation centre with the other two target co-ordinates.



Antares aerial inside radome

When no altitude is requested, the Antares automatically performs long-range surveillance at low elevations, thus considerably augmenting the low cover at the surveillance radar with which it is integrated.

TEST EEQUIPMENT:
Included in the equipment is a control and monitoring panel. This is an elaborate system that not only enables the operator to locate failures but also enables him to differentiate between failures that will adversely affect performance and require immediate action and those for which action can be postponed.

CHARACTERISTICS:
Type: Automatic height-finding radar system (with low-elevation long-range surveillance capability)
Frequency: S-band
Coverage (90% detection probability):
Altitude: at least 30,000 metres
Elevation: −2 deg to +35 deg
Azimuth: 360 deg
Altitude Accuracy: +300 metres to 150 nm
Capacity: More than 100 targets/min
Data Renewal Rate: 10 sec
Radome Diameter: 18 metres
Reflector Size: 9 metres × 8 metres
Gain: 45 dB
Polarization: Circular
Peak Power: 1 MW
Mean Power: 1 kW (for each transmitter)
Noise Figure: 3.5 dB with parametric amplifier
STATUS:
In production
MANUFACTURER:
Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

2062.153
AQUITAINE II TRACKING RADAR

DESCRIPTION:
Aquitaine II (TH.D 1804) is a modernised version of the earliest of the Thomson-CSF range of tracking radars and is a very high precision equipment designed for trajectography and satellite tracking.

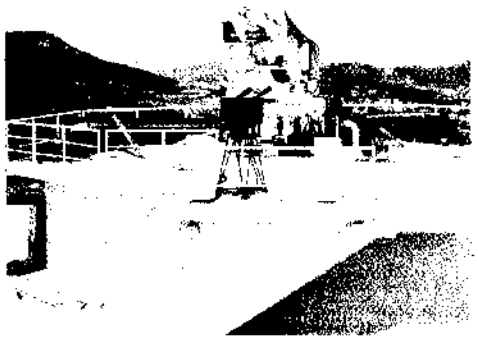
A monopulse C-band radar, automatically tracks radar echoes or transponder signals at distances up to about 4,000 km. The equipment comprises an aerial turret, with which are associated the RF and IF receiver circuits, a 1 MW peak transmitter, codable and tunable from 5,450 to 5,825 MHz, an operating console, a coding and interconnection cabinet and a power supply cabinet. The range-finding unit – in the console – is fitted with a synchronising device that allows the radar to be used in series with other tracking radars of the same or different types.

DEVELOPMENT:

Originally developed by CFTH-HB – now Thomson-CSF – the earlier Aquitaine radar incorporated much of the design experience gained with the Cotal radars that the company had been working on since 1950. The first Aquitaine (TH.D 1800) was delivered in 1963 and the first of the modernised Aquitaine II radars was delivered in 1967. Seven sets have entered service on French firing ranges.

CHARACTERISTICS:

Turret:
Accuracy of the rotation axis: 3×10^{-5} rd
Accuracy of analysis axis: 3×10^{-5} rd
Natural frequency: 20 Hz
Aerial:
Cassegrain type with polarization reversion:
Diameter: 3 m
Polarization: Vertical
Gain: 42dB
Beamwidth: 1.3°
Receiver:
Monopulse:
Tunnel-diode RF amplifiers:
Stability of the zero ecartometry: $+3 \times 10^{-5}$ rd
AFC for transmission and reception:
Transmitter:
1-MW magnetron, codable and tunable over a range of: 5,450-5,825 MHz
Transmitter frequency controlled by a high-precision standard cavity:
Range Finding Unit:
Arithmetic range finding with automatic lock-on and ambiguity cancellation:
Tracking speed: 14,000 m/sec
Quantum: 2 m
Nominal range detection: 4,000 km
Turret Servomechanisms:
Control by thyristor and electromagnetic couplers:
Automatic bandwidth changeover:
Maximum speed:
Azimuth: 0.6 rd/sec
Elevation: 0.45 rd/sec
Acceleration (azimuth and elevation): 4.5 rd/sec²
Digital Data Outputs:
Angular definition (precision in coder): 2 seconds of arc
Range definition (arithmetic range-finding): 2 m
Performance:
Tracking accuracy:



Aquitane II Tracking Radar

Angular: 0.03 mrd (6 seconds of arc)
Range: 2 m
Range detection possibility:
On radar echo of 1 m² (S/N = 0 dB): 300 km
On 500 W transponder (S/N = 20 dB): 4,000 km

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France

2066.153
ARABELLE PORTABLE TRANSPONDER

DESCRIPTION:

Arabelle is an X-band/VHF secondary radar transponder designed for use as a means of locating and identifying troops or vehicles in a battle area. It operates in conjunction with a surveillance radar but is secure against hostile radars: when interrogated by a friendly X-band radar it responds with a coded VHF signal that can be identified by a responsor at the friendly radar station. Of general use in battlefield conditions, the equipment is obviously particularly useful in poor visibility conditions.

In its portable version, the equipment is in the form of a rifle consisting of a double barrel, the walls of which function as a VHF dipole radiator. The components are housed inside the barrel and consist of the control unit, the transmitter-receiver, the coding circuits and the battery compartment. The power supply is provided by dry cells or by rechargeable cadmium-nickel batteries, both options being available without modifying the equipment. The transponder is normally carried slung over the shoulder, and can be used in that position without prior setting up. It can also be used in a stationary position, mounted on a built-in tripod stand. Its weight is less than 5 kg, including batteries. Operation is either fully automatic or manually controlled. A robust and weather-proof instrument, it operates automatically in any position, without impairing the operator's freedom of movement.

The vehicular variant consists of a single unit of compact size easily installable in any vehicle, and an antenna. The power supply is provided by the vehicular battery.

CHARACTERISTICS:

Receiver frequency: X-band
Transmitter frequency: 3 pre-set frequencies
VHF peak power: 15 watts
Response code: 16 separate combinations (VHF)
Range: Same as interrogator radar range
Weight: 5 kg
Power Supply: 8.4 V built-in batteries. Continuous service: 10 hours. 24 V vehicular batteries, through converter
Power consumption: 5 watts with built-in batteries

MANUFACTURER:

Electronique Marcel Dassault, 55 Quai Carnot-92-Saint Cloud, France.

2063.153
ARTOIS TRACKING RADAR

DESCRIPTION:

The Artois now being developed by Thomson-CSF is an electronic-scan multi-target tracking radar designed to perform highly accurate differential trajectory measurements.

The principal features of this radar are electronic scanning in a cone having a vertex angle of 10° minimum, instantaneous deflection from pulse to pulse and multi-target tracking with controlled variable interlace.

CHARACTERISTICS:

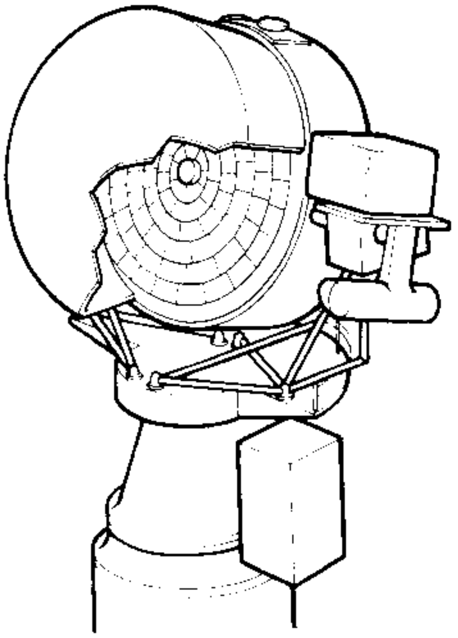
Type: Monopulse tracking radar
Frequency: C-band
Beam control: Electronic scanning in two dimensions
Peak power: 1 MW
Pulse duration: 0.3 microsec or less
Read-out: Numerical
Simultaneous tracking: 3 targets on skin echo or on transponder (range: 4,000 km)

STATUS:

Under development

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.



Artois Aerial

2121.153
ATC APPROACH RADAR TRS 2060

DESCRIPTION:

The TRS 2060 radar station is an improved version of the THD 1098 (described under this entry number in previous editions while it was still in development), which can be supplied with an integrated IFF aerial and is now available as either a mobile or a static installation. It has been designed for easy transport and setting up, and is capable of being used in a variety of operational conditions. Both its mobility and its performance make it well suited for use as an autonomous surveillance station, or for complementing or locally enlarging the coverage of a long-range radar (gap filler) role for example in an air defence system.

TRS 2060 is housed in and mounted on a cabin made of plastic material and comprises, as basic equipment:

(a) a single-beam antenna, with sharp beam and remotely controlled linear/circular polarization, fixed directly on the cabin roof;
(b) an S band transmitter receiver (1 MW peak, 2 kW average), entirely transistorised, of small

size, reliable and easy to maintain;
(c) an operator position with PPI display.

In addition, there can be added – to increase system reliability and versatility – a second transmitter-receiver with a microwave coupling device permitting diversity operation and a digital MTI processing rack. Remoting equipment can also be added – up to about 3 km by cable link or tens of kilometres by microwave link.

DIGITAL MTI (phase-coding):

Digital computer techniques are used to determine the phase variations of received echoes and compare them with a threshold which represents the boundary between fixed and moving targets. The result of this process is a series of blanking signals that are used to inhibit the normal radar video in the presence of clutter. This form of MTI operation eliminates the velocity response effect which produces target fading in delay-line MTI equipments.

TRANSPORT:

The cabin can be transported either by a conventional truck or by cargo aircraft. The station's standard equipment includes handling means. The aerial divides into three sections which are transported in special frames made of light material.

DEPLOYMENT:

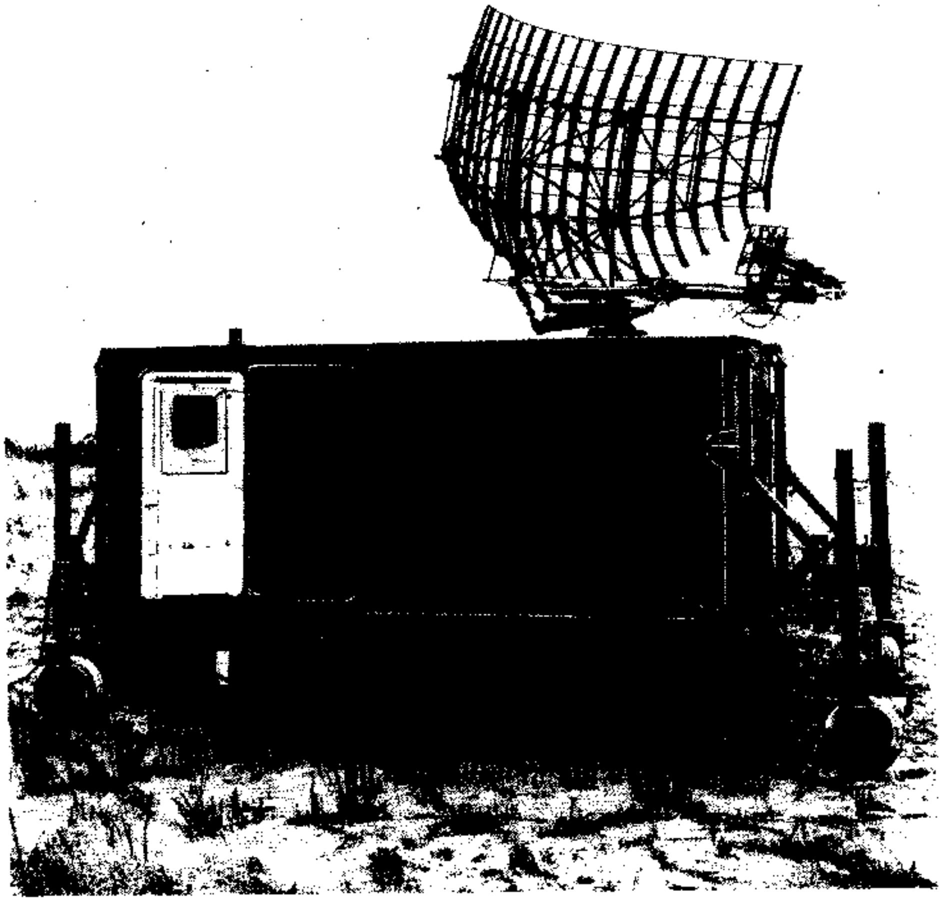
A 4-man crew installs the TRS 2060 station in less than two hours.

CHARACTERISTICS:
Antenna:
Type: AC316
Polarization: Linear/circular
Reflector dimensions: 5 × 2.3 m
Horizontal beamwidth (3 dB): 1.4° + 10%
Cosecanted pattern: In excess of 40°
Gain: 34 dB
Rotation speed: 7.5/15 rev/min
Transmitter-Receiver:
Type: TH.D.047
Frequency range (covered with 2 tunable magnetrons): 2,990-3,200 MHz
Peak power: 1 MW
Average power: 2 kW
Pulse duration: 4 microsecs 2 microsecs
P.R.F.: 500 Hz; 1,000 Hz
Receiver:
Parametric amplifier incorporated
Noise figure: Less than 5 dB
Reception chains: Log with differentiation/expansion and CFA chain
Digital MTI (phase-coding):
Double canceller loop 3 PRFs: sub-clutter visibility: 25 dB
Power supply: 220/380 V, 50 Hz, 20 kVA
Performance:
Detection range: 70 nm (130 km) on modern fighter, for a detection probability of 80% with single T/R unit

STATUS:
In production.

MANUFACTURER:
Thomson-CSF-Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

Interior of the TRS 2060 operational cabin



TRS 2060 surveillance radar – mobile version

2059.153
ATC APPROACH RADAR TRS 2065

DESCRIPTION:

Designed to provide surveillance in the terminal areas of civil and military airports, TRS 2065 is an S-band radar of modular design which can be developed from a basic station to match increasing operational requirements.

The special requirements of terminal area surveillance are met by an aerial of computer-aided design. The double curvature reflector produces a cosecant-squared pattern, the cosecant being accentuated at high elevations to increase the target signal to ground-clutter signal ratio at close range. The pattern has a sharp cut-off at low elevations to provide good protection against fixed echoes.

The 1.5° horizontal aperture ensures satisfactory functioning of the MTI while allowing a high data renewal rate (rotation speed : 15 rev/min). Atmospheric interference is reduced by circular polarization.

Depending on the option, the equipment comprises one or two independent chains for frequency diversity operation.

The transmitters are fully transistorised except for the magnetron and one thyratron. The repetition frequency is modulated to cancel the blind speeds of the MTI system.

The receiver is entirely solid-state and its modular design permits a wide range of physical configurations. The MTI system utilises digital techniques for the measurement of echo phase variations. The signal processing system includes an automatic dense area detector and an interference suppressor.

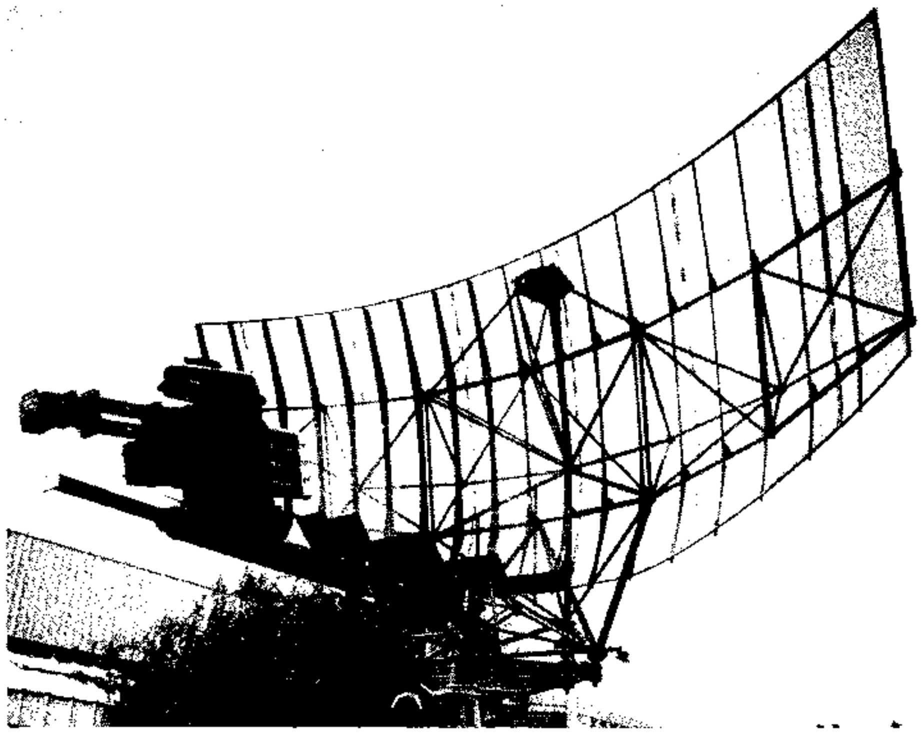
The equipment can be remotely controlled.

CHARACTERISTICS:
Coverage: (90% detection probability on a 2-m² fluctuating target), 50 nautical miles.
SCV: Better than 25 dB
Blind speeds: First blind speed higher than 1,000 knots.
Frequency: S-band
Aerial: Azimuth beamwidth: 1.5°. Gain 34 dB. Switchable circular/linear polarization. Rotation speed: 15 rev/min.

Transmitter: Peak power: 650 kW. Pulse duration: 0.75 microsec. PRF: 1,000 Hz.
Receiver: Noise figure: 2.5 dB.

STATUS:
In quantity production

MANUFACTURERS:
Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222 Bagneux, France.



Aerial of the TRS 2065 ATC radar

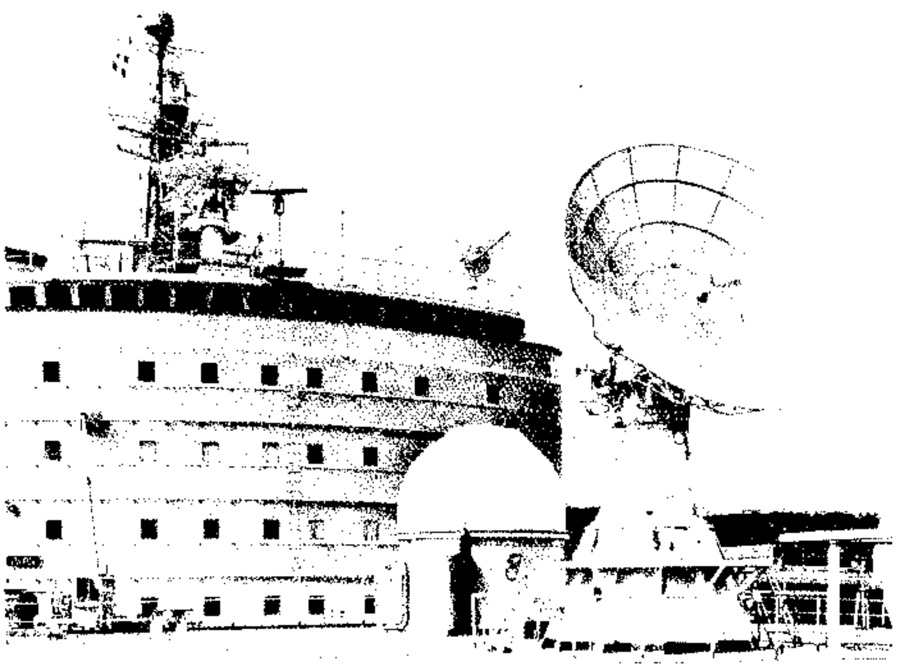
2065.153
BEARN TRACKING RADAR
DESCRIPTION

Béarn (TH.D 1216) is a high-precision C-band automatic tracking radar designed for the trajectory of high-speed missiles at long range.

Facilities offered by the radar include manual or automatic acquisition of a target dynamically or statically designated by the rendezvous method, automatic tracking of radar echoes or transponder signals up to 4,000 km; elevation, azimuth and range co-ordinate read-out as numerical data in real time; automatic change-over to memory tracking in case of loss of signal; polarization switching without interruption of tracking; synchronization of a chain of radars interrogating the same transponder; and, for shipborne installations, autonomous and automatic stabilisation of the pointing axis.

DEVELOPMENT:

Béarn was developed by Thomson-CSF and the first installation was made on the missile recovery ship Henri Poincaré in 1966. Since then, a dozen sets have been installed or are being delivered to meet the needs of the French firing ranges, both in France and overseas.



Naval installation of Béarn Tracking Radar

CHARACTERISTICS:
Aerial:
Cassegrain feed system:
Diameter: 4 m
Antenna gain: 44 dB
Beamwidth at 3 dB: 0.9°
Sidelobe level: 19 dB
Polarization: 3 (at operator's choice)
Turret and Servos:
Azimuth rotation: non limited
Elevation rotation: −15° to +195°
Total accuracy of the axis analysis: 0.1 mrd rms or better
Azimuth servomechanism:
Speed: 1 rd/sec
Acceleration: 2 rd/sec²
Elevation servomechanism:
Speed: 0.5 rd/sec
Acceleration: 2 rd/sec²
Transmitter:
Magnetron (TV 313) tunable in the band of: 5,450-5,825 MHz
Peak power: 1 MW
Pulse length: 1.7 microsec
PRF: 585.5 Hz
Receiver:
Overall noise figure (including duplexer and RF head): 6.5 dB or better
Sensitivity (S/N = 0 dB): 136 dB
Logarithmic IF amplifier:
AFC by receiving and transmission:
Operation modes: 4 (radar, transponder, combined with radar priority, combined with transponder priority)
Tracking modes: 2 (radar, DF)
Digital Range Measurement Unit:
Range possibility: More than 4,000 km
Maximum tracking speed: More than 14,000 m/sec
Maximum tracking acceleration: More than 30,000 m/sec²
Automatic acquisition:
Automatic ambiguity cancellation:
Instantaneous gathering:
Digital Data Outputs:
Range discrimination: 2 m
Angular discrimination: 0.05 mrd
Performance:
Range detection possibility:
On radar echo of 1 m² (S/N = 0 dB): 300 km
On 50W transponder (aerial gain 0 dB): 4,000 km
Tracking accuracy:
In range: 3 m rms
In elevation and azimuth: 0.1 mrd rms (20 sec of arc)

MANUFACTURER:
Thomson-CSF Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France

2083.153
DOMINO 30
DESCRIPTION:

Domino 30 is a search and target designation radar to be used against low and very low-flying targets. Separable into loads of small volumes and weights, it can be mounted on a carrier (armoured or not), in a cabin or at a fixed site.

The principal operational use is as a central radar in a defence system, performing surveillance target designation for several fire positions which may be either anti-aircraft guns or short range missiles. Owing to the radar's range, the spacing between the fire positions and the radar may reach several kilometres. In such a system, the radar can provide omnidirectional search with a high data renewal rate (45/minute), an audible alarm when a target is detected and bearing and range designation of selected targets by means of electronic markers. An automatic track-while-scan system can also be added.

Domino 30 is a crystal-controlled, coherent pulse doppler radar, with a moving target sub-clutter visibility of at least 60 dB. The detection volume is delimited by a range of 30 km and an altitude of 15,000 ft, with a vertex angle of 35°. The domain of detected radial speeds ranges from 30 to 500 m/s. The radar is both reliable and rugged thanks to extensive use of solid-state components; the only vacuum tube being the triode transmitter valve.

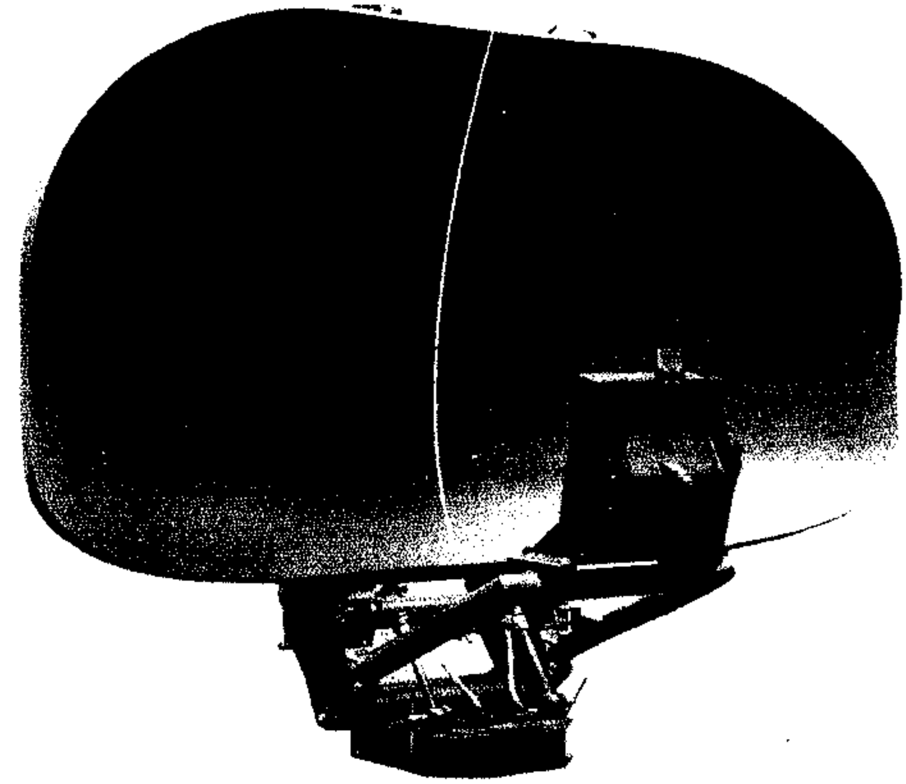
Six sub-units make up the complete basic radar – the aerial system, the transmitter-receiver cabinet, the signal processing cabinet, a converter unit, a control box and a set of connecting cables. Provision is made for adding an IFF interrogator and aerial to the primary radar.

CHARACTERISTICS:

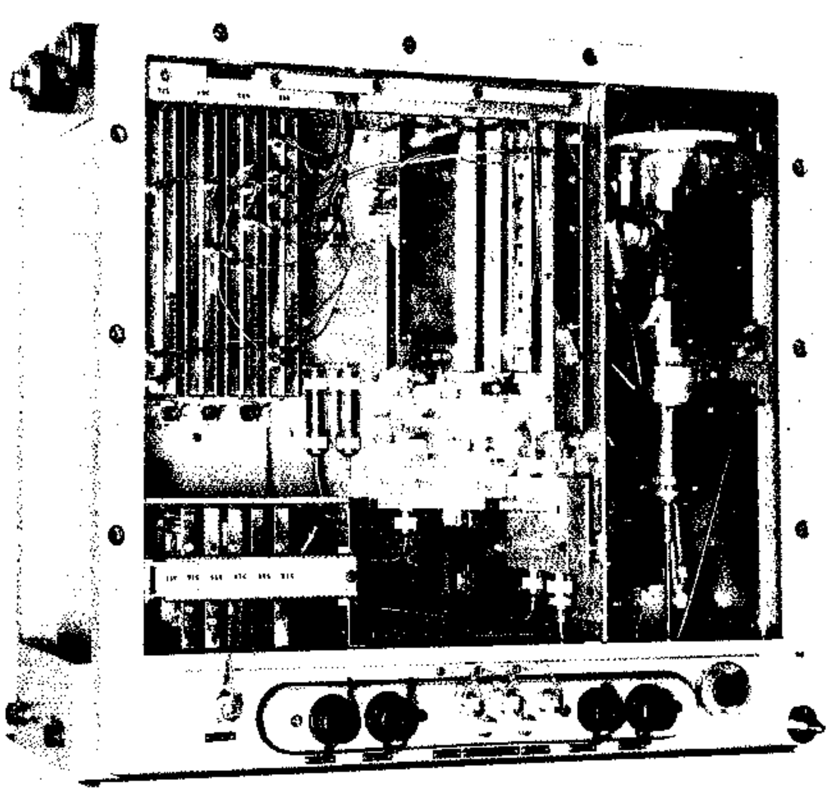
Frequency band: L-band
Peak power: 1 kW
Average power: 45 W
Azimuth beamwidth: 6.5°
Elevation pattern: Cosecant squared, aperture 35°
Rotation speed: 45 rev/min
Radial speed range: 30-500 m/s
Range resolution: 1,500 m
Detection range: 30 km on modern fighter
Accuracy of bearing designation: 1.5° (rms)
Accuracy of range designation: 400 m (rms)
ECCM devices: CFAR receiver strobe on jammer
Subclutter visibility: 60 dB or better
Compatible with IFF:
Climate conditions: −50° to +55°C
Consumption: About 5 kW
Weights:
aerial system: 190 kg
transmitter-receiver cabinet: 75 kg
signal processing cabinet: 70 kg
converter unit: 20 kg
control box: 5 kg

STATUS:
In quantity production since the beginning of 1969 under a NATO-member country's contract.

MANUFACTURER:
Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222-Bagneux, France.



Domino 30 Aerial



Domino 30 Transmitter-Receiver

2157.153
GROUND-BASED IFF INTERROGATOR

DESCRIPTION:

The equipment described below can be used to make any of three types of IFF ground interrogation equipment.

Heart of the system is the transmitter-receiver (interrogator-responsor) ER-116-A which, but for one tube, is a fully solid-state unit making extensive use of digital integrated circuits. The sub-assemblies of this unit are pluggable and are common with the airborne and shipborne versions and also with other specialised systems such as that for the Crotale weapon system (**2074.131**).

By itself the ER-116-A constitutes a single locally-controlled interrogator-responsor. If this is added to a BC-361-A control box it becomes the NR-S1-1-A locally or remotely-controlled single interrogator-responder. Addition of a further ER-116-A and a switching unit TK-256-A converts the system to the NR-S1-1-A dual interrogator-responsor with local or remote control.

CHARACTERISTICS:

Transmitter receiver ER-116-A
incorporates a coder, a transmitter and one or two receivers
Peak radiated power: Selectable: 0.5, 1 or 2 kW
Transmission Frequency: 1,030+0.5 Mc/s (0.2 optional)
Receiver Sensitivity: −83dBm
Receiver Frequency: 1,090 Mc/s
Double receiver: for side lobe suppression (optional)
Possible modes: 1, 2, 3/A and C – mode 4 with associated equipments
Interlacing facilities: 3 modes out of 4, with changing selections each rotation of the antenna. Permanent self monitoring of all operational characteristics. Antenna switch for side lobe suppression at the interrogation (optional)
Size: two units of a standard 19'' rack
Power supply: 220 V 50 c/s, 120 W
Switching supply: TK-256-A
Enables ground based installations to operate with two transmitter receivers ER-116-A with automatic switch over in the event of failure of one of the equipments
Size: Two units of a standard 19'' rack
Control box BC-361-A
Allows the remote control of a single ER-116-A, or of two of them associated with a switching unit TK-256-A

MANUFACTURER:
Le Matériel Téléphonique (LMT) 46-47, Quai Alphonse Le Gallo, 92103 Boulogne-Billancourt, France.

2100.153
LONG RANGE RADAR LP 23 (TRS 2050)
DESCRIPTION:

LP 23 (TRS 2050) is a long-range L-band surveillance radar intended for air defence detection networks and air traffic control applications. Its modular design features advanced digital signal processing specially intended to facilitate the plot extraction and narrow-band data transmission which are essential to modern automated air-defence systems.

Aerial:

The double curvature reflector produces a cosecanted elevation pattern and a steep slope on the ground side for minimum ground illumination. The double-horn primary feed permits use of the signals received from high and low coverage. This double-beam technique considerably reduces parasitic signals due to angles, rain or ground clutter. Circular polarization is used for rain effect rejection.

The antenna accepts an on-mounted IFF aerial (alternatively, an IFF aerial can be integrated with the primary radar aerial if required).

Transmitter:

The TRS 2050 radar is fitted with two ER 720 transmitters operating in frequency diversity. The ER 720 solid-state transmitter, built according to military standards, uses a 2.2 MW Liquid-cooled magnetron under-run for long life (15000 hours typical). A special EHV transistorised regulation device is included for high frequency stability and high MTI performance.

Receiver:

Modular design allows selection from a wide range of modes of operation with dual coverage. The all-solid-state receiver features a low-noise parametric amplifier, a stable local oscillator with AFC and a wide dynamic range logarithmic amplifier.

Digital Signal Processing:

The MTI operation consists essentially in a comparison of the pulse-to-pulse phase variation with respect to a reference. This is achieved by phase measurement, storage, integration and threshold detection processes carried out with digital logic circuitry.

Interference from other radars, second-time-around returns and some kinds of jamming are eliminated by video quantization and correlation techniques.

CHARACTERISTICS:

Aerial:

Gain: 36 dB (main beam) : 35.5 dB (auxiliary beam)
Polarization: Circular
Vertical pattern: Cosecant-squared to +40°
Horizontal aperture: 1.2° at −3 dB
Height: 9 m
Span: 13 m
Rotation speed: 6 rev/min

Transmitter:

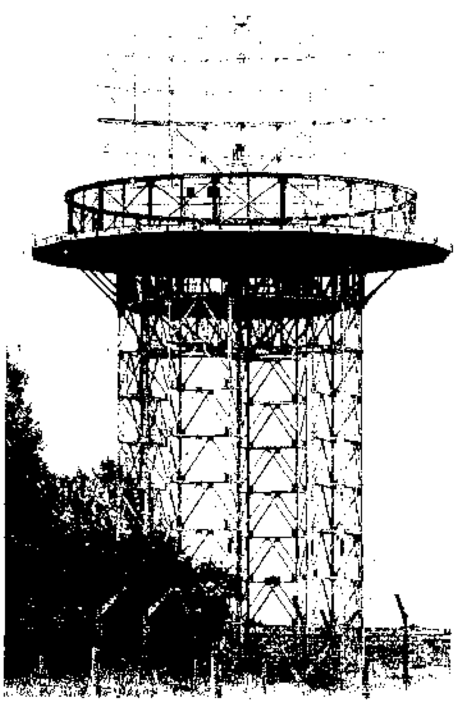
Operating frequency: L band (1250-1350 MHz)
Peak power: 2.2 MW
Standard PRF pulse durations: 250 Hz — 4 microsec/375 Hz — 3 microsec.
Dimensions: 1.77 m × 1.41 m × 0.91 m
Power supply: 220/380 V — 50 Hz 15 kVA

Receiver:

Noise figure: Less than 3 dB (with parametric amplifier)
Log. amplifier dynamic range: 70 dB
Dimensions: 1.71 m × 0.58 m × 0.84 m
Power supply: 220 V — 50 Hz — 1 kVA
M.T.I.:
Sub-clutter visibility: 25 dB

DEVELOPMENT:

Design and development of the LP 23 were carried out under the sponsorship of the French Administration. The first prototype was completed in 1969. More than 10 sets have been delivered in France and elsewhere.



LP 23 long-range radar aerial

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

2102.153
MATADOR 3-D RADAR TRS 2210
DESCRIPTION:

Under the code name Matador (for Mobile And Three-dimensional Air Defence Operations Radar), Thomson-CSF has developed a three-dimensional S-band radar, which when associated with a mobile operations centre, provides three-dimensional coverage, very high accuracy of height-finding and a high data renewal rate.

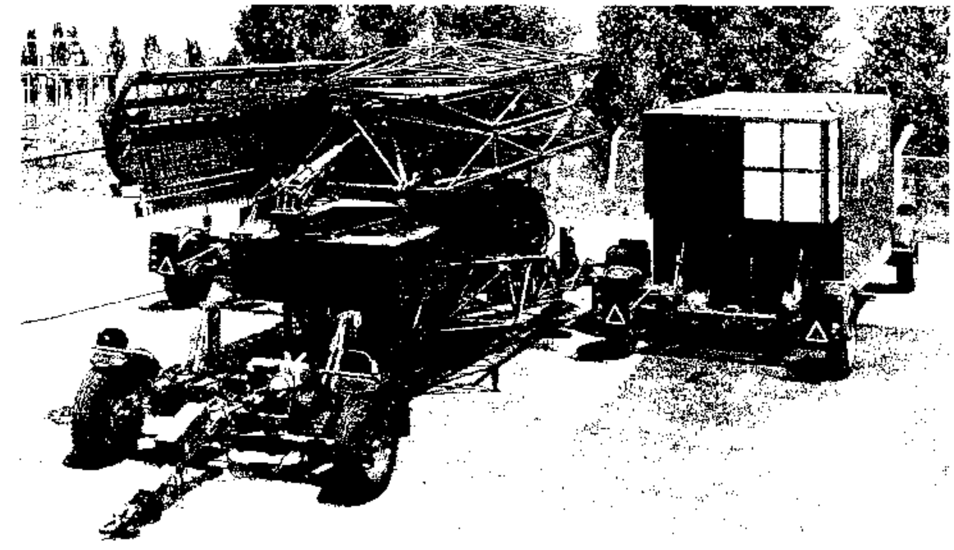
This equipment is designed with a view to extreme mobility and great rapidity of deployment: and it is primarily intended to be used in mobile air defence stations.

The radar is transportable by road, rail, aircraft Transall C 130 (or equivalent) or helicopter (Super-Frelon or equivalent). The installation time is less than one hour. The radar is intended to be utilised either as a "gap filler" station with automatic remoting of data to an operations centre, or in conjunction with a mobile operations centre (e.g. Midas **2106.151**) to constitute an autonomous mobile air defence station.

Use of elevation electronic scanning makes it easy to adapt the mode of operation to suit particular conditions; choices include general 3-D surveillance, surveillance restricted to a selected elevation sector (low-elevation surveillance) and accurate measurement of altitude by pointing the radiated beam at specific targets.

Matador comprises a platform supporting an antenna (foldable for transit), a transmission cabin and a receiver cabin.

The antenna is a cylindro-parabolic reflector whose reflecting surface is made of folding sections made from square mesh (circular polarization operation). Azimuthal scanning is obtained by rotating the antenna continuously about a vertical axis. The primary feed is a linear array of elementary feeds, radiating circularly polarized waves, coupled with two waveguides through directive couplers. The two waveguides allow monopulse operation to perform the height-finding function. Digital electronic phase-shift networks inserted between the elementary feeds and the corresponding directive couplers control the pointing of the beams. Owing to the dispersive character of the feed, the use of three different frequencies produces the radiation of three stacked beams. These three beams constitute a geometric figure whose shape cannot be altered, which is moved as a whole through the action of the phase shifters controlled by an antenna pointing device. In order to minimise losses and also the degradation of monopulse measurements, some reception components (receiver protecting circuits, parametric amplifiers, mixers and IF pre-amplifiers) are grouped in a casing located just below the rotating joints. IFF is provided for in the design of the antenna.



Matador units in travelling position

The transmission cabin comprises mainly three S-band magnetron transmitters, each delivering a mean power of 2kW, the outputs of which are grouped in a single waveguide by means of a triplexer, a device which requires no adjustment in case of operating frequency change (anti-jamming). These transmitters are modern equipments, fully transistorised except for the microwave tubes. They are of small size, highly reliable, and their maintenance is facilitated by the integration of numerous test points. They use modern ECCM and anti-clutter techniques.

The receiver cabin groups the receivers, the MTI cabinet, the extractor, the plot processing and altitude computing equipment, the control device for the tilting of the antenna according to the mode of operation imposed and the monitoring desk.

The receiver circuits comprise the anti-jamming chains and three angle error chains. The MTI device processes the signals received from the lower beams. The extractor performs the extraction of primary and secondary plots and allows them to be associated together. It is followed by a plot processing equipment which cancels fixed or slowly moving plots, computes altitude, and permits a precise measurement of the altitude of designated targets. The device generates the data in a digital form permitting the transmission of plots to a remote centre.

The monitoring desk groups the monitor controls of the station's operation. This most complete system enables the operator to locate failures and to determine when intervention is necessary; postponed intervention when the failure does not interrupt the operation of the station, or immediate intervention.

CHARACTERISTICS:

Operational performance:

General surveillance: Elevation scanning through 24° with initial elevation adjustable

Fine altitude measurement: For elevations ranging from −5° to about +30°

Detection range: 130 nm on modern fighter (Pd = 80%)

Fine altitude accuracy: Better than + 2.5 mr

Data renewal rate: 12 s

Antenna Characteristics:

Gain: 40 dB

3 dB apertures: azimuth: 1.5°

elevation: 1.9°

Polarization: Circular fixed

Rotation speed: 5 rev/min

Transmission Characteristics:

For each of three transmitters

Peak power: 0.6 MW

Average power: 2 kW

Pulse duration: 5.8 microsec

PRF: 500 Hz

Reception Characteristics:

Intermediate frequency: 30 MHz

Noise figure: 3.5 dB (with parametric amplifier)

Bandwidth: 250 kHz

MTI subclutter visibility: 30 dB

Environmental Conditions:

Temperature ranges:

Operating: −25°C to +50°C

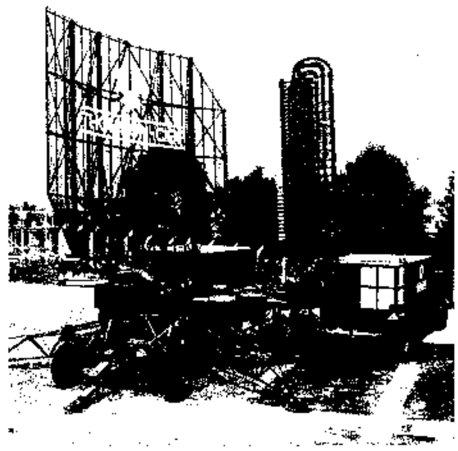
Storage: −40°C + 70°C

Wind speeds:

Operating: 100 km/h (non-iced)

STATUS:

In production



Matador 3-D Radar with aerial erected in operational position

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222-Bagneux, France.

2104.153
MEDIUM RANGE RADAR TA 23 (TRS 2055)

DESCRIPTION:

TA 23 (TRS 2055) is a high-power radar operating at L-band, used in air defence and for terminal area applications.

Main features are:

- *dual-channel operation* (frequency diversity) allowing automatic stand-by, enhancement of coverage and anti-jamming capabilities.
- *use of digital MTI processing*, with dense area detector and interference processor.
- *double-beam antenna*, making it possible to divide the volume of detection into high and low coverage, and to use alternately the signals received from the two coverages. This technique considerably reduces parasitic signals. The antenna structure includes a support frame for an on-mounted IFF aerial.

Transmitter:

This is a solid-state ER 720 type transmitter, built to military standards. Only two types of tubes are used: magnetron and thyratron. The rugged, liquid-cooled magnetron is under-run and has proved to have a life time in excess of 15,000 hours. Special EHV-regulation transistorized circuits assure a high stability of the interpulse transmitted frequency, for high MTI performance with staggered p.r.f.

Receiver:

Fully solid-state, the RR 700 receiver has a low-noise parametric amplifier with a highly stabilized local oscillator. Reception includes a logarithmic channel with a wide dynamic range.

MTI processing:

The MTI uses digital techniques. It operates by measurement of the phase variation between the transmitted pulse and the successive received pulses. Phase variations are applied to a comparator with a threshold, which blanks out the video signal in the presence of fixed echoes.

CHARACTERISTICS:

Aerial:

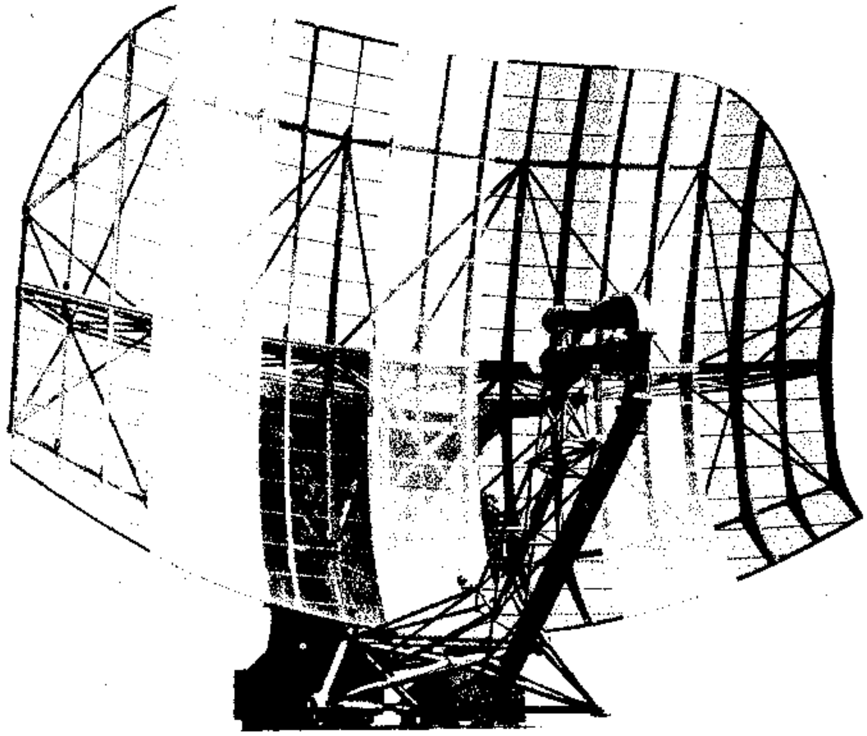
Gain: 32 dB

Polarization: Linear or circular (switchable)

Vertical pattern: Cosecant to 45°

Horizontal beamwidth: 2.3° at −3 dB

Reflector height: 5 m



Aerial of the TRS 2055 medium-range radar

Reflector span: 7 m

Rotation speed: 7.5 and 15 rpm

Transmitter:

Operating frequency: fixed in the 1,250-1,350 MHz range

Peak power: 2.2 MW

Standard prf/pulse durations: 500 Hz-2 microsec; 750 Hz-1.5 microsec; 1,000 Hz-1 microsec.

Dimensions: 1.77 × 1.41 × 0.91 m

Power supply: 220/380 V-50 Hz-15 kVA

Receiver:

Noise figure: 3 dB (with parametric amplifier)

Log. amplifier dynamic range 70 dB

Dimensions: 1.71 × 0.58 × 0.84 m

Power supply: 220 V, 50 Hz, 1 kVA

Sub-clutter visibility: 25 dB

DEVELOPMENT:

The design and development of TA 23 (TRS 2055) were carried out under the sponsorship of the French Administration. The first prototype was completed in 1969.

TRS 2055 is now in production. More than 20 sets have been delivered in France and elsewhere.

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222-Bagneux, France.

2117.153
MIRADOR II

DESCRIPTION:

Mirador II is a search and target designation radar designed for use against low and very low flying targets. It is primarily intended to operate for the benefit of anti aircraft systems for point defence. These systems may be "clear-weather" (optical or TV tracking) or "all-weather", that is, fitted with tracking radars; they may utilize guns or missiles. The radar can provide such system with:

omnidirectional search with a high data renewal rate (60 revolutions per minute).

audible alarm if a target is detected.

bearing, elevation and range designation of targets to several fire positions.

evaluation of the threat presented by detected targets on a 4-degree priority basis.

The evaluation of the threat is based on the radial speed/range pair. The coding of the echoes on the PPI enables the operator to estimate the danger presented by the different targets over one antenna scan (1 second), thus giving a fast reaction time for the system. A track-while-scan device can be added to the radar providing an automatic tracking facility.

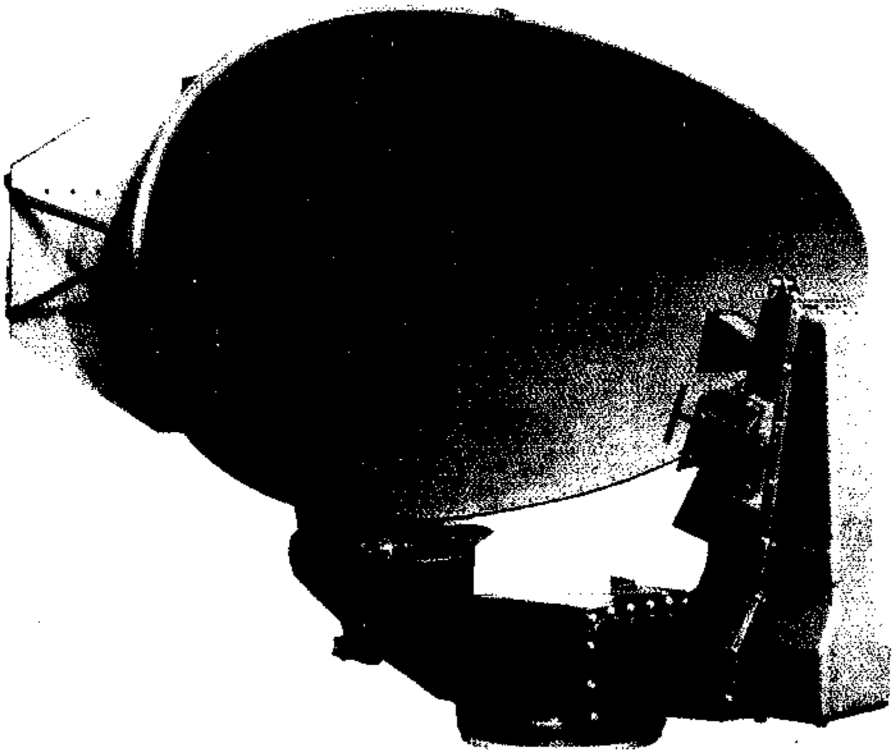
An important current use of Mirador II is as the surveillance element of Crotale (**2074.131**). Generally, however it is a lightweight radar, which can be divided into containers, easily transportable by trucks or helicopters. It can be installed in a vehicle, a cabin, or a hard building, within a very short deployment time.

The Mirador II is a coherent-pulse doppler radar with a high sub-clutter visibility. It operates in S-band, which affords a good bearing resolving power with a relatively small antenna size.

The antenna is a parabolic reflector illuminated by a feed which produces two stacked beams thus providing an elevation assessment for detected targets. The transmitter valve is an air-cooled triode, the rest of the radar being fully transistorised. Signal processing is carried out on nine 2-km channels, the maximum detection range of the radar being 18 km. Processing circuits include anti-clutter filtering and velocity filters. Anti-jamming protection is ensured by the constant-false-alarm-rate (CFAR) receiver. Strobe on jammer is performed on the last range channel.

CHARACTERISTICS:
Frequency: S-band
Peak power: 270 W approx
Average power: 30 W approx
Azimuth beamwidth: 4°
Elevation beamwidth: 13° cosecanted up to 20°
Antenna rotation speed: 60 rev/min
Radial speed range: 45-420 m/s
Range: 17 km on 1 m^2 target (11 km on 0.1 m^2 target)
Accuracy of bearing designation: 0.75° (rms)
Accuracy of range designation:
400 m (rms) without track-while-scan
200 m (rms) with track-while-scan
Subclutter visibility: at least 55 dB
Climatic conditions: −30° to +55°
ECCM devices: CFAR receiver strobe on jammer
Compatible with IFF:
Consumption: 1.5 kW approx

STATUS:
In quantity production since 1969.



Mirador II Aerial

MANUFACTURER:
Thomson-CSF, 1 rue des Mathurins, 92222-Bagneux, France.

2129.153
OEIL NOIR 1
DESCRIPTION:

The Oeil Noir 1 radar is designed for surveillance and acquisition of low-flying air targets within the framework of a mobile defence system. Normally associated with a twin 30-mm gun in an armoured turret, it can also be used with any other anti-aircraft gun system for the engagement of low flying aircraft.

Oeil Noir 1 is a coherent-pulse Doppler radar providing a high sub-clutter visibility of moving targets. Entirely solid-state except for the transmitter tube, it has the reliability and ruggedness required for use on a battlefield. Use of L-band makes it possible to extract the radial velocity of the target without ambiguity. The radar discriminates between approaching and receding targets, and between slow and fast targets. This is the basis of the threat evaluation process that makes the reaction time of the weapon system short.

OPERATION:
Omnidirectional Search:
This is performed by the radar operator with a PPI display installed in the turret. A high data renewal rate is ensured by a rapid rotation of the antenna (60 rev/min). Codification of targets is used for threat evaluation.
Bearing Acquisition:
The operator uses an electronic alidade inscribed on the PPI screen. Making it coincide with the target's direction, brings the turret and guns to bear in the right direction.
Range Finding:
After acquisition of the target in bearing by the radar and in elevation by an optical unit, the antenna is locked in the direction of the target and the radar operates as a range-finder, providing an accurate measurement of the range.
DEVELOPMENT:
Developed on a French Government's order (Direction Technique des Armements Terrestres), has been equipping the anti-aircraft tanks of the French Army armoured divisions since 1967. (See entry **2138.131**).

AMX-30 tank with S.A.M.M. turret equipped with Oeil Noir radar

CHARACTERISTICS:
Frequency band: L band
Peak Power: 120W
Average power: 24 W
Azimuth beamwidth: 10°
Elevation pattern: Cosecant squared, aperture 35°
Rotation speed: 60 rpm
Radial speed ranges: 50 to 160 m/s for slow targets 160 to 300 m/s for fast targets
Range: 15 km on modern fighter
Range-finding accuracy: +50 m (between 3,800 and 15,000 m)
Subclutter visibility: At least 50 dB
Temperature range: −40°C to +55°C
Consumption: About 1 kW, fed from 24 V d-c
Weights:
Antenna: 65 kg
Transmitter cabinet: 50 kg
Receiver cabinet: 50 kg
PPI: 15 kg
Control box: 5 kg
Junction box: 20 kg
MANUFACTURERS:
Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

2131.153
OLIFANT

DESCRIPTION:

Olifant is a man-portable CW/FM patrol radar designed primarily for use by infantry operating in insecure areas. The radar proper weighs only 4 kg and can therefore readily be hand operated. Batteries, which weigh about 7 kg, are carried in a shoulder pack: there is also a tripod that can be used when the radar is controlled by a sentry.

Azimuth scanning is performed by manual pointing and range scanning is by a single control directly calibrated in metres. The presence of a moving target is indicated by an identifiable sound on the operator's earphones. Range on a moving man is about 1,600 metres and on a vehicle it is about 2,200 metres.

CHARACTERISTICS:

Operating mode: CW-FM
Operating frequency: X-band
Range: 1,600 m walking target; 2,200 m vehicle target
Accuracy of range measurement: 30 to 50 metres approximately
Speed of detected targets: 4 to 30 km/hr
Power supply: built-in 24 V battery, continuous service 12 hours
Power consumption: 14 watts
Weight:
Patrol version: 11.7 kg
Sentry version: 15.4 kg

MANUFACTURER:

Electronique Marcel Dassault, 55 Quai Carnot-92-Saint-Cloud, France.

Olifant man-portable CW/FM patrol radar

2132.153
OLIFANT II (DR-PT-6)

DESCRIPTION:

Olifant II is a Ku-band coherent pulse-Doppler patrol radar designed to detect, locate and identify moving targets at very short range.

A light and rugged device the radar can be carried and operated by one man; and, worn on the chest, it can be used immediately the operator stops moving. When on patrol, therefore, all he has to do is to halt facing in the right direction and switch on the radar. If there is a moving object within range in the direction in which the radar is pointing the operator will hear an identifiable signal in his headphones.

The complete portable equipment weighs only 9 kg including a battery that will give 12 hours continuous service. For sentry duty a tripod is available: it weighs only another 3 kg. Detection range is about 1,000 metres on a moving man; on a moving quarter-ton vehicle it is more than 2,000 metres.

STATUS:

Mass production

MANUFACTURER:

Thomson-CSF, Division Equipements Avioniques et Spatiaux, 175 boulevard Gabriel-Péri, 92-Malakoff, France.

Olifant II radar

2120.153
PERCEVAL HELICOPTER RECOVERY RADAR

DESCRIPTION:

Perceval is a highly mobile helicopter recovery radar station. Its functions include early warning (secondary radar), approach and recovery (primary radar), and landing. All these functions can be carried out simultaneously.

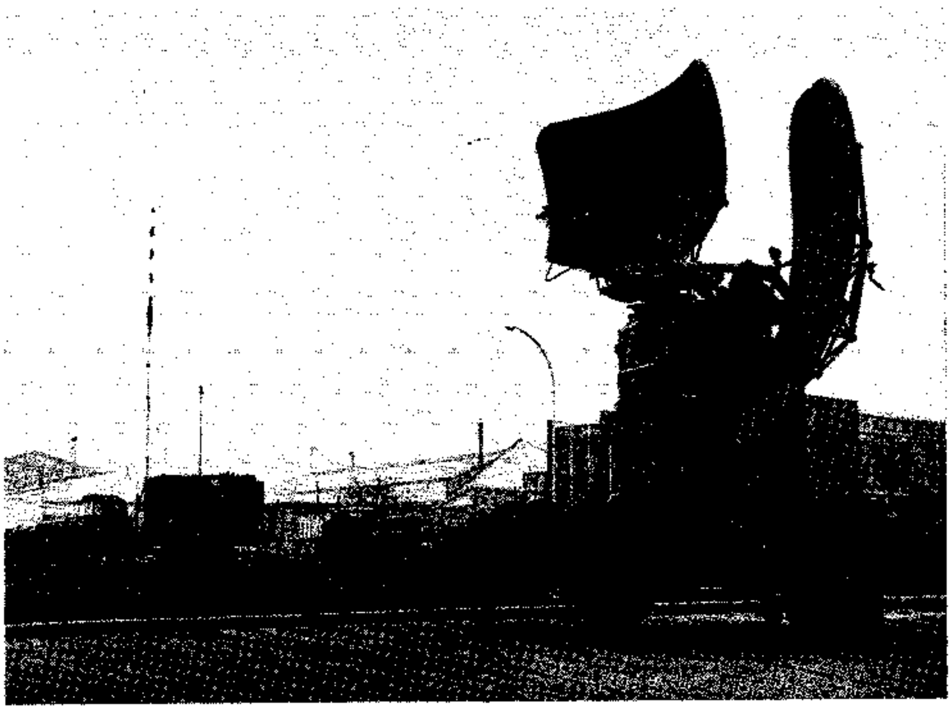
The station comprises a lightweight trailer supporting the radar transmitter-receiver unit, the IFF interrogator and the aerials, a cabin housing two displays, associated means of telecommunication, an MTI device and a passive decoding system, and a trailer carrying a power generating set.

The aerial system comprises an azimuth aerial which can rotate continuously and an elevation aerial which scans in the vertical plane. The IFF aerial is integrated with the primary radar aerial.

The transmitter and the receiver operate in X-band and are transistorised and miniaturised. The MTI is a digital phase-threshold system.

CHARACTERISTICS:

Primary radar:
Transmitter: Operating frequency band: X band. Peak power: 200 kW (magnetron output). Pulse duration: 0.7 us. Pulse repetition frequency 1,400 Hz (staggered)
Receiver: Intermediate frequency 30 MHz. Noise figure not more than 8.5 dB. Reception chain



Perceval radar station

logarithmic characteristic with differentiation/expansion. Fixed echo cancellation phase-comparison, digital MTI double cancellation and staggered PRF

Aerials: Azimuth reflector dimensions 2 × 1.2 m, beamwidth 1.1°, cosecanted up to +25°, gain 38dB. Polarization circular, fixed. Scanning range −15° to +15°. Integrated IFF aerial. Elevation reflector dimensions 2.25 × 0.95 m beamwidth (in vertical plane) 0.95°. Gain more than 37 dB. Polarization circular, fixed. Scanning range −2° to +15°

Range capability: (PD = 80%, target 5 m^2). Coverage of the azimuth aerial (surveillance and landing) maximum range: 75 km, altitude: 3,000 m. Detection in the elevation plane (elevation aerial): 70 km

STATUS:

Production

MANUFACTURERS:

Thomson/CSF, Division Radars de Surface, 1, rue des Mathurins, 92222-Bagneux, France.

2119.153
PICADOR MOBILE 3-D RADAR

DESCRIPTION:

PICADOR TRS 2200 is a mobile air defence radar station operating in S-band. This station combines in a single equipment the radar functions of three-dimensional surveillance, height-finding and low-altitude surveillance. Designed to be transportable and capable of being deployed rapidly, it can be used for surveillance and interception control either as an autonomous station or as a gapfiller integrated into a large Air Defence system.

The complete station comprises an equipment cabin, an operations cabin and power generators.

Equipment Cabin:

On the reinforced roof of this cabin is fixed the aerial system which comprises a single reflector and three primary feeds. One of these is for 3D search and height finding coverage and is an electro-mechanical rapid scan feed; a second is for low-altitude plan coverage; and the third is for IFF coverage (with a supplementary omnidirectional aerial for the ISLS function).

The following units are grouped inside the equipment cabin:

- two transmitter-receivers, respectively feeding the 3-D cover aerial and the low cover aerial. Each transmitter is equipped with a magnetron which is continuously tunable by means of a single knob control. The receiver is fitted with a low noise parametric amplifier and comprises CFAR chains for ECCM purposes,
- an RF switch whereby coverage can be maintained in case of failure of either transmitter-receiver,
- a signal processing equipment with a digital MTI and an extractor,
- an IFF interrogator,
- a drive assembly for continuous or programmed rotation of the aerial.

Operations Cabin:

In this cabin are the display units and associated operational controls. Three positions are provided:

- master controller position with a 405mm PPI, passive and active IFF decoding facilities, aerial servo controls and telecommunication equipment control (VHF-UHF-SSB),
- intercept operator position with a 405mm PPI, altitude computer and automatic altitude read-out device and operational controls (both PPI displays receive video signals corresponding both to the 3-D and to the low altitude plan coverages),
- height finding position with an RHI display which is at the disposal of either operator for manual height measurement.

CHARACTERISTICS:

Operational performances:

Detection range: 200 km on a 2 m^2 fluctuating target (Pd = 80%)

Altitude coverage: No practical ceiling with a maximum elevation angle of 16°

Mobility: Transportable by truck or cargo aircraft

Antenna characteristics:

Antenna size: 3.4 × 3.7 m

Gain: 37dB

Beamwidth: 2° × 2°

Rotation speed: 5 rev/min (with a reduced speed over a sector in the programmed rotation mode)

Polarisation: Linear/circular

Transmitter-receiver (Type Th.D 047):

Magnetron: tunable 150 MHz in S-band

Peak power: 1 MW

Pulse duration and PRF: 4 microseconds-500 Hz

Noise figure: 4.5 dB

Subclutter visibility: 30 dB

Power supply:

220/380 V three-phase 50 Hz

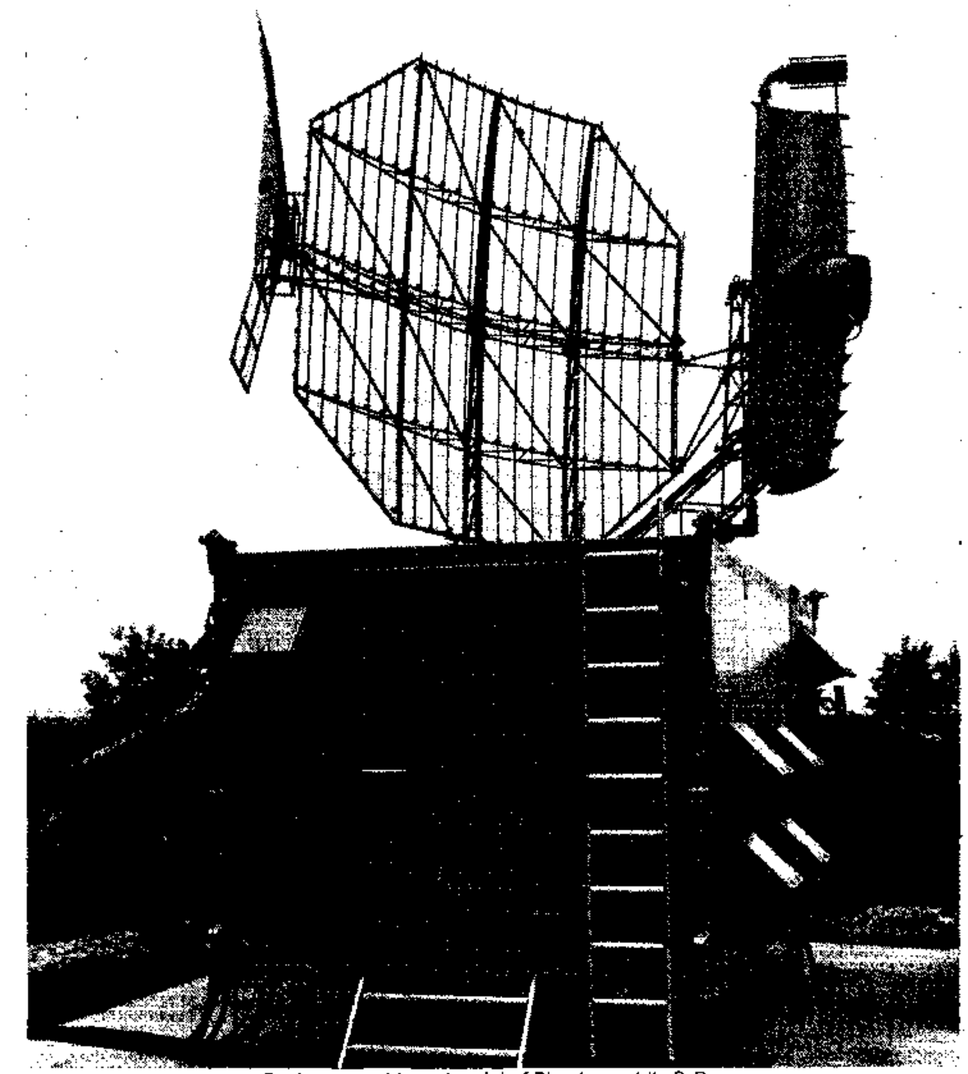
Consumption: 25 KVA

STATUS:

First prototype of the RST 2200 was completed in 1968. Now in series production.

MANUFACTURERS:

Thomson-CSF— Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.



Equipment cabin and aerial of Picador mobile 3-D radar

2133.153
PRECISION APPROACH RADAR TH.D.1012

DESCRIPTION:

This PAR is a recent Thomson - CSF development of compact design. Solid-state circuitry has been used wherever possible to reduce weight while at the same time permitting the incorporation of a stand-by transmitter. Careful design and construction of the two aerial reflectors and feeds produces signals that result in a display presentation of high quality; and provision for changing the orientation of these aerials makes it possible for a single installation to be used to control landings on two runways (4 QFVs).

The complete radar comprises an aerial assembly, two transmitter-receivers, a display assembly with two indicators and junction boxes. The azimuth and elevation aerial reflectors are identical in design and are fed with RF power through a chopper which supplies power to the two aerials alternately. Polarisation can be varied from linear to circular to suit meteorological conditions. The two rotating aerial assemblies are mounted on a rigid frame which can be orientated in any one of four positions.

Two identical transmitter-receivers are provided, only one of which is operational while the other is at stand-by. To ensure immediate availability of the stand-by equipment arrangements are made for it to transmit into a dummy load.

The two indicators also are identical both in design and in presentation so that one can be used to carry out the complete approach operation in the event of failure of the other. For added clarity of presentation the measured elevation and azimuth angles are exaggerated in the display.

CHARACTERISTICS:

Antennae:

High definition beam: 0.5° at −3 dB

Low definition beam: 2.7° at −3 dB

Gain: 42 dB

Attenuation of the first sidelobe: At least 25 dB

Frequency band: From 9,000 to 9,200 MHz

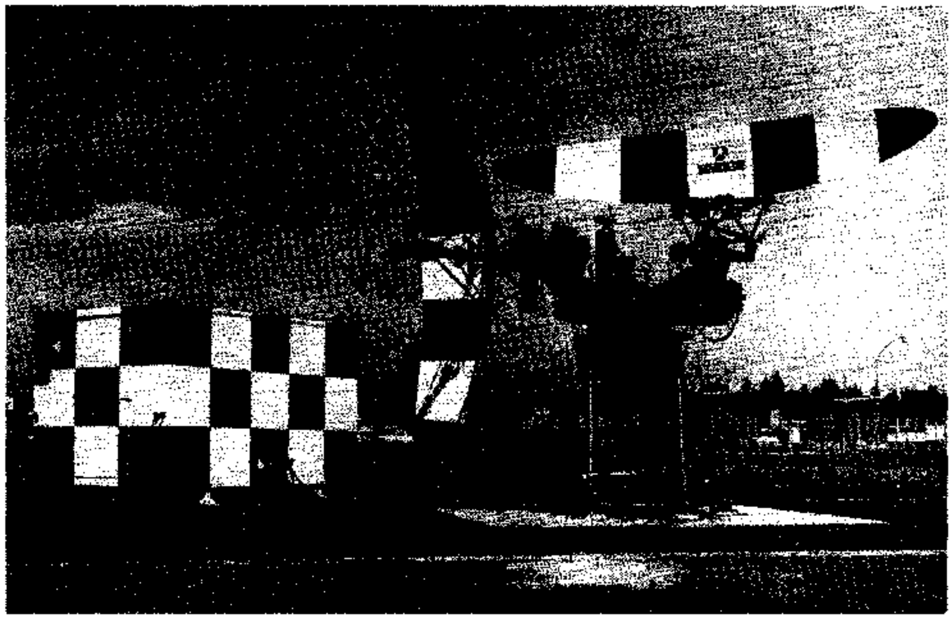
Ellipticity ratio in circular polarization: At least 0.9

Transmitter:

Frequency band: 8,500 to 9,600 MHz

Peak power: 40/200 kW

Pulse length: 0.5 microsecs
PRF: 2,000 Hz +1%
Receiver:
IF: 30 MHz
Bandwidth: 8 MHz +2 MHz
Noise figure: About 10 dB
Range: 18 nm on 2 sq m target
Information rate: On azimuth and elevation picture every half second
Azimuth scanning: —5° to +15°
Elevation scanning: —1° to +6°
Screen diameter: 40 cm
Range scales: 0/5 km - 0/20 km
MANUFACTURER:
Thomson-CSF, Parc de Rocquencourt, B.P. 2000, 78 Versailles, France.



TH.D 1012 PAR installation

2152.153
RALF LOW-ALTITUDE ACQUISITION RADAR

DESCRIPTION:

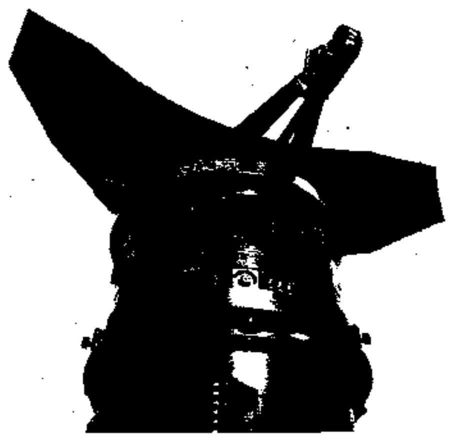
RALF (Radar Acquisition of Low Flyers) is a light-weight radar designed for surveillance and acquisition of low flyers in a heavy environment of ground or sea clutter. It is highly mobile, modular and flexible and can thus be installed in shelters or in vehicles such as armoured transport. Efficient digital MTI and ECCM circuits provide a very low false alarm rate. The radar is thus easy to operate: it may also be remotely controlled. It is compatible with other air surveillance radars for gap-filler applications and may be fitted with IFF equipment.

Using an advanced technique of non-recurrent pulsed Doppler radar (RACINE process), RALF avoids blind speeds, in spite of the short transmitted wave length, while keeping the high subclutter visibility factor of the pulsed coherent radars. This means that it can detect targets with radial velocities ranging from 10 to 2,000 knots without losses due either to velocity ambiguities or to heavy clutter.

The transmitter uses a low cost magnetron and an improved coherent receiver allowing for a high subclutter visibility factor. Signal processing and data extraction are performed digitally. Data processing and display are either a SINTRA console for fire control systems or a SINTRA "Ministrada" centre (**2115.151**) for air space surveillance and air defence detection.

CHARACTERISTICS:
Antenna:
Horizontal beam width: 1.5°
Vertical beam width: cosecanted
Side lobe level: —20 dB or less
Polarization: vertical or circular
Rotation speed: 20 rev/min
Transceiver:
Average transmitted power: 200 W
Frequency: X-band (variable)
Pulse repetition frequency: Random
Receiver noise figure: 8 dB
Rain clutter attenuation: more than 20 dB
Signal Processing: Digital MTI and extractor
Sub clutter-visibility factor: at least 40 dB (antenna rotating)
Range resolution: 75 m
Weight: 160 kg plus data processing and display units
Power consumption: 1.5 kVA at 220 V/400 Hz

STATUS:
A model was field tested in 1971. Airborne tests have been carried out for AEW evaluation.



Ralf low-altitude acquisition radar

MANUFACTURERS:
Radar:
Laboratoire Central de Télécommunications (LCT), 18-20 rue Grange-Dame-Rose, 78140-Vélizy-Villacoublay, France.
Data Processing and Display:
SINTRA, 26 rue Malakoff, 92600 Asnières, France.

2137.153
RAPACE AFV SURVEILLANCE RADAR

RAPACE is a surveillance radar designed for AFV use to detect moving targets – especially in conditions of poor visibility.

DESCRIPTION:

The equipment is a pulse-Doppler radar consisting of two main units, one mounted on the outside of the vehicle and the other mounted inside. The external unit is a Ku-band radar with a sector-scanning antenna whose azimuth rotation axis is automatically vertically stabilised up to ± 15° in roll or pitch. Azimuth scanning is ± 60° at 20°/sec and elevation scanning is ± 20°.

Inside the vehicle is a display and control box. Range and bearing of targets are automatically displayed on this, the synthetic display being of the mosaic type in which the lighting of one of an array of luminous points informs the operator of the intensity of the echo and its azimuth and range. After initial detection in this way the data can be refined by means of an electronic magnifier that 'multiplies' the display by six in each direction; and further tracking and target identification is achieved by the use of the operator's earphones.

The equipment is rugged and can withstand the shocks both of vehicle manoeuvres and of its own gunfire. Since the radar is intended to be used only when the vehicle is stationary, however, the antenna is folded for protection while the vehicle is on the move.

Detection range is from at least 1.5 km (pedestrian) to at least 5 km (tank) and the localisation accuracy is ± 25 metres in range and ± 10 mils in azimuth. Targets travelling at between 3 km/h and 50 km/h can be detected.

CHARACTERISTICS:
Operating frequency: Ku-band
Peak power: 2 W
Antenna gain: 32 dB
Beamwidth (3 dB):
Azimuth: 3.5°. Elevation: 3.5°
Area scanned:
Azimuth: ± 60°, Elevation: ± 10°
Scanning speed: 20°/sec
Noise factor: Better than 7 dB
Range: Pedestrian: better than 1.5 km. Tank: better than 5 km
Measurement accuracy: Azimuth: ±10 mils, Elevation: ± 10 mils, Range: ± 22 m
Power supply: Vehicle battery
Power consumption: Less than 100 W
Operating temperature: —40°C to +55°C
Weight: 20 kg

STATUS:
Prototypes.

MANUFACTURER:
Electronique Marcel Dassault, 55 Quai Carnot, 92-Saint-Cloud, France.

2141.153
RASIT 72A/RAPIERE BATTLEFIELD SURVEILLANCE RADAR

DESCRIPTION:

RASIT 72A/Rapiere is a long range (20 km) battlefield surveillance radar, for the detection, acquisition, localisation and recognition of moving targets, either on or near the ground in all weather conditions.

The equipment is a pulse Doppler radar. It operates in X-band and uses a coherent receiver and multiple range gates and filters designed for a high probability of detection.

Echoes detected over the surveyed zone are displayed on a B-scope daylight display, connected to an electronic memory.

For each target acquired, the polar and UTM coordinates are displayed on the B-scope and the Doppler tone is transmitted to the operator either by loudspeaker or by ear-phone. The operator is thus able to recognize pedestrians, wheeled and tracked vehicles, aircraft and helicopters.

An automatic system can be arranged to trigger an acoustic alarm as soon as a target enters the surveyed zone. The operator can select the width of the surveyed zone from 30° to 120° and can choose the length surveyed by operating in either of two modes –

NORMAL: over-all radar range of 20 km

MAGNIFIER: any zone 2.5 km long within the total range.

The equipment can be operated by a single inexperienced operator in a variety of conditions. Typical operating times are 10 seconds to survey a zone 100° wide and 20 km long, and 30 seconds to acquire a target.

The antenna beam can automatically sweep a sector or can be stopped and then oriented towards a target. The antenna is equipped with a polarizer making the radar insensitive to atmospheric perturbations. The radar also has very effective ECCM capabilities.

The RF unit can be mounted on a tripod with the control cabinet 50 metres away. Alternatively it can be mounted on any of a variety of military vehicles, such as the Berliet VXB 170A (**5059.102**) or the Alvis-British Leyland Spartan (**5040.102**), with the control cabinet inside the vehicle.

CHARACTERISTICS:

Operating frequency: X-band (200 MHz range)
Peak power: 3 KW
Polarization: Linear or circular
Range: (Probability of detection: 90%)
Pedestrian 14 km
Vehicle More than 20 km
Helicopter 15-20 km
Range reduction: (4 mm/h rain) Less than 10%
Accuracy: azimuth ± 8 milliradians. range ± 10 m
Subclutter visibility: More than 45 dB
Display: B-type daylight oscilloscope, numerical display of polar and UTM coordinates, Doppler tone, automatic acoustic alarm
Power drain: 150 W (28 V)
Temperature range: −40°C to +55°C
Reliability: Computed MTBF higher than 1,000 hours
Over-all weight: 70 kg
Number of loads: 4
Weight of the heaviest load: 25 kg
Distance between radar head and operator unit: 50 m max
Provision for target data transmission
Built-in tests

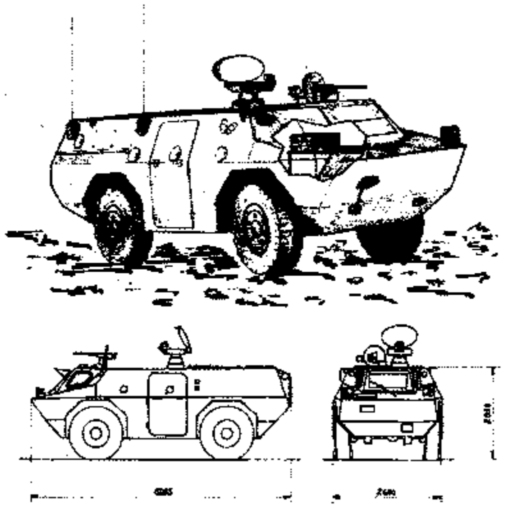
OPTIONS:

Remote slave TV monitor; Automatic range tracking; Remote control of antenna elevation; Automatic surveillance over 360°.

STATUS:

Preproduction. Prototypes under test by the French Army and by three other European armies.

RASIT 72A battlefield surveillance radar



RASIT 72A – impression of mounting on Berliet VXB 170A

MANUFACTURER:

Laboratoire Central de Télécommunications, 18-20 rue Grange-Dame-Rose, 78140-Vélizy-Villacoublay, France.

2153.153
RASIT 72/B BATTLEFIELD SURVEILLANCE RADAR

DESCRIPTION:

RASIT 72/B, a lightened version of RASIT 72/A Rapiére (**2142.153**), has the radar head fastened on the operating unit. The antenna orientation is controlled by hand.

CHARACTERISTICS:

Similar to a RASIT 72A/RAPIERE, except for:
Display: Linear (versus range) solid state display, numerical display of range, azimuth scale on the antenna
Power drain: 100 W (28 V)
Over-all weight: 50 kg
Radar head and operating unit are fastened together:

STATUS:

Similar to RASIT 72A/Rapiere.

MANUFACTURER:

Laboratoire Central de Télécommunications (LCT), 18-20 rue Grange-Dame-Rose, 78140-Vélizy-Villacoublay, France.

2154.153
RASIT 72 C BATTLEFIELD SURVEILLANCE RADAR

DESCRIPTION:

RASIT 72 C is a shorter range (10 km) version derived from RASIT 72A/Rapiere.

The computer for polar/UTM coordinates conversion is offered only as an option and the equipment power drain does not exceed 120 W (28 V).

STATUS:

Not definitely known but believed to be preproduction.

MANUFACTURER:

Laboratoire Central de Télécommunications (LCT), 18-20 rue Grange-Dame-Rose, 78140-Vélizy-Villacoublay, France.

2143.153
RASURA BATTLEFIELD SURVEILLANCE RADAR

Rasura is available as either a portable or a vehicle-mounted equipment and is designed to detect the presence of moving targets in a battlefield or curfew area. Any pedestrian or vehicular movement within an area several miles in radius is detected and located with sufficient accuracy in bearing and range for it to be engaged.

DESCRIPTION:

Rasura is a Doppler autocoherent pulse radar operating in X-band. Detected targets are indicated to the operator by a sound signal in his headphones. Distance and bearing are displayed directly on the equipment indicator.

Azimuth scanning is either manual or by 4 degree sections: range scanning can be either manual or automatic. Typically the equipment will be set to scan automatically in range while the operator monitors the azimuth data. When a target is audibly detected the operator can stop the range scanning and lock the equipment manually on target: the characteristics of the audible signal will then enable him to identify the nature of the target.

Reliable range is about 2 km on crawling targets and 5 km on pedestrians or vehicles, but targets may be detected at greater ranges and the equipment may usefully be set for a range of 7-10 km, since vehicles may be detected at 10 km and pedestrians at 7 km. Location accuracy is 25 m in range and less than 17 mils in azimuth. It takes about 18 seconds to scan a sector 5 km deep and subtending an angle of 70 mils.

The portable version consists of three harness loads of 20 kg each and is powered by nickel-cadmium batteries. The vehicle-mounted version has a converter unit in place of the batteries and the equipment is powered by the vehicle supplies.

CHARACTERISTICS:

Operating frequency: X-band
Peak power: 2-3 kW
Over-all noise factor: Better than 9 dB
Pulse width: 0.5 microsec
Antenna gain: 29 dB
Beamwidth (3 dB):
Azimuth: 4°. Elevation: 8°
Sensitivity: —128 dB/W
Sub-clutter visibility: 40 dB
Detected target speed: Fast 12-60 km/h, Slow 4-15 km/h
Range: Vehicles: at least 5 km. Walkers: at least 5 km. Crawlers: at least 2 km
Range accuracy: +25 m
Azimuth accuracy: Better than 17 mils
Power supply: Cadmium-nickel battery or converter
Power consumption: 60W
Operating temperature: —25°C to +50°C
Weight: 3 × 20 kg packs for portable versions

STATUS:

In quantity production. Supplied at least to the armed forces of France, Germany and the Netherlands.

MANUFACTURER:

Electronique Marcel Dassault, 55 Quai Carnot, 92-Saint-Cloud, France.

Rasura battlefield radar

2155.153
THREE-DIMENSIONAL RADAR TH.D.1955

The TH.D.1955 is a long-range three-dimensional S-band air defence radar. The successor to the Palmier radar it ranks among the most powerful radars of its type in the world.

DESCRIPTION:

Major features of this radar are its high-power (20 MW peak) transmitter, its elaborate acrial structure and its range of ECCM facilities that enable it to function satisfactorily in an ECM environment. The equipment is transistorised to the maximum extent possible, is of modular construction and has built-in test facilities. Major components are

a multibeam antenna, the large size of which ensures a high gain and a great sharpness of beam in both elevation and azimuth;
a high-power transmitter with amplifier chain, compatible with modern anti-jamming techniques (random-frequency transmission, pulse compression, etc.);
a multibeam reception system ensuring the accurate measurement of the elevation of any target, and the regulation of the false alarm rate;
the system includes numerous devices for fighting active and passive jamming as well as natural parasitic echoes; a non-saturable automatic extractor device.

PERFORMANCE:

Range capability of the TH.D.1955 is better than 400 km on fighter aircraft – there being no practical altitude limitation. Elevation measurement accuracy at long range is from 2 to 4 milliradians. The data renewal rate is 6/minute.

DEVELOPMENT:

The design and development of the station were carried out under a contract of the Service Technique des Télécommunications de l'Air.

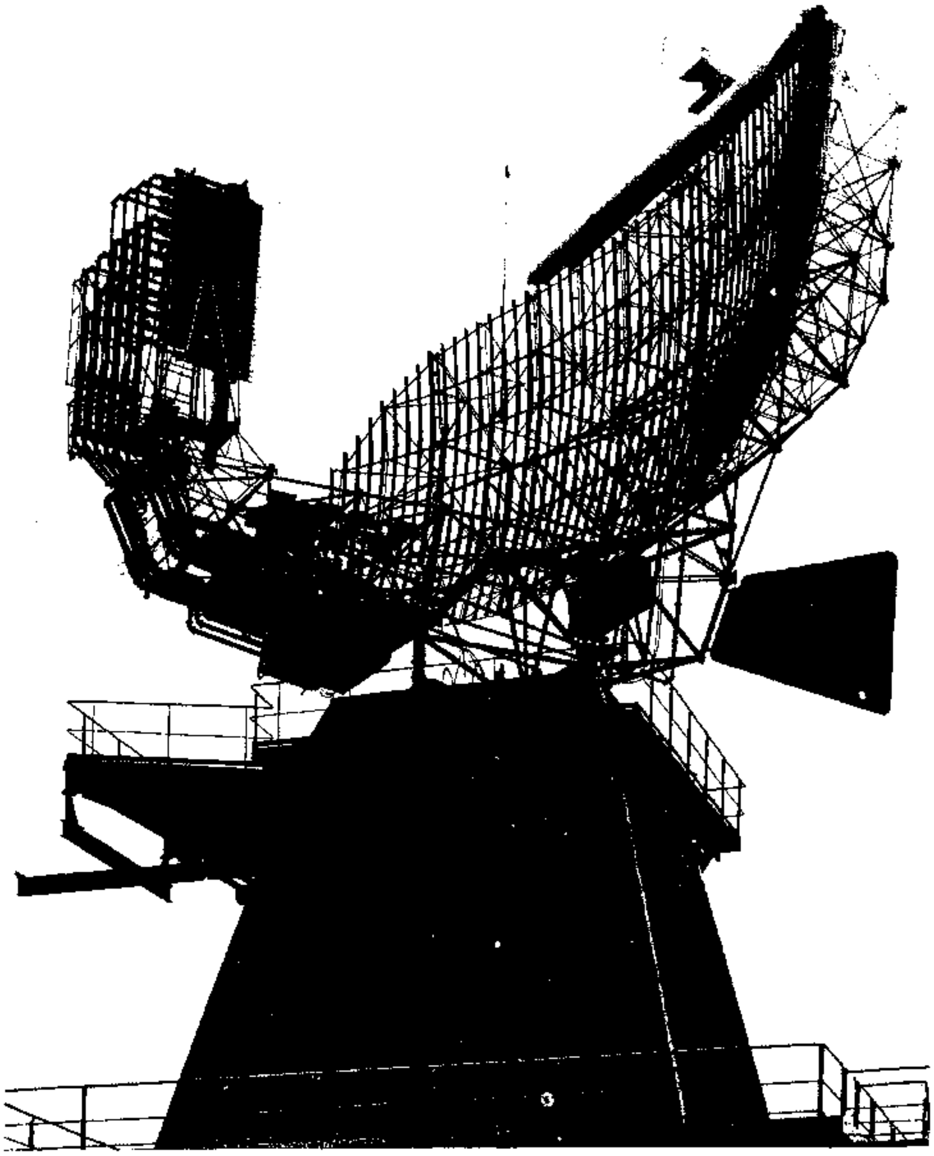
The first feasibility studies date back to 1955 and the contract for the final version was awarded in 1963.

CHARACTERISTICS:

Operating frequency band: S-band
Antenna dimensions: 16 × 6 m
Gain: 46 dB
Polarization: At the operator's discretion
Peak power transmitted: 20 MW
Elevation: To over 20°
Range: More than 400 km on fighter aircraft
Data renewal rate: 6/minute

STATUS:

The equipment is in production and more than 20 sets have been constructed. Besides France, several countries have been, or are being, equipped with TH.D.1955 stations and the equipment has been selected by NATO as the main feature of its new radar coverage (NADGE plan – see section 1 D 2a 1181.181)



TH.D.1955 Long-range 3-D radar aerial

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222 Bagneux, France.

2156.153
TIGER RADAR TRS 2100

Under the code name TIGER (for Terrifically Insensive to Ground Effect Radar), Thomson-CSF has developed a lightweight high-performance radar for the detection of low-flying aircraft. Good performance in severe clutter conditions is achieved by the simultaneous use of moving target indicator circuits based on Doppler frequency filtering and of pulse compression to limit the volume in which clutter echoes can mix with useful echoes. The radar can be used either as an autonomous detection centre, with local exploitation of radar data, or as a gap-filler station linked to an Air Defence network.

DESCRIPTION:

The use of S-band makes it possible to have an aerial with a high gain and high angular resolution but with a relatively small reflector (5 × 2.3 m). The reflector profile is C-shaped with double curvature and the vertical pattern has a steep slope at low elevations and is supercosecanted at high elevations. This arrangement leads to good sub-clutter visibility and detection capability both at low incidences and at close ranges. Circular polarisation is used to improve detection characteristics in bad weather. The antenna rotates at 15 rev/min thus providing data renewal every 4 seconds.

The transmitter uses a coherent amplifier chain. The transmission frequency is obtained from a highly stabilised crystal oscillator; and for frequency agility purposes transmission is carried out at different frequencies distributed at random over 200 MHz. The output power is provided by three successive amplifier stages (two TWT stages and one CFA stage). The phase stability of this chain is such as to ensure good clutter rejection performance. Pulse compression is achieved by incorporating crystal dispersive networks, the propagation time of which varies with the frequency in the transmit and receive circuits.

The receiver is preceded by a wide band, low noise-parametric amplifier. Rejection of fixed echoes is obtained by a digital linear MTI. A constant false-alarm rate chain operates in parallel with the MTI processing chain.

A set of logic circuits and signal lamps is incorporated in each part of the equipment in order to monitor the principal performance figures and to locate a possible faulty function.

An IFF sub-system is incorporated in the radar.

OPERATION:

The radar is transportable by a light helicopter (loads of less than 560 kg) or by conventional truck or cargo aircraft. The equipment can be cabin-mounted. Deployment can be performed in less than 60 minutes with a team of four men.

CHARACTERISTICS:

Operational performance: on a 2 m^2 (fluctuating target) with Pd = 80%

Tiger TRS 2100 radar aerial

Detection range: 100 km
Altitude detection: Greater than 4,500 m
Elevation pattern: Cosecanted up to 45°
Sub-clutter visibility: Greater than 40 dB
First blind speed: Greater than 1,500 knots
Antenna characteristics:
Antenna size: 5 × 2.3 m. IFF antenna integrated with the primary radar antenna
Gain: Greater than 34 dB
Polarisation: Circular, fixed
Rotation speed: 15 rpm
Transmitter-receiver characteristics:
Frequency range: 200 MHz in S-band
Main power: 450 W
Over-all receiver noise figure: Less than 4.5 dB

STATUS:

Evaluation tests of the first prototype have been carried out. Now in pre-production.

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

2160.153
VOLEX III 3-D RADAR

Volex III is a fixed, S-band, three-dimensional surveillance radar providing continuously and simultaneously the azimuth, range and altitude of any target within its cover volume; it may be used either as 3-D air-defence station or as a height-finder.

DESCRIPTION:

The equipment consists, in the main, of an aerial system and dual transmitter-receivers. The aerial system comprises two aerials mounted side by side on a common turntable. Both are equipped with a Robinson elevation rapid scan primary feed.

Two TH.D.047 transmitter-receivers are coupled to the aerial system through a rotating joint fitted with two high-power channels.

The radar can be associated with an automatic data processing system providing three-dimensional extraction of all the plots pertaining to the targets flying within the detection volume.

Reliability and maintainability are provided for by the mechanical design of the aerial system and use of transistorised circuits and plug-in interchangeable chassis.

Altitude measurement accuracy is better than 600 metres on a modern fighter aircraft at a range of 100 nm (185 km). Coverage is ensured within the volume defined by a range of 150 nm (280 km) an elevation angle of 22° and the full 360° of azimuth. The 3-D data renewal rate is 3/minute.

CHARACTERISTICS:

Aerial system:	VT 359 (lower elevations)	VT 150 (higher elevations)
Span of reflector:	3.3 m	3.8 m
Height of reflector:	6.8 m	3.4 m
Weight:	900 kg	350 kg
Beamwidth:	azimuth: 2° elevation: 1°	azimuth: 2° elevation: 2°
Nominal gain:	40 dB	37 dB
Polarization:	linear + circular (optional)	linear + circular (optional)

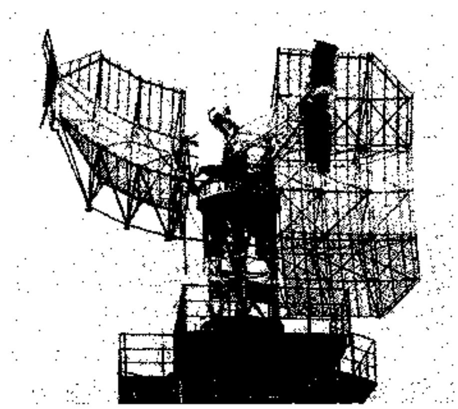
Transmitter (TH.D.047):
Frequency: Tunable through 300 MHz in S-band (with 2 magnetrons)
Peak power: 1 MW
Average power: 2 KW
Pulse duration: 4 microsec
PRF: 500 Hz
Receiver: Low noise, wide-band parametric amplifier (noise figure less than 4 dB). Two reception chains with automatic selection: Lin/IAGC chain; CFAR chain (+ logarithmic chain with anticlutter devices, optionally). Single-knob frequency control

STATUS:

First production set delivered in 1963.

Ten sets already in service in France and a foreign country (Air Defence).

MANUFACTURER:
Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.


Volex III aeriel

INTERNATIONAL

1528.153
RATAC BATTLEFIELD RADAR
DESCRIPTION:
Ratac (Radar de tir pour l'artillerie de campagne) is a lightweight (about 35 kg) battlefield radar providing for detection, acquisition, identification, location and tracking of surface targets such as troops, tanks, vehicles, and low flying helicopters and light aircraft. Other operational functions include artillery direction, surveillance of own forces, and helicopter control. It is comprised of six units and is designed for vehicle mounting. Pulse-doppler, and it is believed, monopulse, techniques are employed, and the operating frequency is in the 5 cm wavelength region. A highly effective fixed target cancellation system is stated to make it possible to locate very slow moving targets with a small radar cross-section, such as a single man. Detection ranges are reported to be 20 km against vehicle targets and 10 km against troops. Good all-weather performance is claimed.

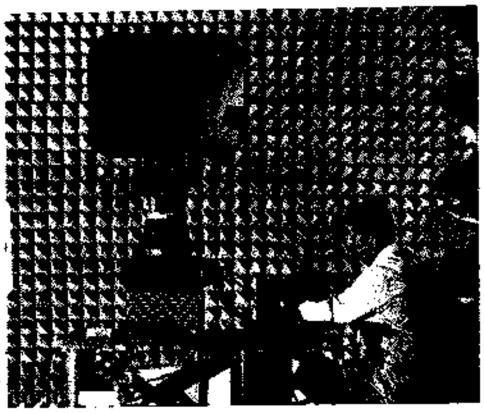
The system incorporates its own computer, and target data can be presented in terms of either polar or grid co-ordinates. An optional plotting-board unit permits target positions and movements to be recorded. A loudspeaker is provided to aid target identification by listening to the doppler characteristics of targets. Automatic target tracking facilities are included, and there are provisions for the transmission of data to own artillery. Operation with vehicle installed IFF is a possible option.

DEVELOPMENT:
Development of Ratac was undertaken by LCT (Laboratoire Central de Telecommunications) under the direction of the French military authority, in 1966. A subsequent agreement between the French and West German Governments provided for joint procurement and production for the armies of both countries. Tests were later carried out by the US Army at Fort Sill.


Ratac radar development installation mounted on M-113

STATUS:
Production in quantity had been commenced by 1972 in French and German companies of the ITT organisation, LMT and SEL, respectively. In May 1972 it was stated that large quantities have been ordered by France, West Germany and the USA. Production for the last of these three is probably being undertaken by the Gilfillan subsidiary of ITT.

MANUFACTURERS:
Le Materiél Téléphonique, 46, quai A. Le Gallo, 92-Boulogne-Billancourt, France.
Standard Elektrik Lorenz AG, 7 Stuttgart 40, Hellmuth-Hirthstrasse 42, West Germany.


Ratac antenna under laboratory test

ITALY

2291.153
INDIGO FIRE CONTROL CENTRE (CT40-GM)
DESCRIPTION:
The CT40-GM is the Italian-built radar and command system based on the Swiss Superfledermaus (**2376.151**) and used with the Indigo surface-to-air missile system (**2235.181**).

As can be seen the system comprises a tracking radar, an infra-red tracker (the white device mounted to the right of the radar aerial) and a command transmitter (the small dark aerial below the infra-red tracker) all mounted on the tracking pedestal.

In the equipment bay in the trailer and protectable by a screen (folded back) are the missile control panel (the lowest of the stack of four units to the left of centre) and the engagement computer display oscilloscope.

MANUFACTURER:
Contraves Italiana SpA, Via Tiburtina, 965-00156 Rome, Italy.

1529.153
LPD-20 SEARCH RADAR

DESCRIPTION:

The LPD-20 is a search and acquisition radar intended for use as a "gap-filler", to counter air threats from low and very low level targets in the region below the useful coverage of other radars. It was developed for use as an autonomous search unit, and it can also be readily fitted into the Contraves Superfledermaus family of fire control systems. The simplest arrangement of this kind employs the same PPI as the fire control system, so that the search radar is unattended and a single operator is able to control the complete radar system for both search and tracking of targets. The standard version is a trailer-mounted equipment, but a truck-mounted model has also been developed.

The main parts of the radar are:

(1) a rotating section, comprising antenna, transmitter/receiver, signal processor, and modulator.
(2) turning gear.
(3) a cabin containing power supplies and operational controls, and
(4) trailer chassis.

System weight (trailer version) is 2,500 kg.

The LPD-20 is a fully coherent pulse-doppler radar. An MTI improvement factor of better than 50 dB is claimed, together with a detection range of about 20 km on targets travelling at speeds between 20 and 410 m/sec at heights up to 4,000 m. Angular resolution is of the order of 1.4 degrees and range resolution about 500 m. Rapid reaction to sudden low-level threats is aided by a high data rate, the use of a common PPI for search and fire control system, accurate target range and azimuth designation data, and transfer from search radar to fire control radar in two to three seconds. Provision is made for the incorporation of IFF Mk 10/SIF facilities into the basic LPD-20 radar.

Typical deployment of Super Fledermaus fire control system with LPD-20 radar

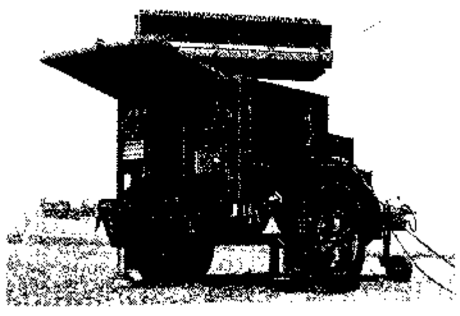
STATUS:

The radar has undergone rigorous field tests in Italy and elsewhere and is now in series production.

Current production of the Superfledermaus fire control system (**2376.151**) incorporates modifications to enable it to be associated with the LPD-20.

MANUFACTURER:

Contraves Italiana SpA, Via Tiburtina, 965-Roma, Italy.



Contraves LPD-20 search and acquisition radar

2243.153
RAT-6L SHORT-RANGE LOW ALTITUDE COVERAGE RADAR

DESCRIPTION:

RAT-6L is a short-range acquisition radar operating in L-band. It has been designed primarily for AA target acquisition for tactical weapon systems and is particularly suitable for operation in a mountainous environment.

A solid-state, coherent L-band transmitter is used in conjunction with two coherent (COHO-STALO) receiver channels with a quadrature phase detector and a sophisticated digital filtering system. This combination gives an overall clutter cancellation (with the antenna rotating) of 60 dB.

Special features of the system include image frequency rejection, radio frequency agility, pulse compression, limiting and doppler filtering and CFAR circuits.

DEVELOPMENT:

The development of this equipment has formed part of a major programme of work on sophisticated modern radars undertaken by Selenia.

CHARACTERISTICS:

Radio frequency: L Band
Maximum range: (1 sq m target): 20 km
Height coverage: 3,000 m
Range resolution: 450 m
Azimuth resolution: 6 deg
Data rate: 60 rev/min
Clutter cancellation: (antenna rotating): 60 dB

STATUS:

In production. Deliveries expected to start in 1972.

MANUFACTURER:

Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12400, 00131 Rome, Italy.

2282.153
RAT-7S LOW COVERAGE RADAR

DESCRIPTION:

RAT-7S is an S-band radar designed to acquire and engage low flying targets in the presence of heavy and extended clutter.

The radar is composed of a single or dual channel transmitter receiver, and a digital processor, housed in a standard shelter. Radar data are displayed on two digital 16 inch (406 mm) displays, contained in an operational room shelter.

Optionally, the radar can be provided with a semi-automated system for the automatic transmission of filtered air situations to an Air Defence Centre.

Antenna Group

The antenna group consists of a mesh covered reflector, a feed, a turntable with rotary joint, and an optional circular polarizer.

The shaped reflector provides a radiated pattern of 2 degrees in the horizontal plane and cosecant squared in the vertical plane.

The two-channel rotary joint is standard in order to allow integration with IFF aerial. The reflector and feed can be folded during transport.

Transmitter

The transmitter unit contains the high voltage power supply, the modulator and the magnetron.

The magnetron used is tunable, and allows an average output power of approximately 450 W.

The PRF is staggered with an average value of 1,000 pps.

Single knob tuning of the transmitter frequency can be provided in the single channel version, and permits selection by push-button of six preset frequencies.

Receiver

The receiver system is housed in a well shielded cabinet, and contains a solid state parametric amplifier, a constant-false-alarm-rate (CFAR) channel, and a pseudo-non-coherent receiver.

An interference sensor automatically selects the most suitable receiver channel for feeding the radar displays.

The sensor is also used to insert an adaptive circuit to normalise, in the ground clutter area, the pseudo-non-coherent video signal in the presence of interference. In this way, it is possible to achieve simultaneous protection against clutter and intentional jamming.

Digital Processor

To extract moving target information, the video signals are processed in a dual digital canceller which uses integrated MOS memories. Such a digital processor, and in particular the digital MTI and the video integrator, has many advantages, e.g.

- no alignment or adjustment is required
- complete independence of PRF
- greatly improved reliability and maintainability.

Display System

The IDM-7 16-inch (406 mm) digital indicator displays radar and synthetic information. It is driven by a radar central unit or a synthetic central unit, or both.

The digital technique provides an unlimited expansion capability, so that additional units can be added when required.

The RAT 7S can be integrated into an air defence network by means of a semi-automated tracking system. This system can be used to bring filtered air situation data to the attention of higher command by automatic, digital transmission of messages.

The system allows the rate aided manual tracking of 20 radar tracks, and the generation of synthetic symbols and video maps (three IDM-7 displays). It includes a rugged, compact digital computer and associated back up units.

The functions integrated in the system are:

- manual initiation and associated manual tracking
- symbol track and synthetic map visualisation
- operator orders and track ball management
- height measurement
- message formatting and modulators management
- on-line diagnostic

OPTIONS:

Dual Frequency Diversity

RAT-7S can be operated in dual frequency mode to increase the maximum range capability and improve ECCM performance.

Transmitter:
Operating frequency: S-band
Antenna:
Dimensions: 380 × 220 mm
3 dB horizontal beamwidth: 2°
Vertical pattern: cosecant squared up to 40°
Gain: 32 dB
Rotation: 10 and 20 rpm
Transmitter:
Type: tunable magnetron
Average power: 450 W

Pulse width: 1 sec
PRF: 1,000 pps staggered
Receiver:
Noise figure: 4.5 dB
MTI receiver: pseudo-non coho/non-coho with digital cancellers
MTI improvement factor on ground clutter: better than 40 dB
CFAR receiver
IDM-7 Display:
CRT: 16" electrostatic focus and electromagnetic deflection
Resolution: 1,000 lines/diameter
Linearity: 22% of diameter
Power requirements: Three phase, 220/380V, 50 Hz power, 9 KVA single channel, 14KVA dual channel
Environmental conditions:
Temperature range (operating): 0° to +50°C (indoor units) – 20° to + 70°C (outdoor units)
Wind: 60 Kts (operating; 100 Kts (not operating)
MANUFACTURER:
Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12,400, 00131 Rome, Italy.

2237.153
RAT-10S COASTAL SURVEILLANCE RADAR

DESCRIPTION:

The RAT-10S is an S-band radar designed for surveillance of the surface of the sea and of the air space above it up to 3,000 metres. Continuous scanning in azimuth is possible and, for coastal defence operations, sector scanning is also available.

The antenna features extremely low side lobes, which is of extreme importance in a coastal installation when the radar is normally flanked by rugged terrain. The antenna unit is constructed of light alloy and the reflector employs slats for the reflecting surface to reduce weight and wind resistance. The RF generator is a tunable magnetron and the receiver uses a parametric amplifier. A number of countermeasures are added to the basic receiver processing circuitry and the most suitable ECCM circuit is selected automatically. With the exception of a few special tubes solid-state circuitry is used throughout.

The radar set contains a monitoring tube for checking waveforms. Built-in cabling and wandering leads permit rapid checking of significant waveforms. A performance monitor is also available.

Electronic equipment is housed in three compact cabinets (transmitter, receiver and antenna servo control), whilst the entire antenna group is capable of being fitted into a 34 feet diameter radome.

Two PPIs and an "A" type indicator are provided as standard.

DEVELOPMENT:

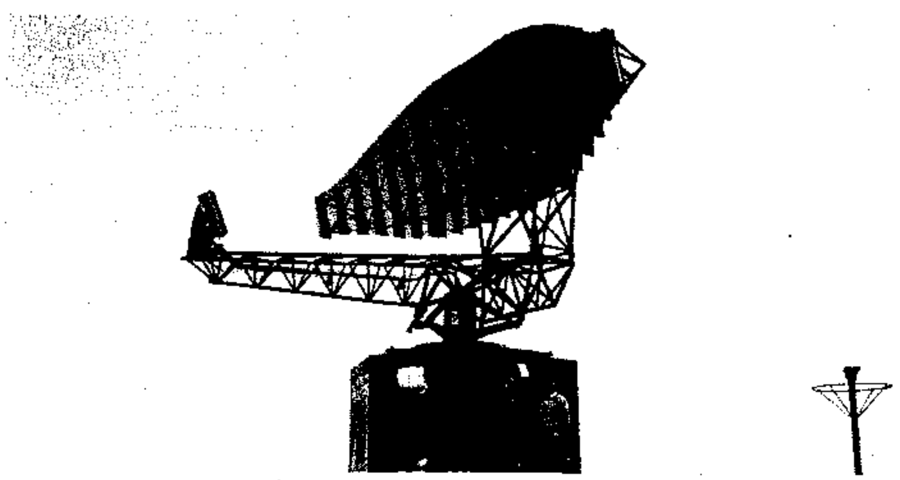
Independent development was started in 1966 and successive modifications have been introduced on account of differing operational requirements. As a result, several optional variants are available to give optimum performance in a particular environment and operational role.

STATUS:

The radar is in production and is in service with coastal radar stations in many countries.

MANUFACTURER:

Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12,400, 00131 Rome, Italy.



Argos RAT 10S Coastal Surveillance Radar

2281.153
RAT-20L LONG-RANGE SURVEILLANCE RADAR

DESCRIPTION:

RAT-20L is an L-band search radar specifically designed for long range surveillance in the presence of heavy clutter in an ECM environment. In order to counteract clutter and ECM disturbances, the radar transmits code modulated pulses.

Particular attention has been paid to choice of the transmitter waveform in order to obtain good anti-clutter and anti-chaff performance even when using frequency agility. The use of frequency agility also contributes, by its ECCM ability, to improving performance. Furthermore, it is possible to achieve good anti-clutter performance by use of the phase-quadrature MTI and frequency agility every "n" pulses. In all cases, regardless of the ECM, clutter, chaff or rain combination encountered, the output processed video is CFAR.

The radar incorporates primary and secondary video extractor.

Aerial

RAT-20L can be fitted with two antennas (see also entry **2248.153**):

G-7 antenna for medium range application or for transportable version.

High gain G-14 antenna for long-range capability in fixed installation.

The antennas are equipped with double-horns for enhancing ground clutter and angle rejection. Circular polarisation is employed for improved weather clutter protection.

Transmitter

The transmitter employs a coherent chain with solid state crystal controlled driver and programmer.

Receiver

The receiver features a solid state RF amplifier and two IF amplifiers. The digital processor is all solid state and employs a phase-quadrature MTI, a coherent limiter and code-matched filter techniques.

CHARACTERISTICS.

Coverage: in excess of 200 nm on 2 sq m. target with Pd = 80% and Pfo = 10-6
Antenna gain (G-14): 36 dB
3 dB beamwidth: azimuth 1.2°, elevation 4° cosecant squared up to 40°
Data rate: 6 rev/min
Peak power: 150 kW
Improvement factor: 36 dB

STATUS:

Prototype tested.

MANUFACTURERER:

Selenia Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12,400, 00131 Rome, Italy.

2280.153
RAT-21C LOW-ALTITUDE SURVEILLANCE RADAR

DESCRIPTION:

RAT-21C is a C-band high power search radar designed to detect low-flying targets in heavy clutter environments. It can be used either as an autonomous radar station or as a gap-filler linked to an air defence centre.

Use of C-band makes possible an antenna system with limited weights and dimensions and good angular resolution. It also allows the lobing effect in the presence of flat reflecting surfaces to be avoided.

RAT-21C has been designed to meet the following operational requirements:

range and height coverage of approximately 90 nm and 3,000 m on a modern fighter;
very good low angle detection of targets over heavy clutter areas;
ability to provide accurate acquisition data;
dual channel transmitter and receiver;
advanced ECCM facilities including frequency agility;
installation in standard shelter;
ease of operation and maintenance.

STATUS:

Prototype tested.

MANUFACTURER:

Selenia Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12,400, 00131 Rome, Italy.

2244.153
RIS-3E MONOPULSE TRACKING RADAR

DESCRIPTION:

The RIS-3E is a monopulse radar of the amplitude comparison type: tracking errors are obtained from information provided by a single pulse, so that conical scanning of the antenna by feed rotation is unnecessary. Apart from the inherent precision of monopulse, the absence of rotating parts guarantees a high precision and stability both in feed positioning and also in the antenna boresight axis alignment. The hydraulic servo system gives a particularly smooth tracking characteristic, allowing the radar to track a great variety of targets, ranging from earth satellites to missiles. Controls and monitoring instruments for the complete system are located in the operating console. In this way the operator can easily monitor the correct functioning of the apparatus and observe the signals displayed on the CRT. Acquisition of a target is initiated by making use of target coordinate data supplied either by other radars or by an optical director. As an alternative method, the radar can search for the target by scanning in both angular axes.

Upon acquisition of the target, either automatically or with hand control, the automatic tracking mode is initiated. Special "coast" circuits provide for velocity memory in order that smooth tracking can be achieved even during particularly unfavourable conditions such as when target fading occurs. The operator can select either skin or beacon tracking, without even momentary loss of the target, even during tracking. The beacon can be interrogated by a pulse position code, so that the same target can be illuminated simultaneously by several radars without the possibility of a false reply from the beacon.

CHARACTERISTICS:

RIS-3E Characteristics:

Antenna:

Reflector diameter: 3.6 metres

Gain (one way): 42 dB

Transmitter:

Frequency tunable: 5,450-5,825 MHz

Magnetron power output: 250 kW peak

Pulse width: 0.5 or 2 microsecs

Code: 2 pulses, 0.5 microsecs duration with 2 microsecs minimum separation

Pulse repetition frequency: 1,640 or 410 Hz

Receiver:

Tuning range: 5,400-5,900 MHz

Noise figure: 10 dB

IF bandwidth: 4 or 0.8 MHz

Antenna Rotation:

Azimuth Coverage: 360° continuous

Elevation Coverage: −10°, +190°

Max angular speed (both axes): 45°/sec

Range gate performance:

Coverage: Up to 350 km

Max speed: 18,000 m/sec

Tracking capabilities:

Max range-tracking rate: 6,000 m/sec

Max range-tracking acceleration: 20 kg

Max angle-tracking rate: 30°/sec

Max angle-tracking acceleration: 20 kg

System performance:

Max angular error: 0.2 mil

Max range error: 3 metres

Environmental conditions:

Ambient temperature (outdoor units): −15°C to +50°C

Ambient temperature (indoor units): 0° to 50°C

Wind load (not operating): 150 km/h (82 knots)

Power requirements:

Supply voltage: 220/380V ± 2%, 50 or 60 Hz

Power drain: 30 kVA

STATUS:

Production.

MANUFACTURER:

Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12,400, Rome, Italy.

2245.153

RIS-4C/A TRACKING RADAR

DESCRIPTION:

The Selenia RIS-4C/A is a C-band pulsed instrumentation tracking radar, for automatic tracking of active and passive targets. Circuits are nearly completely transistorised.

Its principal employment is at missile and space test ranges where precise trajectory mapping is required. Features are included in the design and construction which give the radar those operational characteristics required for high precision tracking of fast targets, and for recording and display of their trajectories.

The RIS-4C/A is a conical scan radar. The deviation of the radiated beam is obtained by rotating the subreflector which is mounted slightly offset' in a Cassegrain antenna geometry. The range tracking system is digital, thus avoiding the use of electro-mechanical components. This results in a good dynamic response and virtually eliminates the need for frequent calibration.

The angle servo system, which is one of the Ward Leonard type with silicon controlled rectifier driving circuits, gives a smooth tracking characteristic over a wide range of angular velocities of the antenna axes, thus enabling the radar to track with great accuracy a wide variety of targets ranging from earth satellites to missiles.

Controls and monitoring instruments for the complete system are located in the operating console. This arrangement allows the operator to monitor the correct functioning of the apparatus and simultaneously observe the signals displayed on the CRTs.

Acquisition of the target is initiated by making use of target co-ordinate data supplied by other radars, by a computer or by an optical director. As an alternative method, the radar can search for the target by scanning about a given position in space. After acquisition of the target either automatically or in manual control, the automatic tracking mode is initiated.

Special "coast" circuits provide for velocity memory, so that smooth tracking is ensured even during particularly unfavourable conditions such as when target fading occurs.

The operator can select either a skin or a beacon tracking mode, without momentary loss of the target, even during tracking. The skin and beacon return signals are displayed on two separate CRT's with "A" and "R" presentations. Since a hard tube modulator is used, the beacon can be interrogated by a pulse position code so that the same target can be illuminated simultaneously by several radars without the possibility of a false reply from the beacon.

Whilst range data is directly available from the range tracking unit in digital form, angle data is digitised by means of encoders. This output data is in the most suitable form for processing, either locally or for transmission to a remote site. A digital computer can be incorporated in the system for data handling for recording and/or co-ordinate conversion into cartesian form to display target trajectories on plotting boards.

ANTENNA SYSTEM:

Reflector. The system employs Cassegrain geometry with one horn feed, placed at the centre of the parabolic reflector, and a hyperbolic subreflector. The subreflector is rotated by a motor to perform the conical scan of the beam; the generator of the reference signal is coaxial with the motor. The assembly is carefully balanced for vibration-free rotation. The pencil-beam pattern has a beamwidth of 1.25° for good angular resolution. The polarisation of the radiation can be vertical, horizontal or circular, CW or CCW, selectable by the operator.

Pedestal. Backlash eccentricity and errors due to mechanical and thermal deformation have been reduced to negligible values. Facilities are incorporated for the adjustment and optimisation of levelling and of the orthogonality of the azimuth to the elevation axis.

Antenna Rotation. The antenna system is of the elevation-over-azimuth type. The performance of the servo system allows rotation of both antenna axes at very high speed and acceleration, and the low speed performance is extremely stable. The servo system has an inherently wide dynamic range and two separate Ward Leonard groups are used for the two rotation axes in order to avoid any dynamic cross interference.

TRANSMITTER:

Hard Tube Modulator. A hard tube modulator-transmitter has been used in the RIS-4C/A to provide good stability in pulse timing, duration and shape, thereby assuring a high intrinsic accuracy for the range measuring system. Such a modulator also gives the possibility of radiating at a high PRF to track targets unambiguously out to 1,280 km using an nth-time-round system.

Modes of Operation. The transmitter is able to radiate RF pulses of 1.0 microsecond duration for normal tracking of passive targets. The use of a hard tube type of modulator also makes possible the generation of pulse trains, and this advantage is used to provide a beacon interrogation mode of operation. In this mode, the transmitter sends out two pulses, each of 0.5 microsecond duration, and having a spacing which is continuously variable between 2 and 10 microseconds. Four different PRF values are possible in order to solve the ambiguities resulting from the nth-time-round returns. After acquisition of the target the ambiguities are solved automatically.

Magnetron. The standard transmitter uses a 250 kW tunable magnetron (type RK 7156) which gives the flexibility of operating the radar at the most convenient frequency, and also of interrogating a beacon whose receiver frequency falls within its tuning range. Forced-air cooling is provided for the magnetron and other power tubes.

A 1 MW transmitter is also available (optional) to improve the overall system performance. A convenient soft tube modulator can be provided if the beacon code interrogation mode is not required.

RECEIVER:

A dual channel receiver is provided for the simultaneous reception and display of skin and beacon returns. The klystron local oscillators are duplicated so that tuning of the two receivers at different frequencies is possible. Both the skin and beacon loops are provided with AFC and a special drift-free circuit is used in the beacon channel for a positive tuning of the receiver even when the beacon signal is not present and the loop is open.

The skin signal receiver incorporates a parametric amplifier for high sensitivity and tracking accuracy. STC for attenuation of strong close echoes, and FTC for echo discrimination are provided.

TRACKING SYSTEM:

Range tracking is achieved by employing a completely digital technique, thus removing any rotating part, or electromechanical components and enhancing accuracy, dynamic response and reliability. Additionally, range data is directly available in digital form for processing.

Targets moving with velocities up to 10,000 m/sec and with accelerations up to 50 g, can be tracked. Actual tests on static targets yield accuracies in range measurement of better than 2 metres and angle measurement of better than 0.15 mil.

Angular tracking is performed through a Ward-Leonard servo system which allows angular speed up to 35°/sec and angular accelerations up to 30°/sec².

DATA OUTPUT:

Target co-ordinates are displayed in digital form on the master console, right above the CRTs so that the operator has all the elements necessary for monitoring the tracking.

Angle data is available in analogue form, from coarse-fine synchros, and in digital form from encoders. Range data is available in analogue form as d.c. voltage increasing linearly with range. Digital range data is supplied by the tracking unit.

Range and angular automatic tracking error voltages are available in d.c. form, together with AGC voltage and other analogue data relative to the radar status.

DATA PROCESSING AND DISPLAY.

Tracking data is processed by a digital computer to organise it in suitable form for recording on magnetic or paper tape. In this way, a permanent record for trajectory reconstruction is obtained.

Simultaneously, spherical co-ordinates are converted and the target trajectory is displayed on one or more two-pen plotting boards in cartesian co-ordinates.

STATUS.

Production.

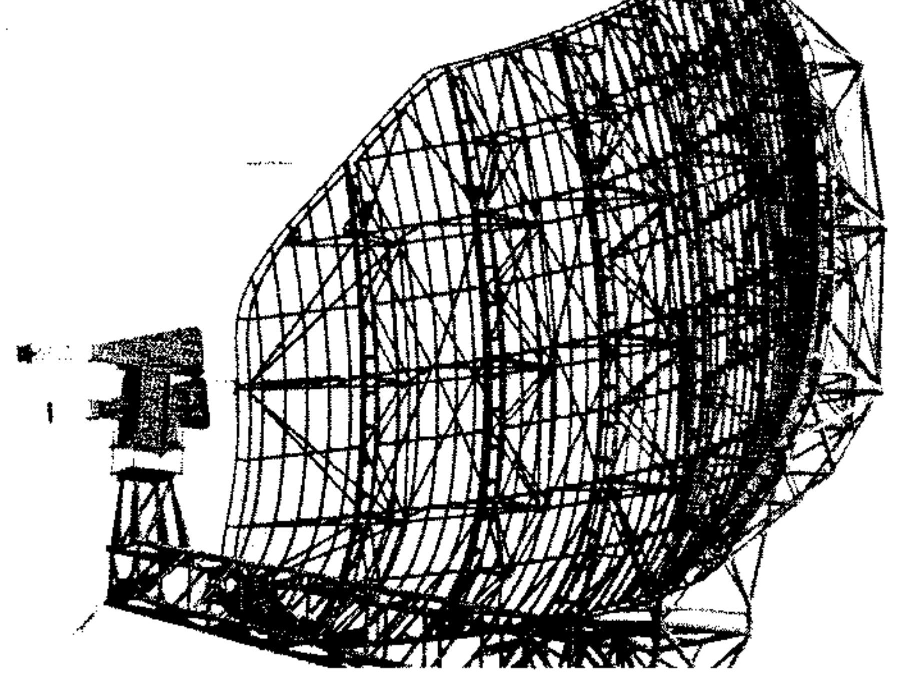
MANUFACTURER.

Selenia Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12,400, Rome, Italy.

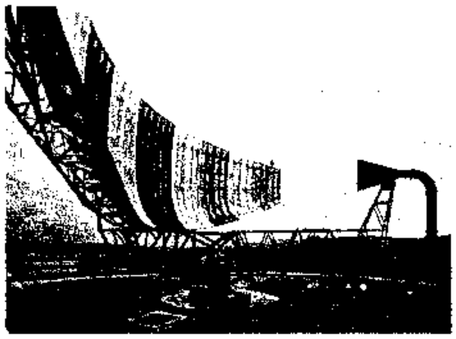
2246.153
RIS-5X DRONE TRACKING RADAR
DESCRIPTION:
RIS-5X is a radar specifically designed for tracking drones for the purpose of controlling them when they are out of sight. It is capable of automatically tracking such a drone, either by skin tracking or by beacon tracking up to a maximum range of 274 km.
The projection of the drone trajectory in the horizontal plane is traced on a plotting board which has a selection of range scales which can be chosen for accuracy or convenience as required. The height of the drone is presented to the operator on a coarse-fine dial system, the coarse dial having a maximum reading of 108,000 feet (about 33,000 metres) and the fine dial reading 3,000 feet (about 914 metres) per revolution.
CHARACTERISTICS:
Antenna unit:
Reflector paraboloid: 2 m dia
Gain: 40 dB min
Transmitter:
Output peak power: 2.00 kW ± 10%
Frequency: 9,375 ± 30 MHz
Pulse length: 0.5 and 3.0 microsec ± 10%
Pulse repetition frequency: 1,200 and 240 Hz ± 10%
Receiver:
Noise figure (skin and beacon): 10 dB (when skin tracking, beacon receiver NF is 24 dB approximately
IF bandwidth: 0.65 and 4.0 MHz ± 20% (skin) 7 MHz (beacon) approx
AVC (skin only): FTC and STC
Characteristic: linear or logarithmic (switchable)
Display console:
Max beacon delay: adj: 0.35 microsecs
PPI, RHI, REI presentations ranges: 10-20-50 100-250 nm
RHI presentation: height scale from 0 to 10 nm
A/R scope: sweep lengths 4, 20 and 250 nm
Data presentation unit:
Slant range: Coarse 0 to 300,000 yds fine 0 to 10,000 yds (approx 274 km and 9.14 km)
Ground range: Coarse 0 to 300,000 yds fine 0 to 10,000 yds
Elevation: Coarse −20° to 100° fine 0 to 10°
Azimuth: Coarse 0 to 360° fine 0 to 10°
Height: Coarse 0 to 108,000 ft fine 0 to 3,000 ft
Plotting board:
Paper size: 30 × 30 inches (762 × 762 mm)
Range scales: 30,000, 60,000 and 300,000 yds (approx 27, 55 and 274 km)
Trace accuracy: Better than 0.02 inch (0.5 mm)'

Tracking performance:
Max range velocity: 1,000 m/sec
Max angle speed: 20°/sec
Range error: 20 m
Angle error: 0.05°
STATUS:
In production.
MANUFACTURER:
Selenia Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12.400, Rome, Italy.

2248.153
SELENIA CIVIL/MILITARY ATC RADARS
The Selenia series of Air Traffic Control radars comprises three basic equipments:
—The ATCR-2T a high power L-band radar
—The ATCR-3T a medium power S-band radar
—The ATCR-4T a medium power L-band radar.
All three equipments can be furnished in single or dual channel configurations, with frequency diversity if desired, are fully solid state and use dentical Digital Processors which include digital MTI-video integrators. The range was introduced in 1968.
ATCR-2T
ATCR-2T is a 23 cm L-band high power radar. Full use has been made of the latest advances in micrologics and integrated circuits. Two antennae are available, the G-7 and the G-14, both having dual beams with switchable linear to circular polarisation. The G-14 is designed to give extra long-range where this is a requirement.
The radar can be supplied either in single channel version or the dual channel configuration in which case it can be operated in diversity or use the second transmitter as a hot stand-by.
A tunable vapour cooled magnetron with a peak power of 1.8 MW is employed and the P.R.F. is triple staggered to give a first true blind speed well outside the speed capabilities of modern aircraft. High stability of the transmitted pulses is achieved by transistorisation of the modulator circuits and the regulated EHV supply.
The receiver has a broadband parametric amplifier using a solid state pump oscillator, resulting in a low noise figure. A digital processor is included which incorporates a fully digital double canceller MTI and video integrator resulting in a high improvement factor and a clean PPI display.
A clutter mapper is also provided: this device defines areas in which MTI video is desired by switching out normal radar video in the presence of clutter, but in other areas raw video is automatically displayed. A video correlator eliminates "second time round" echoes and rejects non synchronous returns and noise.
Provision for on-mounting SSR is standard and the antenna has a triple channel rotating joint.
The ATCR-2T can be controlled and checked out remotely. A performance monitor continuously monitors noise figure, transmitted and received power. Alarms are initiated (remotely, if required) when these pass a preset threshold.
CHARACTERISTICS:
G-14 Antenna:
Main Beam:
3 dB horizontal beamwidth: 1.2° ± 0.12°
3 dB vertical beamwidth: 4°
Vertical pattern: Cosecant squared up to more than 40°
Antenna gain: 36 dB
Sidelobe levels: −26 dB
Integrated cancellation ratio: 25 dB
Auxiliary Beam:
3 dB horizontal beamwidth: 1.25° ± 0.15°


The G-14 Antenna of the Selenia ATCR-2T and ATCR-4T radars

3 dB vertical beamwidth: 4° ± 0.4°
Antenna gain: 35 dB
Sidelobe levels: −25 dB
G-7 Antenna:
Main Beam:
3 dB horizontal beamwidth: 1.25° ± 0.15°
3 dB vertical beamwidth: 7.5° ± 1°
Vertical pattern: Modified cosecant squared with added high angle coverage
Antenna gain: 32.5 dB
Sidelobe levels: −23 dB
Integrated cancellation ratio: 20 dB
Auxiliary Beam:
3 dB horizontal beamwidth: 1.3° ± 0.3°
3 dB vertical beamwidth: 7.5° ± 1°
Antenna gain: 31 dB
Sidelobe levels: −22 dB
Squint angle between main and auxiliary beam: 8°
Antenna tilt: +1° to +6°, manually adjusted
Antenna Group:
Operating frequency: 1,250 to 1,350 MHz
Polarisation: Horizontal and circular (switchable)
Turning rate: Standard turning rates are 5 and 10 rev/min or 6 and 12 rev/min (other speeds are available)
Transmitter:
Magnetron (vapour cooled): M5051 (1,205 to 1,310 MHz) or M5052 (1,305 to 1,355 MHz)
Peak power: 1.8 MW


The G-7 antenna

Average power: 2,300 W
PRF (average): 300 to 800 Hz
Receiver DMTI:
Parametric amplifier:
Bandwidth: 1,250 1,355 MHz
Noise figure: 2.5 dB
Dynamic range: 1 dB compression at − 30 dBM
Preselector filter:
Bandwidth: 7 ± 1.5 MHz
Image rejection: 60 dB
IF centre frequency: 30 ± 0.5 MHz
Receiver features: AFC, STC, DMTI, video integration, video correlation, and clutter mapper
DMTI: Coherent, dual canceller with selectable

feedback using asynchronous memory
Cancellation ratio (rack): 40 dB
Overall cancellation ratio: 33 dB
Environmental conditions:
Indoor units:
Operating temperature: 0° to 50°C
Antenna group:
Operating temperature: —40° to +70°C
Wind load: 110 knots – G-7 antenna, the G-14 is designed to operate under a radome

ATCR-3T

This equipment is an S-band 10 cm medium power radar suitable for approach or GCA surveillance.

The aerial turns at 7.5/15 rev/min (switchable) or if desired at 10/20 rev/min (switchable). With the aerial turning at 15 rev/min and with the transmitter operating at 1,000 pps the coverage achieved on a small jet aircraft with the single channel ATCR-3T is about 45 nautical miles and over 6,000 metres. Short range low cover properties make the radar extremely suitable for fighter recovery

CHARACTERISTICS:
Antenna group:
3 dB horizontal beamwidth: 1.5 + 0.15°
3 dB vertical beamwidth: About 5°
Vertical pattern: Modified cosecant squared with added high angle coverage
Antenna gain: 33 dB
Sidelobe levels: —26 dB
Polarisation: Horizontal and circular (switchable)
Integrated cancellation ratio: 20 dB typical
Antenna tilt: —2° to +8°, manually adjusted
Turning rate: 7.5 and 15 rev/min (switchable)
Rotary joint: 2 RF channels
Transmitter:
Magnetron (air cooled): RK 5586
Tuning range: 2,700 to 2,900 MHz
Peak power: Up to 800 kW
Average power: 450 W
PRF: Up to 1,000 Hz
Receiver-DMTI:
Parametric amplifier:
Bandwidth: 2,700 to 2,900 MHz
Noise figure: 3 dB maximum
Preselected filter:
Bandwidth: 20 + 4 MHz
Image rejection: 50 dB
IF centre frequency: 30 + 0.5 MHz
Receiver features and DMTI: As for ATCR-2T
Over-all cancellation ratio: 30 dB
Environmental conditions:
Indoor units: Operating temperature 0° to 50°C
Antenna Group:
Operating temperature: —30° to +50°C
Wind load: Up to 130 km/h (turning at 15 rev/min)

ATCR-4T

This radar is a medium-powered version of the ATCR-2T employing a peak power of 500 kW and is especially suitable as an approach radar or for GCA surveillance. Either the G-7 or the G-14 antenna can be utilised according to operational requirements.

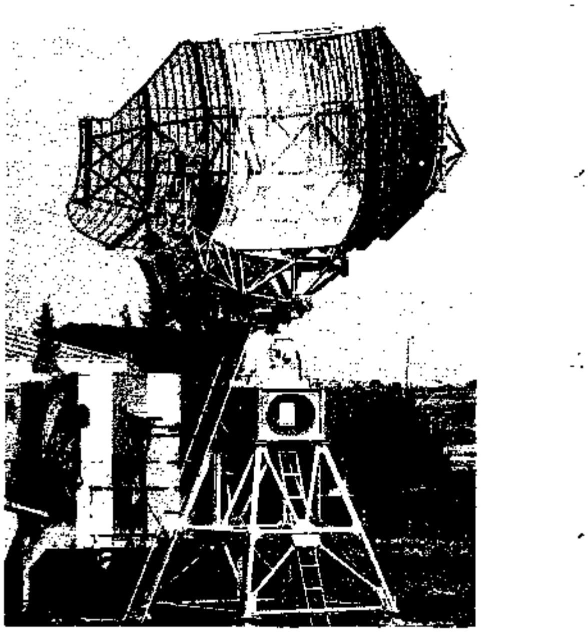
With the antenna rotating at 15 rev/min the range coverage of the ATCR-4T on a small jet aircraft is over 60 nautical miles in single channel, with a height coverage of over 9,000 metres. In dual diversity the range coverage on a small jet aircraft is over 75 nautical miles, with a height coverage of over 12,000 metres.

In its normal version, the radar has a PRF of 1,000 pps with a pulse width of 1 microsecond, giving an average power output of 500 W. The pulsed magnetron is tunable over the frequency band 1280-1350 MHz.

The receiver/MTI chain is identical to that of the ACTR-2T and features the same digital processor resulting in a system which is flexible, reliable and easier to maintain.

The shape of the MTI velocity response curve can be varied whilst the radar is operating. This allows the operator to control the MTI response to slowly moving targets such as cars, birds, small aircraft etc.

As with the ATCR-2T, a clutter mapper is provided to delineate segments in which MTI video is desired; in all other segments the video is normal. Video correlator and video integrator are also identical to those of the higher powered radar.



The Selenia ATCR-3T radar

CHARACTERISTICS:
Antennae: As for ATCR-2T
Transmitter:
Magnetron (air cooled): 5J26
Tuning range: 1,280-1,350 MHz
Peak power: 0.5 MW
Average power: 500 W
PRF: Up to 1,000 Hz
Receiver-DMTI: As for ATCR-2T
Environmental conditions: As for ATCR-2T

STATUS:
All three radars are in current production. The ATCR-2T was developed in 1969-70 as a result of orders from the Swedish Air Force and Telecommunications Board.

MANUFACTURER:
Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina Km 12,400, Rome, Italy.

2249.153
SENTINEL RQT-9X PORTABLE INFANTRY RADAR

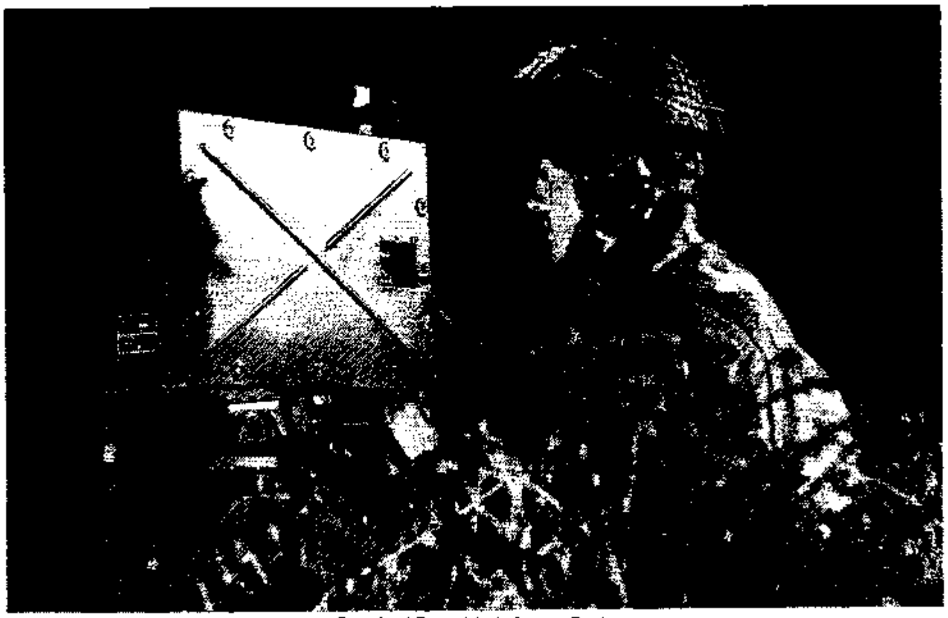
DESCRIPTION:
The Sentinel RQT-9X is a lightweight, man-portable battlefield surveillance radar. It provides instantaneous detection and location of any moving target at ranges from zero up to 3.8 km.

The radar design, with the exception of the transmitting tube, is all solid state and is based upon the technique of transmitting a continuous wave radiofrequency signal for search in azimuth (Surveillance Mode) and a continuous wave with 0-180° phase modulation according to a pseudo-random code for ranging (Ranging Mode). In both cases frequency modulation of the transmitted signal is added to achieve better performance. Change over from Surveillance to Ranging Mode is obtained simply by operating a switch.

In the Surveillance Mode the radar receives all targets within the range coverage of the equipment and therefore provides panoramic surveillance of the ground. The presence of moving targets, such as single men, troops, vehicles, etc is given to the operator by a warning sound signal. Its intensity, pitch and rhythm enable the operator to identify the type of the detected target.

In the Ranging Mode the radar receives only target echoes present in the selected range gate and is able to measure the range. To that purpose the range knob is operated until a signal is heard in the earphone. By the use of the "pseudo-random" code, the acoustic signal of the target echo has a very sharp peak and the operator is able to obtain an accurate range measurement.

DEVELOPMENT:
Started in 1962 on behalf of the Italian Army. In 1966 the equipment was successfully tested by the NATO M.O. and is now in general operational use.



Sentinel Portable Infantry Radar

CHARACTERISTICS:
Antenna System:
Polarisation: Vertical
Azimuth beamwidth (3 dB): 4°
Elevation beamwidth (3 dB): 12°
Gain: 26 dB
Transmitter:
Klystron: VA 210 B modified
Power output: 40 mW
Type of emission: CW-FM with 0-180° phase modulation by a pseudo-random code
Code element width: 0.4 microsec
Receiver:
Noise figure: 16 dB
Display: Aural
Detection frequency bandwidth: 50-1,530 Hz

STATUS:
The equipment was type approved by the Italian Army in 1970. It is in service with the Italian infantry and has been supplied to the armies of other countries.

MANUFACTURER:
Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12,400, Rome, Italy.

JAPAN

2297.153
AIR TRAFFIC CONTROL RADARS

DESCRIPTION:

A range of radars covering most aspects of civil aircraft movement is made by the Nippon Electric Company Ltd. These radars are made primarily to comply with ICAO and other civil aviation specifications: however, some of them have been supplied to the Japanese Defence Agency (JDA) and these are briefly described below.

Airport Surveillance Radar (ASR)

S-band surveillance radar for use in terminal area air traffic control. Two versions exist – the NPG-360 which has a range of 60 nm on small commercial aircraft and the NPG-460 which has a range of 80 nm on a jet fighter. About 20 dual installations of one or other or both of these radars have been supplied to the JDA. Both radars have beam widths of 1.2°, data renewal rates of 15 rev/min and digital MTI. NPG-310 has a 500 kw transmitter and a transistor RF amplifier giving an over-all noise figure of 6 dB; NPG-460 has a 3.5 MW transmitter and a parametric amplifier receiver giving a noise figure of only 3 dB.

Precision Approach Radar (PAR)

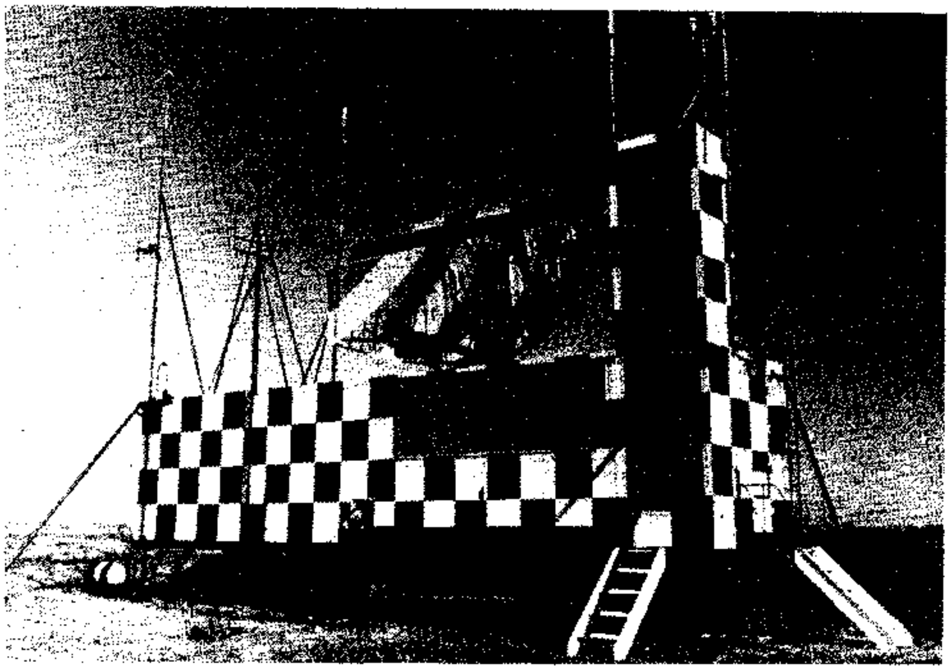
NPG-435 is a precision approach radar which has been deliberately built to a standard above the ICAO requirement so that it can be used on fighter airfields. Detection range is more than 10 nm. A dozen dual installations have been supplied to the JDA.

Secondary Surveillance Radar (SSR/SIF)

NPG-542 is a complete ICAO-specification SSR system with interrogator/responsor decoder and deprinter and with SIF capability. About fifty of these systems have been supplied to the Japanese military and civil aviation authorities.

Ground Controlled Approach Radar (GCA)

NPM-454 is the system number given to an integrated installation comprising ASR, PAR and SSR/SIF elements together with communications sub-systems. The component elements are eventually those described above but slightly reconfigured to suit the integrated installation. The secondary radar aerial is a linear array mounted on the primary radar aerial. Five of these systems have been supplied to the JDA.



NPM-554 mobile GCA system

Automated ATC System

Nippon Electric have developed a sophisticated ATC automation system for the Civil Aviation Bureau (JCAB) and semi-automated air warning and control systems to the JDA. No details are available.

STATUS:

All the above are believed to be operational with the JDA. Two other radars developed by Nippon Electric are the high-power NPG-434 Air Route Surveillance Radar (ARSR), which is believed to have been brought by the JCAB only, and the NPM-510 mobile 3-D radar described in entry **2298.153**.

MANUFACTURER:

Nippon Electric Company Ltd, NEC Building, 33-1, Shiba-Gochome, Minato-ku, Tokyo 108, Japan.

2298.153
MOBILE THREE-DIMENSIONAL RADAR NPM-10

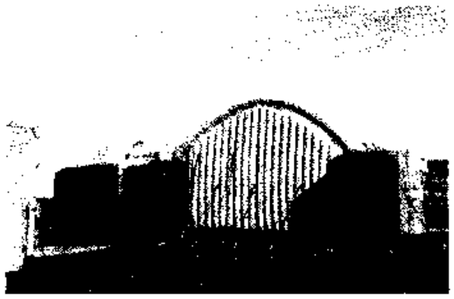
DESCRIPTION:

The NEC NPM-510 three-dimensional radar is a highly mobile equipment with several novel features. Among these may be mentioned the aerial system, which is rotated in azimuth but electronically scanned in elevation and which consists mainly of a planar array that can be folded for transport, and the rapidly erected inflatable equipment shelter.

A compact and light system relying extensively on solid-state technology the radar is also claimed to be highly reliable. Salient features of the circuitry are a CFA transmitter chain, chirp pulse compression, digital MTI and automatic target detection, tracking and altitude computation.

STATUS:

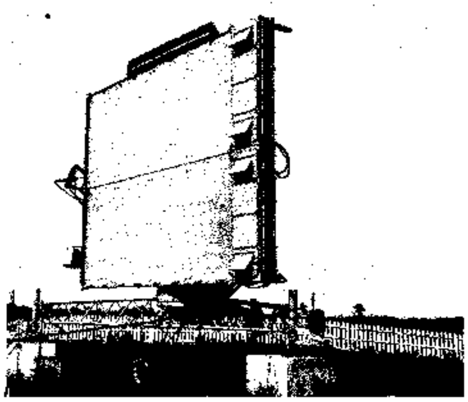
The radar has been supplied to the Japanese Defence Agency but other details are not known.



Inflatable operations centre for the NEC radar

MANUFACTURER:

Nippon Electric Company Ltd, NEC Building, Shiba-Gochome, Minato-ku, Tokyo 108, Japan.



Planar aerial of the NEC mobile 3-D radar

NETHERLANDS

2302.153
INTEGRATED RADAR SYSTEM FOR 35 mm AA TANK

DESCRIPTION:

One of the 35 mm anti-tank tank systems described in Part 1 Section A2b of this book (**2370.131**) contains an integrated radar system designed and manufactured by N.V. Hollandse Signaalapparaten.

The radar system has been designed to detect and identify aircraft at very low to medium altitudes and to track them automatically. It has the following important features:

- integrating all-weather search and tracking systems with a very short reaction time;
- search while tracking through 360°;
- search on the move, with compensation for vehicle's speed;
- good performance in clutter and ECM environment;
- compact rugged design and module concept to facilitate maintenance;
- auto-alarm, alerting the operator when a target is detected outside a preset range.

CHARACTERISTICS:

Antenna System:

Search antenna: Slotted waveguide type

Length: 1.50 metres

Horizontal beamwidth: 1.4°

Vertical beamwidth: 30°

Polarisation: Horizontal or vertical

Rotational Speed: 60 rpm

Tracking antenna: Parabolic with cassegrain reflector and monopulse feedhorn

Diameter: 0.6 m

Beamwidth: 4.2°

Transmitter/Receiver:

Transmitter power: 160 W average

Frequency: X-band

Search channel: MTI with double canceller (digital)

Tracking channel: Pulse doppler

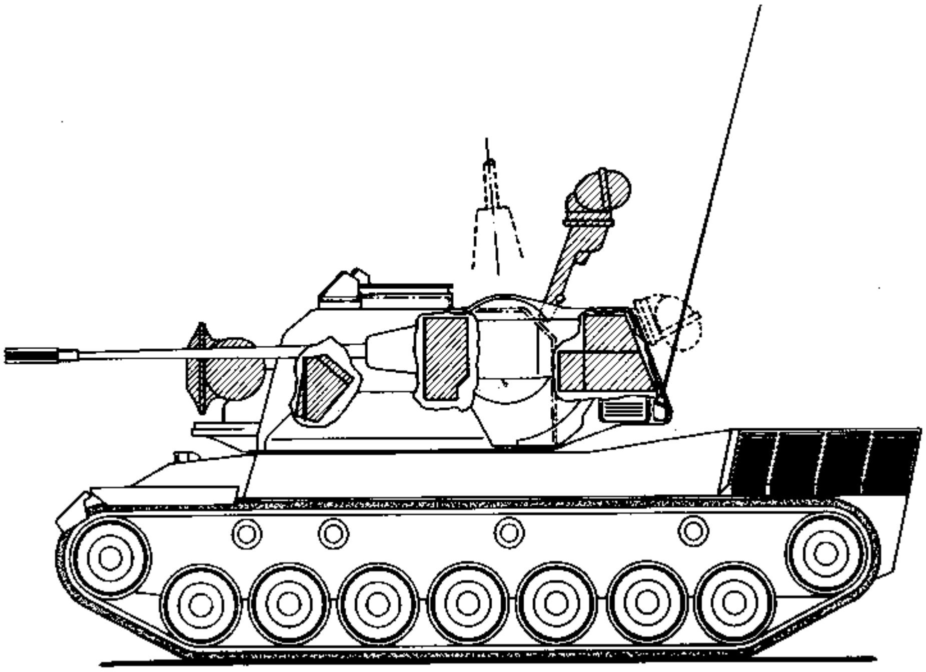
ECCM: Digital video correlator (ISU), pulse-length discriminator (PLD). Passive tracking in X-band, PRF stagger

Noise figures: Search receiver 7 dB, tracking receiver 9 dB

Radar Display and Control Panels:

PPI: Diameter 25 cm, north oriented clutterfree picture, compensated for vehicle's speed. Arrangement of controls to high standard of human engineering. IFF completely integrated

with the search system
Power: Power consumption of the radar equipment: 200 V 380 Hz approx 2 kVA.
MANUFACTURER:
N.V. Hollandse Signaalapparaten, Hengelo, Netherlands.



The disposition of radar system units in the 35 mm AA tank

1557.153
SLAM – SIGNAAL LOW AIR-DEFENCE MODULE

DESCRIPTION:

SLAM is a compact, mobile lightweight forward area air defence radar unit, suitable for either land transport on a two-wheeled trailer or by helicopter airlift. Tactical applications include air target detection and identification, target tracking and designation for low-level air defence; and also surface target detection in the presence of natural clutter and ECM. It is designed for one-man remote operation, and integration into systems for area or point defence, and coastal defence. Provision is made for the incorporation of IFF/SIF, including dipoles embodied in the antenna housing.

The operating frequency is in the X-band, and low-level air search facilities are provided to ranges up to 30 km. Operating features of SLAM include: coherent doppler MTI (digital) with complete clutter elimination; accurate determination of track positions in range and bearing; high resolution; auto-alarm facility to alert operator when a new target is detected. ECCM provisions include: interference suppressions unit, based on video correlation techniques; pulse length discrimination; PRF stagger.

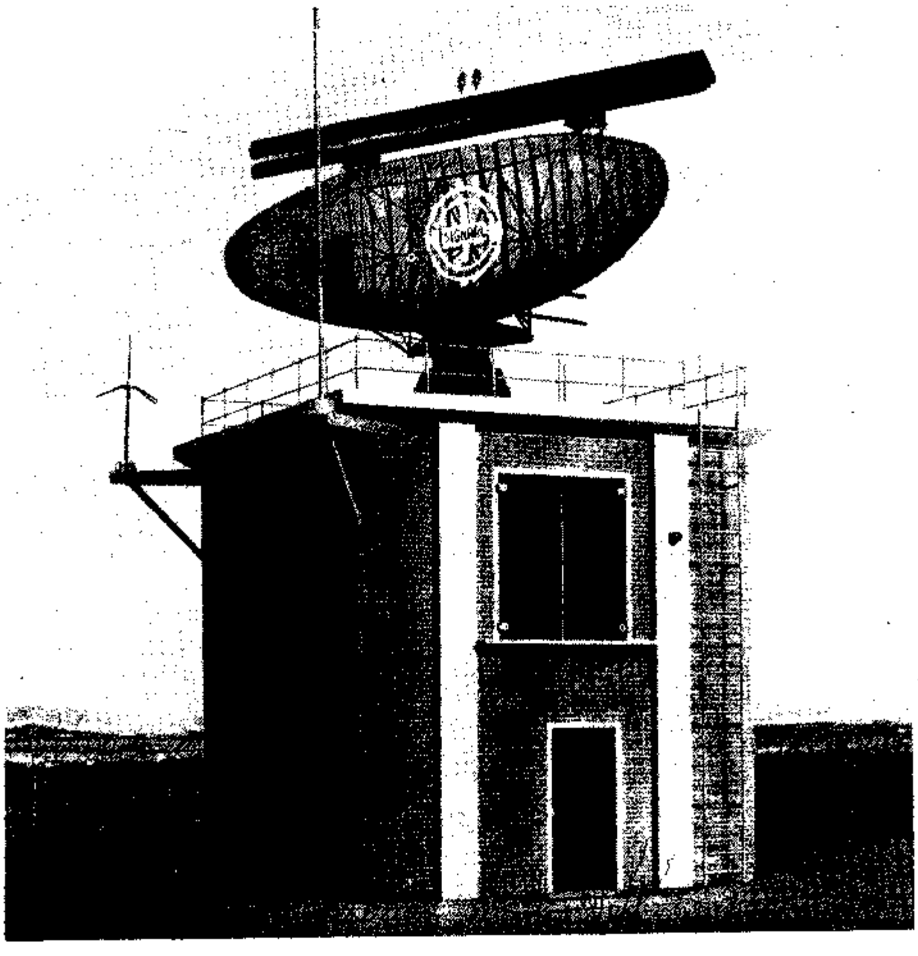
SLAM Specification:
Antenna:
Type: Parabolic cosecant-squared
Span: 1.6 m
Horizontal beamwidth: 1.4 degrees
Vertical beamwidth: 12 degrees
Polarisation: Horizontal
Rotation rate: 40 rpm
Sidelobe level: −22 dB
Resolution: 25 mils - azimuth, 40 m — range
Transmitter/Receiver:
Power: 200 W average
Frequency: X-band
Pulse length: 0.25 microsec
PRF: 4000 pulse/sec, random jumping
Receiver channel: Linear
Receiver noise: 7 dB
Weights:
Basic radar set: 950 kg
Wheeltrain: 450 kg
Total: 1400 kg
MANUFACTURER:
Hollandse Signaalapparaten, Hengelo, Netherlands.

1556.153
STAR – SIGNAAL TERMINAL AREA RADAR

DESCRIPTION:

STAR is an S-band air surveillance radar suitable for airfield and terminal area control applications. The system is available in four configurations: (a) single transmitter – single beam, (b) dual (diversity) transmitter – single beam, (c) single transmitter – high and low cover beams, (d) dual (diversity) transmitter – high and low cover beams. Two rates of rotation are available for the stainless steel scanner, which has provision for an on-mounted secondary surveillance radar antenna. The low-noise receiver incorporates a parametric amplifier, and other features of the system are circular polarisation; digital MTI; logarithmic receiver with FTC; and STC, adjustable in slope and amplitude. Transmitter peak pulse power is 750 kW and the operating frequency band 2,700-2,900 MHz – Pulse length of 0.5 or 2 microseconds are available with PRFs of 1,000 or 250 pulse/sec (staggered) may be used.

MANUFACTURER:
Hollandse Signaalapparaten, Hengelo, Netherlands.



STAR – Signaal Terminal Area Radar installation

POLAND

2340.153
POLISH RADAR

Little information is available on Polish radar developments. It is known, however, that the Industrial Institute of Telecommunications in Warsaw has for many years been working on radar developments and some definite information has been made available on the radars that have been developed for civil ATC purposes.

As an illustration of radar capability, therefore, it may be of interest to note a few details concerning one of these radars, the Avia B L-band airways surveillance radar.

Avia B is a 23 cm wavelength radar using high-power magnetron transmitters and a low-noise parametric amplifier in the receiver. Operating in frequency diversity it has two 1.5 MW peak power transmitters. The parametric amplifier used in the receiver is an original Polish development. The radar has an MTI system, and staggered PRF is used to eliminate blind speeds in the practical range of aircraft performance. The polarisation of the transmitted radiation may be varied from linear to circular.

Maximum range on a 15 sq m target with 90% detection probability is 240 km with a ceiling of 26,000 metres.

AVIA B Characteristics:

Operating frequency: 1,310 and 1,346.2 MHz
Peak Power output: 2 × 15 MW (frequency diversity)
Pulse repetition frequency: 400 Hz mean (recurrence 7:8)
Pulse length: 3 microseconds
Noise Factor: 3.5 dB
Fixed Echo Suppression: 30 dB
Antenna Rotation speeds: 5 or 10 rev/min
Antenna Gain: 32 dB
Horizontal Beamwidth: 1.3°
Vertical beamwidth: 40°
Polarisation: Variable from linear to circular

SWEDEN

2329.153
C-BAND SEARCH RADAR TYPE PS 70/R

DESCRIPTION:

This is a new mobile search radar system carried in an air-conditioned cabin mounted on a standard truck. The system is primarily intended for a new Swedish anti-aircraft missile system but can be used advantageously wherever a modern search radar is desirable.

PS 70/R is a C-band fully coherent pulse doppler radar with range coverage 40 km. The antenna, which is mounted on a folding mast, is raised 12 m above ground during operation. A hydraulic system is used for levelling the radar as well as for the erection of the antenna mast. The system has a built-in power generator enabling it to be self-supporting.

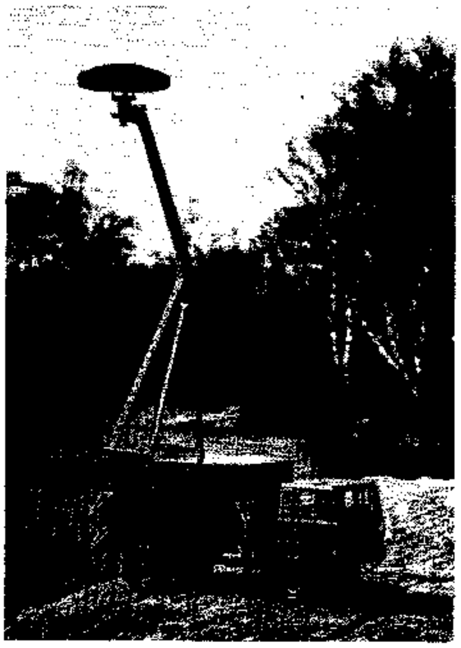
A target data transmitter is incorporated and can feed information on target coordinates, speed and direction to fire control units.

STATUS:

In production.

MANUFACTURER:

Telefonaktiebolaget L. M. Ericsson, MI Division, S-43120, Mölndal, Sweden.



PS 70/R radar system

2355.153
PEDER II COHERENT-ON-RECEIVE FIRE CONTROL RADAR

This is a Ku-band monopulse tracking radar designed for use in fire control applications where the multipath problems associated with lower frequency radars seeking to achieve the same data-renewal rate are troublesome.

STATUS:

Field tested by the Swedish Army.

MANUFACTURER:

Telefonaktiebolaget L. M. Ericsson, MI Division, S-43120, Mölndal, Sweden.

2481.153
ISIDOR PORTABLE INTRUSION RADAR

DESCRIPTION:

Isidor is a small portable CW radar which gives a visible and audible indication of the presence of men or moving vehicles within a range of some 300 metres for men and at least 1 km for moving vehicles. The main electronics unit is mounted on a tripod and can either be left to guard a particular line of approach or rotated by hand to survey an area. Presence of a target is indicated by a lamp and headphones can be used to monitor and interpret the signal. Several radars can be coupled to one remote control unit which has a lamp display for each radar and can be used to couple the headphones to any radar.

The transmitter emits a narrow pencil beam with low sidelobes – thereby making the radar difficult to detect.

CHARACTERISTICS:
Frequency: 10.5 GHz
Transmitter Power: 10 mW
Range Capability:
Against walking man 300 m
Against moving vehicle 1,000-2,000 m
Antenna:
Beam width 11°
First side-lobe level better than —23 dB
Wide angle side-lobe level better than —40 dB
Power Supply: 10-30 V DC (0.2 A at 12 V)
Weight (excl. battery): 2.5 kg
Dimensions:
Width and height: 20 cm
Depth: 10 cm

MANUFACTURER:

Telefonaktiebolaget L. M. Ericsson, MI Division, S-431 20 Mölndal, Sweden.

2325.153
PE-48/T AA FIRE CONTROL RADAR

DESCRIPTION:

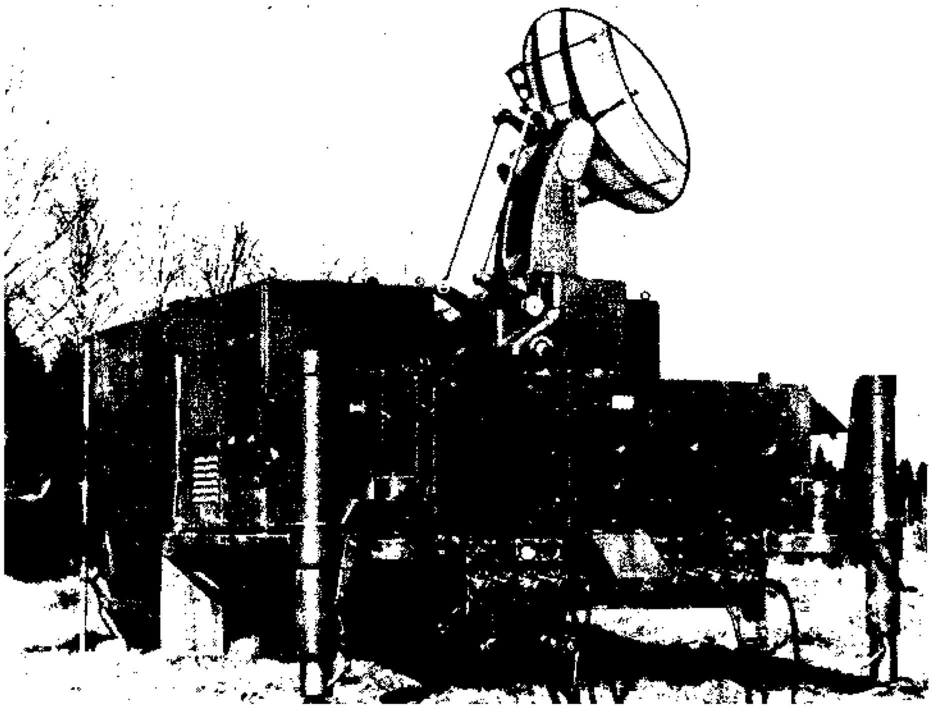
PE-48/T is a mobile range and angular tracking X-band anti-aircraft fire control radar which can also be used as a search radar. As can be seen in the accompanying picture, the radar antenna pedestal is mounted on a levelled platform which is the upper surface of the equipment container. Within this container is a fire control computer made by Arenco Aectronics, and this is used to compute firing data for transmission to the two 40 mm or 57 mm Bofors AA guns which the radar is used to control.

STATUS:

Operational but no longer in production. Final delivery to the Swedish Army was made in 1967.

MANUFACTURER:

Telefonaktiebolaget L.M. Ericsson, MI Division, S-43120 Mölndal, Sweden.



PE-48/T radar mounted on an Arenco computer

2327.153
PE-452/T AA FIRE CONTROL RADAR

DESCRIPTION:

PE-452/T is a mobile X-band range-measuring anti-aircraft fire control radar manufactured by L.M. Ericsson in Sweden under licence from CSF (now Thomson-CSF), France.

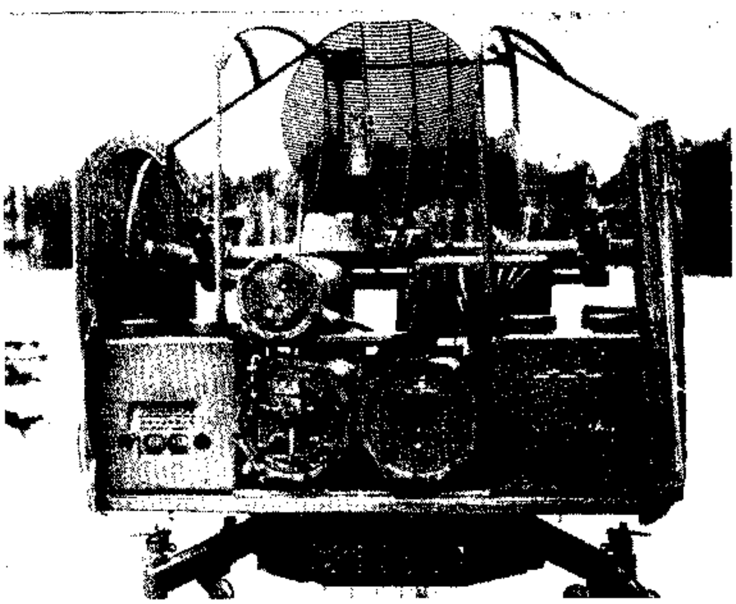
The radar is mounted on a fire control unit (with optical angular tracking) manufactured by Contraves AG, Switzerland. The latter unit also contains a fire control computer which calculates and supplies firing data to two 40 mm Bofors AA guns.

STATUS:

Operational but no longer in production. Final delivery to Swedish Army made in 1967.

MANUFACTURER:

Telefonaktiebolaget L.M. Ericsson, S-43120 Mölndal, Sweden.



PE-452/T radar mounted on a Contraves FC computer

2328.153
PE-453/T AA FIRE CONTROL RADAR

DESCRIPTION:

PE-453/T is a mobile X-band anti-aircraft fire control radar developed in Sweden by L.M. Ericsson by modifying the PE-451 range-measuring radar made by CSF (now Thomson-CSF) in France.

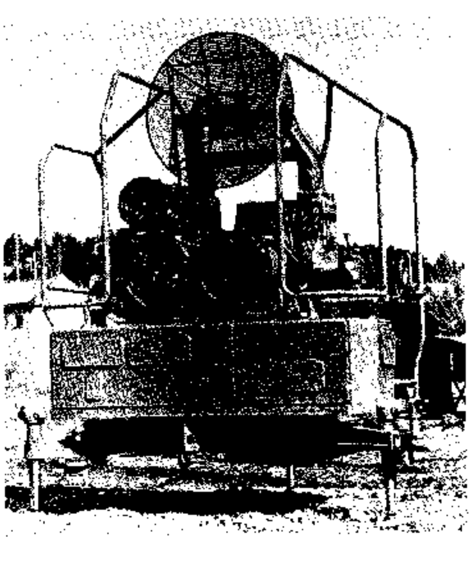
The PE-453/T provides range and angular tracking and operates in conjunction with a fire control computer, made by Contraves AG, Switzerland, and housed in the cabinet on which the fire control radar is mounted. Outputs from the computer are used for the control of two 40 mm Bofors AA guns.

STATUS:

Operational but no longer in production. Final delivery to Swedish Army made in 1967.

MANUFACTURER:

Telefonaktiebolaget L.M. Ericsson, S-43120 Mölndal, Sweden.



PE 453/T radar mounted on a Contraves FC computer

2326.153
PS-171/R AA SEARCH RADAR

DESCRIPTION:

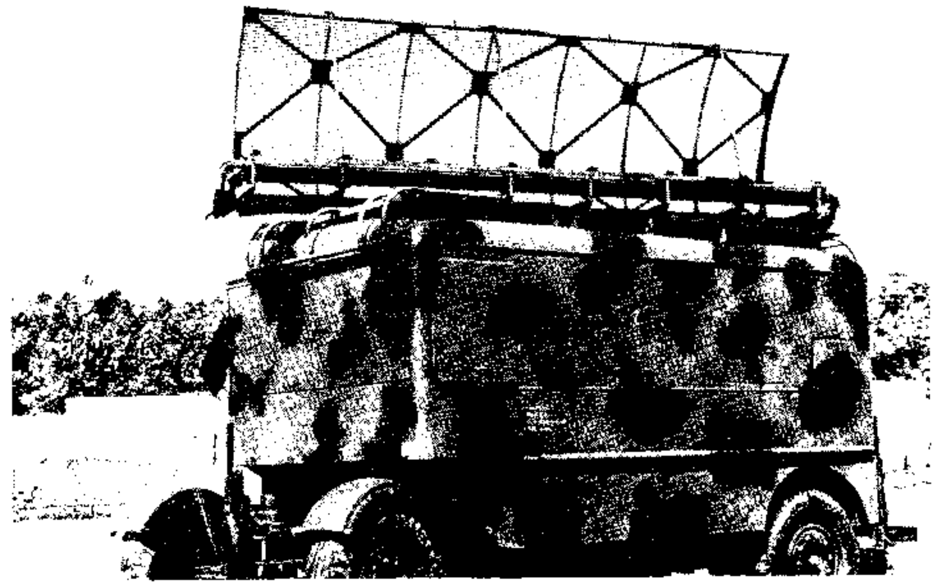
PS-171/R is a mobile, trailer-mounted, S-band search radar which is used as the early warning element in some Swedish anti-aircraft fire control systems.

It was manufactured by L.M. Ericsson under licence from CSF (now Thomson-CSF), France. Modifications to the original design were developed by LME to make it possible to use electronic components available in Sweden at the time. The transmitter and modulator was also designed to operate with the PS-17 radar which was manufactured in its entirety by CSF.

STATUS:

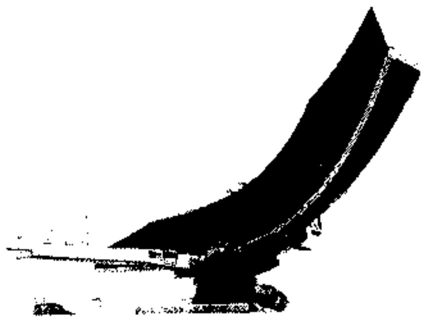
Operational but no longer in production. Final delivery to Swedish Army made in 1955.

MANUFACTURER:
Telefonaktiebolaget L.M. Ericsson, S-43120 Mölnda, Sweden.



PS 171/R Search Radar

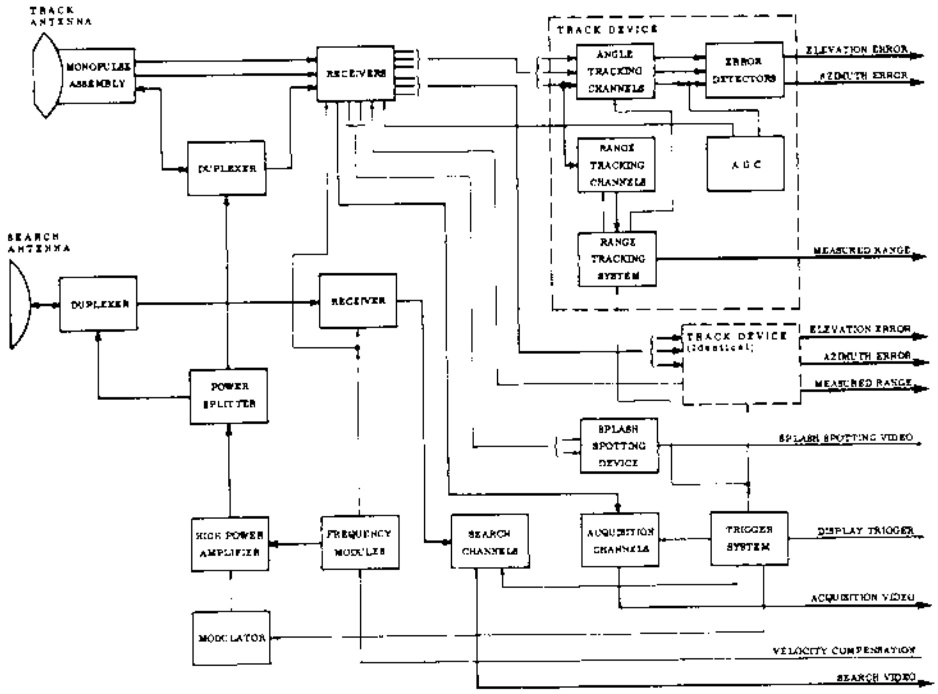
1549.153
PHILIPS 9 GR 600 RADAR
DESCRIPTION:
The designation 9 GR 600 applies to the X-band, frequency-agile radar transmitter/receiver which forms the basis of Swedish military radar and fire control systems for both land and naval uses. Used with the 9 GA 205 antenna, it forms the main sensor of the 9 KA 400 (Mareld) coastal artillery fire control system (Entry No. **1548.181**). The only other known applications are ship-borne, and further entries will be found in the appropriate sections.
CHARACTERISTICS:
Transmitter:
Frequency range: Random pulse-to-pulse frequency shift up to 450 MHz in the band 8700-9500 MHz
Pulse peak power: 200 kW
PRF: 2000-3000 Hz
Pulse width: 0.2 to 1.5 microseconds
Output valve(s): One or two spin-tuned magnetrons
Receiver:
Frequency range: 8500-9600 MHz
Bandwidth: 3 and 8 MHz, matched to pulse length
Noise: 10 dB average, 8 dB with low-noise preamp
Receiver characteristics: Lin and log, log/lin STC
Optional features: Image rejection mixer pre-amplifier; Dicke-fix receiver; pulse-length discriminator; IAGC; narrow-band jamming suppression; spectrum analyser; passive ECM mode; frequency programming
Antenna: 9 GA 205
Type: Parabolic
Frequency band: 8.3-9.6 GHz
Rotation: Up to 40 rpm
Beamwidth: Horizontal 0.6 deg, Vertical 4.5 deg
Gain: 40 dB
Sidelobes: 28 dB
Aperture: 4500 × 625 mm
Weight: 225 kg



Philips 9 GR 600 radar

STATUS:
In service.
MANUFACTURER:
Philips Teleindustri AB, Fack, S-175-20, Järfälla-1, Sweden.

2357.153
UAR 1021 COMBINED SEARCH & TRACK PULSE DOPPLER RADAR
This combined fully coherent search and track pulse-Doppler radar is derived from the earlier ECSTRA I equipment. It employs a single X-band transmitter which feeds the independent search and track antenna by way of a power splitter. The tracking sub-system uses a monopulse technique with a Cassegrain antenna; the search system uses a cheese antenna.
Important features of the equipment are the high clutter attenuation resulting from the coherent pulse Doppler-system, the ECCM capability resulting from the broad band system (900 MHz) and the possibility of operating either on a fixed frequency (chosen from five with a change time of less than 10 milliseconds) in the pulse-Doppler mode or with random pulse to-pulse frequency



Block schematic of UAR 1021 combined search and track radar

UAR 1021 combined search and track radar in Contraves Skyguard system agility within 900 MHz in the non-Doppler mode; the monopulse angular tracking system; and the digital range tracking system.

CHARACTERISTICS:
Frequency: 8.6-9.5 GHz
MTI improvement factor: 45 dB
Peak power: 26 kW
Noise factor: 12 dB
Pulse repetition frequencies: Three different triplets in the interval 4.8-8.1 KHz with rapid cyclic switching
Pulse width: 1.5/0.5 microsec selectable
Antenna Gain: 36 dB
Antenna Diameter: 1 m
Range coverage: PD-Mode: 0.3-18 km, FA-Mode: 0.3-25 km
Acquisition interval: 1,120 m
Velocity window: 22-385 m/sec
Angle tracking accuracy: 1 mrad
Range tracking accuracy: 8 m +0.0002.R

STATUS:
In production for the Contraves Skyguard system (**2377.151**).

MANUFACTURER:
Telefonaktiebolaget L. M. Ericsson, MI Division, S-43120, Mölndal, Sweden.

2356.153
UAR 1022 TRACK ONLY RADAR

DESCRIPTION:
This radar is essentially the tracking sub-system of the UAR 1021 combined search and track radar (**2357.153**) but is offered as a separate radar for application where either the tracking function is the only one required or where it is desired to associate an X-band tracker with a search radar operating in a different frequency band.

MANUFACTURER:
Telefonaktiebolaget L. M. Ericsson, MI Division, S-43120, Mölndal, Sweden.

SWITZERLAND

2551.153
CONAR ARTILLERY RADAR FIRE CONTROL SYSTEM

DESCRIPTION:
Only limited information on this system has so far been made available. It comprises a conical-scanning lock-follow tracking radar, the aerial pedestal of which can be retracted inside the cabin in which the system is transported, and a CORA II digital computer.

In operation the radar tracks a projectile fired by an associated weapon system and the measured co-ordinates are used by the computer, which is programmed with the appropriate ballistics, to predict the fall of shot, and compute appropriate corrections.

Conar is intended primarily for use with two major Swiss artillery weapon systems, the DIRA rocket system (**2386.103**) and the M-109U 155 mm SP Howitzer (**2998.103**).

MANUFACTURER:
Contraves AG, Schaffhauserstrasse 590, 8052 Zürich, Switzerland.

CONAR Artillery FC system

THE UNITED KINGDOM

1018.153
CYMBELINE MORTAR LOCATING RADAR

DESCRIPTION:
Cymbeline (British Army nomenclature: Radar FA No 15 Mk 1) is an extremely rugged self-contained radar (including power supply) with a detachable display unit. The radar is mounted on a four-legged structure supported on screw jacks fitted with hydraulic absorbers.

The equipment is transported either on a two-wheeled trailer or on a FV432 armoured personnel carrier (**5007.102**). In the latter mode the screw jacks are replaced by an automatic hydraulic levelling system.

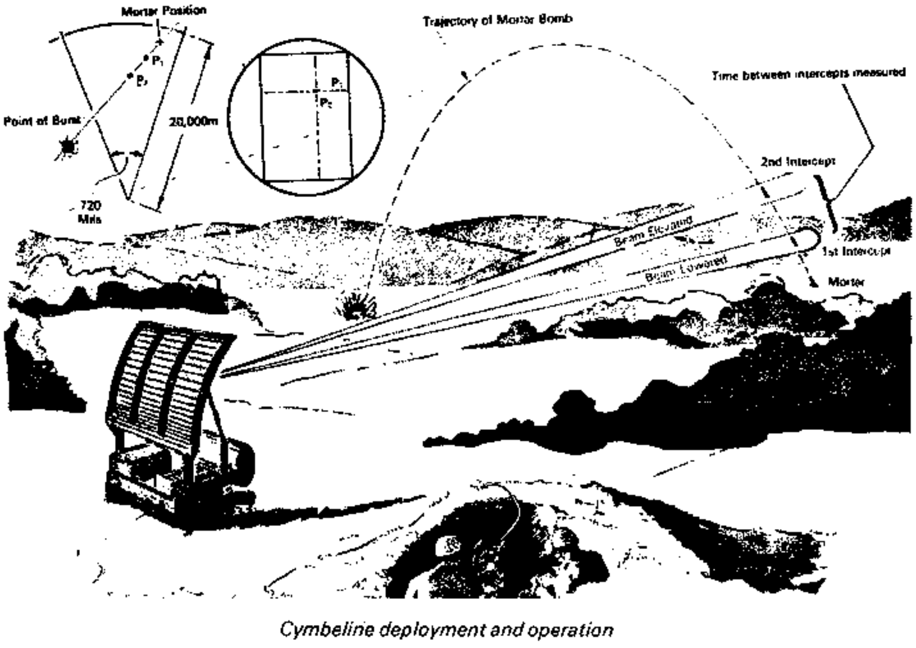
The antenna system consists of a Foster Scanner which illuminates a parabolic cylinder reflector and produces a pencil beam scanning in azimuth. The complete radar head can be rapidly rotated to cover any required sector; for example, 180° rotation in 15 seconds. When in transit the reflector folds down.

Below the antenna is an equipment box which houses the Main Electronics Unit, the Power Unit and the Display Unit during transit.

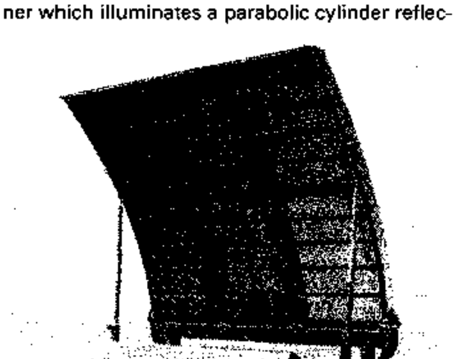
The Main Electronics Unit contains the Transmitter/Receiver and the radar timing and computer modules.

The Display Unit can be removed from the equipment box for remote operation for distances up to 15 metres. It consists of a short-persistence 'B' scope on which the radar returns are displayed. It also carries all the controls necessary for the operation of the radar. The mortar co-ordinates are shown on another unit which is detached and can be used at distances up to 2 metres from the display.

The radar is normally operated from a Wankel gasoline engine/generator set, mounted on the



Cymbeline deployment and operation



Cymbeline mortar locating radar

equipment, which provides 1.5kW at 28V d.c. Alternative sources providing 1.5kW at a voltage between 22V and 30V d.c. can be used.

The equipment is suitable for air transport up to heights of 12,800 m. All units are sealed, and as the mounting feet have integral hydraulic shock absorbers, the equipment is suitable for transportation by helicopter as an underslung load.

OPERATION:

The radar enables the operator to plot two points in the bomb trajectory, and to measure the slant range and bearing to each of these positions. The time taken for the bomb to travel between the two points is also measured and the computer uses this information together with the pre-set elevation angles to determine the firing position of the mortar. This entire process takes place in about half a minute.

Additional facilities have been provided to ensure the maximum accuracy of location and ease of operation over a wide range of operational conditions. For maximum range performance a switched single beam is used, and an additional beam position is available to alert the operator for making the first intercept. For short range working a double-beam mode of operation may be selected to obviate operator reaction time errors. This facility also improves the multiple target capability.

Provision has also been made for the internal fitting of an optional digital data storage module. This enables the radar returns to be stored to provide a long-persistence display so that operator concentration can be reduced while improving the marking accuracy. Data storage also improves multiple handling capability.

Two operators are normally required, but in an emergency one will suffice.

The 13 cm 'B-scope' CRT display, which incorporates a fibre-optics faceplate for daylight viewing, presents the full azimuth cover of the radar at all times, but range coverage can be displayed in zones of 4,000 m or 8,000 m. Counters on the unit permit the co-ordinates of the radar to be set in, and those of a located mortar to be read out.

Cymbeline can also be used for the adjustment of 'own' artillery fire by determining the co-ordinates of the target position. Other applications include local surveillance and control of helicopters and light aircraft.

TEST AND TRAINING EQUIPMENT:

Maintenance is usually by isolation and removal of a complete unit. Built-in test equipment enables an operator quickly to isolate a fault to a particular unit and replacement of a faulty unit by a spare unit enables the operator to bring the radar back into service with a minimum of time out of action.

A faulty unit is withdrawn to a Repair Vehicle for servicing. This vehicle comprises an air-portable container body mounted on a suitable wheeled carrier. The vehicle is an air conditioned unit, containing a complete slave radar and fully equipped with repair and test facilities for the servicing of units.

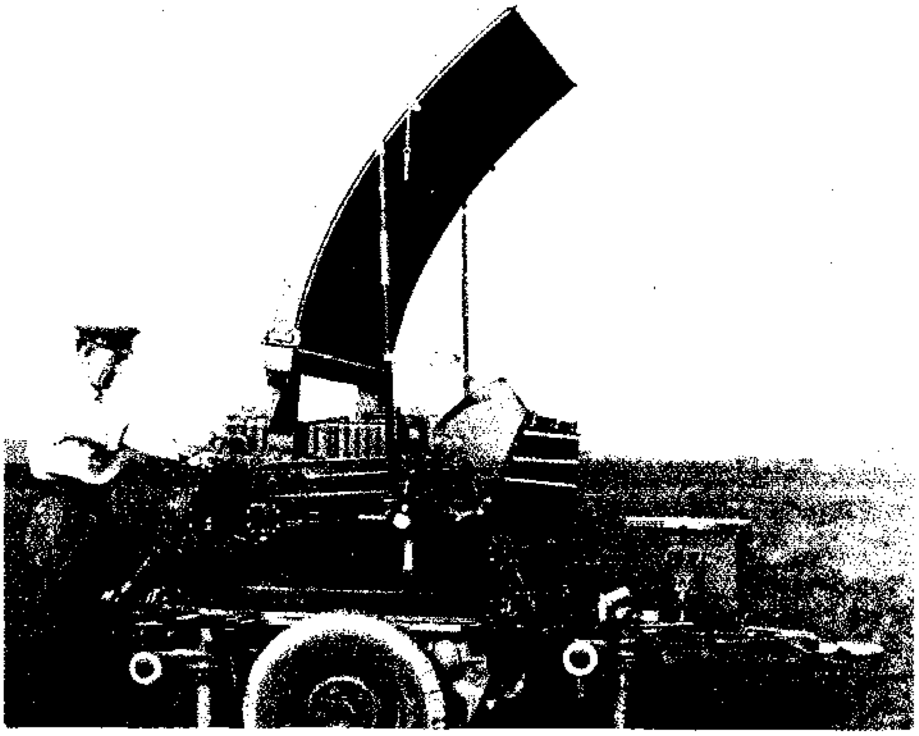
A simulator, built into the Display Unit, provides realistic synthesised waveforms at the CRT to represent intercepts of mortar bombs for operator training.

DEVELOPMENT:

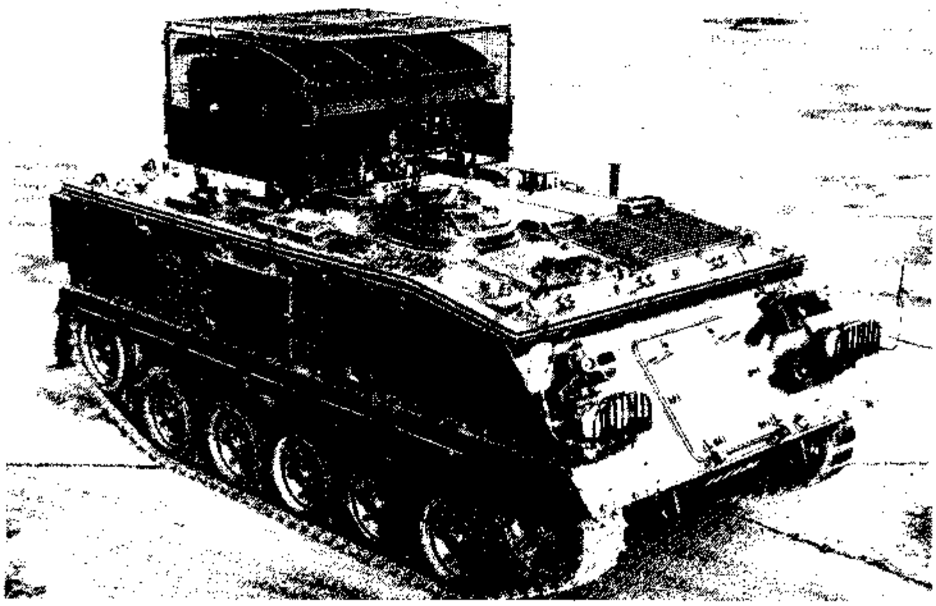
Cymbeline was developed as a lighter, more mobile, successor to the Green Archer mortar locating radar. Partners in the programme were EMI Electronics, the UK Ministry of Technology (mainly the Royal Radar Establishment), and the British Army.

CHARACTERISTICS:

Weight of radar: 300 kg
Weight of power supply: 85 kg
Height (stowed): 1.07 m
Height (operational): 2.29 m (when removed from trailer)



Cymebline mortar locating radar ready for use on trailer mounting



Cymbeline mounted on FV432 (reflector folded for transit)

Length: 1.50 m (when removed from trailer)
Width: 1.70 m (when removed from trailer)
Frequency: X-band
Peak power: 100 kW
Aerial: Foster Scanner with reflector
Sector scan: 720 mils
Bearing limits: 12,000 mils total rotation
Speed of Rotation: 200 mils per second
Presentation: 'B' type display with displayed 0 – 20,000 m and selected 4,000 m and 8,000 m zones
Minimum range: 1,000 m
Maximum displayed range: 20,000 m
Radar reliability: 200 hours MTBF (excluding power source)
Electronic units: Fully sealed and desiccated with air to air heat exchanger
Power Requirements:
Supply: 22V to 30V dc 1.2 kW mean, 1.35 kW peak
Generator: Wankel (Silenced). Weight: 85 kg. Reliability: 200 hours MTBF
Operating Limits:
Temperature: −32 to +52 deg C
Altitude: Sea level to 3,000 m
Wind conditions: No loss of accuracy up to 90 km/h

STATUS:

Deliveries to the British Army commenced in mid-1973.

MANUFACTURERS:

EMI Electronics Ltd, Hayes, Middlesex.

2413.153
FIRELIGHT TARGET ILLUMINATING RADAR

DESCRIPTION:

Firelight is a Target Illuminating Radar (TIR) for use with the Bloodhound and Thunderbird Surface-to-air guided missile systems. The equipment is land mobile and air-transportable and the complete radar is housed in a single trailer.

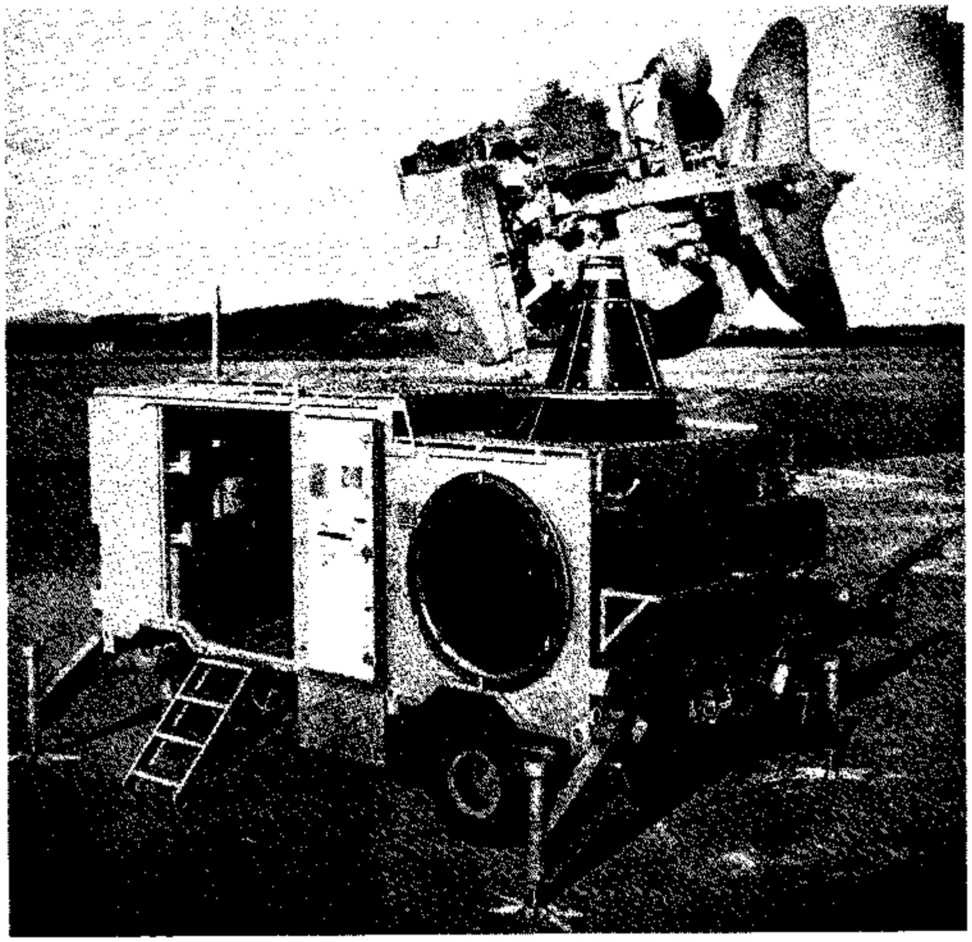
Basically an X-band CW Doppler auto-follow radar, the equipment also performs the function of illuminating the target and thereby providing the reflected radiation to activate the semi-active homing system of the Bloodhound and Thunderbird missiles. In addition it has a limited target search facility and is equipped for target identification.

In its normal operational role the TIR is supplied with target range and bearing information from a surveillance radar associated with the missile system. After appropriate co-ordinate transformation this data will define the target's position in a region bounded by bearing and elevation arcs which may be further restricted if information from a height-finding radar is also available. The TIR aerial system is so arranged that it can search the region thus defined and locate the target, whereafter it is locked on and follows the target automatically. Simultaneously a positive identification process is initiated resulting in a decision – made by the Engagement Controller in the Launch Control Post (LCP) – whether or not to engage the target.

When following a target the radar supplies angular position and velocity co-ordinates to the LCP. When a missile has been launched, the TIR continues to track the target, and the reflected signal is used by the homing equipment in the nose of the missile to bring it close enough to the target for the proximity fuse to detonate the missile warhead.

A CW system was chosen for this radar because of its good performance in the presence of natural or ECM interference. The use of X-band radiation makes possible a reasonable degree of angular accuracy with an aerial system that is small enough to be retracted within the radar trailer for transportation.

The whole of the main equipment (excluding power supplies) is housed in a single trailer which is jacked up on site. This trailer contains the transmitter receiver, servo systems, aerials and built-in protection and checking capability. The whole unit may be transported by air and is proofed against rain, snow, ice, sea spray and wind-driven sand.



Ferranti Firelight Target Illuminating Radar

Development History:

Development commenced on a British Government contract in December 1957, the manufacturers, Ferranti Ltd, having already been co-operating with the Bristol Aeroplane Co Ltd (and subsequently with the British Aircraft Corporation) on the development of the Bloodhound guided missile system. The first prototype was completed in November 1960 and the equipment went into service with the Royal Air Force (with Bloodhound) in December 1962 and the British Army (with Thunderbird) in May 1963.

Characteristics:

Type: Mobile CW Doppler auto-follow radar
Frequency: X-band
Main aerial: 2.1 m diameter
Mobility: Land-mobile. Air-transportable
Facilities: Search and follow. Target identification. Built-in self-testing capability
Associated systems: Bloodhound and Thunderbird SAGW systems

Manufacturer:

Ferranti Ltd, Electronic Systems Dept, Ferry Road, Edinburgh EH5 2XS, Scotland.

2412.153
GREEN ARCHER MORTAR LOCATING RADAR

Description:

Green Archer (British Army nomenclature Radar F.A. No. 8) is a radar and computer system designed for the rapid location of enemy mortar positions and for observation and correction of friendly counterfire. It can also be used for air burst and trajectory ranging of artillery fire and for other surveillance purposes.

Two men only are required to operate the equipment, which will locate mortars of 75 mm calibre with great accuracy at ranges up to 8 km and larger mortars at greater ranges with little loss of accuracy.

The system comprises an X-band sector-scanning radar, an analogue computer and ancillary equipment. There are two standard versions: FA No. 8 Mk I is mounted on a 4-wheeled trailer; FA No. 8 Mk II is mounted on a self-propelled vehicle – either the armoured personnel carrier type M 113 or FV 436.

Function:

A mortar is located by measuring the coordinates of a mortar projectile at two points on its ballistic trajectory, measuring the time of flight between these two points and computing the origin of the trajectory – and hence the location of the mortar – from these measurements.

To obtain the required measurement accuracy a radar beam that is narrow both in azimuth and in elevation is necessary, and that of Green Archer is approximately 2 degrees. Because of this, if targets are not to be missed, the sector scan must be executed at such a speed that a complete cycle takes no longer than it will take a mortar projectile at minimum range to pass through the beam. A Foster scanner is used for this purpose.

The radar beam is switchable in elevation so that when a target has been detected at low elevation the sector scan can immediately be transferred to a greater elevation to obtain the second measurement. Target information is presented on a B-scope display for the measurement of range and bearing (elevation being predetermined for both lower and upper scan); and the display covers a sector some 40 degrees wide and 17 km long or, by switching, any 4 km part of this zone from 0 to 16 km.

Measured and predetermined coordinates of the target's position on lower and upper scans are fed into the analogue computer and from these, and the measured time interval between the two sightings, the computer calculates the Cartesian coordinates of the position of the mortar and presents them to the operator.

Power Supply:

Power for the equipment is provided by a 4.5 KVA 200 V 400 Hz 3-phase diesel-engined generator. Since Green Archer will often be operated in forward areas there is a danger that the noise made by a generator may give away the position of the radar. The generator is heavily silenced, therefore, and is located well away from the remainder of the equipment. It is designed to be inaudible at 200 metres on a still night.

Development:

Development of this system was initiated by the British authorities and was under the technical supervision of the Royal Radar Establishment with E.M.I. as prime contractor. The development contract was awarded in 1955; trials of prototype equipment took place in 1958 and 1959; and the equipment went into service with the British and Swedish armies in 1962.

Status:

Obsolescent. No longer in production and being superseded in the British Army and others by Cymbeline (**1018.153**). Still in service in the Argentine, Denmark, India, Israel, South Africa, Switzerland and West Germany.

Manufacturer:

Prime contractor: EMI Electronics Ltd, Hayes, Middlesex.

2483.153
INFANTRY COMBAT RADAR GS No 18 Mk 1

Description:

Little information on this development had been received by press date, but it is understood that this radar has been jointly developed by Marconi Radar Systems and the UK MoD Procurement Executive (the technical establishment is not known – but see **2482.153**) to meet the requirements of the British armed forces for a portable battlefield surveillance radar – presumably as a successor to the GS No 14 Mk 1 listed here under its commercial designation of ZB298.

The radar is understood to work in J band and to have separate search and discrete ranging modes covering distances up to 2 km. All-up weight is believed to be 8.0 kg while in infantry-portable form this weight can be reduced to about 4.5 kg.

STATUS:
Not definitely known but presumably advanced development.

MANUFACTURER:
Marconi Radar Systems Ltd, Marconi House, Chelmsford, Essex.

2457.153
MARCONI HIGH-POWER STATIC RADARS

Marconi Radar Systems now incorporates, as part of GEC-Marconi Electronics, the radar activities of the former AEI organisations; which in turn inherited the Metropolitan-Vickers radar interests which extended back to the first British radar development work before the Second World War.

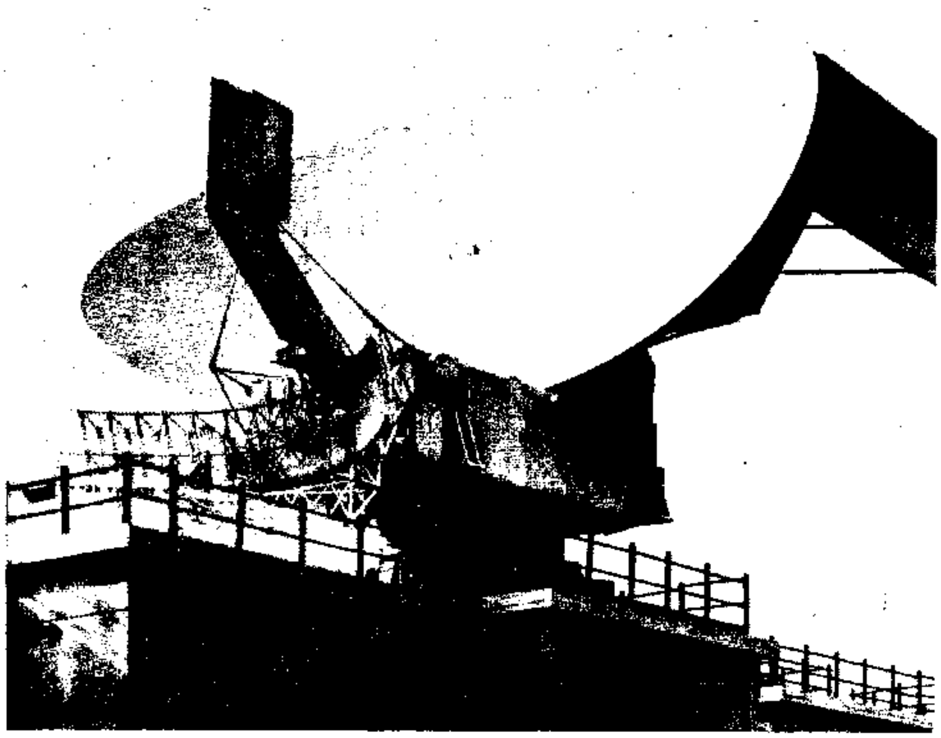
The present Marconi Radar Systems organisation thus numbers among those of its former products which are still in service a number of high-power static radar systems used for defence purposes, some of which are volumetric radars. Information relating to these radars is still largely subject to security restrictions; and it is possible here to give only typical characteristics which do not necessarily correspond with the characteristics of any one radar.

Illustrated here is one of the volumetric radars, the **Type 85**: this is a high-power stacked-beam equipment which is used in the UK air defence system (**2443.181**). The 40-series volumetric radar (**2478.153** and see also **2429.181**) can to some extent be regarded as a derivative of this radar. Other large static radars still in operational use are:

Type 82 – an S-band volumetric radar having a single curvature reflector with a linear feed.

Type 84 – a high-power L-band surveillance radar with anti-jamming facilities. It has a paraboloid reflector fed by a hornstack.

MANUFACTURER:
Marconi Radar Systems Ltd, Chelmsford, Essex, England.



Type 85 radar

2458.153
MARCONI HIGH-POWER STATIC SURVEILLANCE RADARS (LINEAR FED)

DESCRIPTION:

Included among the range of high-power static radars referred to generally in entry **2457.153** is a family of surveillance radars using single curvature reflectors illuminated by linear feeds. The aerial system may comprise single or back-to-back dual reflectors operating in S-band or L-band. The later aerials feature a squintless feed (see entry **1168.153**). A range of transmitter/receivers can be operated singly or in diversity.

Members of this family believed still to be operational are:

Types S247, S266: S- and L-band back-to-back aerials Type SA116, 45 ft (13.72 m) aperture. Transmitter/receivers SR1000 2.5 MW S-band; SR1020 2¼ MW L-band.

Type S647: S- and L-band back-to-back aerials Type SA116 45 ft (13.72 m) aperture. Transmitter/receivers S2012 2¼ MW S-band; S2011 2 MW L-band.

Type S631: S- and L-band back-to-back aerials Type S1011 and S1014 with squintless feeds, 45 ft (13.72 m) aperture. Transmitter/receivers in diversity 2 × S2012 2¼ MW S-band; 2 × S2011 2 MW L-band.

S-band aerials for all the above have a parabolic section while the L-band aerials are cosecanted.

Other radars in the earlier series which were specified but are not known to be operational were:

S255: Single 45 ft (13.72 m) L-band cosecanted aerial.

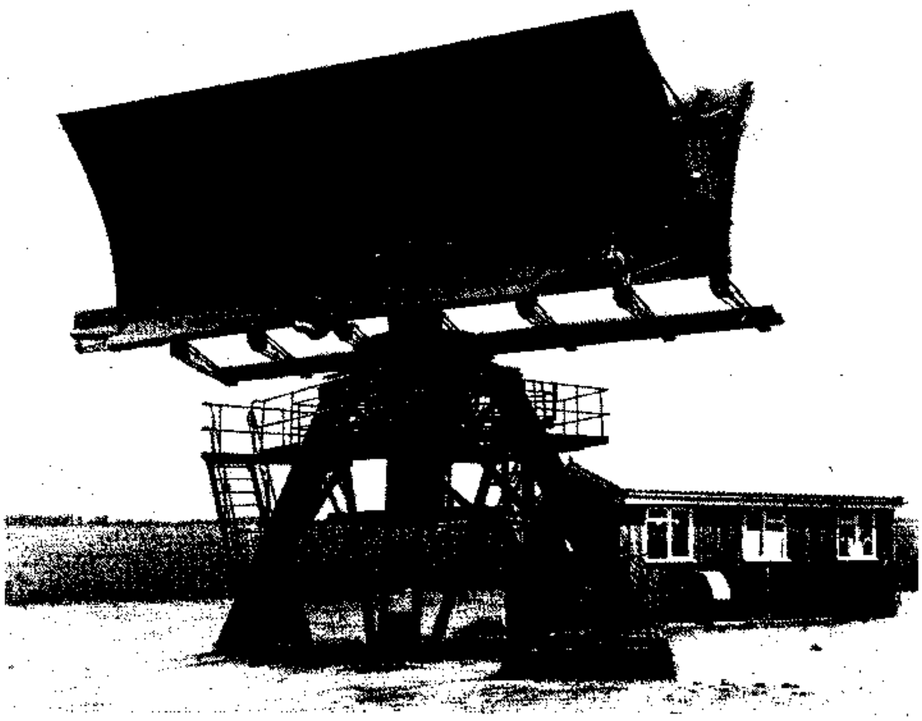
S265: Back-to-back 45 ft (13.72 m) S-band parabolic and cosecanted aerials.

S300: Back-to-back 45 ft (13.72 m) L-band parabolic and 60 ft (18.29 m) L-band cosecanted aerials.

S316: Back-to-back 60 ft (18.29 m) L-band and 45 ft (13.72 m) S-band cosecanted aerials.

S319: Single 60 ft (18.29 m) L-band cosecanted aerial

S320: Back-to-back 45 ft (13.72 m) L-band parabolic and cosecanted aerials.



Back-to-back L-band (front) and S-band aerials with squintless linear feeds

Transmitters having peak powers of at least 2¼ MW were specified for use with all these radars.

The achievable ranges are in excess of 500 km (300 nautical miles). Single curvature reflectors and squintless linear feeds give both low sidelobe level and diversity capability. These features, together with two-band working and ECCM receivers, ensure very high resistance to jamming. Extremely stable transmitters and digital signal processing enable the radar to maintain a high data rate with good clutter supression. Plot extraction and narrow band transmission facilities, track extraction with manual or automatic initiation and comprehensive display facilities allow integration with a wide range of defence systems.

CHARACTERISTICS:

	S-band	L-band
Aerial:		
Gain	45 dB	37 dB
Beamwidth:	0.5°	1.2°
Sidelobes:	Both –28 dB	
Polarisation:	Both horizontal (circular)	
Max rotation rate:	8 rev/min	

Transmitter:
Peak power: 2.25 MW 2 MW
Pulse length: 2.5/50 microsec
PRF: 300/600
Receiver:
Noise figure: 3.8 dB 2.8 dB
Signal Processor:
Stagger: Six period or random
Cancellation ratio: 40 dB static
Max MTI range: More than 120 nautical miles.

Some further information on Marconi static air defence radars will be found in entry **2429.181**.

MANUFACTURER:
Marconi Radar Systems Ltd, Chelmsford, Essex, England.

2478.153
MARCONI 40-SERIES VOLUMETRIC RADAR

DESCRIPTION:

The Marconi 40 Series S-band defence radar provides plan position and height data covering a range of 400 km (220 nautical miles) and a height of 30,500 m (100,000 ft) on targets of not less than 4 square metres. A computer obtains height data automatically each aerial revolution on every target detected within the radar cover.

Anti-jamming is achieved by the use of a stacked beam aerial system with a separate receiver for each beam, wide frequency diversity, high mean transmitted power, pulse compression techniques and a combination of special Electronic Counter Counter Measures (ECCM) receivers and compatible Moving Target Indication (MTI). These features, together with circular polarization also make the radar highly resistant to interference from ground clutter and rain.

Aerial System

The aerial consists of a reflector and hornstack in a stacked beam system. The reflector is paraboloidal in contour and measures 12.2 m (40 ft) across by 4.67 m (15 ft 4 in) high. When transmitting, the transmitter power is divided in the waveguide system and fed to twelve horns. The relative phase of r.f. energy at each horn is such that co-phasing is achieved in the far field. The beamwidths of the lower beams are 0.62 degree horizontal by 1.25 degrees vertical. The maximum gain of the aerial is 44.5 dB with azimuth side lobes 27 dB down on the peak of the main beam. When receiving, each horn feeds its own receiving system. Elevation coverage provided by the common transmitter/receiver system is continuous up to 30 degrees. Circular polarisation of the bottom four beams can be employed to give improved performance in rain and is controlled from the radar supervisor's console. An IFF aerial is mounted on the radar aerial and produces a beam aligned in azimuth with the radar aerial beams.

Twelve waveguides connect the r.f. slipring stack to the horn feeds in the hornstack, rising through the aerial turntable into and along the aerial baseframe and finally up the hornstack itself. Flexible sections are included to allow for thermal expansion, and the lengths of the runs contained in the baseframe are arranged as part of the co-phasing system.

The high power waveguide system is contained in three racks fulfilling the functions of combination of power from the two transmitters, splitting the combined power, establishment of the correct phase relationship between the twelve channels, duplexing and monitoring. Sections of the waveguide system are pressurised where necessary.

Transmitter

Two transmitters are provided, each operating over two frequency bands, each band being 50 MHz wide. Thus a total bandwidth of 200 MHz is employed within a total bandspread of 450 MHz. Frequency diversity within each band is employed, selection being at random.

MTI is obtained by operating the transmitter at the same frequency on successive pulses before randomly selecting a different frequency pair. The pulse spacing between frequency pairs can be optimised for ground clutter or chaff.

For the purposes of surveillance of military and civil aircraft in peace time, performance is such that only one transmitter need be operated, with the advantage of more economical running of the radar and protection of security. The unused transmitter can be run up and operated into an r.f. dummy load for testing.

Each transmitter output stage consists of a high power amplifier of the hybrid t.w.t./klystron type, delivering an S-band pulse of peak power 3 megawatts typical, with a pulse length of 10 microseconds. Each pulse is frequency modulated over 2 MHz as required for pulse compression. A stage of amplification is provided in each transmitter by a t.w.t. amplifier to raise the exciter input to a level suitable for the output amplifier. Each stage individually and in combination provides an output constant in amplitude over the full operating bandwidth.

Buffer alternators are provided between each transmitter power supply and the primary input supply to ensure that electrical interference is eliminated from other radar circuits and associated equipments used in the overall system.

Exciter

The exciter generates the r.f. signal which, after mixing with the swept frequency i.f. pulses, is fed to the transmitter for amplification. Eight oscillators provide the frequency diversity feature of the radar and these are selected and timed from controlled input signals. Outputs from the exciter provide the local oscillator frequencies for the receiver. Another output provides r.f. pulses for injecting into the receiver waveguide for test purposes. The design of the microwave circuits has been realized almost entirely in printed circuit stripline.

Receiver Waveguide

The outputs from the twelve duplexers in the high power waveguide system are fed to low noise t.w.t. amplifiers in the receiver racks through waveguide containing a gas discharge tube to attenuate transmitter breakthrough, and to a directional coupler through which r.f. test pulses are injected from the exciter system.

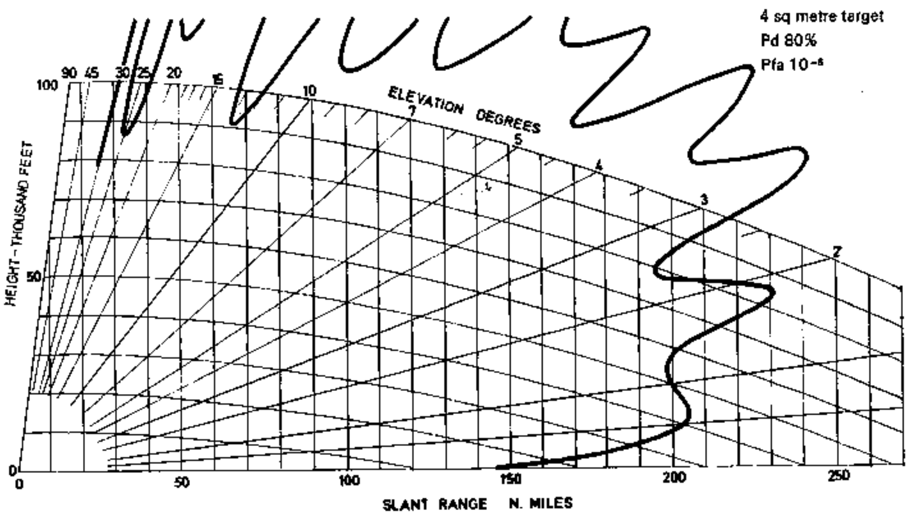
R.F. Receivers

Signals from the twelve receiver waveguides are passed to twelve identical receiver systems, the first units of which are t.w.t. radio frequency amplifiers. In each system, a switched filter passes the amplified signal to mixers, the output from which is at the first intermediate frequency of 148.5 MHz.

After amplification in a wide band amplifier the signal is divided into two and is further processed in two different i.f. receiver channels.

Log Receivers

One part of the amplified signal at 148.5 MHz is used to provide amplitude information for height finding. This is accomplished by reducing the signal to 13.5 MHz second i.f. and after passing through a dispersive network, the compressed signal is fed to the log amplifier. R.F. signals injected simultaneously into each receiver channel are used to ensure that the characteristics of each are identical, this being required for height computation.



40-Series radar coverage

ECCM Receivers

The other part of the amplified signal at 148.5 MHz is used to feed the ECCM receiver system, the outputs of which, after further processing, constitute the input to the display and data handling system. This receiver channel has a characteristic providing a constant false alarm rate output without limiting, even though the jamming signal may fluctuate. After being reduced to the second i.f. of 13.5 MHz in a mixer, the signal passes through a dispersive network and the compressed signal is fed to the MTI and video processing system.

I.F. Oscillator and Distribution

The swept frequency i.f. pulses for the exciter are generated passively by means of an impulsed dispersive delay line system and after conversion to 148.5 MHz are passed to the exciter system. All the intermediate frequencies in the radar are harmonically related to 13.5 MHz. The output of a basic 13.5 MHz crystal oscillator is multiplied by 12 to provide a 162 MHz signal. This signal is split to provide twenty-four independent 162 MHz second Local Oscillator signals.

MTI

The method used is to transmit two pulses on the same frequency and split the output of the ECCM receivers into amplitude and phase channels before and after a delay equal to the pulse spacing. The phase channel provides the velocity information relative to a weighted mean of clutter, chaff and other targets on the same bearing. The amplitude channel is used to amplify and detect the i.f. and after gain equalisation to combine the two signals in an AND-gate (the latter function provides a means of p.r.f. discrimination). Analogue multiplication of the instantaneous amplitude with the appropriate function of phase gives the output of the MTI system. The radar can be operated in three different modes, namely: non-MTI, MTI Mode 1 and MTI Mode 2. Non-MTI mode is used when neither clutter nor chaff is present in sufficient quantity to limit the performance of the radar. MTI Mode 1 is used to combat ground clutter out to a maximum range of 360 km (194 nautical miles). MTI Mode 2 is used to combat both ground clutter and chaff out to a maximum range of 180 km (97 nautical miles). In each case MTI can be terminated before the maximum range; thereafter returns are processed, without MTI cancellation, out to the maximum range of the radar.

Video Processing

The various video processing circuits are used to generate a Constant False Alarm Rate (CFAR) output under conditions of clutter, chaff, rain, jamming etc, as well as receiver noise. This is achieved by the use of an automatic clutter gating system which normally selects the non-MTI output for processing. When the presence of clutter or chaff is detected, the MTI output is selected and the clutter or chaff is cancelled before processing. Fast automatic gain controls are provided on the MTI and Non-MTI output to bring the mean level of the noise to a predetermined upper limit. After the appropriate CFAR output has been chosen, video pulses wider than 0.75 microsecond (6 dB point) are rejected by a pulse length discriminator. This circuit is useful in rejecting interference from other radars, impulse jamming and partially cancelled ground clutter.

The signal is then sent along two paths. One is for the PPI via a mixer and a spurious target cancellation system used to remove ambiguities due to split pulse working. The other is for the height computer via a video digitiser which produces a 6-volt pulse for every signal passing the detection threshold.

Auto Height Computer

The digitised video output from the video processing circuits in each beam is used to gate into a peak reading store the required pulses existing at that time in the log channels. The highest pair of adjacent outputs gives the approximate height of the target by defining the nearest cross-over. To find the fine increment of height, these two outputs are subtracted and compared with the calibration curve for this cross-over of elevation against log difference. Multiplication by the range then provides the height increment. The coarse and fine heights are added so that a pulse output proportional to the height of the target is provided for every detected target.

On demand, the set of signal strengths in a pulse packet for a given target are compared in an analogue store and the height corresponding to the strongest return is converted into an eight-digit binary code and passed to the data handling computer.

Two manually interchangeable height computers are provided for reliability.

CHARACTERISTICS:

Transmitters: Two klystron amplifiers each delivering a peak power of 3 MW (typical). Transmitter 1/2 operates on eight frequencies selected within two bands. Transmitter 4/5 operates in eight frequencies selected within another two bands. The bands are separated to give a frequency diversity covering more than 450 MHz

Pulse recurrence frequency: With no MTI the p.r.f. is 323 pulses/sec. With short pulse spacing MTI the p.r.f. is 233 pulse pairs/sec. With long pulse spacing MTI the p.r.f. is 182 pulse pairs/sec

Pulse length: 10 microseconds frequency modulated for pulse compression

Receivers: Separate receiver systems fitted in each beam provide outputs for height finding and ECCM.

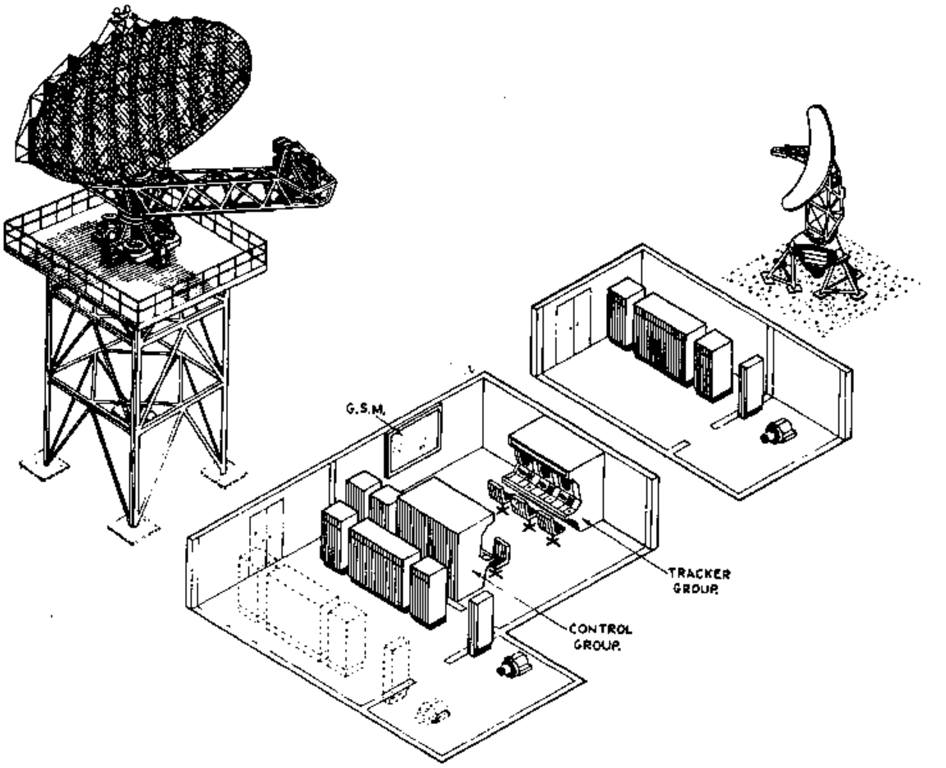
Circuits in each receiver provide pulse compression from the radiated 10 microsec pulses to 0.5 microsec pulses. Swept gain is independently applied to each ECCM receiver. The dynamic range of each receiver is 70 dB

MTI: Two models of MTI are provided. Mode 1: Ground clutter – MTI to range of 360 km (194 nm). Mode 2: Chaff and ground clutter – MTI to range of 180 km (97 nm)

Video processing: Pulse length discrimination, pulse repetion frequency discrimination and wind speed correction associated with MTI and fast acting gain control are applied to each beam

Automatic height finding: Heights of all aircraft detected within the cover are automatically computed every revolution of the aerial and are available for feeding to a computer or display

Environmental conditions: The equipment will operate at full performance over a wide range of climatic conditions. It is protected against rain, salt, water spray, wind blown sand, snow, ice and electric storms.



Arrangement of a control and reporting station

Exposed parts operate satisfactorily within a shade air temperature range of —10 to +50°C with a maximum difference between the sunlit and shade air temperatures of 25°C.

Maximum wind speed for operation is 150 km/h (80 knots). The structure will withstand windspeeds of up to 227 km/h (120 knots) without damage

Air conditioning and equipment cooling air: Plant installed in the building provides an environment of 25°C at an r.h. of 50% with two air changes per hour, and also provides equipment cooling facilities

Equipment cooling (water): The water cooling system extracts surplus heat from the two transmitters and their associated waveguide loads, and rejects this heat to the airconditioning plant via a water/water heat-exchanger

A.C. Power Supply: Primary AC power is derived from an external source. The incoming three-phase supply is switched and metered in the radar building. The AC power required is 415V+5%, 3-phase, 4-wire, 50 Hz+2% at approximately 250 kVA.

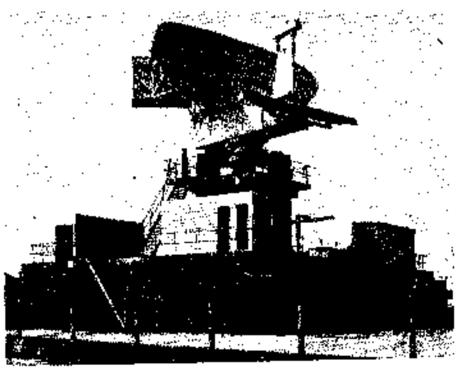
Coverage: Basic radar performance is shown in the Coverage Diagram.

The coverage is modified with the application of MTI and depends on the Mode employed, the beam in which the target is present, and whether or not the target is within a clutter gated area.

The effect of using a single transmitter only is to reduce the noise limited range performance by 16% and within the clutter gated areas to increase the velocity band in which detectability is reduced

Relative height accuracy: At a range of 185 km (100 nm) the relative height between two 4m^2 targets at similar plan positions and between altitudes of 4,575 m (15 000 ft) and at least 18,300 m (60 000 ft) is measured with a root mean square (r.m.s.) accuracy of 366 m (1 200 ft). This relative height accuracy is maintained so long as the two targets are not separated in elevation by more than one beamwidth, i.e. approx 4,270 m (14 000 ft) vertical separation at 185 km (100 nm) range

Absolute height accuracy: Height is measured with an absolute accuracy of 457.5 m (1 500 ft) r.m.s. on target of 4m^2 at 12 200 m (40 000 ft) at 185 km (1)) nm) range. (Allowance has been made for the effect of a 129 km/h (70 knot) wind on the aerial, but not for local atmospheric anomalies.)


40-series volumetric radar for static air defence systems

Effect of ground clutter on height accuracy: The foregoing figures for height accuracy are degraded for any measurement in which ground clutter is detected at exactly the same plan position as the target.

Except in the case of very severe clutter the degradation is only of significance when beam 1 is involved in the computation

Plan position accuracy and discrimination: The accuracy with which a target track is maintained and the power of the over-all system to resolve two closely spaced targets is dependent on the display and rate-aided tracking system as well as on the radar itself.

In the following characteristics the accuracy and discrimination are therefore quoted simply as limited by the parameters of the radar

Radar range accuracy: 100 m r.m.s.

Radar range discrimination: Two similar sized aircraft on the same bearing and separated by 100 m in range are recognizable as separate aircraft on a suitably expanded display.

This power of range discrimination is not of operational value and is purposely degraded by pulse stretching at the video output in order to obtain a brighter display of aircraft echoes

Radar bearing accuracy (beams 1-8): 0.2° r.m.s.

Radar bearing discrimination (beams 1-8): Two similar sized targets at the same range, but separated in bearing by 0.8° are recognized as separate targets

Radar bearing accuracy and discrimination (beams 9-12): In beams 9-12 the bearing accuracy and discrimination are scaled in accordance with the increased azimuth beamwidth.

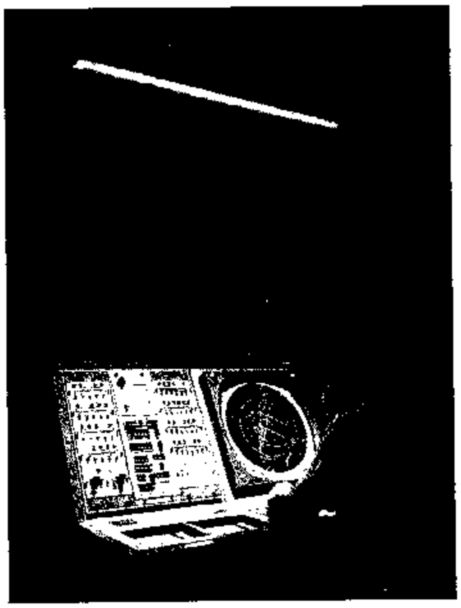
In the case of targets at 12,200 m (40,000 ft) the tangential plan position accuracy is better than 450 m and the tangential plan-position discrimination is better than 1,800 m.

MANUFACTURER:
Marconi Radar Systems Ltd, Chelmsford, Essex, England.

2459.153
MARCONI L-BAND SURVEILLANCE RADAR TYPE S654

DESCRIPTION:
This is an L-band radar particularly designed to provide airways surveillance and TMA/approach control facilities for military air traffic control. The dual-beam, high rotation rate aerial, stabilised transmitter, low-noise receiver and digital signal processing provide continuous cover of the smallest fighters in the most adverse clutter conditions. Integrated plot extraction and display facilities provide varied operational systems.

CHARACTERISTICS:
Aerial:
Gain: 33 dB main, 30 dB auxiliary
Beamwidth: 1.7°
Sidelobes: −23 dB
Polarisation: Switched linear/circular
Max rotation rate: 15 rev/min
Transmitter:
Peak power: 2 MW or 800 kW
Pulse length: 2/5 microsec
PRF: 220/850
Receiver:
Noise figure: 2.8 dB
Signal processor:
Stagger: Six period or random
Cancellation ratio: 40 dB static
Max MTI range: Better than 120 nautical miles
MANUFACTURER:
Marconi Radar Systems Ltd, Chelmsford, Essex, England.


Display console of S654 radar in the Central Operations Room of the Canadian Forces Base at Lahr in West Germany

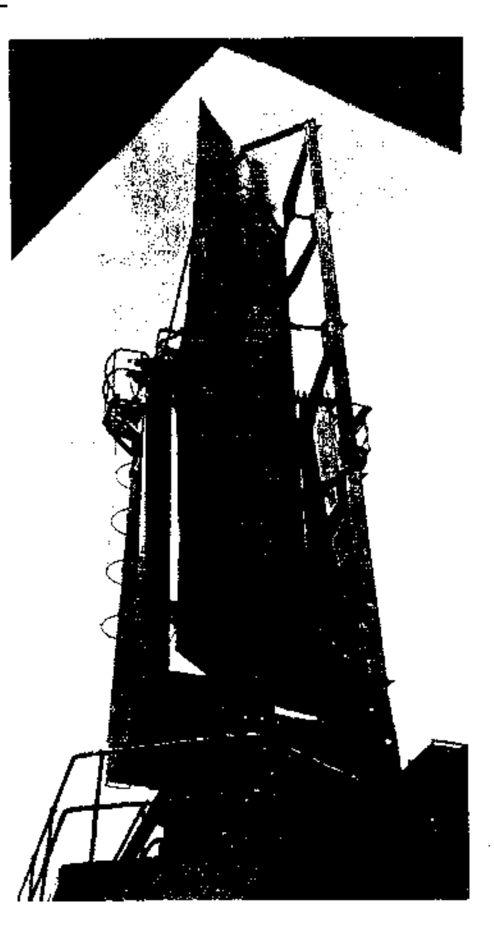

S654 radar tower

2462.153
MARCONI LONG-RANGE HEIGHTFINDING RADAR TYPE 669

DESCRIPTION:
This is a long range S-band height finder radar capable of providing at least 17 heights per minute with an overall accuracy of ±457 m (1,500 feet) at 280 km (150 nautical miles). Discrimination at this range is better than 247 m (900 feet). Modes of operation are single shot, automatic or manual searchlight, burn-through, volumetric and sector scan. The single curvature linear fed aerial has very low sidelobes and is hydraulically driven for minimum response times. Either manual or automatic height extraction is available.

This radar is a derivation from the S269 radar, fourteen of which are used in the NADGE chain stretching 3,000 miles from Norway to Turkey, itself a derivation from the S244.

CHARACTERISTICS:
Aerial:
Gain: 40 dB
Vertical beamwidth: 0.6°
Sidelobes: −20 dB
Nod duration: 2 sec
Slew rate: 90° in 2.5 sec
Transmitter:
Peak power: 2.52 MW
Pulse length: 2.5/5 microsec
PRF: 300/600
Receiver:
Noise figures: 3.8 dB
MANUFACTURER:
Marconi Radar Systems Ltd, Chelmsford, Essex, England.


Heightfinding radar type 669

2463.153
MARCONI MOBILE AND TRANSPORTABLE TACTICAL CONTROL RADARS

DESCRIPTION:
This entry relates to a pair of radars, Types S330 and S404, developed on a British defence contract for use with the Thunderbird guided weapon System (**2460.131**).

Little information concerning these radars is available for publication. The S330 is a surveillance radar with back to back aerials working in S band and L-band; the S404 is a heightfinder working in C band. In operation these radars are used for tactical control in association with a sophisticated display and data processing system such as Nomad (**2421.181**). Further details of methods of operational use can be found in the entries for Thunderbird and Nomad and in that for

Thunderbird 22 (**2461.181**).

Both radars are fully mobile and air-transportable. They are not, however, the only mobile and transportable Marconi radars and attention is drawn to entry **1168.153** which deals with the S600 series.

MANUFACTURER:

Marconi Radar Systems Ltd, Chelmsford, Essex, England.

2480.153
MARCONI TRANSPORTABLE TACTICAL RADAR TYPE S259

DESCRIPTION:

Type S259 is an air-transportable L-band tactical radar with limited ground mobility. It comprises a demountable aerial, a 2 MW transmitter and sophisticated receiver, signal processing and display equipment, all units except the aerial (which is pallet-mounted for transport together with sundry ancillary equipment) being contained in two container cabins.

The aerial has a light tubular and mesh reflector, of modified parabolic shape, which divides into three sections. This reflector is illuminated by a boom-mounted feed horn to give horizontal and vertical beamwidths of 3.8° and 10°, the pointing angle in the vertical plane being adjustable from −2° to +5°. The feed horn incorporates an IFF dipole which produces an IFF radiation pattern coincident with the primary pattern.

A 2 MW transmitter-receiver from the S600 series (Type S2011 – see **1168.153**) is used. This generates a 5 microsecond radiated pulse and provides received echoes in the form of linear and logarithmic pulse-length discriminated (PLD) video. The linear output can be processed by a double-cancellation MTI system and MTI or PLD outputs can be selected at will. The signal processing sub-system also includes provision for pulse recurrence frequency discrimination (PRFD) and double p.r.f. stagger (PRFS). Controls are provided to enable PRFD and PRFS to be switched in or out and to adjust the MTI range. Transmitter run-up and frequency changing can also be controlled remotely from the display cabin as also can the IFF system.

A single 12-inch autonomous display unit is supplied as standard with provision for a second unit. Provision is made for two primary radar video outputs and one IFF output. A passive IFF decoder is incorporated. Cabin air-conditioning and wave-guide dry air supply equipment is mounted on the transport pallet for the aerial.

CHARACTERISTICS:

Transmitter peak power: 2 MW
Receiver noise factor: 4.5 dB
Beamwidth: Horizontal 3.8°. Vertical 10°
Sidelobes: Horizontal: −26 dB with respect to main lobe. Vertical: −20 dB with respect to main lobe
Gain: Greater than 27 dB
Rotation rate: 0-15 rev/min. variable
Tilt: −2° to +5° manual adjustable
Aerial dimensions: Horizontal: 4.88 m (16 ft). Vertical: 1.45 m (4 ft 9 in)
Cabin dimensions: Height 1.91 m (6 ft 3 in). Depth: 1.93 m (6 ft 4 in). Width: 3 m (9 ft 10 in)
Insulation factor: U=0.15
Pallet dimensions (loaded): Height: 2.43 m (7 ft 8 in). Dpeth: 2.9 m (9 ft 6 in). Width: 3.5 m (11 ft 6 in). Weight: 1800 kg (4000 lb)

MANUFACTURER:

Marconi Radar Systems Ltd, Chelmsford, Essex, England.

1168.153
MARCONI S600 SERIES RADARS

DESCRIPTION:

The S600 range of radar equipment incorporates 13 different types of aerial heads, five different transmitters and a wide range of signal processing equipment built in modular form. Marconi Myriad Computers can be integrated with this basic equipment together with data displays, to provide advanced data handling facilities for any system. IFF secondary radar can be incorporated, the aerials fitting onto any of the surveillance radar heads.

Different combinations of the equipment can be used to form radar systems covering any of the following functions – ground control of interceptors (GCI), tactical control for weapon systems, early warning and reporting, general air surveillance, military or civil air traffic control, coast watching etc.

TRANSPORTABLE INSTALLATIONS:

A number of the radar heads in the S600 series have been specially designed for rapid transportation. Complete aerials, built onto wheeled chassis have been designed with sections of the aerial folding away to form a compact package which can be stowed in most of the military transport aircraft currently in use. The electronics can be built into mobile containers with removable wheel units for stowing in an aircraft. All the units are sufficiently compact and light to be lifted by existing military helicopters.

The containers which house the electronic equipment will take any two S600 transmitter/receivers and associated signal processing equipment. Alternatively with only one transmitter, a single container can house data handling and display equipment.

TRANSPORTABLE SURVEILLANCE AERIALS:

Type S1015: 5.49 × 1.83 m parabolic S-band
Type S1010: 5.49 × 1.83 m cosec^2 S-band
Type S1016: 5.49 × 1.83 m cosec^2 L-band

TRANSPORTABLE HEIGHT-FINDER AERIAL:

Type S1017: 4.27 × 1.3 m C-band aerial

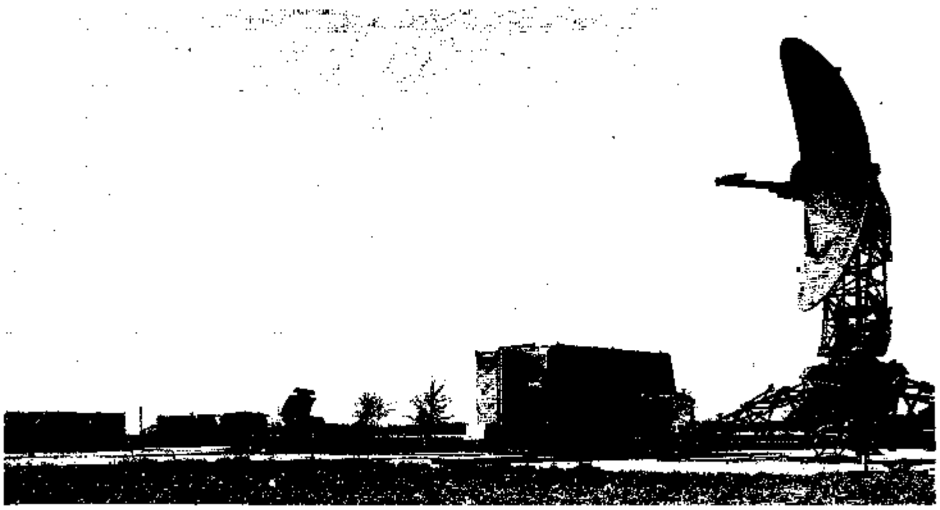
STATIC SURVEILLANCE AERIALS:

Type S1011: 13.72 × 4.57 m parabolic S-band
Type S1012: 13.72 × 4.57 m cosec^2 S-band
Type S1013: 13.72 × 4.57 m parabolic L-band
Type S1014: 13.17 × 4.57 m cosec^2 L-band

Back-to-back combined L-band and S-band aerials having the characteristics of either S1011 or S1012 combined with those of S1013 or S1014 (four combinations in all) can be constructed (see, for example, Type S631 in entry **2458.153**).

STATIC HEIGHT-FINDING AERIALS:

Type S1006: 12.19 × 2.13 m S-band aerial (wavelength 10 cm)



S600 units deployed

AERIAL FEEDS:

The S600 surveillance aerials are a new range having single curvature reflectors. An advanced type of feed system is employed, (known as a "squintless feed") which provides accurate distribution of the radar signal over the surface of the aerial reflector. Operated in conjunction with a suitable multiplexer, up to five transmitters can be operated simultaneously into one aerial.

TRANSMITTER/RECEIVERS:

The S600 Series uses five transmitter units whih can provide signals for any of the combinations of radar heads.

Except for thyratrons and RF output valves, solid-state techniques are employed throughout; microelectronic circuits are used where they enhance the equipment's performance, or represent an over-all saving in cost. The transmitters are:

Type S2010: 1 MW S-band
Type S2011: 2 MW L-band
Type S2012: 2.25 MW S-band
Type S2013: 1 MW C-band
Type S2021: 800 kw L-band

Each of these transmitter units has three separate sections, one containing the modulation equipment, another the output stage and radio frequency equipment and the third, control equipment, automatic frequency control, trigger circuits, the receiver circuits and the first stages of the radio frequency circuits. In addition, there are integrated test facilities to maintain an almost continuous check on the important parts of the equipment. A performance monitor is also available, as a separate unit, to provide data on the equipment; it can be used to measure the performance of a number of transmitters where multiple transmitters are employed for diversity operation.

Interior of a typical cabin

DIVERSITY OPERATION:

This technique of combining the outputs of more than one transmitter into a single aerial gives the operational advantage of wider frequency coverage, higher total power and diversity reception, thus considerably enhancing over-all performance. A sharp cut-off multiplexer enables up to five separate transmitters to be operated simultaneously, within a region which is 10% of the frequency band.

SIGNAL PROCESSING:

The S600 Series employs a number of sophisticated signal processing techniques all of which are built in solid state. The suppression of clutter using this signal processing equipment is claimed to be superior to that of any previous radar system of comparable cost. The basic receiver system has a parametric amplifier input and linear or logarithmic PLD video output; and provision is made for the incorporation of a full ECCM receiver system. A double-cancellation MTI system is incorporated and PRF stagger or PRF discrimination can be added.

ADDITIONAL FACILITIES:

Additional facilities giving more specialised signal processing have been developed by Marconi. One of these techniques is called doppler cancellation which allows slowly moving localised clutter to be eliminated. Clutter of this type can be caused by the weather or by radar blocking devices such as chaff.

DEVELOPMENT:

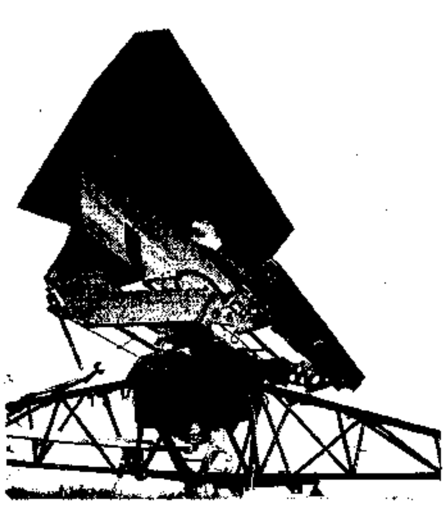
The S600 Series was developed by Marconi as a private venture and was first revealed in late 1967. Some of the radars in the series are identified in the following list which incorporates some cross-references to other entries.

S600-S613	All transportable/mobile radars (S600-605 are surveillance radars)
S600	S-band IMW with parabolic aerial
S600H	As S600 with cosecanted aerial
S604H	L-band 2 MW with cosecanted aerial
S605H	As S604H with second (diversity) transmitter
S613	C-band heightfinder (**2479.153**)
S614-S6—9	All static radars
S614L	S-band IMW low-cover
S630	Back-to-back S-band and L-band with two pairs of transmitters in frequency diversity
S631	Back-to-back S-band and L-band with high-power transmitters in multiple diversity (**2458.153**)
S635	S-band IMW with parabolic aerial
S635H	As S635 with cosecanted aerial
S637	C-band IMW heightfinder
S638	L-band 2 MW with cosecanted aerial
S647	Back-to-back S-band and L-band with high-power transmitters (**2458.153**)
S654	Back-to-back L-band 2 MW. Special aerial (**2459.153**)
S669	S-band high-power heightfinder (**2462.153**)

CHARACTERISTICS:

Typical characteristics of the main range of surveillance radars are:

	S-band	L-band
Aerial:		
Gain:	37 dB	28 dB
Beamwidth:	1.4°	3.2°
Sidelobes:	Both horizontal/circular	
Max. rotation rate:	15 rpm	
Transmitter:		
Peak power:	1 MW	2 MWW
Pulse length:	2.5/50 microsec	
PRF:	300/600	
Receiver:		
Noise figure:	3.8 dB	2.8 dB
Signal Processor:		
Stagger:	Six period or random	
Cancellation ratio:	40 db static	
MAX. MTI range:	120 nautical miles	



S600 Series transportable surveillance radar deployed for use

STATUS.

Various radars from this series have been supplied to the UK Government, NATO, and several other countries.

MANUFACTURER:

Marconi Radar Systems Ltd, Chelmsford, Essex, England.

2479.153

MARCONI S613 HEIGHTFINDING RADAR

DESCRIPTION:

This is a mobile/transportable heightfinder radar working at C-band. It integrates with any of the surveillance radars in the S600 to S605 range, utilising the same form of construction. The digitally controlled aerial is capable of providing 22 heights a minute and the height is automatically extracted, a unique facility in mobile systems. Modes of operation are normal, sector scan and volumetric scan.

TYPICAL CHARACTERISTICS:

Aerial:

Gain: 39.5 dB

Vertical beamwidth: 0.9°

Sidelobes: —25 dB

Nod duration: 2 sec

Slew rate: 180° in 2 secs

Transmitter:

Peak power: 1 MW

Pulse length: 2/5 microsec

PRF: 300

Receiver:

Noise figure: 4.5 dB

MANUFACTURER:

Marconi Radar Systems Ltd, Chelmsford, Essex, England.

Marconi S613 height finder radar

2464.153

MARCONI 800 SERIES RADARS (LAND-BASED)

DESCRIPTION:

The Marconi 800 series of surveillance and tracking radars was introduced in 1972. The early members of the series (type numbers in the range 801-839) are all naval radars and are described in the next section of the book. Type numbers in the ranges 840-849 and 850 onwards have been allocated to coastal defence radars and land-based weapon radars respectively. Several radars of these types have so far been announced and are briefly described below.

Type S841 is a mobile coastal defence surveillance radar which provides and continuously updates accurate range and bearing co-ordinates on surface targets for weapon fire control systems.

The radar operates at a fixed frequency, selected in the band 9.3 to 9.5 GHz; it incorporates track-while-scan, digital range and bearing data extraction and has an autonomous fixed coil display. The aerial is a 2.44 m (8 ft) linear array with a parabolic reflector.

Greater operational flexibility is achieved by Type S842, which is similar to Type S841, except that a broader band squintless feed aerial system is used and the transmitter is tunable over the frequency range 8.6 to 9.5 GHz.

The ST850 target tracking radar and television system has been designed, in co-operation with Short Bros. and Harland, as an integral part of the Tigercat weapon system (**2465.131**) to improve its performance in conditions of poor visibility by giving a dark fire capability.

The ST850 is contained in a mobile air conditioned cabin with the radar director on its roof. The system is simple to use, is flexible in operation and can be speedily deployed. This radar is more fully described in entry **2466.153**. The ST851 target tracking radar is a derivative of the ST850 which incorporates a Sperry general-purpose digital computer for the prediction of aim-off to give blind fire gun control. Without the television system, this unit will control small calibre rapid fire anti-aircraft guns and the complete equipment gives maximum flexibility to a combined missile/gun point defence system.

The S860 and S865 are mobile surveillance radars designed to support the ST850 and ST851 through the provision of target positional data. The S860 is a manned cabin with a dual operator position feeding target coordinate data to up to three fire control units. The S865 is housed in a smaller unmanned cabin from which radar data is transmitted, again, to up to three fire control units. In this case, however, the fire control units are provided with their own ppi displays so that target indication can be carried out by the fire control operator.

MANUFACTURER:
Marconi Radar Systems Ltd, Chelmsford, Essex, England.

2482.153
MARCONI/RRE SHRIMP BATTLEFIELD SURVEILLANCE RADAR

DESCRIPTION:
Jointly developed by Marconi-Elliott Avionic Systems and the Royal Radar Establishment, Shrimp is a very light J-band surveillance radar, which can detect moving vehicles and men at ranges up to 3 km and 1 km respectively. Total system weight including tripod mount and accessories is only 8.5 kg; but the radar can also be supported on a harness carried by one man in which case the weight is only 3.5 kg.

No other details of consequence had been received by press date.

STATUS:
Believed to be at an advanced development stage

MANUFACTURER:
Marconi-Elliott Avionic Systems Ltd, Elstree Way, Boreham Wood, Herts, England.

2415.153
PLESSEY ACR 430 AIRFIELD CONTROL RADAR

DESCRIPTION:
This X-band radar has been designed principally as a simple and inexpensive airfield aid for precision azimuth approach guidance and local area surveillance. Suitable for use with all types of aircraft, it may also be used for monitoring other landing aids, for marshalling traffic and for other surveillance duties.

Extensive use is made of fibreglass construction for strength and low weight, and solid state and integrated circuit design are used throughout. Installation is facilitated by the breakdown of the radar head equipment into readily handled sub-assemblies.

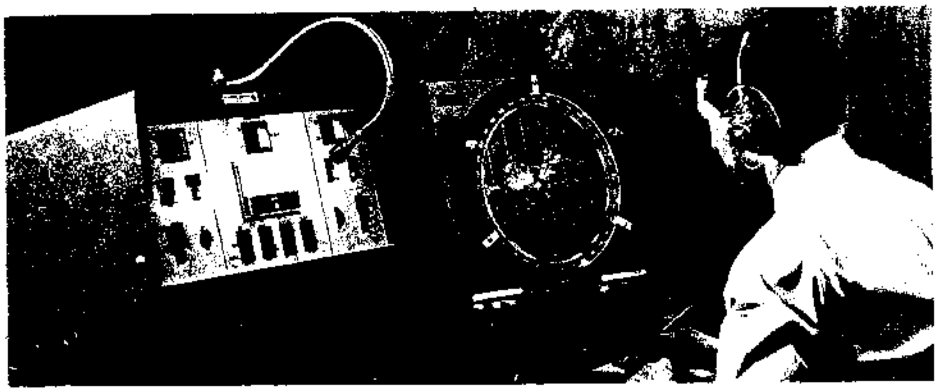
Two separate coverage beams are radiated and the associated equipment channels use identical parallel electronic units which may be rapidly interchanged. Reliability is thus further improved by parallel redundancy giving high operational availability.

A double curvature aerial is illuminated by two horns, each of which is coupled to a transmitter/receiver. One horn produces a cosecant pattern; the other produces a pencil beam which is geometrically centred to provide the high degree of accuracy necessary for approach guidance. Aerial rotation rates of either 20 or 40 rev/min can be selected from the remote control unit.

The two transmitter/receivers, together with their power units, are located in a housing at the back of the aerial. Each transmitter provides a peak power of 50 kW. The signal output at intermediate frequency is passed by cable to the remote radar control unit. The two IF receivers housed in this unit provide a wide range of receiver modes for interference and clutter rejection.

In a standard installation the remote control unit is associated with two 305 mm diameter autonomous rotating coil displays; and the three units may be remoted from the aerial site by up to 1,000 metres without the need of line amplification. Each display has a switchable electronic approach line and electronic bearing marker whilst a comprehensive switching arrangement enables alternative horn/transmitter/receiver/display combinations to be selected.

Considerable attention has been given to minimising installation and maintenance time. The complete equipment consists of the aerial assembly (with transmitter/receivers built in) and the two displays and control unit. With the exception of the input power cables, the only cable required to be installed on site is the cross-site cable connecting the aerial assembly to the remote control unit.

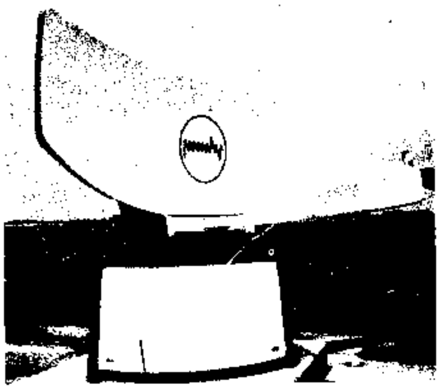


ACR 430 control unit and display

HISTORY:
Development of this radar was started in 1968 and the first prototype completed in 1969. The equipment is used by the British Government, local authorities and several overseas countries.

CHARACTERISTICS:

Radiation:
Frequencies: 9,320 ± 20 MHz and 9,460 ± 20 MHz
Polarisation: Circular (fixed)
Aerial:
Rotation rate: 2 speeds 20 ± 10% rev/min and 40 ± 10% rev/min in wind speeds of up to 55 knots with survival in wind speeds up to 120 knots
Tilt: 0 deg to + 18 deg adjustable from radar control panel (tilt is referred to nose of low beam)
High beam: Horizontal beamwidth 0.55 deg at — 3 dB points: Vertical beamwidth 2.5 deg cosecant squared to greater than 25 deg
Low beam: Horizontal beamwidth 0.55 deg at — 3 dB points: Vertical beamwidth 2.5 deg at — 3 dB points
Transmitters:
Magnetron peak power: 50 kW nominal
Pulse duration: (a) 0.1 microsec; (b) 0.5 microsec
Receivers:
Noise factor: Not worse than 10 dB
Frequency control: Automatic and manual
Characteristics: Linear: Linear differentiation; Logarithmic; Logarithmic differentiation; Wideband limiting; Pre-set sensitivity time control variable in range and level (all selected at radar control unit)
Displays:
Type: Autonomous rotating coil, desk-mounted plan position indicators
Quantity: Two displays are provided as standard equipment



Plessey 430 Airfield Control Radar Aerial assembly

Range scale: 4, 8, 16 or 32 nautical miles (7.4-29.3 km) per display radius
Range accuracy: Better than 10% of the range selected
Range ring accuracy: Better than 1% of the indicated range down to ½ nautical mile (0.93 km)
Azimuth accuracy: Better than ± 0.5 deg. The display system automatically aligns in azimuth
Environmental:
External temperature: —40 deg C to + 70 deg C
Internal equipment temperature: 0 deg C to + 40 deg C

MANUFACTURERS:
Plessey Radar, Addlestone, Weybridge, Surrey, England.

1140.153
PLESSEY AR-1 SURVEILLANCE RADAR

DESCRIPTION:
10 cm band, single-beam surveillance radar of modular design for fighter recovery, GCA surveillance, low-level surveillance, coastal surveillance and target acquisition.

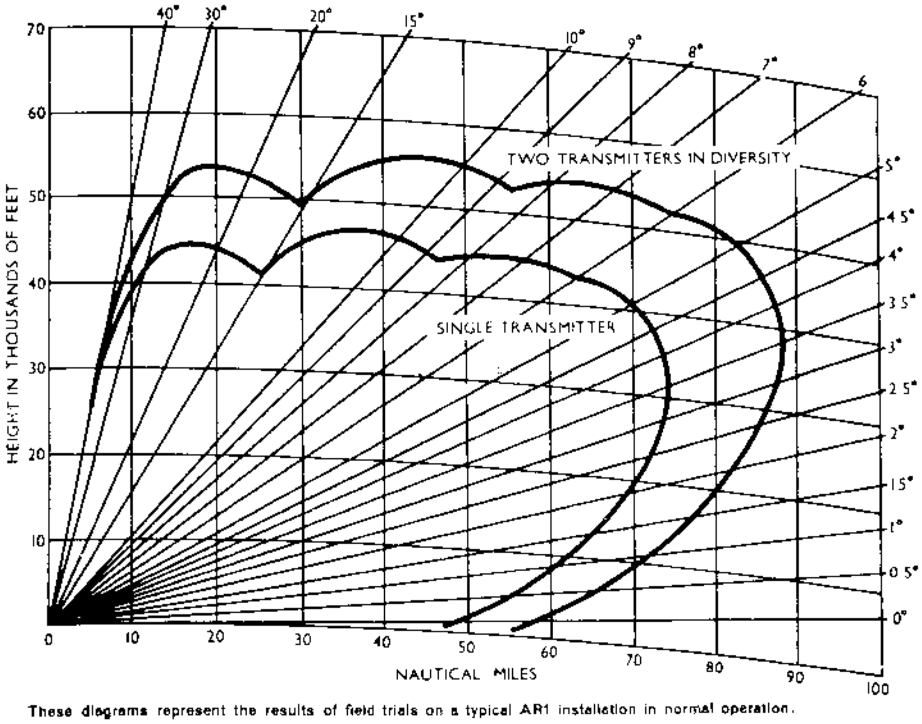
Coverage on Canberra-type aircraft extends to 120 km (75 nm) and over 12,000 metres (40,000 ft) with a single transmitter. With the transmitters in frequency diversity the coverage is 157 km (85 nm) to over 15,250 metres (50,000 ft) at 80% detection probability. (see coverage diagram).

DEVELOPMENT:
The AR-1 was developed as a private venture in 1963 and entered service in 1964.

More than 100 AR-1 units were ordered by the British Government and other countries.

The AR-1 has now been superseded in production by the AR-15 (**2456.153**).

MANUFACTURER:
Plessey Radar, Addlestone, Weybridge, Surrey, England.



FLIGHT TRIALS COVERAGE DIAGRAM

Aircraft type	Canberra
Blip-scan ratio	80%
Polarisation	Linear

These diagrams represent the results of field trials on a typical AR1 installation in normal operation.

2484.153
PLESSEY AR-3D THREE-DIMENSIONAL AIR DEFENCE RADAR

DESCRIPTION:

The following brief notes relate to a new radar introduced by Plessey Radar Ltd shortly before our press date for this section.

AR-3D is an S-band air defence surveillance radar giving three dimensional information on targets by mechanically rotating the radar beam in azimuth and electronically scanning in elevation. The latter process is carried out by using the "squint" effect of frequency variation when using a linear array. The aerial feed is such a linear array comprising a vertical waveguide, whose internal stepped construction slows the velocity of propagation within the guide and an array of slot radiators from the guide. By slowing the internal wave a substantial beam deflection can be achieved by means of a modest frequency variation.

A long pulse is radiated and the transmitted frequency swept within the pulse – the sweep waveform being adjusted to vary the dwell time with change of sweep angle so as to obtain the appropriate effective coverage pattern. Target returns are thus centred on frequencies which indicate target elevation angle with each pulse. The returns are filtered at the receiver to give the required effective elevation "lobing" in coarse sectors of about 2° each. Returns from each "lobe" are then pulse compressed using a new design of acoustic surface wave equaliser to give an effective pulse length of 0.1 microsecond. Fine angle measurement is then made by frequency measurement on the compressed pulses.

CHARACTERISTICS:

Coverage: Adjustable. Typically 180 nm on 2 sq m target

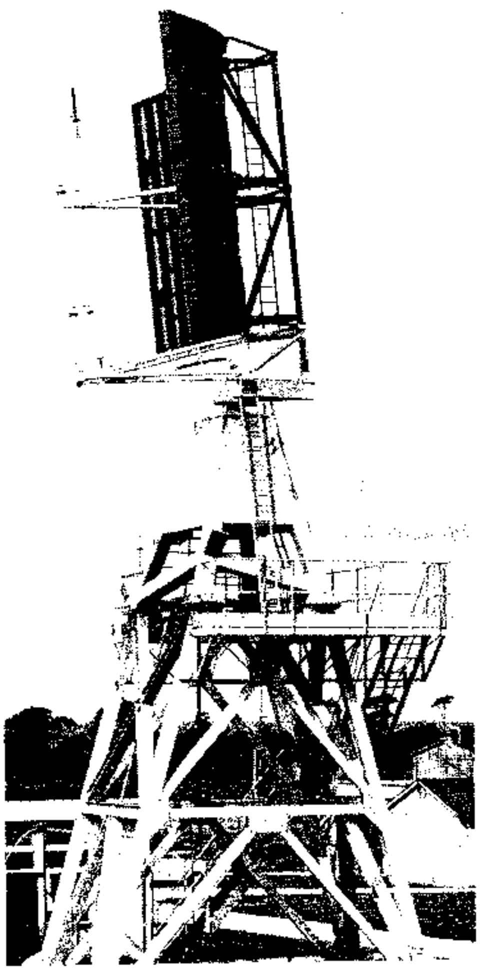
Radiation: Frequency selective within S band. The operating bandwidth is 200 MHz. Independent frequency selective filters for each of thirteen elevation channels, each having a band-width of approximately 20 MHz. The data below refers to linear polarisation.

Antenna:
Type: Linear array and parabolic cylinder
Polarisation: Horizontal
Beamwidth (azimuth): 1°
Beamwidth (elevation): 2°
Peak Sidelobe (azimuth): 25 dB
Peak Sidelobe (elevation): 23 dB
Scanning Angle: 30°
Adjustment: +4°–2°
Gain: 41.3 dB
Rotation Rate: 6 rev/min
Transmitter:
Peak Pulse Power: 1.11 MW
Mean Power: 10 kW
PRF: 250 pps
Frequency Band: S-band
Bandwidth (to 1.0 dB): 200 MHz
Pulse Length: 36 microsec
PA Tube: High power klystron grid modulated
Transmit Modes: Continuous or fast on/off
Receiver:
No. of Elevation Channels: 13
Bandwidth: 20 MHz/channel
Compression Ratio: 130:1 (lower channels)
Accuracy:
Elevation: 0.15°
Range: 15 m
Range Resolution: 40 m

STATUS:

An experimental model in an advanced development state was publicly demonstrated in June, 1974. Production models will use a new 1 MW klystron developed under UK government contract and the aerial will be somewhat larger than that illustrated here.

MANUFACTURER:
Plessey Radar, Addlestone, Weybridge, Surrey, England.



Experimental/demonstration model of Plessey AR-3D air defence radar aerial

2456.153
PLESSEY AR-15 SURVEILLANCE RADAR

DESCRIPTION:

Developed from the successful AR-1 series (**1140.153** above), the AR-15 is also an S band surveillance radar of modular design and suitable for operational uses similar to those for which the AR-1 was designed but including a so a mobile role (see **1141.153** below). The basic modules of the AR-15 can be used to provide a range of fixed installations with either single or dual transmitter/receivers.

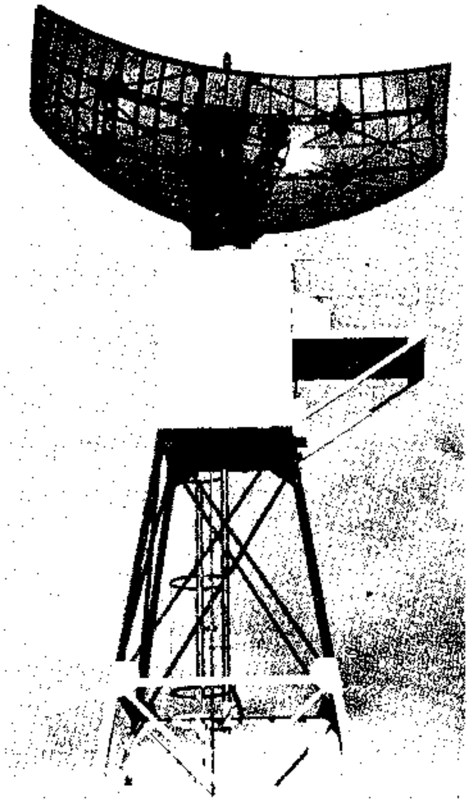
AR-15 coverage is similar to that of the AR-1 and the coverage diagram accompanying entry **1140.153** is representative also of the AR-15.

CHARACTERISTICS:

Frequency: Spot frequencies in the bands 2880 MHz to 3020 MHz (Alternative available)

Polarisation: Variable from linear through elliptical to circular. The performance figures quoted in this specification refer to linear polarisation.

Aerial:
Gain: 32 dB ± 1 dB relative to isotropic radiator
Horizontal aperture: 488 cm
Horizontal beamwidth: 1.5° to half power points
Vertical aperture: 198 cm
Horizontal sidelobes: –21 dB relative to maximum aerial gain within ±5°, –24 dB outside ±5°
Rotation rate: 15 rev/min clockwise. (At 50 Hz



Plessey AR-1 surveillance radar

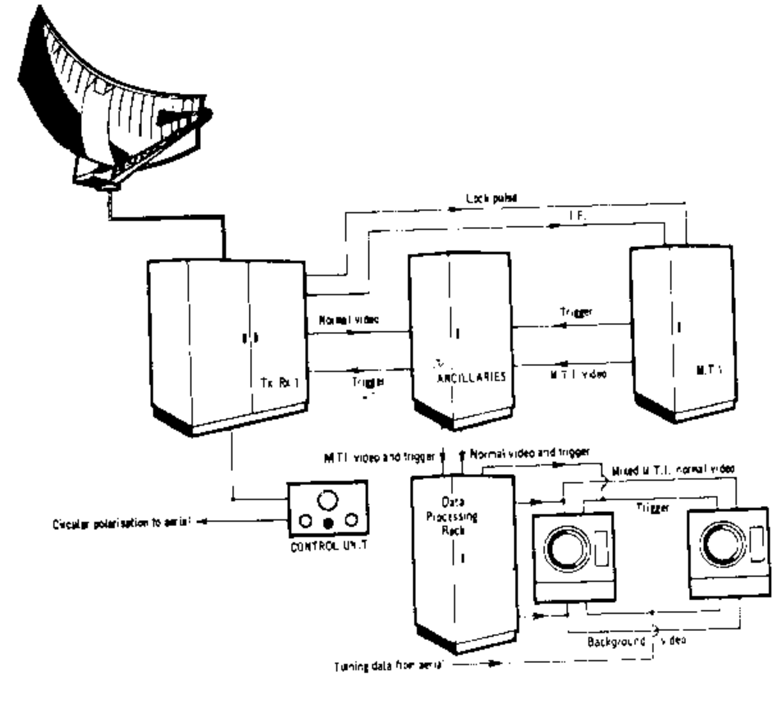


Diagram showing AR-1 radar system options

supply)
Windspeeds: Turning 70 knots. Survival 120 knot gusts
Transmitter:
Magnetron peak power: 625 kW nominal
Pulse length: 1 microsecond
Pulse recurrence frequency: 700 pps
Frequency range: (1) 2,700 to 2,900 MHz. (2) 2,900 to 3,100 MHz under local oscillator control
Receiver (Paramp):
Noise factor: Not worse than 4.5 dB
Intermediate frequency: 30 MHz
Overall bandwidth: 1.2 MHz
Automatic frequency control: AFC facility provided on magnetron
Receiver characteristics: Linear, Log, Linear plus differentiation, Log plus differentiation. (Selected at radar control unit)
Moving target indication: Digital MTI with cancellation ratio of 33 dB is fitted. This provides a typical SCV of 27 dB

DISPLAYS:
Transistorised fixed coil displays from the Plessey range.

STATUS
The AR-15 entered service in 1972 and is now in use overseas.

MANUFACTURER:
Plessey Radar, Addlestone, Weybridge, Surrey, England.

1141.153
PLESSEY AR-15 MOBILE SURVEILLANCE RADAR

DESCRIPTION
This is a mobile version of the AR-15 surveillance radar. Its performance is the same as for the static version (**2456.153**) but the equipment configuration is in some respects different.

The system is mobile with a cross-country capability which includes the possibility of deployment in desert conditions: the equipment is installed in containers which can be loaded into C-130 transport aircraft when detached from the trailers. The configuration of equipment is as follows:

Aerial Trailer:
A special purpose trailer which carries the aerial cabin, aerial and turning gear, with the IFF antenna mounted on the primary radar aerial reflector. Facilities for stowage of the off-mounted reflector and the other ancillary items are included.

Radar Container:
A container and trailer, which contains the radar transmitter-receiver equipment and the IFF transmitter-receiver, and has space for workshop facilities.

Radar Display and Radio Container:
A container and trailer which contains up to three radar displays, the IFF decoding equipment and up to three VHF/UHF transceivers with appropriate controls.

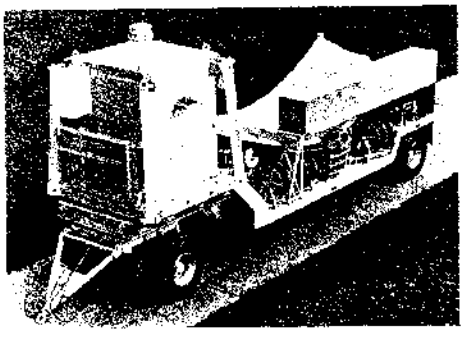
Diesel Generators:
Two mobile diesel generators are used for supplying power to the system. One of these is for stand-by purposes. In addition further cabins can be provided to house the crew and to provide mess facilities if required. The two diesel generators have adequate power to provide the local domestic supply for the crew.

AR-15 mobile system as deployed

DEVELOPMENT:
1970-1971.

STATUS.
In overseas service.

MANUFACTURER
Plessey Radar, Addlestone, Weybridge, Surrey, England.



Mobile radar aerial in road trim

2416.153
PLESSEY AR-5D AIR DEFENCE RADAR

DESCRIPTION.

This recently introduced radar is designed for the long range detection of small targets at both high and low levels. Operating in L band it has a maximum range coverage of 550 km, but its discrimination and short range performance are adequate to make it suitable for fighter recovery and marshalling as well as for long range detection.

The design concept provides for single and diversity transmitter-receiver configurations for maximum reliability and resistance to electronic countermeasures (ECM); and for use in conjunction with specialised ECCM receivers.

Particular attention has been paid to signal processing techniques which provide well defined aircraft responses in a form suitable for easy viewing by controllers using PPI displays and for compatibility with computer controlled data handling in air defence systems. IFF is available and can be fitted.

PERFORMANCE

Coverage is shown for typical military supersonic aircraft, using parameters selected to give maximum range.

The maximum display range of the AR-5 can be either 370 or 550 km depending upon the requirement. The high level coverage provided is sufficient to enable even the smallest aircraft to be tracked at maximum operational altitude. Low coverage at close range is also good and, subject to local siting limitations, it is possible to track aircraft to within 1.8 km of the aerial head. This performance is more than adequate for fighter recovery purposes whilst the ability to track fighters from take-off greatly simplifies operations by eliminating hand-overs from short-range to long-range radars.

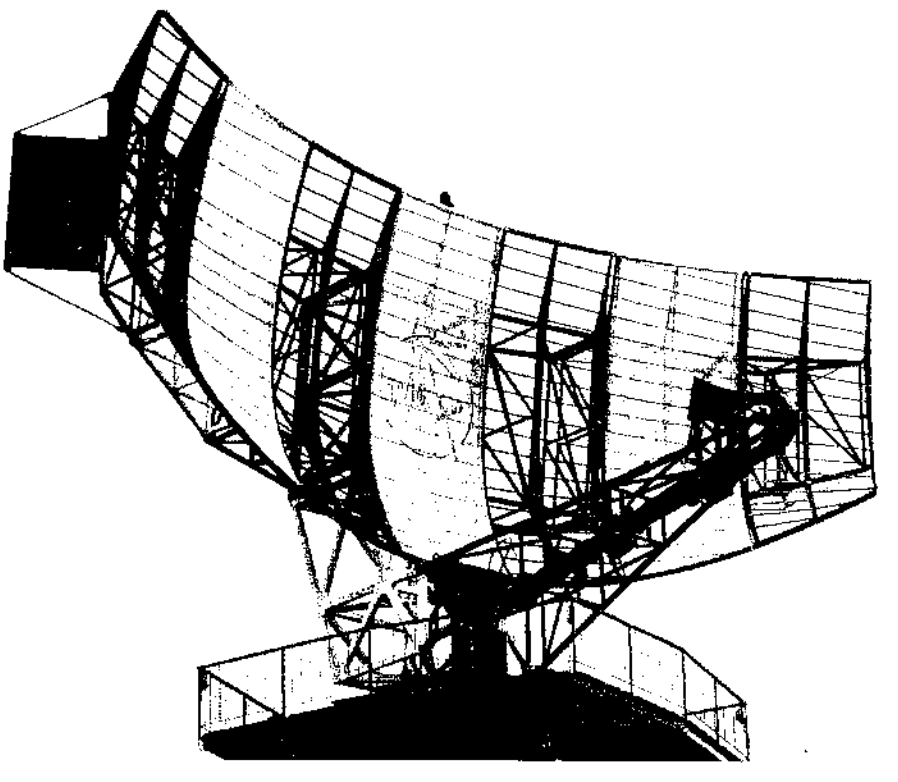
Two horns are used in the aerial feed system to derive the overall coverage pattern. The primary horn is used for both transmission and reception and provides the main pattern. The second horn, used for reception only, is fitted immediately below the primary horn and is adjusted to give a separation in elevation of approximately 5 deg between the axes of maximum gain of the two horns. The use of the second horn ensures adequate suppression of 'angels' whilst maintaining full coverage on wanted targets. Appropriate r.f. switching between the primary and secondary coverage patterns ensures that there is no loss of wanted targets.

Horizontal aerial beamwidth is 1.2 deg which provides an azimuth discrimination of 1 deg, thus ensuring that aircraft passing at a range of 370 km will be shown as separate echoes when separated by only 7.5 km. This, coupled with a range resolution of less than 290 m at maximum range, allows full control in the final stages of an interception.

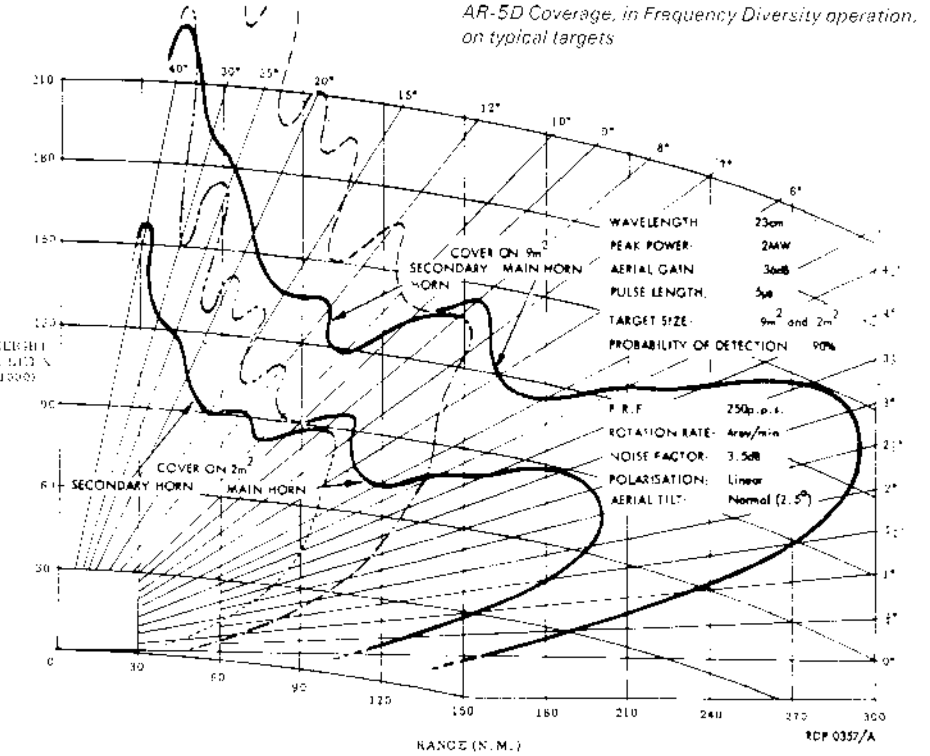
The standard aerial system has a rotation speed of 8 rev/min. This has been selected to meet the requirements of long-range detection, narrow aerial beamwidth and good MTI performance. The AR-5 employs a full transistorised digital MTI system which provides an overall sub-clutter visibility of 27 dB with the aerial rotating at 8 rev/min. PRF stagger is used to reduce the number of blind speeds. Using a single transmitter, the first blind speed is approximately 1,050 knots but with two transmitters operating in frequency diversity, there are no blind speeds within the performance capability of any envisaged aircraft.

Facilities are provided for superimposing raw radar video onto MTI video to enable the aircraft controller to select a background of permanent echoes which will not obscure aircraft returns. This facility enables the controller to provide a measure of terrain clearance to aircraft flying in the vicinity of high ground.

Weather returns are suppressed by use of variable linear to circular polarisation. Advantage is taken of the good target-to-clutter ratios at 23 cm operation to employ special receiver techniques for added improvement should any residual



AR-5D aerial



AR-5D Coverage, in Frequency Diversity operation, on typical targets

clutter remain after the introduction of circular polarisation.

CHARACTERISTICS.

Radiation:

Frequency: 1 or 2 frequencies in band 1,250 to 1,365 MHz. Each transmitter can be supplied optionally to operate on up to 4 selectable frequencies

Diversity guard band: 35 MHz nominal

Polarisation: Variable linear and variable from linear through elliptical to circular

Aerial:

Gain: 36 dB relative to isotropic radiator

Horizontal beamwidth: 1.2 deg at half-power points

Vertical beamwidth: 3.5 deg to half-power points with shaping to 40 deg

Aerial rotation rate: 6 to 15 rev/min single speed with option of half speed switching

'Angel' suppression: A second (receive) r.f. feed is provided

Transmitter:

Output valve: Tunable magnetron

Power output: 2.0 MW peak

Pulse length: In the range 2 to 5 microsec

Pulse recurrence frequency: in the range 250-750 pps with 7-period stagger

Receiver:

Type: Parametric amplifier

Over all noise factor: Not worse than 3.5 dB

Intermediate frequency: 30 MHz

Characteristics: Switchable to linear, logarithmic, Dicke f.x, ECCM logical (logarithmic with pulse length discrimination gated by Dicke-fix). Differentiation can be applied to any of these

Digital Moving Target Indicator:

Type: Double loop cancellation

Cancellation: Rack only 41.5 dB
Power Supplies:
Voltage: 380-440 V, 3-phase, +6%
Frequency: 50 Hz or 60 Hz
Power: 70 kVA total load at nominal 0.85 power factor and wind speed of 60 kt
Environment:
External equipment: Temperature, −40 deg to +70 deg C
Radar head equipment: Temperature, 0 deg to +55 deg C
Humidity: From 0 to 100%
Aerial: Rotation at 8 rev/min in wind speeds up to 80 kt (148 km/h) un-iced. Rotation at 8 rev/min in wind speeds up to 60 kt (111 km/h) iced up to 9.7 kg/sq metres. Survival in wind speeds up to 120 kt (222 km/h) un-iced

STATUS:

AR-5D has been selected by the British and other Governments and meets a wide range of operational requirements. Display systems are available to meet all applications from the simplest to the most complex computer-controlled Air Defence Control Centre.

The Plessey Type HF 200 Heightfinder Radar (**1142.153**) is of compatible performance and is normally supplied as the heightfinding element in ground controlled (GCI) systems.

MANUFACTURER:

Plessey Radar, Addlestone, Weybridge, Surrey, England.

1142.153
PLESSEY TYPE HF 200 HEIGHT-FINDING RADAR

DESCRIPTION:

This is a high power S-band nodding heightfinder which can be integrated with any plan radar. The nodding aerial has high gain (40 dB), a narrow vertical beamwidth (0.75 at 3 dB points) and fast slewing and nodding speeds can be imparted to the 35 ft (10.67 m) reflector by the action of two separate hydraulic systems. The maximum vertical sweep arc of the reflector is 36° but in the case of long range targets, where even at high altitudes the angle subtended is relatively small, the angle of sweep is automatically reduced as a function of range to avoid unnecessary waste of time and RF energy.

The hydraulic nodding system forms an integral part of the aerial structure and the hydraulic slewing system consists of a gearbox and motor on the aerial structure with an oil pump and control mechanism mounted in a box at the base of the aerial.

An S-band transmitter of 2½ MW peak power and an RF head which includes the receiver (which incorporates a selection of anti-jamming facilities) are contained in two adjacent cabinets.

Type HF 200 radar data is displayed upon a height range indicator (HRI). This may be associated with one or more azication PPI displays, height information being displayed upon a height scale at the HRI display and upon indicators at the PPI positions.

Relative heights between two aircraft may also be measured and the information indicated remotely.

Control of the aerial can be effected automatically from a suitable azication PPI whose operator adjusts a variable range and bearing marker line or symbol so that it coincides with the echo from the selected target. This action automatically applies position control signals to the hydraulic systems. The aerial slews on to the target bearing and the reflector nods over an angle sufficient to illuminate the target and the length of the height/range strobe on the HRI display alters to correspond to target range.

In computer-controlled data handling systems the aerial can be controlled automatically, the target height data being updated in a sequence determined by the computer programmes.

A basic control system based on verbal communication between PPI positions and the HRI operator is also available as a fundamental capability.

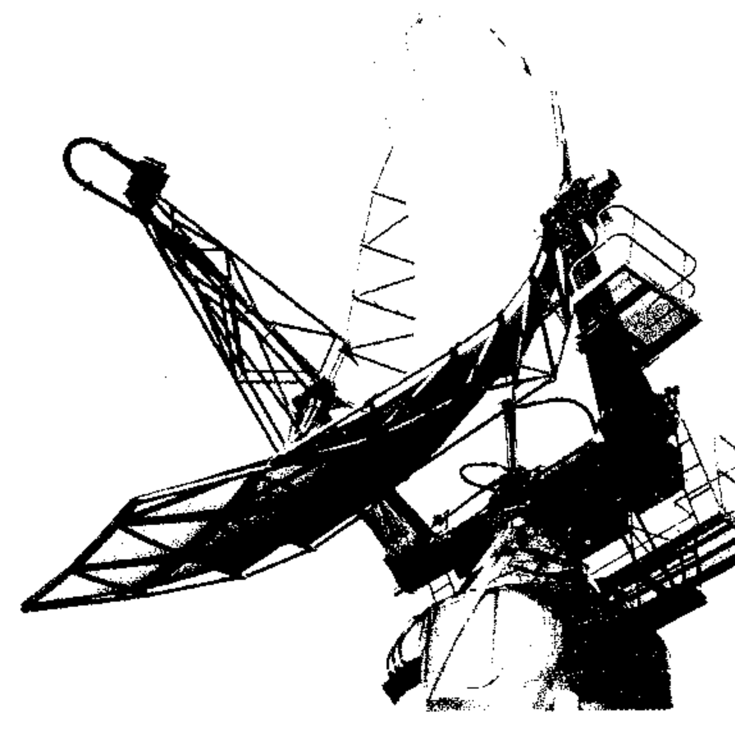
OPERATION:

The precise operational use for which the height data is intended determines the number of heightfinders and the nature and arrangement of the display equipment. For emergency early warning applications the heightfinder can be fitted for operating in a volumetric standby role over an adjustable azimuth sector which may be centred on any bearing.

Automatic Azication programming

This sub-system consists basically of a digital computer with a permanently wired-in programme. It is reliable, practically tolerance free and has operational flexibility.

A digital allocator uses a set of 14 bus highways in a ring-main configuration to couple all or any of the PPI to the allocator (up to 29 PPI may be used with one Type HF 200). Five of the highways specify a digital address which connects the designated PPI to the highway, five more specify the



Plessey HF 200 radar head

function of mode in that PPI and the remaining four carry a decimal number. A similar analogue system composed of some 8 bus highways is used to carry all the analogue information between the allocator and the PPI in use. Each PPI would have its own indicator unit for the height readout, complete with its own binary stores and decoders. It communicates exclusively with the digital allocator for all demands, height data and mode indication. Height requests are normally dealt with on a sequential basis, though selected PPI positions can request on a priority basis.

The allocator first scans the PPI positions sequentially for priority requests. If there are no priority requests and the aerial is free, the allocator will scan for non-priority requests and allocate control of the heightfinder accordingly. All PPIs have the facility for making absolute or relative height requests on a non-priority basis; priority facilities should be accorded only to certain selected PPI.

When a PPI position is granted control of the Type HF 200, the allocator conveys range and bearing information on the target in question to the HRI and aerial as required. After acting on this, the heightfinder system feeds target height information back to the allocator, where it is converted from analogue to digital form and routed via the digital highway to the height indicator of the requesting PPI. The height is indicated for a period of 30 seconds, or until the next request, and is represented by three figures and a decimal point, giving height in units of 100 ft.

Priority requests take precedence but any non-priority height processing already taking place in the system will be completed before attention is given to the priority request. A light indication appearing in place of the first figure on the digital height indicator (red for priority and green for non priority) informs the PPI operator that his request is next to be answered. A relative request will allow access to the height finder for two target height measurements, and the second readout will be the relative height between the two targets.

An extension of the allocator system permits the use of two Type HF 200 with up to 29 displays. In this case, two interface units optimise the use of the two heightfinders, while a control-allocator channels the PPI position requests and replies as already described.

DEVELOPMENT

Development was initiated in 1956 and the first prototype was completed in 1957. The first HF 200 entered operational service in 1958. Continuous development and improvement has been maintained since then.

CHARACTERISTICS:

Aerial System:
Reflector: Perforated aluminium alloy double curvature surface having a horizontal aperture of 2.44 m and a vertical aperture of 10.67 m
Polarisation: Variable, linear to circular (All figures given below are for linear polarisation)
Vertical beamwidth: Not greater than 50 minutes of arc at −3 dB points
Vertical sidelobes: (a) First or major side lobes better than −23 dB. (b) Minor sidelobes within ±8° of centre of main lobe better than −25 dB (c) Sidelobes from ±8° to ±13° better than −27 dB
Horizontal beamwidth: 2.5 ± 0.5° at −3 dB points
Gain: Better than 40 dB with respect to an isotropic radiator
Maximum nodding angle: −3° to +33° (with video blanking for 2° approximately at bottom end of nodding sweep)
Nodding rate: 20 sweeps per minute for the maximum nod angle (36°). 60 sweeps per minute for the minimum nod angle (8°)
Variation of nodding rate: Automatically as a function of range, giving an increased data rate

on long range targets

Nodding mechanism: Oil hydraulic system

Maximum slewing speed: 6 rev/min in either direction

Acceleration rate: 43 degrees/second^2

Slewing rate: Typical examples from state of rest to state of rest are: 30° in 2.1 seconds; 60° in 2.9 seconds; 120° in 4.4 seconds; 180° in 5.9 seconds

Slewing mechanism: A servo-controlled oil hydraulic system capable of providing the above rates with an adequate safety margin and operating with a maximum error of less than $\pm\frac{1}{2}°$. These speeds are obtainable in winds of 60 knots with an ice loading of 2 lb/ft^2. The aerial is capable of operating in an 80 knot wind without appreciable reduction of performance

Data transmission: A magslip resolver, coupled 1:1 with nod shaft, feeds nodding data to height/range display

Angle markers: Pulses of 5 volt amplitude with a separation of 2.5° are fed from an elevation angle marker generator

Volumetric scan: The sector sweep is variable from 3°-90° in steps of 3°. The start of the sector can be positioned at any azimuth angle throughout 360° (optional)

Circular polariser: Variable from linear through elliptical to circular. Ellipticity not greater than 1 dB in circular setting

RF bandwidth: 100 MHz within the frequency limits of 2,850-3,100 MHz

Slew video blanking: During slewing, microswitches give video blanking on the HRI display to within approximately 3° of the azication bearing

Transmitter/Receiver:

Frequency band: 2,850-3,100 MHz

Magnetron peak power: 2.5 MW nominal, subject to a duty cycle not exceeding 0.00142

RF pulse length: 5.5 microseconds nominal

Pulse repetition frequency: Preset in the range 220-230 pps

Receiver noise factor: 3.5 dB nominal at input to paramp

Receiver characteristic: Choice of linear, logarithmic, or ECCM processing

Differentiation: Can be applied to the selected video

Receiver bandwidth: 4.5 MHz logarithmic, 225 KHz linear

Receiver IF: 30 MHz (nominal)

Automatic frequency control: Maintains IF to within $\pm$50 KHz

Swept gain: Variable, pre-set at head amplifier

STATUS:

HF 200 radars are in world wide service. The latest solid-state version of the equipment is in production.

MANUFACTURER:

Plessey Radar, Addlestone, Weybridge, Surrey, England.

2424.153
RAPIER SEARCH & ACQUISITION RADAR

DESCRIPTION:

This system is an integral part of the Rapier anti-aircraft guided weapon system (**2424.131**). Little information has been officially released on this part of the system, and the following is an assessment based on available data.

This equipment comprises a primary surveillance radar working in conjunction with a computer and a secondary radar (IFF) interrogator-responsor to locate, identify and, where appropriate, initiate the tracking of enemy targets. The whole equipment is located in the Fire Unit of the Rapier system.

In the search mode the radar – a coherent pulsed Doppler equipment – scans continuously through 360° in azimuth. When a target is detected its azimuth range and velocity are measured, and on the same scan it is interrogated by the IFF whose dipole aerial is mounted on and rotates with that of the primary radar. If a "friendly" response is received the information on that target is cancelled from the system and the search continues without interruption.

If the target is adjudged hostile, an alarm signal is sent to the remainder of the equipment, the measured co-ordinates are used to direct the Tracker (see description of Rapier) towards the target and the operation of the radar is restricted to an arc containing the target.

It is, of course, possible that a friendly target might fail to respond to the IFF interrogation on a single pass of the surveillance system – e.g. because of an unfavourable aspect of the airborne aerial – but the above procedure provides time for a "friendly" response to be received before the engagement has gone too far.

STATUS:

Since the complete equipment forms an integral part of the Rapier system, deployment and similar details given in the description of the weapons system apply equally to the search and acquisition radars.

MANUFACTURERS:

Primary Radar and Aerials

Decca Radar Ltd, Decca House, Albert Embankment, London SE1 7SW, England.

Microminiature IFF Equipment

Cossor Electronics Ltd, Pinnacles, Elizabeth Way, Harlow, Essex, England.

2428.153
SCORPION TARGET ILLUMINATING RADAR

DESCRIPTION:

Scorpion is a target illuminating radar (TIR) used with the Bloodhound surface-to-air guided missile system. Intended primarily for use with static installations of this system, the equipment can nevertheless be dismantled into transportable units.

Basically an X-band CW Doppler autofollow radar, the equipment also performs the functions of illuminating the target and thereby providing the reflected radiation to activate the semi-active homing system of the Bloodhound missile. In addition it has a limited target search facility and is equipped for target identification.

In its normal operational role the TIR is supplied with target and range bearing information from an associated surveillance radar. After appropriate co-ordinate transformation this data will define the target's position in a region bounded by bearing and elevation arcs which may be further restricted if information from a height-finding radar is also available. The TIR aerial system is so arranged that it can search the region thus defined and locate the target, whereafter it is locked on and follows the target automatically. Simultaneously, a positive identification process is initiated, resulting in a decision made by the Engagement Controller in the Launch Control Post (LCP) whether or not to engage the target.

When following a target the radar supplies angular position and velocity co-ordinates to the LCP. The missile launchers are servo-controlled using this positional information so that the missiles are always aligned and ready for firing. When a missile has been launched the TIR continues to track the target; and the reflected signal is used by the homing equipment in the nose of the missile to bring it close enough to the target for the proximity fuse to detonate the missile warhead.

A CW system was chosen for the Bloodhound TIR because of its good performance in the presence of natural or ECM interference. Scorpion is one of two TIRs available for use with Bloodhound, the other being FIRELIGHT which is a similar radar better suited to mobile roles. Scorpion is a larger radar than Firelight – the linear dimensions of the aerial system being twice as great – and has therefore a better long-range performance: furthermore, advantage has been taken of the added equipment space available to build in a considerable amount of circuit duplication with consequent increase in reliability.

CHARACTERISTICS:

Type: Static CW Doppler auto-follow radar

Frequency: X-band

Main Aerial: 4.2 m diameter

Facilities: Search and follow. Target identification

Associated system: Bloodhound SAGW System

MANUFACTURER:

Marconi Radar Systems Ltd, Leicester, England.

2439.153
RAPIER TRACKING RADAR

DESCRIPTION:

Only limited information is available regarding this "blindfire" attachment for the Rapier surface-to-air guided missile system (**2424.131**), which was first shown in mock-up form at the 1970 Farnborough Air Show and in engineered form two years later.

The radar has been developed by the Radar Control Division of Marconi Space and Defence Systems, with Marconi-Elliott Avionic Systems as a major sub-contractor. This development was carried out on a UK Ministry of Defence funded programme with the British Aircraft Corporation as prime system contractor. The radar is designed to meet the threat posed by more advanced low-level strike aircraft which can operate at night and in low visibility. Until these aircraft became a real threat, low-level high-speed attacks were carried out in daylight and the original 'clear-weather' Rapier was devised by BAC with optical tracking to meet this threat. With the radar tracker in the system, the operator has a choice, up till the moment of launch, of which system will be the most efficient for the engagement.

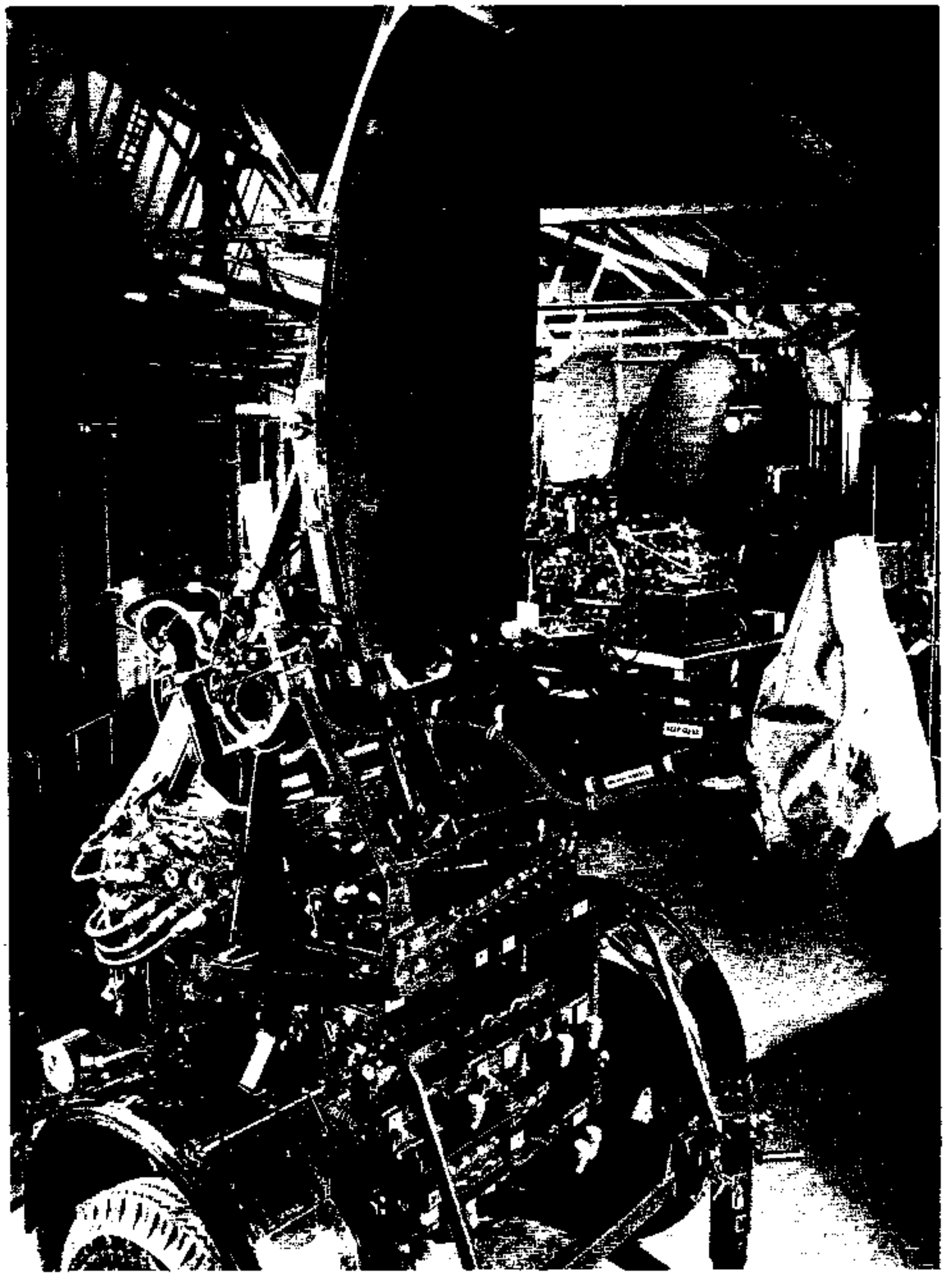
The radar incorporates advanced electronic techniques using boresight errors for accurate positioning of its own aerial and the angular difference between the missile and target sightlines for the generation of command guidance signals. The extremely narrow beam-width is the key to the accuracy and very low-level capability of the system, and also reduces the chances of background clutter, such as ground echoes or rainfall, obscuring the target echo. A number of other electronic measures are also designed into the system to minimise the effect of clutter and other unwanted signals.

The tracking radar is initially alerted to a hostile aircraft by the system surveillance radar, which indicates the approximate direction of the threat. The tracking radar will immediately swing onto this bearing, and rapidly establish the exact bearing, range and height of the target. When the radar is locked onto the target, the missile is launched and this, too, is tracked by the radar. The difference between the target and missile angles is instantly derived within the system and commands are automatically transmitted to the missile to guide it onto the target.

With a very fast-reacting, lightweight and mobile system such as Rapier, it is vital that the radar fits in with the operational concept with minimum change. The radar tracker is a self-contained, 'plug-in' unit, and requires no extra personnel to operate it.

STATUS:
An initial production contract was announced early in 1973 and the equipment is now in full production.

MANUFACTURER:
Marconi Space and Defence Systems Ltd, Warren Lane, Stanmore, HA7 4LY, England.



Rapier 'blindfire' radars in production

2466.153
ST850 TIGERCAT RADAR
DESCRIPTION:
Designed for use with the Tigercat surface-to-air missile system (**2465.131**) the ST850 radar with its associated television equipment gives the missile system an all weather capability as well as enhancing the clear weather performance through the provision of a television auto-gather facility. In conditions where the missile is visible, it is automatically gathered within a few seconds of launch after which the engagement is completed manually from the television monitor. In bad weather or at night, the missile is acquired by a second channel in the radar and indications of its deviation from the target line of sight are presented on the television monitor, enabling the operator to complete the engagement.

The radar is housed in a mobile cabin and can be integrated with the S860 and S865 mobile surveillance radars.

The cabin contains a two-bay equipment cabinet: one bay houses the tracker servo drive circuits and the X-band transmitter; the other houses the receiver and signal processing equipment and the master programming unit.

System controls and monitoring/indicating equipment are located in a separate control console sited at one end of the cabin. Two operator positions are provided at the console – one for radar/television operation and the other for missile control.

The cabin is fully air conditioned and its dimensions are approximately 3 metres long by 2 metres high by 2 metres wide. It is fitted with attachment points for mobilisors, screw jacks for levelling and lifting eyes for transportation.

The director is mounted on the roof of the cabin. It carries a 1 metre diameter aerial and the television camera. It is capable of continuous rotation in azimuth, being mounted clear of the cabin roof so that radar and television visibility extends from an elevation of 85° to a depression of 5°. When the equipment is sited higher than the surrounding terrain, targets flying below 0° elevation level can be tracked.

Facilities are incorporated in the director support framework on the cabin, so that the director can be lowered from its operational position into the cabin for stowage during transportation, when its overall height is 2.4 metres.

The aerial is of the twist-cassegrain type. A four-horn monopulse feed and comparator provide three separate r.f. outputs (viz. sum, elevation difference and azimuth difference signals) for processing in the i.f. receivers to produce acquisition and auto-follow data. High accuracy of angular data results from the combination of a narrow pencil beam and the monopulse signal processing.

The television camera is aligned to the radar boresight and provides optical information on the target being tracked by the radar. This system consists not only of a conventional camera and display, but also a data processing system which permits gathering of the Tigercat missile on to the television line of sight.

The pulse modulated transmitter employs an X-band magnetron to deliver a typical power of 160W mean and 180 kW peak. The magnetron is motor tunable over the frequency band 8.6 GHz to 9.5 GHz, being manually controlled from the radar console.

The local oscillator is a solid-state microwave source with voltage tuning to permit automatic frequency control, which controls the oscillator frequency to follow the tuning of the magnetron and maintains the correct intermediate frequency in the receiver.

The r.f. portion of the receiver system is housed on the elevation assembly behind the aerial. The i.f. outputs are connected via co-axial cables and the azimuth slipring unit to the i.f. portion of the receiver, which is housed in one of the equipment cabinets in the cabin.

The signal processing has two channels: the main one for acquisition and tracking of the wanted target; the subsidiary one for acquisition and tracking of the missile. All functions are carried out automatically using digital techniques under control of the master programming unit.

The master programming unit organizes the operational sequence of the radar in response to commands from the operator at the control console, and signals from the radar sub-system.

In defence situations where Tigercat missiles are supported by AA guns, the S1850 fire control unit can be extended, by the addition of a general purpose digital computer, to form the S1851. This latter unit can give prediction of aim off and automatic system control thus providing blind-fire gun control.

In support of the S1850 and S1851 tracking radars, the mobile surveillance radars type S860 and S865 are available. The S860 is fully autonomous with its own operators whilst the unmanned S865 feeds data to the tracker cabins but both can provide target indication facilities for multiple fire control units.

MANUFACTURER:
Marconi Radar Systems Ltd, Chelmsford, Essex, England.

2490.153
ZB 298 SHORT-RANGE GROUND SURVEILLANCE RADAR

DESCRIPTION:
ZB 298 (British Army nomenclature GS No 14 Mk 1) is a mobile radar for the detection, recognition and location of moving targets on the battlefield by day and by night in all weather conditions. In addition to these battlefield surveillance and target acquisition functions it can also be used for adjustment of artillery and mortar fire, for border protection, for sea and river surveillance and for protection of airfields and installations.

DESCRIPTION:
ZB 298 is a non-coherent pulsed doppler radar operating in X-band with a range out to 10 kilometres. Other than a long-life magnetron of proven high reliability, solid state techniques are employed throughout. The radar is inherently rugged in construction and requires no extra protection or special cases for transit. In its man-portable role it can be carried by two men.

The equipment can be brought into or out of action in 2-3 minutes, and is operated by one non-technical operator. Operator controls have been kept to a minimum and number five only.

The display unit, from which all operations of the radar can be controlled (including movement of radar head in azimuth and elevation), incorporates a unique solid-state visual display, which allows moving targets to be simply and rapidly acquired (and tracked), even in the presence of clutter and other interference. An audio display (headset) allows the operator to listen to the doppler signal of the selected target: these signals permit easy recognition of the type of movement.

The radar head is mounted on a tripod and the display unit – from which all radar functions can be controlled – can be located 20 or more metres away. The radar head can also be mounted on a wide range of military vehicles with the display unit inside. If required, the radar can be operated with the vehicle hatches closed.

OPERATION:
The radar head is controlled in azimuth and elevation by handwheels mounted on the display unit. The visual display is a gallium phosphide screen on which are displayed signals from any selected 1,000 metre range zone – adjustable in 500 metre steps and incorporating a 50 metre range marker bracket. Fine range control allows adjustment of range to 5 metres. An audio gate is ganged to the 50 metre bracket enabling audio signals appearing in that gate to be heard in the headphones. In addition, a 1,000 metre audio gate is available to give audio alarm over a selected 1,000 metre band.

Range presentation is by means of numerical indicator tubes giving direct range reading in 5 metre steps. Azimuth is shown on a direct-reading scale of mils with 2-mil graduations and elevation on a similar scale with 10-mil graduations.

DEVELOPMENT:
ZB 298 was developed on a British Government contract starting in 1964. The first prototype (B model) was completed in 1966 and the equipment is now in service. It is used by infantry battalions, armoured reconnaissance regiments and artillery observation posts.

TEST AND TRAINING EQUIPMENT:
Special check out and fault diagnosis equipment is supplied by the manufacturers enabling repairs to be effected by non specialist technicians.

A simulator, developed concurrently with the main equipment, makes use of audio signals previously recorded on tape from a ZB 298 radar. Up to four standard ZB 298 display units can be connected to the simulator. The simulator allows the instructor to control and graduate instruction, and the operator can be practised in all aspects of detecting, tracking (in range and azimuth) and recognising targets in a variety of different conditions including clutter and ECM effects, using all the controls on the display unit. With the aid of the simulator an operator can be trained to operate ZB 298 in a matter of days. The simulator also enables regular practice to be given in the recognition of different classes of targets.

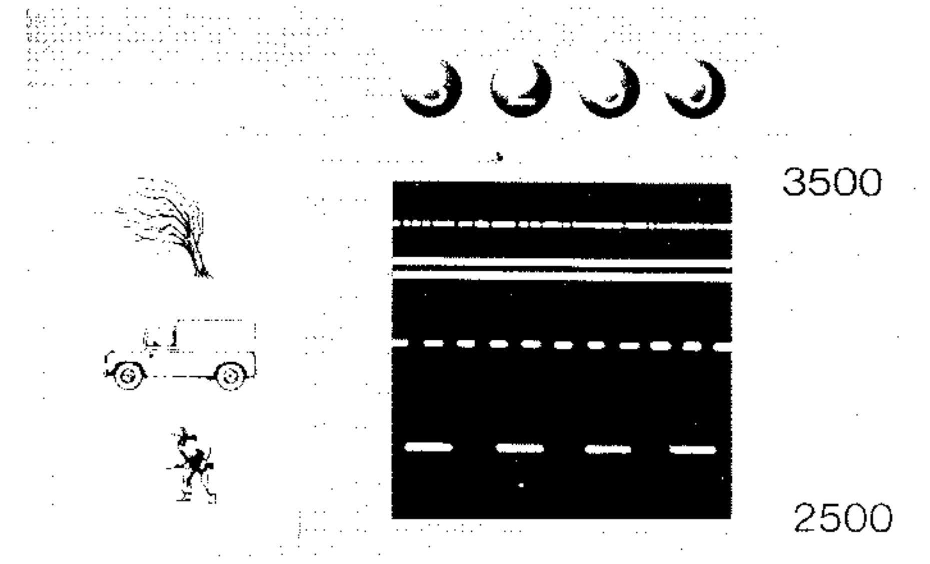
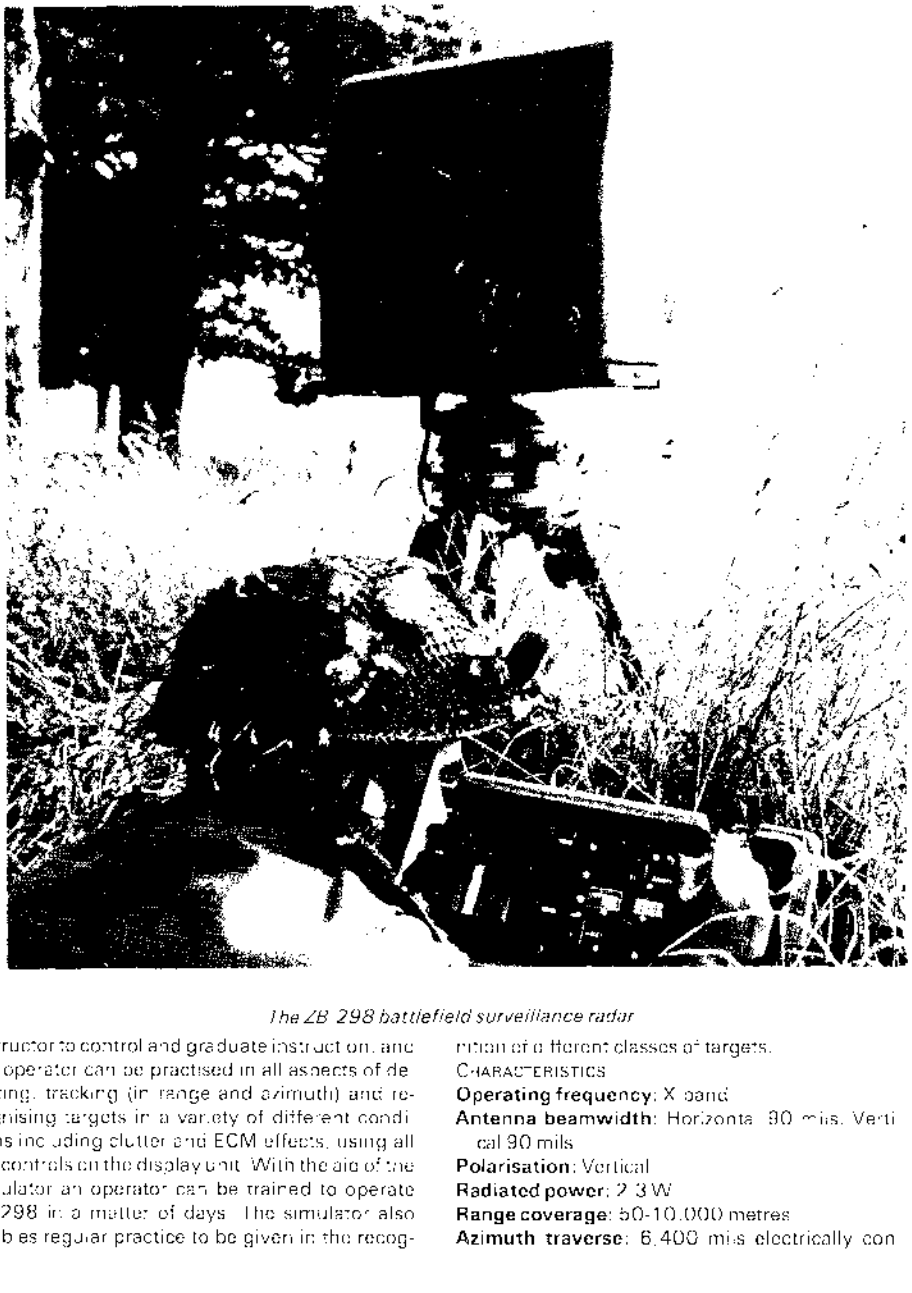
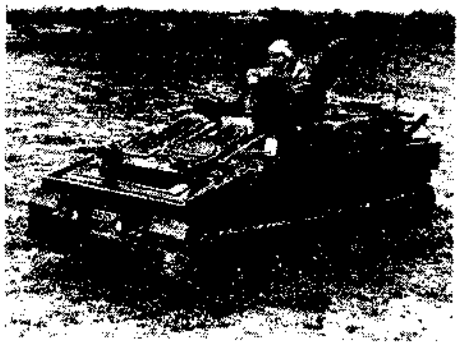


Diagram of ZB 298 solid-state visual display, showing appearance of various types of target, range, read-out and range markers. The continuous double line shows the position of the range marker and the numerals above denote its range

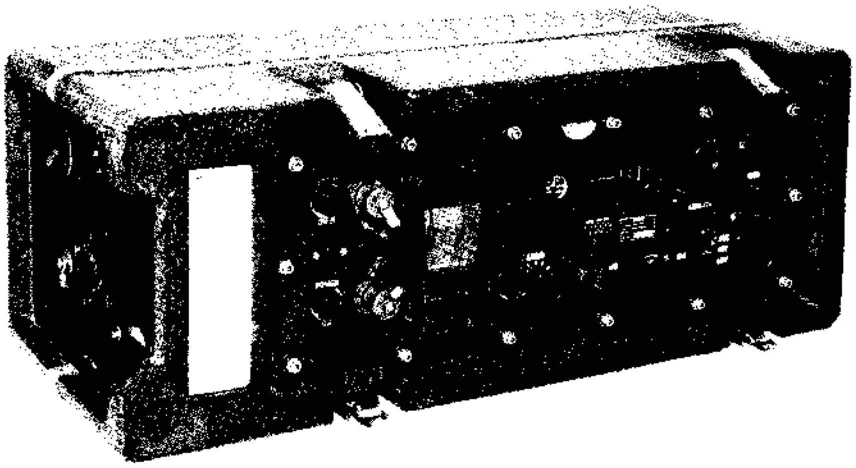


The ZB 298 battlefield surveillance radar

CHARACTERISTICS
Operating frequency: X band
Antenna beamwidth: Horizontal 30 mils, Vertical 90 mils
Polarisation: Vertical
Radiated power: 2.3 W
Range coverage: 50-10,000 metres
Azimuth traverse: 6,400 mils electrically con



ZB 298 mounted on the Spartan armoured personnel carrier



ZB 298 control and display unit

trolled from display unit
Elevation limits: +355 mils electrically controlled from display unit
Weights (approximate):
Radar head: 11.36 kg
Display unit: 8.36 kg
Tripod: 10.00 kg
Battery: 10.44 kg
Physical dimensions:
Radar head: 508 × 483 × 178 mm
Display unit: 508 × 187 × 203 mm
Tripod: Length collapsed 610 mm. Max dia 292 mm
Cables: Data (display to tripod) 3 m long or 30 m. A longer cable can be provided if required
Power (display to battery) 2 m (78 in)
Temperature range: Operating −40°C to +50°C: stored −40°C to +70°C
Power supply: U.K. Army uses Varley 24V secondary battery, non-spill, lead acid. Alternative batteries to meet special user requirements can be provided

MANUFACTURERS:
Marconi-Elliott Avionic Systems Ltd. Mobile radar Division, Elstree Way, Borehamwood, Herts, England, (a member of GEC-Maroni Electronics).

2410.153
COSSOR IFF GROUND EQUIPMENT

Since pioneering sidelobe suppression techniques in the early 1950s, Cossor Electronics have maintained an important role in the field of SSR/IFF. They have had wide experience in the planning and installation of civil SSR and military IFF systems and their current range of compatible surface equipments includes:

SSR.700 – Civil/military SSR/IFF ground systems.
SSR.750 – Military defence IFF system.
SSR.800 – Naval IFF systems.
CVP.100 Series – Video processing equipments.
CRS.320 – SSR/IFF aerials for on-mounting.
CRS.381 – Off-mounting or autonomous operation.

Miniaturised IFF Mk. 10 (SIF) Systems

A range of IFF systems of rugged construction is available:

IFF.825 – For mobile radar systems.
IFF.825M – Variant of IFF.825 for marine use (Fast Patrol boats).
CVP.114 Series – Defruiter/Decoder equipment.

IFF for Missile Systems:

Cossor have developed and manufactured the IFF elements for the following missile systems.

Blowpipe – (**2409.131**)
Rapier – (**2429.131**)
Thunderbird – (**2460.131**)

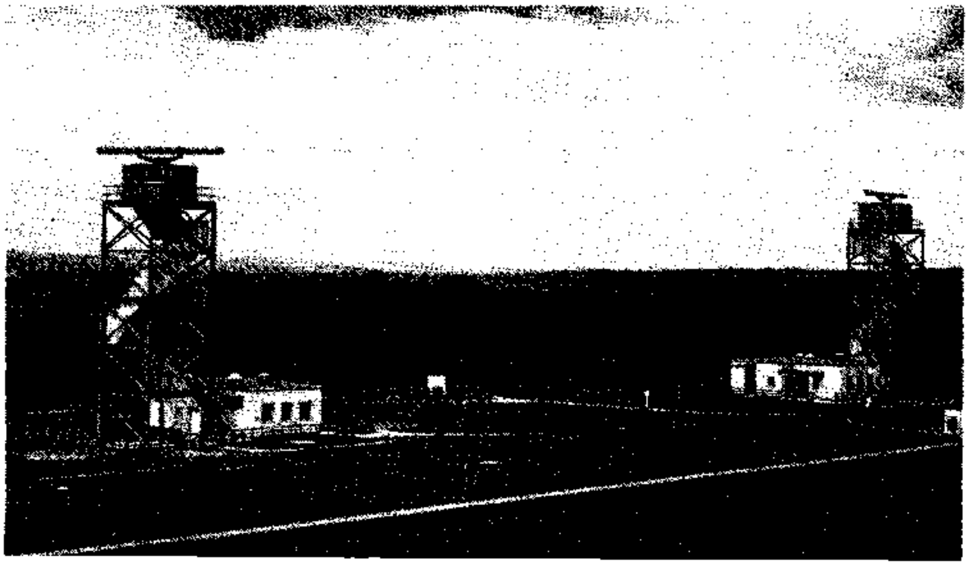
SSR.700

DESCRIPTION:

Designed for static installations, the SSR.700 system is compatible with many primary radars in an on-mounted configuration. The secondary radar aerial can be slaved to a primary for an off-mounted configuration, or the system can be used autonomously.

The SSR.700 interrogator-receiver uses solid-state techniques throughout, except for the final amplifier stages and the equipment parameters fully meet the requirements of STANAG 5017 and ICAO Annex 10.

When a primary radar has a spare channel in the rotating joint for IFF, the secondary aerial may be on-mounted. Aerials of different apertures are available to suit the IFF system requirements. Each aerial can provide three-pulse sidelobe suppression with pattern switching provided by a high speed r.f. switch above the rotating joint. The design of this switch obviates the need for an external drive pulse.



The Cossor SSR installation at Burrington, Devon

In the off-mounted configuration sidelobe suppression switching is performed in the interrogator.

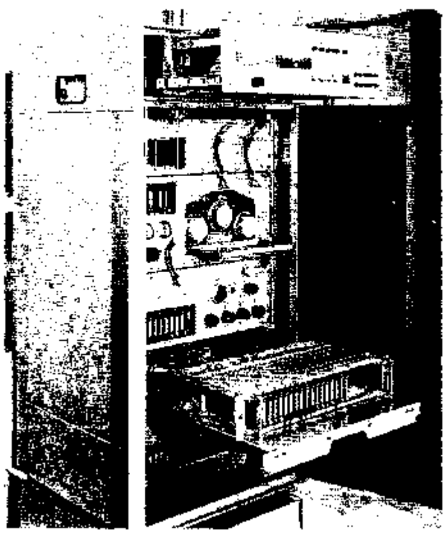
Automatic changeover between channels is included and extensive remote control facilities are provided.

The replies from transponders can be processed in a number of different ways and equipments are available to provide:

passive decoding
active/passive decoding
plot extracted data

The manner of presentation of processed data can be arranged to suit the desired arrangement.

CHARACTERISTICS:
Transmitter performance:
Frequency: 1,030 + 0.1 MHz
Power: 2 kW (peak)
Pulse Duration: 0.8 + 0.1 microsec
P.R.F.: 150 Hz to 450 Hz
Transmission modes: All civil/military modes. Pulse spacing tolerance +0.1 microsec
Mode Interlace: Single. Double. Triple. Triple with Aerial



SSR 700 equipment rack

Receiver performance:
Centre frequency: 1,090 + 0.1 MHz
Bandwidth: 10 MHz at −3 dB points
Defruiter: Cross mode correlation type with selection of 2/6, 2/7, 2/10 defruiting criteria. Store cycle time, 1.3 microsec. Range to suit requirements
Decoder: Facilities to suit requirements
Available controls: Raw – undecoded replies displayed. Bracket Decode – All transponders replying with bracket pulses are displayed. Mode/Code – all transponders replying with the mode/code as selected give an additional display indication. SPI – All transponders replying with the special identification pulse give a particular display indication
Emergency/communications failure: Transponders replying with code 7700 or code 7600 give a special display indication
Mode C decode: Height translation of Mode C replies by Flight Level or active display

STATUS:
The first system was delivered in May 1970. Equipments have been ordered by United Kingdom Board of Trade, Norway, Sweden, Denmark, Austria, Australia, Thailand, Israel and SHAPE Technical Centre.

A high power derivative, SSR.750 has been ordered by the United Kingdom Ministry of Defence (Air) for the Air Defence Radar Stations.

MANUFACTURER:
Cossor Electronics Limited, The Pinnacles, Harlow, Essex, England.

2418.153
PLESSEY IFF Mk 10 (SIF) INTERROGATION AND DECODING EQUIPMENT

DESCRIPTION:
Plessey's ground IFF Mk 10 equipment – which also provides all the basic facilities of the civil SSR system – is designed for use in conjunction with primary surveillance radars and uses an interrogator aerial that can be mounted on a suitably modified primary radar aerial.

IFF/SSR service is provided for transponder-equipped aircraft to a range in excess of 185 km and interrogation can be performed on two or three modes selected from the six IFF/SSR modes interlaced as desired.

Two sets of passive decoding controls, each having three separate code channels, are provided as standard but more can be added if required.

Solid state technology is used throughout, except in the transmitter r.f. stages, and most of the receiver and decoding circuits use integrated circuit components.

The system characteristics conform with STANAG 5017 and the equipment meets the environmental requirements of DEF 133 for partially protected ground equipment.

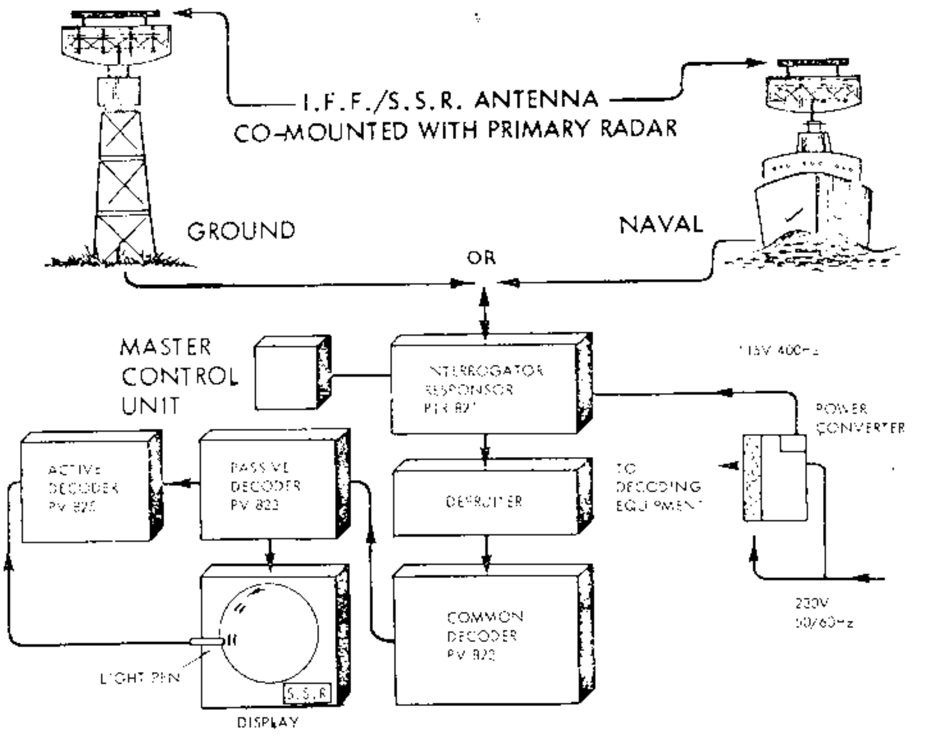
A block schematic diagram of the equipment shows the principal units. The interrogator aerial is the Litton/IFF 015B which has a 4.27 metre aperture with a beam-width of 4.25 deg. It can be mounted directly on any primary radar that can be provided with a double coaxial rotating joint to permit feed of secondary radar r.f. pulses to the IFF aerial and which can be mechanically modified to take the load. This aerial is capable of operation with a 3-pulse side lobe suppression system using sum and difference pattern switching with the switch in the aerial assembly.

A maximum peak power output of 5kW is supplied by the interrogator-responsor on all modes. This unit includes automatic test facilities that give an indication of transmitter output power and receiver sensitivity, and the circuits for performing the functions of mode encoding the transmitted interrogation pulses.

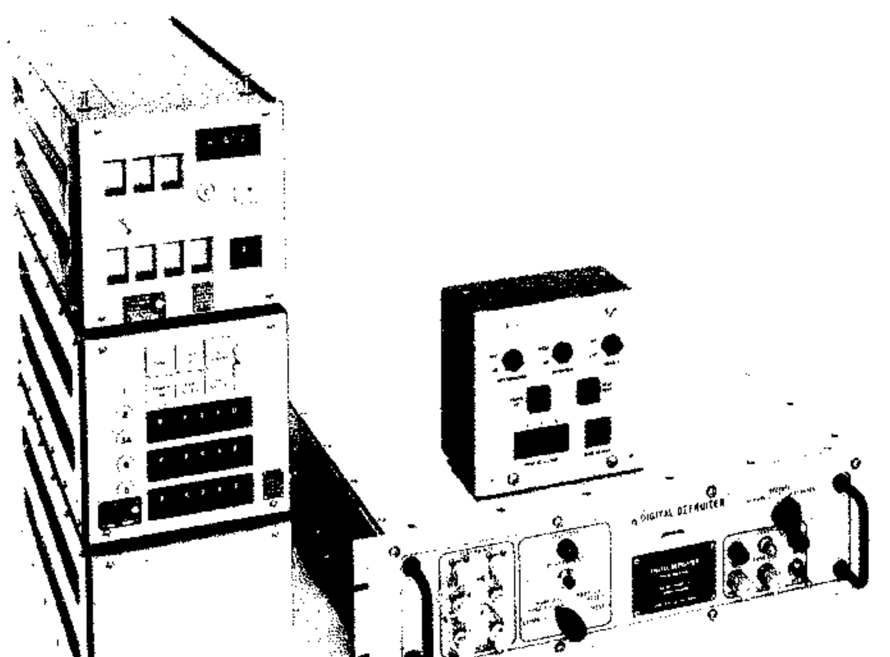
The common decoder logic unit contains the circuits for performing the functions of common decoding (serial-to-parallel code conversion and emergency recognition) of the received transponder replies.

Two passive decoders are provided, each giving three channels of decoding for a given mode, or decoding three separate identity codes each on a different mode. The passive decoder control unit provides thumbwheel selection of the three passive mode/code combinations, and video selection for the presentation of decoded replies on the primary radar display. The video selector switches provide the following functions:

Power On: Control of non-common decoder power supplies.
Raw: Undecoded IFF video.
Bracket Decode: All aircraft responding to the interrogator are indicated by a single slash overlaying the primary radar echo.
Code Decode: All aircraft responding on the modes and codes selected by the three channel thumbwheel switch groups are defined by a double slash, the first of which overlays the primary radar echo.
Lamps mounted on the front panel indicate:
T/R fault
Communications Failure' or A/C Emergency



Block diagram of Plessey IFF/SSR Interrogation and Decoding Equipment



Units of the Plessey IFF Mk 10 (SIF) system.
Left (top to bottom): Active Decoder, Passive Decoder, Common Decoder.
Right: Master Control Unit (top), Digital Defruiter (bottom)

Modes selected for interrogation

Additionally the following responses are displayed:

I/P or SPI. Aircraft replying with I/P on IFF Mk 10 (SIF) (2 train reply) or common system SSR (SPI) pulse, are defined by a wide single slash or 'bloomer'.

Emergency: Aircraft replying on:

Basic IFF Mk 10 (4 pulse reply) or IFF Mk 10 SIF (4 train reply) or Common systems SSR (codes 7600 and 7700), are defined by two wide slashes or 'double bloomer'.

When an emergency reply is detected, the response is immediately initiated on the display, however, the 'CMMS FAIL' and 'A/C EMERGENCY' lamps are activated only when the emergency reply is validated. This means the receipt of a preset number of emergency replies (preset from two to six) on adjacent p.r.i.s, before alarm initiation.

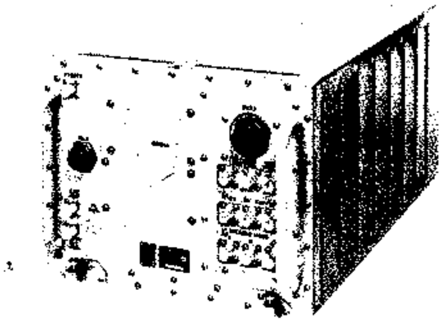
The range of IFF equipment is supplemented by an active decoder and a defruiter using digital techniques which can be provided as options.

HISTORY:

Plessey have been working on ground IFF/SSR systems for some years; and this particular development was begun in 1967 – a prototype equipment being completed in October 1968. Systems have been delivered to a number of overseas customers and the equipment is in quantity production.

MANUFACTURER:

Plessey Radar, Addlestone, Weybridge, Surrey, England.



Plessey IFF Interrogator

THE UNITED STATES OF AMERICA

2506.153

ADAR – ADVANCED DESIGN ARRAY RADAR

DESCRIPTION:

This radar, so far an experimental system, has been designed to use electronically steered beams for the simultaneous tracking of close flying multiple targets – such as might be encountered when an incoming strategic missile separates out its warheads and decoys.

The transmitting and receiving arrays are separate, the former being a planar phased array that steers the transmitted beam by ferrite phase shifters. The radiated beam thus produced subtends angles of 3 degrees and 5 degrees. Wide-angle coverage is achieved by dividing the array into sub-arrays with time delays in the sub-array feeds.

The receiving array consists of a micro-wave optical system that takes its inputs from a multiplicity of horns, each of which produces a receive beam. A microwave switching matrix selects the desired beams and connects them to receivers. The receive beamwidth is 2 degrees. Microwave amplification is provided at each beam terminal output.

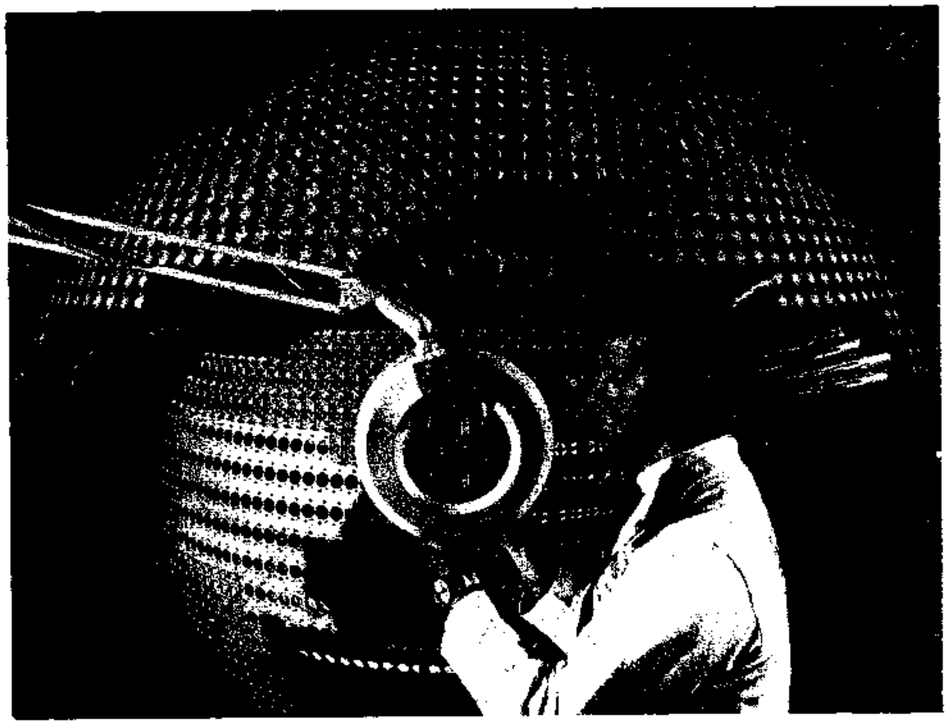
Scanning and tracking are completely automatic.

DEVELOPMENT:

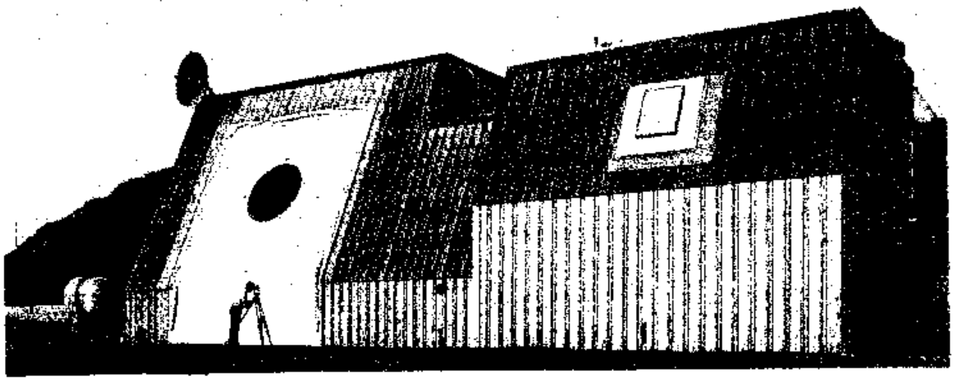
The equipment has been built and tested under a £20 million programme sponsored by the US Army's Advanced Ballistic Missile Defence Agency. Tests so far carried out have demonstrated the ability of the radar to resolve a number of close flying targets and track them simultaneously.

MANUFACTURER:

Hughes Aircraft Company, Fullerton, California, USA.



Part of one of the many antenna sub-systems in the ADAR receiving antenna



An engineering model – believed to be one-tenth scale – of the ADAR radar under test in California. The right-hand antenna is the transmitter, the receiving antenna on the left is hemispherical in shape. The small antenna in the top left-hand corner of the structure is part of a data link

2846.153

AN/FPQ-6 AND AN/TPQ-18 PRECISION INSTRUMENTATION RADARS

DESCRIPTION:

AN/FPQ-6 and its transportable version AN/TPQ-18 are high-accuracy, amplitude comparison monopulse, C-band instrumentation radars designed primarily for tracking long-range high-velocity targets such as re-entry vehicles. They can function either in skin-tracking (single-pulse) or beacon tracking (pulse train) modes. The only differences between the two radars relate to the arrangement of their constituent units.

Physically the radars are large, 5 transmitter cabinets and 60 cabinet racks being required to house the basic electronics. The aerial is some 9 metres in diameter and uses a 5-horn Cassegrain feed. The transmitter has a peak power of 3 MW.

Targets can be tracked out to some 50,000 km and at target speeds up to 18 km/sec. Aerial tracking precision is 0.05 mil. In order to keep the data rate high when tracking such distant targets an "nth time round" unambiguous measuring technique is used – which makes possible prf's of 160 or 640. At the other extreme the aerial can be slewed at a rate of up to 28°/sec.

MANUFACTURER:

RCA Government and Commercial Systems, Moorestown, New Jersey, USA.

2508.153
AN/FPQ-6 (MODIFIED) MONOPULSE TRACKING RADAR

DESCRIPTION:

AN/FPQ-6 is a C-band monopulse missile precision instrumentation radar used for tracking spacecraft or ballistic missiles.

Originally designed to give tracking ranges on spacecraft responder beacons up to 32,000 nautical miles, these radars have now been modified to give skin tracking ranges up to 800 nm and beacon tracking ranges to over 60,000 nm. The modification, by Radiation Inc, involved the installation of a sparless Dielguide feed and a cooled parametric amplifier.

STATUS:

Four of these radars are in service at the USAF Eastern Test Range (Patrick AFB), Grand Turk, Ascension and Antigua. All have been modified.

MANUFACTURER:

Original manufacturer, RCA Government and Commercial Systems, Moorestown, New Jersey, USA.

Manufacturer of extended range modification equipment, Radiation Inc (subsidiary of Harris-Intertype Inc), Melbourne, Florida, USA.

Part of the antenna of the modified AN/FPQ-6 tracking radar at Patrick AFB

2857.153
AN/FPQ-13 TRACKING RADAR

DESCRIPTION:

AN/FPQ-13 is the designation of a modified version of the AN/FPS-16 C-band monopulse missile tracking (skin tracking and secondary radar) radar.

The modification consists of the addition of a Dielguide cassegrain feed which is designed to increase the aerial efficiency by 80% with consequent increase in range. The feed is a conical sparless structure which is designed to provide a more uniform illumination of the 6-metre reflector and reduce spillover. Radar transmitter power is 5 MW peak and 10 kW average.

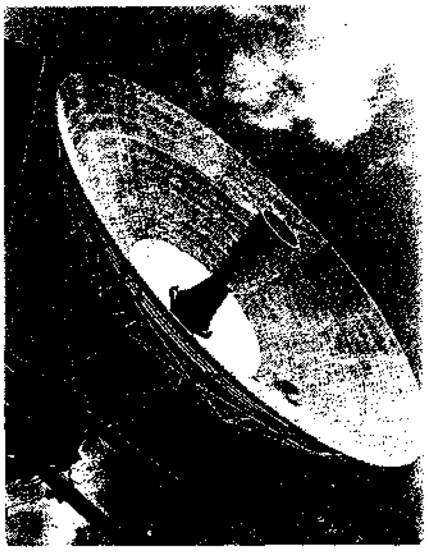
STATUS.

The radar is part of the USAF Eastern Test Range tracking network.

MANUFACTURERS:

Original FPS-16 radar: RCA Government and Commercial Systems, Moorestown, New Jersey, USA.

Dielguide modification: Radiation Inc (subsidiary of Harris-Intertype Inc), Melbourne, Florida, USA.



Dielguide-equipped aerial of AN/FPQ-13

2492.153
AN/FPS-6 HEIGHT-FINDING RADAR

DESCRIPTION:

For many years the AN/FPS-6 Radar has been the principal height-finder used by US Armed Forces and many allied nations. Over 400 of these equipments have been delivered, including the mobile version, the AN/MPS-14 (**2496.153**).

A high-power S-band nodding-beam radar, the AN/FPS-6 is noted for extreme accuracy at long range, and three available versions give it wide versatility under a variety of environmental conditions.

The arctic tower installation consists of a 50-foot radome (either air-supported or rigid) mounted on a 25-foot, two-storey enclosed tower structure. De-icing is provided by a battery of infra-red lights inside the radome. Radome pressurising (when required), RF, and other electronic equipment is housed in the tower structure.

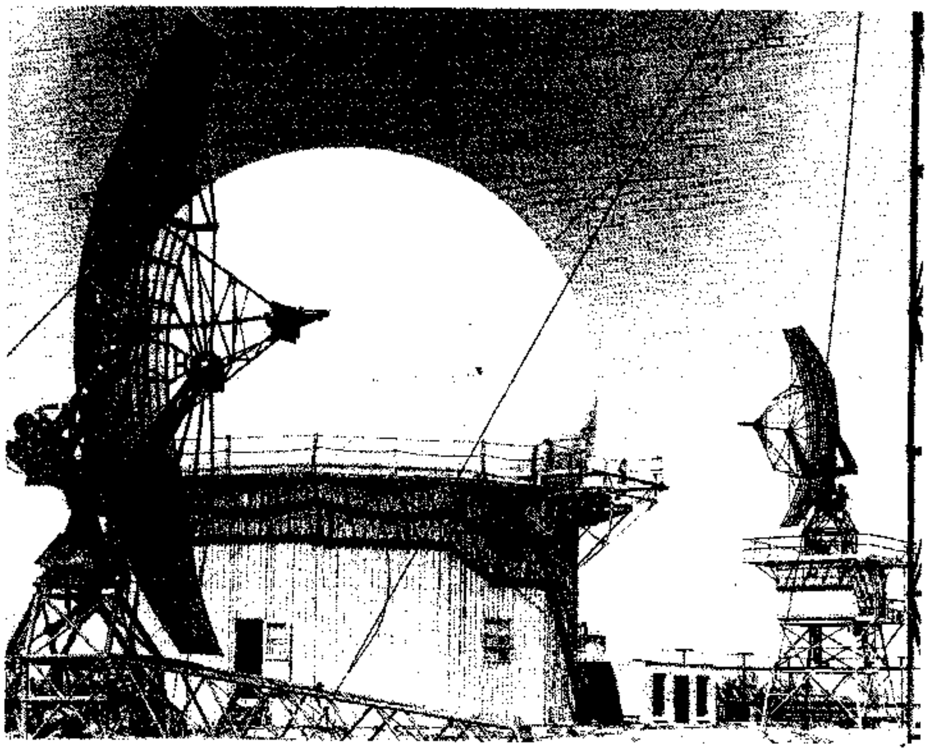
The temperate tower installation is designed for moderate or tropical climates. The 25-foot supporting structure for the antenna includes an enclosure for RF equipment.

The mobile version (AN/MPS-14) is a six-truck, three-trailer system designed for transport on short notice to new strategic or tactical sites.

The reliability and capability of the basic AN/FPS-6 system has benefited from a continuous improvement programme. Sets with various improvements have been designated as AN/FPS-6A, AN/FPS-6B, AN/FPS-6C, AN/FPS-6D, AN/FPS-89 (**2512.153**) and AN/FPS-90. All these improvements are available in field conversion kit form for the updating of radar sets from earlier production.

STATUS:
Operational.

MANUFACTURER:
General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.



Arctic Tower and Temperate Tower versions of the AN/FPS-6 height-finding Radar with the mobile version known as AN/MPS-14 in the foreground

2526.153
AN/FPS-7 3-D SEARCH & GCI RADAR

DESCRIPTION:

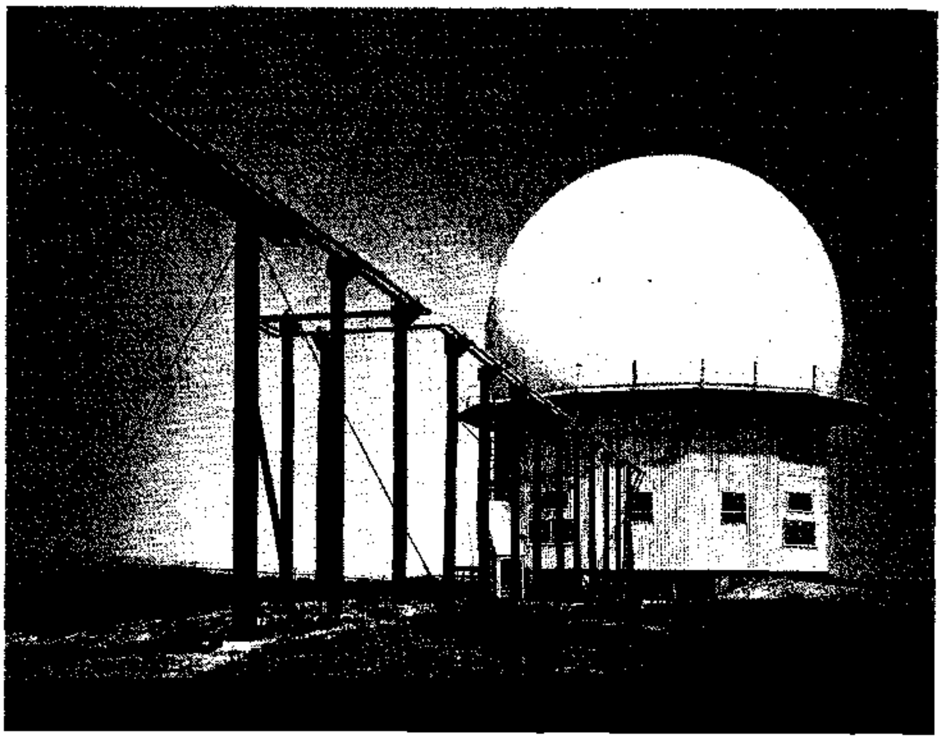
AN/FPS-7 is a very high power L-band (1,250-1,350 MHz) monopulse 3-D search radar. The equipment uses a stacked-beam heightfinding technique, the stack consisting of seven channels.

Search range is approximately 500 km and height coverage is up to 45,000 metres. The transmitter output stage is a high power klystron which delivers 10 MW at any of up to ten preset transmitter frequencies and with a pulse width of 6 microseconds. A dual-channel transmitting system is provided. When channel A is connected to the antenna through the waveguide switch, channel B is fed to a dummy load. This feature permits full preventive maintenance to be performed without having the equipment off the air.

The basic radar uses several separate but identical receiving systems. Spare receiving channels are available, and may be switched in place of some of the active receivers. The receiver incorporates MTI and anti-jamming circuits.

STATUS:
Operational.

MANUFACTURER:
General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.



AN/FPS-7 3-D Radar

2493.153
AN/FPS-8 SEARCH RADAR

DESCRIPTION:

The AN/FPS-8 is a medium-power L-band search radar designed for aircraft control and early warning and is installed at commercial airports and military bases both in the United States and overseas.

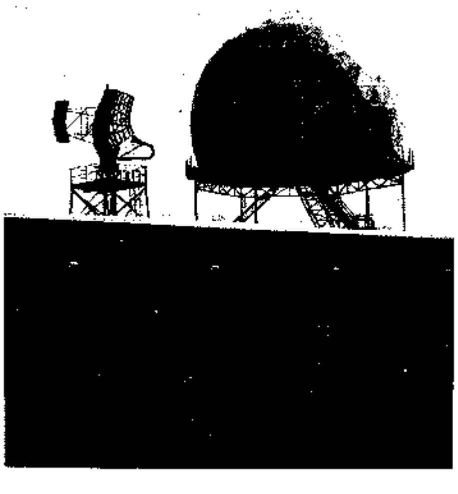
In most installations the antenna is exposed, being mounted on a temperate tower. For severe environmental conditions, the AN/FPS-8 is self-contained in an arctic tower with a protective radome

Over the years improvements have been made to the basic AN/FPS-8, culminating in the present version, whose nomenclature is AN/FPS-88 (V) (**2512.153**).

The AN/FPS-8 also has two mobile versions, the AN/MPS-11 and the AN/MPS11A (**2495.153**).

STATUS:
Operational.

MANUFACTURER:
General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.



AN/FPS-8 Search Radar

2527.153
AN/FPS-14 AND AN/FPS-18 MEDIUM-RANGE SEARCH RADARS

DESCRIPTION:

AN/FPS-14 is an S-band medium-range search radar. It has a power output of 400 kW and transmits 1 microsecond pulses at a PRF of 891-909 Hz. The antenna beamwidth is 1.4 degree between 3 dB points in the horizontal plane and 30 degrees in the vertical plane. Vertical or horizontal polarisation may be selected by the operator. Search range is about 110 km. AN/FPS-18 is similar to AN/FPS-14 but has a 1-2 MW transmitter.

STATUS:

Operational in the SAGE system and in Korea.

MANUFACTURER:

Bendix, Communications Division, Baltimore, Maryland, USA.

2528.153
AN/FPS-20 – AN/FPS-100 FAMILY OF LONG-RANGE SEARCH AND GCI RADARS

DESCRIPTION:

AN/FPS-20 is one of a family of very long-range dual-channel search and GCI radars. It is widely used partly because it was one of the equipments supplied under the MAP programme.

An L-band system, FPS-20 has a search range of some 350 km. The transmitter uses a power klystron with a 2 MW output. Pulse width is 6 microseconds and the PRF is 360 Hz. The antenna gain is 35 dB and the receiver noise figure 9 dB.

MTI is fitted and the radar has anti-jamming circuits. Data transmission facilities are included.

STATUS:

In service in many countries. AN/FPS-20 and subsequent members of the family are used in the SAGE (**2803.181**) and AWCS (**2533.181**) systems. Other static radars in the family are AN/FPS-20A, -20B, -64, -65, -66, -67 and -100. AN/GPS-4 and AN/MPS-7 are the mobile versions.

MANUFACTURER:

Bendix, Communications Division, Baltimore, Maryland, USA.

2494.153
AN/FPS-24 SEARCH RADAR

DESCRIPTION:

The AN/FPS-24 is a high-power low-frequency search radar. Each channel consists of 26 major cabinets, with an additional 11 cabinets that are common to both channels. It has very highly sophisticated anti-jamming features that make it extremely valuable in hostile environments.

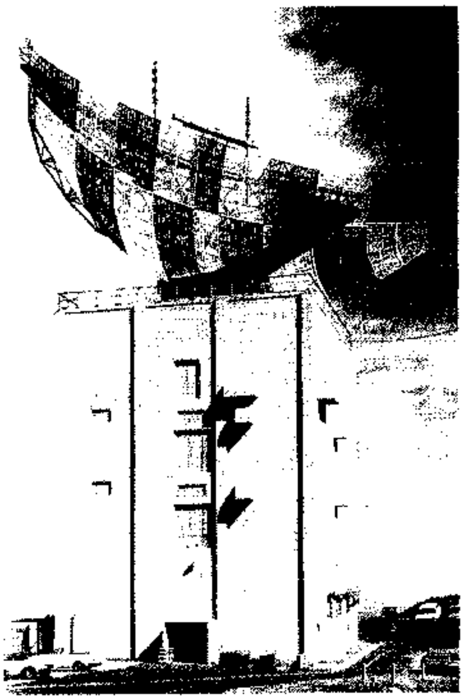
The radar is usually installed in a six-storey building with the antenna on top. In severe climatic conditions the antenna is enclosed in a radome, which is designed to withstand winds up to 150 knots. The overall antenna system weighs 92 5 tons.

STATUS:

Operational.

MANUFACTURER:

General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.



AN/FPS-24 Search Radar

2509.153
AN/FPS-49 EARLY WARNING AND TRACKING RADAR

DESCRIPTION:

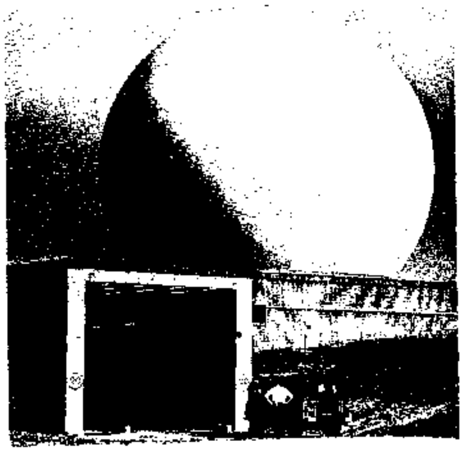
One of the two basic types of radar used in the Ballistic Missile Early Warning System (BMEWS – **2525.181**), the AN/FPS-49 is a very large tracking radar that can also be used in a surveillance mode. It is installed at two of the three BMEWS sites, Thule (Greenland) and Fylingdales Moor (UK). At the third site, Clear (Alaska), a slightly different radar, the AN/FPS-92 – which is said to be an improved version of the AN/FPS-49 – is in use. To the extent that the three tracking radars at these three sites differ, one from another, it should be noted that the description that follows relates in the main to the AN/FPS-49 (A) radars at Fylingdales Moor.

The main reception and transmission element is a 25-metre diameter parabolic reflector mounted on a conical pedestal and capable of being rotated in azimuth and elevated and depressed so as either to track a detected target or to search for one continuously. A variety of possible scanning patterns provides for a number of search modes as well as for target acquisition and tracking. Scan rates of at least 10 degrees per second are attainable and the powerful hydraulic drive system employed is said to eliminate backlash.

Dish illumination is by four horns, to provide monopulse operation in both planes, with separate horns for reception. The system radio frequency is in the UHF band and the radar operates on several frequencies in that band. Having regard to this and the dish diameter it is probably reasonable to suppose that the beamwidth, between half-power points, is in the region of one to two degrees.

Output power is in the megawatt region, p.r.f. is 27 pulses/second (pulse duration unknown) and maximum range is about 5,000 km. Each radar has three power amplifiers; and in normal operation two of these are on-line at a time while the third is a "hot spare" feeding into a dummy load. The receivers incorporate low-noise parametric amplifiers.

The antenna structure is protected from the elements by a 43-metre diameter radome. This is of honeycomb-sandwich construction and consists of two high-density skins 1 mm thick with a Kraft-paper honeycomb core 15 cm thick. The honeycomb is made up in hexagonal and pentagonal blocks and 1,646 of these blocks make up the radome. The transmission efficiency of the radome is 98%; the average boresight error is 0.1 mil and the maximum error 0.3 mil; the boresight error rate is 0.005 mil/mil.



FPS-49 radar dome at Fylingdales Moor
(UK Ministry of Defence (Air) Photograph)

STATUS:

Operational. See note on FPS-50 status (**2512.153**) below.

MANUFACTURER:

RCA Government and Commercial Systems, Moorestown, New Jersey, USA.

2511.153
AN/FPS-50 EARLY WARNING RADAR

DESCRIPTION:

AN/FPS-50 is the big static radar of the Ballistic Missile Early Warning System (BMEWS). It is installed at two of the three BMEWS sites at Thule (Greenland) and Clear (Alaska).

The radar uses a fixed antenna system comprising a 122-metre-wide and 50-metre-high parabolic-torus reflector which is fed by an organ-pipe scanner. Two narrow beams at two different angles of elevation are produced by this antenna and these two beams are caused to scan simultaneously over a sector in the near-horizontal plane so as to produce two horizontal direction fans, one above the other. As a missile passes through these beams its position and velocity co-ordinates are measured, from which can be calculated the trajectory, impact point, impact time and launch point.

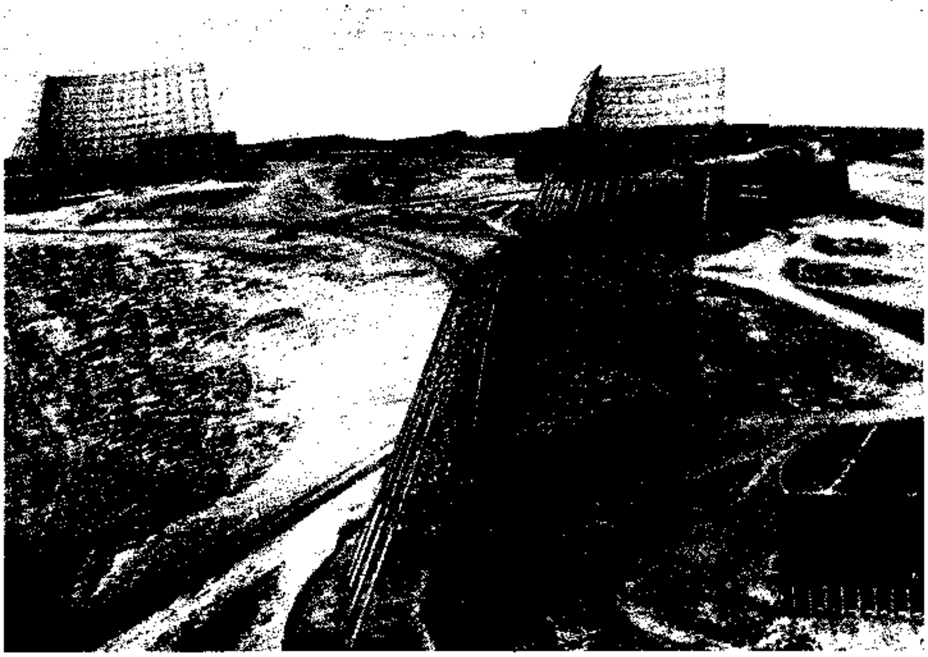
A parabolic-torus reflector was chosen for this radar because it provides an economical measure of scanning the beam from a physically large antenna over a wide scan angle without deterioration of pattern over this arc. The disadvantages of the arrangement are the large size of the total assembly and the large sidelobes that appear in intermediate planes.

Scanning such a reflector can be achieved in various ways; but in the AN/FPS-50 it is accomplished by arranging a series of feeds on the focal points of the torus and switching the transmitter power from one point to the next with an organ-pipe scanner.

At Clear and Thule the AN/FPS-50 radar are used in conjunction with the AN/FPS-49 or similar tracking radar. At the third station (Fylingdales Moor, England) only AN/FPS-49 or equivalent radars are used for early warning and tracking.

STATUS:
Operational.

MANUFACTURER:
General Electric Co, Heavy Military Electronic Systems, Syracuse, New York, USA.



AN/FPS-50 Early Warning Radar

2546.153
AN/FPS-85 LONG RANGE PHASED-ARRAY RADAR

DESCRIPTION:

This is a very large fixed-array radar located in Florida with its principal axis aligned due South across the Gulf of Mexico and capable of transmitting and receiving over an arc extending 60 degrees on either side of this axis.

A UHF system with a nominal frequency of 442 MHz, the radar uses separate transmit and receive arrays located side by side and both inclined at approximately 45 degrees to the horizontal. Exact dimensions of the arrays are not known, but the transmitter array is square, contains 5,184 transmitter modules and has a side of something over 30 metres. The receiver array is octagonal, contains some 39,000 antennas feeding 4,660 receivers and has a width of some 60 metres.

Peak radiated power has been reported as 32 MW with a nominal transmitter beamwidth of 1.4 degrees. Effective receiver beamwidth is said to be 0.8 degree. As already noted the radar beams are steerable over a 120 degree arc in azimuth: in elevation the coverage is about 105 degrees – from the radar horizon to 15 degrees beyond the zenith. The radar is thus able to track objects northwards at high elevation angles. In the normal tracking mode the receiver complex uses a 3 × 3 matrix of "beams" (i.e. receiving directions) in a monopulse mode for optimum resolution. Radiated energy can be varied, by using different modulations, to suit target requirements. In the original design only two energy levels could be selected but additional modulators are being provided to extend the range of choice and hence improve the efficiency of the radar.

This power level selection, together with all other control functions, is performed by IBM 360/65 computers, there being two of these in main and standby roles in the radar complex. These computers are programmed with both routine surveillance and routine and special tracking requirements: they carry in their memory orbital details of space objects for routine tracking so that the radar beam can, at an appropriate time dependent both on its position and the relative priority of the observation, be pointed in the direction in which the target would lie if its orbit had not been perturbed: since both intentional and accidental perturbation are common, the radar will normally have to execute a small search to locate and lock on the target.

Originally designed as the main US-based active sensor of the SPACETRACK system (**2825.181**) the FPS-85 is now to be used also to supplement the FSS-7 radars of the SLBM detection system (**2810.181**) and to operate as an Alternative Space Defence Centre (ASDC). The FPS-85 receives its SPACETRACK directions from NORAD Space Defence Centre (SDC) which also has as its SPADATS inputs the BMEWS (**2525.181**) and the US Navy SPASUR sensors. At this centre all known data on space objects near the Earth is filed in the computer memories; and incoming data on a space object can be checked against these memories to determine whether or not it is a known object in approximately two seconds. To guard against computer or other failure at the SDC the same data is to be held on file at the ASDC, which has an IBM 360/40 as well as its two IBM 360/65 computers, but in a form requiring more human intervention for a full search than is required at the SDC. It is said that a full search at the ASDC may take one minute.

Similarly the SDC processes data from all SPADATS sensors fast enough to issue new orbital data for all stations three times a day, whereas the ASDC will be able to do this only once a day.

DEVELOPMENT AND STATUS:

The FPS-85 was developed by Bendix, starting in 1962, and was the first large phased-array project in the USA. The first model was destroyed by fire in 1965 but was rebuilt and put into operation in 1969. It is currently operational in its SPACETRACK role, spending approximately one-third of its time to space surveillance and the remaining two-thirds to routine and special tracking assignments from NORAD. It is also now operational as an ASDC.

It is currently being modified, by the addition of the new modulators referred to above and of suitable software, to perform the SLBM detection function. It is expected to be operational in this role in mid-1974; and will then, in non-raid conditions spend about 30% of its time on space surveillance, 50% on space tracking for NORAD and 20% on SLBM early warning surveillance.

MANUFACTURERS:

Prime contractor for the radar – Bendix, Communications Division, Baltimore, Maryland, USA.
Computers – IBM.

2512.153
AN/FPS-88 SURVEILLANCE RADAR

DESCRIPTION:

AN/FPS-88 is a medium-size L-band static surveillance radar. It is an improved version of the long-established AN/FPS-8 (**2493.153**), the improvements relating to range performance and to signal processing facilities.

The radar features a high-gain antenna, circular polarisation, dual-channel operation, a parametric amplifier receiver and a radar signal processor with some ECCM capability. There is also provision for using the main antenna as an IFF radiator.

STATUS:
Operational.

MANUFACTURER:
General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.

2513.153
AN/FPS-89 HEIGHTFINDING RADAR

DESCRIPTION:

The AN/FPS-89 is a high-power S-band nodding-beam radar. It is an improved version of the AN/FPS-6 radar (**2492.153**), and like the AN/FPS-6 it is available in an arctic tower installation, a temperate tower installation, and a mobile version.

STATUS:
Operational.

MANUFACTURER:
General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.

2847.153
AN/FPS-105(V) RANGE INSTRUMENTATION RADAR

DESCRIPTION:

AN/FPS 105(V) is designed for range use to make accurate measurements of target position and velocity for performance evaluation. It can be installed either in a permanent ground station or be packaged for shipborne use.

Its aerial is a 365 cm diameter solid-surface parabolic dish fed by a monopulse four-horn feed. Polarisation is vertical. The aerial can rotate continuously in azimuth and can be rotated through 200° (−10° to +190°) in elevation a cable being used to avoid the need for a rotating joint. Microwave circuits are mounted on the rotating section of the aerial mounting. The transmitter will radiate single pulses, pairs or triplets as required. Peak power is 1 MW and recurrence frequencies and pulse widths can be chosen for 160 and 640 pps and from 0.25, 0.5 and 1.0 microsecond respectively. Transmitter frequency is in C-band.

The digital range tracker contains a precise frequency standard and "ntn time round" circuits to enable a relatively high recurrence frequency to be used despite the long measuring ranges. Automatic search and lock-on are provided during target acquisition. 25 bits of range data are supplied by the system at data rates up to 40 times per second.

MANUFACTURER:

RCA Government and Commercial Systems, Moorestown, New Jersey, USA.

2538.153
AN/FSS-7 SLBM DETECTION AND WARNING RADAR

DESCRIPTION:

This radar provides surveillance for the detection of sea-launched ballistic missiles and generation of warning for trajectories having impact points in the Continental United States. It is now deployed in several of the perimeter states of the USA.

A network of seven of these sensors with their associated data processing and remote display equipment has been developed and supplied by Cincinnati Electronics Corporation – successor by purchase of the Evendale operation of Avco Electronics Division. Prior to this an experimental programme was carried out, using the AN/FPS-26 heightfinder of the SAGE system (**2803.181**). in 1966: the FPS-26 was produced in quantity by Avco between 1958 and 1963.

The radar developed by Cincinnati Electronics has a parabolic antenna which performs both search and tracking functions and is capable of extremely high altitude missile detection.

The FSS-7 is automated by the computer control and programmed for sequential search, acquisition and tracking functions with attendant data processing for trajectory calculations and threat evaluation. Warning messages are generated for display at NORAD, SAC and the Pentagon.

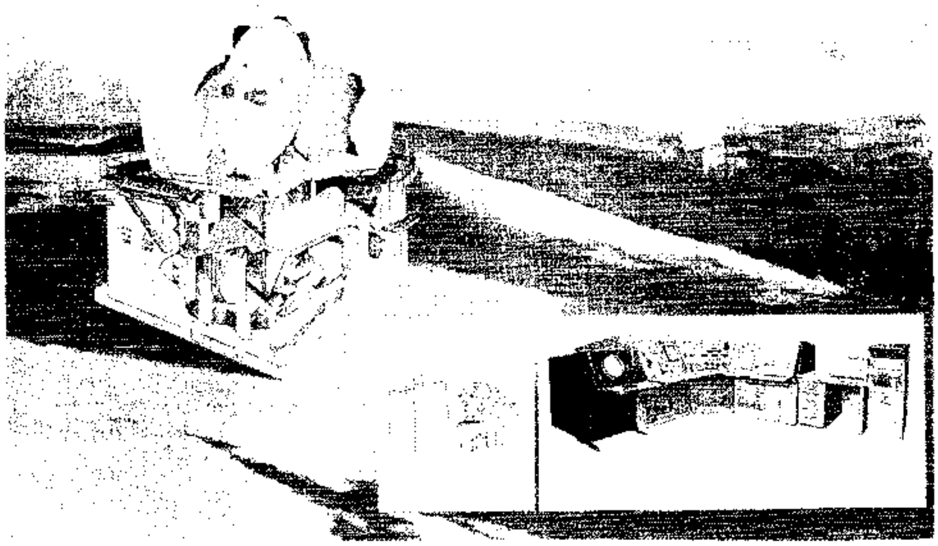
STATUS:

Operational since 1971. Radars deployed in Maine, North Carolina, Florida, Texas, California (two radars) and Oregon. Responsible authority – USAF Aerospace Defence Command.

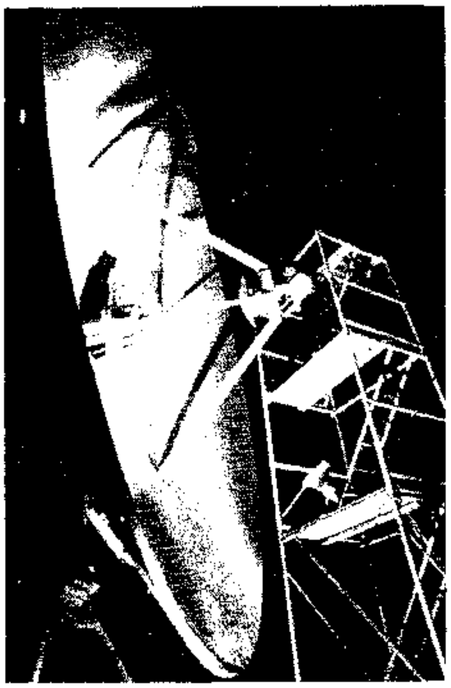
Numerous modifications to increase utilisation of the radar's performance capabilities have been incorporated since 1971 and work is continuing on others.

MANUFACTURER:

Cincinnati Electronics Corporation, 2630 Glendale, Milton Road, Cincinnati, Ohio 45241, USA.



Cutaway drawing showing arrangement of the FSS-7 units with displays inset



FSS-7 aerial

2497.153
AN/MPQ-4 MORTAR LOCATING RADAR

DESCRIPTION:

The AN/MPQ-4 provides quick identification to pinpoint enemy mortar positions in map coordinates, enabling artillery units to launch counter-attacks. It uses a two beam intercept principle of location with positive first shell acquisition and has the capability for handling multiple targets.

All the equipment is mounted on two two-wheel trailers, each designed for its specific purpose. One trailer carries the primary radar equipment, while the other carries the primary power supply (a petrol engine generator set) and auxiliary equipment such as cable and spare parts.

The AN/MPQ-4 can be operated from virtually any site and can be set up in 15 minutes. Once set up it can be operated by one man. The operating and control console may be used on the equipment trailer or in a remote location.

CHARACTERISTICS:

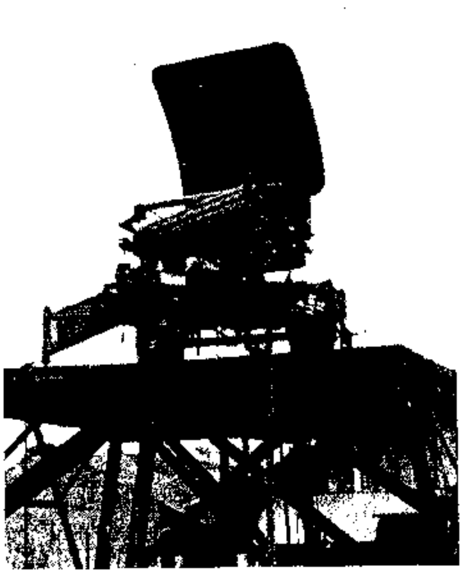
Frequency: 16 GHz
Detection range: 10,000 m (maximum)
170 m (minimum)
Sector scan: 25 degrees
Elevation coverage: −6° to +12°
Accuracy: within 50 m at 10,000 m
Presentation: B scope, 140 mm CRT
Weight: 2,268 kg
Mounting: two wheel trailer
Antenna: Reflector with Foster dual scanner feed

STATUS:

Operational.

MANUFACTURER:

General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.



AN/MPQ-4 Mortar Locator

2500.153
AN/MPQ-10A MORTAR LOCATING RADAR
DESCRIPTION:

The AN/MPQ-10A radar was initially developed in August, 1950 by the United States Army Electrics Command and was the first American mortar locating radar system. A total of 485 radar sets were delivered to the US Army between September 1951 and September, 1954. Radar AN/MPQ-10A is a mobile radar designed to locate and track mortar and artillery shells. It can be used with associated recording equipment to locate the point of origin and point of impact of the projectile. This radar set is designed primarily for use with Azimuth-Elevation Range Recorder RD-54/TP or Mortar Locator Computer CP-75/MPQ or other suitable automatic plotters or computers as a counter-mortar radar system. It is able to detect and accurately locate hostile artillery during and after firing. The system contains target display devices to assist in reducing the time between detection and the decision to fire, and operates on a continuous schedule under all conditions of weather, visibility and electronic environment. It is capable of being integrated into a field artillery unit which has the organic capability of delivering fire on the located target.

The radar consists of three major components: the tracker mount which contains radar set components; radar set control and the power unit.

CHARACTERISTICS:

Frequency range: 2,740 to 2,960 MHz
Pulse repetition frequency: 1,000 pulses/second
Pulse width: .8 microseconds
Polarisation: Vertical and horizontal
Peak power output: 200 kilowatts
Receiver sensitivity: −95 dbm
Signal-to-noise ration: 1.5 decibels
IF: 30 MHz
Tracking range: 460 m-18,300 m
Tracking height: 0 to 28,700 m
Tracking speed: 0 to 3,220 km/h
Azimuth tracking rate: 350 mils/second
Elevation tracking rate: 250 mils/second
Sector scan (azimuth): 200 - 800 mils
Transmitter: Magnetron
Presentation: B scope, 178 mm cathode ray tube, J-scope 76 mm cathode ray tube
Antenna: Off-centre dipole (conical scan) parabolic reflector
Weight: 2,722 kg

STATUS:

Believed obsolescent.

2495.153
AN/MPS-11 AND AN/MPS-11A SEARCH RADARS
DESCRIPTION:

The AN/MPS-11 and AN/MPS-11A are mobile versions of the AN/FPS-8 medium-power L-band search radar (**2493.153**). The difference between the two mobile versions is that the AN/MPS-11 antenna is mounted after arrival at site on a manually erected tower, while the AN/MPS-11A antenna is permanently installed for transport and operation on a 40 mm gun carriage, permitting more rapid initial operating capability.

The AN/MPS-11 may be transported by aircraft or by two trailers and nine M-35 trucks. Set-up time, with 15 men, is two hours.

STATUS:

Operational.

MANUFACTURER:

General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.

2496.153
AN/MPS-14 HEIGHT-FINDING RADAR
DESCRIPTION:

The AN/MPS-14 radar is the mobile version of the AN/FPS-6 high-power S-band nodding-beam radar (**2492.153**). It is designed for transport by six trucks and three trailers to temporary strategic or tactical sites. Trailers are functionally designed for quick loading and unloading, and assembly and disassembly may be accomplished in rapid and efficient fashion.

The trailers serve the dual purpose of transporting the equipment and supporting certain electronic components during operation. For example, the RF equipment need not be removed from the trailer for operation, and the entire unit is protected by a prefabricated shelter assembled at the site. The shelter is equipped with space heaters and lighting fixtures.

The AN/MPS-14 system's electronic components are identical to and interchangeable with those of the AN/FPS-6.

STATUS:

Operational.

MANUFACTURER:

General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.

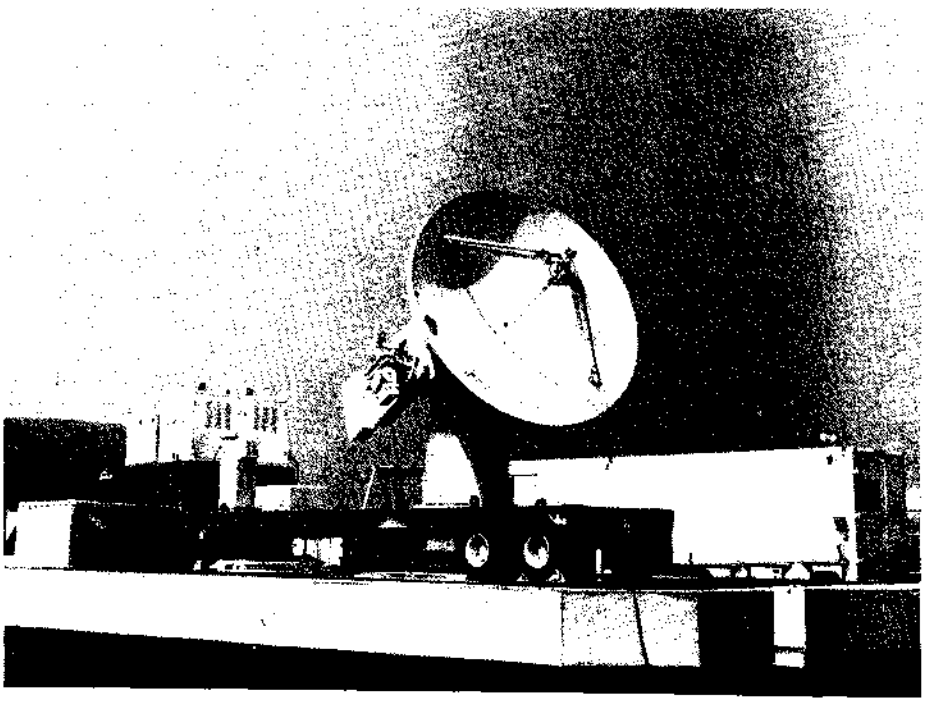
2514.153
AN/MPS-36 MISSILE TRACKING RADAR
DESCRIPTION:

AN/MPS-36 is a new type of mobile instrumentation radar built originally in 1970 for the US Army testing grounds at White Sands Missile Range.

The radar can accurately track targets travelling up to 36,000 knots at ranges up to 60,000 km. Data accuracy has been measured at one metre in range and target velocities within 5 cm/sec on trajectories of missiles and missile re-entry vehicles.

Advanced integration circuits are extensively designed into the equipment. A general-purpose computer has been integrated into the radar to provide real-time mission support and pre- and post-system checkout and calibration.

The radar is housed in a 12.4 metre electronics trailer and a 366 cm diameter antenna is mounted on an 11 metre pedestal trailer. With this arrangement, the radar can be moved from site to site on roads, air, or sea and be operational within eight hours after arrival.



AN/MPS-36 Missile Tracking Radar

CHARACTERISTICS:

Transmitter Power: 1 MW min
Antenna Gain: 43 dB min
Antenna Beamwidth: 1.2° max
Antenna Sidelobes: 20 dB min
Pedestal Coverage, Elevation: −5° to +185°
Pedestal Coverage, Azimuth: Continuous
Azimuth Tracking Rate: 890 mils/sec
Elevation Tracking Rate: 500 mils/sec
Azimuth Acceleration Rate: 400 mils/sec^2
Elevation Acceleration Rate: 400 mils/sec^2
Azimuth Tracking Precision at 20 dB S/N: 0.2 mils, RMS
Elevation Tracking Precision at 20 dB S/N: 0.2 mils, RMS
Range Tracking Precision at 20 dB S/N: 2.7 m, RMS
Range Tracking Precision at 10 dB S/N: 6.4 m, RMS
Range Tracking Precision at 6 dB S/N: 9.1 m, RMS
Range Rate Tracking Precision at 20 dB S/N: 90 cm/sec RMS
Range Tracking: 2,000 nm min
Installation Time to Power On: 8 hours, max
Receiver Noise Figure: 4 dB max
Maximum Range, 6-inch Sphere: 90 km
Reliability (Design Goal) – MTBF: 100 hours

STATUS:

The first equipment was delivered in 1970 and met or exceeded all design specifications. Eleven radars are now operational at US test ranges and three have been provided to Germany. The radars are used for studies of weapons systems and space programmes.

MANUFACTURER:

RCA Government and Commercial Systems, Moorestown, New Jersey, USA.

2540.153
AN/PPS-5 COMBAT SURVEILLANCE RADAR

DESCRIPTION:

AN/PPS-5 is a portable battlefield radar designed to detect and locate individual men up to 5,000 metres and groups of men or small vehicles up to 10,000 metres.

Particular features of the equipment are automatic or manual sector scanning and full-range surveillance. The significance of the latter is that in the automatic scanning mode the operator is presented with a picture that shows all detectable targets in the azimuth sector scanned. This display as such does not identify the targets, but once he has detected them visually on his display the operator can search the particular area where a target has been detected and identify it aurally in the manner common to most battlefield surveillance radars.

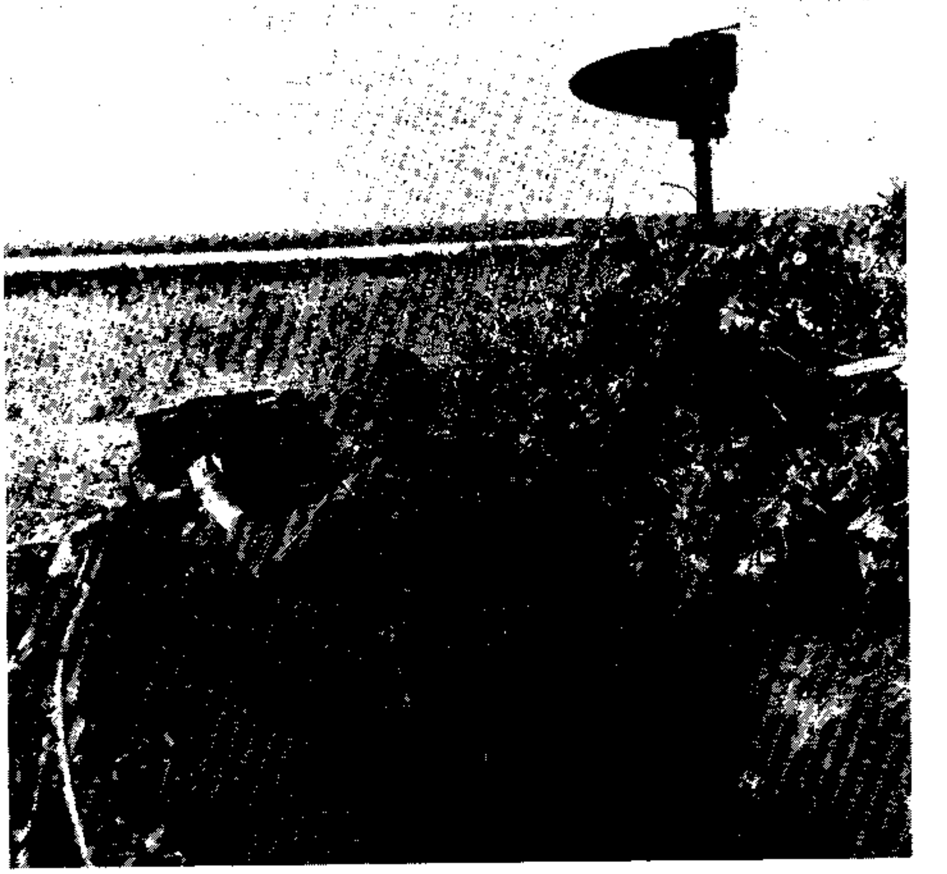
Furthermore, this search is carried out by winding out a range gate until it covers the target; and then stopping the automatic sector scan and adjusting the antenna for maximum signal. In addition to identifying it, therefore, the operator can measure its range and azimuth co-ordinates directly.

The equipment works in the 16-16.5 GHz band (tunable) and has a peak power of 1 kW and a p.r.f. of 4,000 p.p.s. An accuracy of ± 20 metres in range and ± 10 mils in azimuth can be achieved.

Physically the equipment consists of three rugged packages weighing about 40 kg. Power consumption is about 57 W.

MANUFACTURER:

AIL Division of Cutler-Hammer Inc, Deer Park, Long Island, New York 11729, USA.



AN/PPS-5 Radar

2537.153
AN/TPN-19 LANDING CONTROL CENTRAL

DESCRIPTION:

AN/TPN-19 is a terminal ATC system comprising an Airport Surveillance Radar, a Precision Approach Radar and an Operations Centre. The radar systems are linked to the Operations Centre by microwave links (10 nm). The system is designed for rapid world-wide deployment as well as fixed base installations. Packaging techniques make the system completely transportable by aircraft, helicopter or road vehicle.

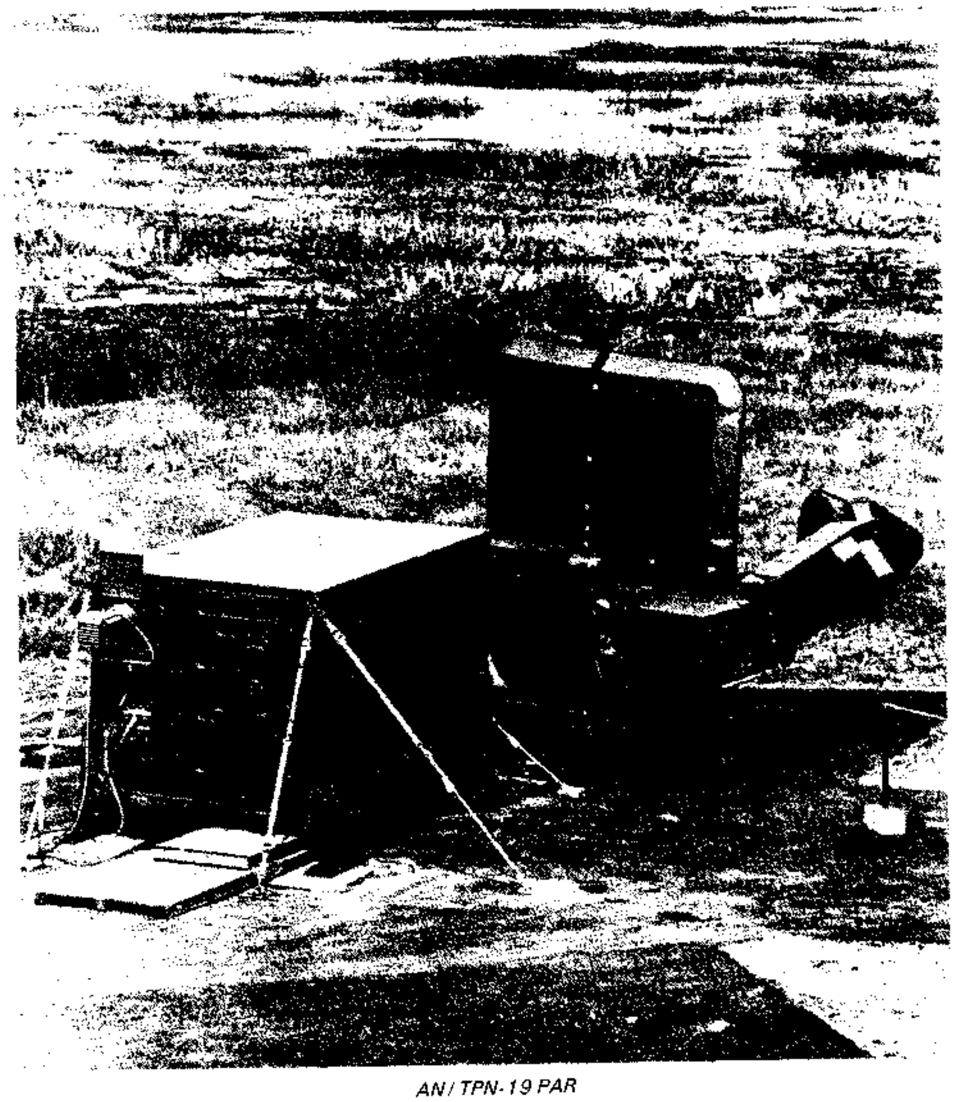
The Airport Surveillance Radar is a dual-channel, 2 × 450 kW S-band, MTI radar. Its most noteworthy features are a multiple (12) horn antenna feed which produces lobe-free coverage up to 12,000 metres and 60 nm on a one-square-metre target; a low-angle pattern which is electrically variable and programmable in range and azimuth to reduce clutter returns; a digital coherent and non-coherent MTI system to eliminate weather returns and a staggered p.r.f. to eliminate blind speeds below 1,100 knots.

The Precision Approach Radar is said to represent a significant advance in the state-of-the-art. Operating in X-band, it has a range of 20 nm even with precipitation at 5 cm/hour. This results from the use of the narrow pencil beam (0.75° × 1.4°) produced by the 824-element phased array antenna of 320 kW. A monopulse system, it can track up to 6 targets simultaneously. For multiple runway coverage the antenna assembly can be slewed through 270°.

In the GCA configuration there are three displays but through simple modular extension the system provides seven displays for a full RAPCON configuration. All displays are dual mode and can be changed to display either an ASR or PAR presentation instantaneously.

STATUS:

AN/TPN-19 has been developed for the USAF Systems Command as part of the Tactical Airbase requirement and is currently in production. The system has successfully undergone rigorous rain tests in which an F4 aircraft was tracked in up to seven inches of rain per hour. The system was also



AN/TPN-19 PAR

the first landing system to meet formal USAF commissioning criteria at Nellis AFB which is located in one of the world's worst ''clutter'' areas.

MANUFACTURER:
Raytheon Company, Equipment Division, Wayland, Massachusetts 01778, USA.

AN/TPN-19 Landing Control Central

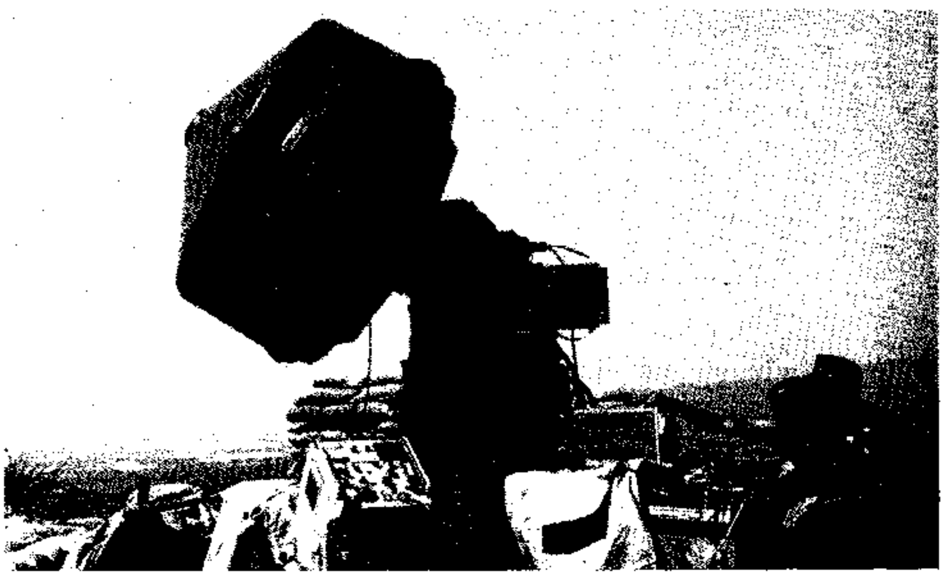
2498.153
AN/TPQ-10 RADAR COURSE DIRECTING CENTRAL

DESCRIPTION:
The AN/TPQ-10 Radar Course Directing Central is designed to provide accurate all-weather guidance to aircraft for performance of close air support missions.

The equipment consists of a tracking radar and an operational shelter containing the radar controls, a computer, displays, and communication equipment. Designed specifically for tactical air operations, it is easily transported by helicopter, cargo aircraft, or truck.

The AN/TPQ-10 is normally manned by a strike controller and a radar operator. The strike controller is responsible for maintaining voice contact with the aircraft and other ground units, inserting required data into the computer, and monitoring the progress of the mission on his display. The radar operator is responsible for identifying and acquiring the aircraft initially and monitoring the automatic tracking.

During a mission the radar tracks the aircraft and provides continuous position data to the computer and to the strike controller's display. Data on target location, wind conditions, and weapon characteristics are inserted into the computer, which combines this information with the continuous aircraft position data from the radar. Commands generated by the computer from this information are transmitted by data link to the aircraft, where they are fed into the autopilot to guide the aircraft to the target. If the aircraft does not have data link equipment, the strike controller can transmit the necessary commands by voice communication.



AN/TPQ 10 Radar Course Directing Central

In addition to close support operation guidance, the AN/TPQ-10 can be used to guide flare missions and all-weather troop and cargo drops, to provide assistance for automatic return to base and ground-controlled runway approaches during conditions of low visibility, and to control drone aircraft.

STATUS:
Operational.

MANUFACTURER:
General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.

1526.153
FORWARD AREA ALERTING RADAR TPQ-32/MPQ-49

DESCRIPTION:
The Forward Area Alerting Radar (FAAR) has been designed to meet a US Army requirement for a lightweight early warning air surveillance radar to increase the effectiveness of air defence weapons, such as Chaparral and Redeye missiles and the Vulcan 20 mm gun system, against low-level aircraft attacks. It has been developed in both transportable and mobile versions, these being designated TPQ-32 and MPQ-49, respectively. The principal system elements and operation are identical or similar in both.

The complete system comprises a 25 cm primary radar with an on-mounted secondary (IFF) horn antenna, shelter- or truck-mounted radar data extraction and processing units, operator's console, VHF data link, and a number of remote target indicators for use at individual missile or gun sites.

The primary radar operates at a frequency in the 25 cm band and is a pulse-doppler equipment using a low-noise stable master oscillator, a grid-modulated travelling-wave-tube transmitter, and an all solid-state homodyne (zero IF) receiver. The receiver translates target information to video frequencies which are range gated, doppler filtered and compared with an alarm threshold. Target data is then transmitted via the VHF data link to remote sites, and presented on the operator's console CRT. The antenna measures 183 cm by 107 cm and is carried on a telescopic mast. The latter is of four sections, pneumatically operated, and capable of extension to a height of about 11 metres. 360 degree coverage is provided. A horn antenna for the IFF is mounted on the upper edge of the main reflector. The IFF system used is the TPX-50, and this provides for either automatic or manual target interrogation.

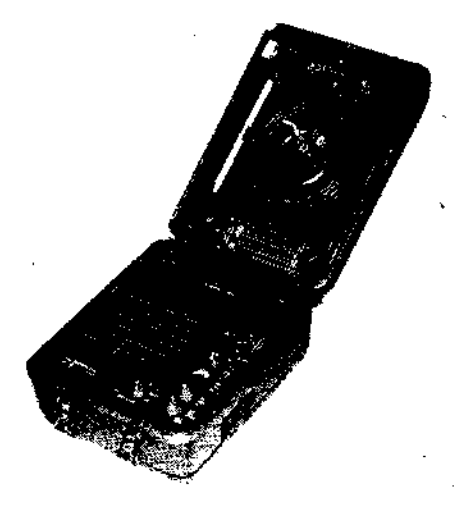
The operator's console has a 25 cm diameter PPI display which normally presents only processed video which is time-shared with the PPI generator and the symbol generator to show targets, a 7 × 7 rectangular grid matrix, and target designation symbols for transmission to remote indicators via the data link. Controls are provided for selection of 'black-scope' or processed video display, sector blanking, threshold adjustment, automatic or manual IFF interrogation, IFF mode selection, radar transmitter/receiver control and self-test functions, and data link operation. The console can be removed from the truck or shelter to enable the complete system to be operated from a position up to 50 metres from the radar site.

The VHF data link VRC-46 has three operating modes: data, voice, and RAID – Rapid Alerting and Identification Display. This link carries target information from the central operator's console to up to 12 remote Target Alert Data Display Sets (TADDS) at weapon sites.

Each TADDS (GSQ-137) consists of a single 6 kg unit comprising a display, audio warning, and VHF receiver. The display consists of a replica of the 7 × 7 matrix appearing on the operator's PPI display with each square representing a specific area of the total radar coverage. The presence of a target in any one square, as determined by the central operator, is denoted by the appearance of a coloured disc in the appropriate square of the TADDS. Green discs denote friendly aircraft and red hostile. Plotting of target tracks is by means of a wax pencil. Controls on the TADDS unit provide for test functions, data link address code selection, and data link receiver frequency selection between 30 and 76 MHz. The lid of the unit carries a magnetic compass for orientation purposes.

The mobile version of FAAR, MPQ-49, is housed in a transportable S-250 shelter, utilising the six-wheel-drive M-561 vehicle as prime mover. The system can also be carried by C-130 transport aircraft, or air positioned in a battlefield environment by a CH-47 helicopter. The TPQ-34 is a modified version of FAAR, in non-mobile form, which provides all-weather target detection and location against personnel and vehicles in densely foliated environments. This version is also known as GSR, Ground Surveillance Radar, TPQ-34.

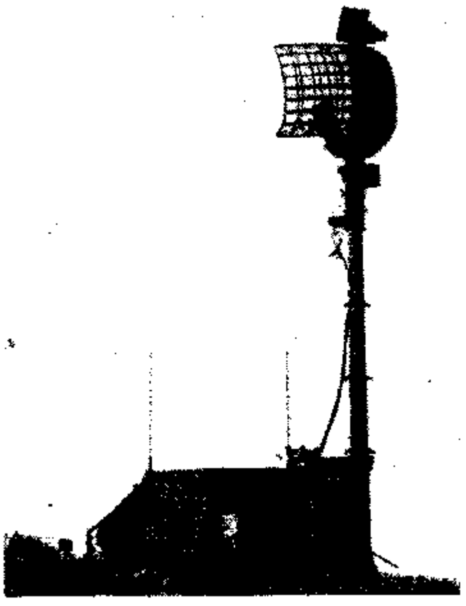
Other applications ascribed to the system include 360 degrees detection of first round mortar and rocket fire, and use as a tactical air traffic control centre. Although designed for essentially manual operation, FAAR is capable of integration with automatic air defence systems.



GSQ-137 Target Alert Data Display Set for FAAR system. Unit contains VHF data link relay and matrix display for presentation of target data from central radar site. A number of these units can be located at anti-aircraft sites

DEVELOPMENT:

Development was undertaken by Sanders Associates, Inc for the US Army Missile Command under a series of contracts. Prototypes were delivered to the US Army in late 1968 and early 1969, and initial production was ordered under a $7.1 million contract in March 1969. In addition to tests at US home bases and engineering establishments, FAAR has been deployed in South-east Asia in the TPQ-34 Ground Surveillance Radar configuration. In this role, the IFF antenna is apparently deleted.



Antenna of MPQ-49 Forward Area Alerting Radar on pneumatically operated telescopic mast. Horn for IFF is carried on reflector upper edge

STATUS:

The first production model MPQ-49 was delivered to the US Army in January 1972, when it was stated that contracts amounting to $30 million had been awarded.

MANUFACTURER:

Sanders Associates, Inc, Radar/Ordnance Division, Crosby Road, Bedford, Massachusetts 01730, USA.

2848.153
AN/TPQ-36 MORTAR LOCATING RADAR

DESCRIPTION:

Limited information only is available on this radar which is currently under development. What is known is that it is an automatic device including electronic scanning, sophisticated computer data processing and a rotating cylindrical map board.

Of light construction and suitable for rapid deployment, the system will comprise an equipment shelter on a Gamma Goat articulated vehicle and an aerial assembly pallet carried on an M-116 trailer.

The system's electronics scanning capability will enable targets to be located over a 90° arc. The signal processing system will be programmed to reject returns from birds, rain or ground clutter.

STATUS:

Development. Hughes announced receipt of a contract from US Army Electronics Command late in 1973. The project is directed by the MALOR (Mortar and Artillery Locating Radar) Project Office of the US Army.

MANUFACTURER:

Hughes Aircraft Company, Fullerton, California, USA.

2849.153
AN/TPQ-39 DIGITAL INSTRUMENTATION RADAR

DESCRIPTION:

AN/TPQ-39 is a one-man instrumentation radar of modular design which can readily be transported by air or over land and can be installed and set up in one hour. It is intended for use in range safety applications or for any target tracking process for target or system evaluation.

A 250 kW C-band transmitter is used with a 1.5 microsecond pulse and a recurrence frequency of 640 pulses per second. The aerial is a 183 cm paraboloid with a point source sequential monopulse feed which can track continuously in azimuth and has an elevation arc of 190° (−5° to +185°).

As the equipment's name suggests, digital techniques are extensively used in the system; and the use of solid-state devices wherever possible has resulted in a radar having a total system weight of less than 2,000 kg and a power consumption of only 15 kW.

STATUS:

A contract for the supply of these radars to all three US armed services was placed in mid-1973 with delivery of three radars due in 1974.

MANUFACTURER:

RCA Government and Commercial Systems, Moorestown, New Jersey, USA.

Units of the AN/TPQ-39 Digital Instrumentation Radar

2529.153
AN/TPS-21 AND AN/TPS-33 PULSE-DOPPLER BATTLEFIELD RADARS

DESCRIPTION:

These two radars are X-band portable manpack equipments used to detect persons or vehicles in motion on the ground. Targets are detected at ranges lying between approximate limits of 100 metres and 18,000 metres with a range measurement accuracy of +23 metres or +1% of range whichever is the greater. Angular accuracy is +25 mils.

Scanning is either manual or automatic in range with sector scan. For the TPS-21 radar detection is solely by audible tone in the operator's headphones; in the TPS-33 equipment there is also an A-scope display.

STATUS:

Operational in US armed forces.

MANUFACTURER:

Admiral Corporation, USA

2516.153
AN/TPS-32 AUTOMATIC 3-D TACTICAL SURVEILLANCE RADAR

DESCRIPTION:

AN/TPS-32 is an automatic digital 3-D tactical radar designed for use by the US Marine Corps for amphibious operation. It is the land or land-sea forces' equivalent of the AN/SPS-48 radar (**1252.253**) used by the US Navy.

Coverage is provided up to 480 km in range and up to 30,000 metres in altitude. The antenna used with the system is a rectangular array some 10 metres in height and inclined at an angle of about 30 degrees to the vertical. The array consists of 18 sub-arrays that are used to produce 9 pencil beams transmitted on 9 different frequencies: these beams are electronically swept in the vertical plane as the antenna rotates. The outputs from the nine receivers associated with these sub-arrays are computer processed to provide data for display on a variety of PPI tubes. An IFF antenna is mounted on top of the main array and IFF signals are combined with the primary radar data to make identification information readily available to the operator.

DEVELOPMENT:

AN/TPS-32 is derived from earlier experimental work carried out on a radar designated XN-2 that was developed by ITT Gilfillan for the US Bureau of Ships. Ten of the new equipments are on order for the USMC and other NATO countries are understood to be interested.

MANUFACTURER:

ITT Gilfillan Inc, 7821 Orion Avenue, Van Nuys, California 91409, USA.

2530.153
AN/TPS-34 TRANSPORTABLE AIR DEFENCE RADAR

DESCRIPTION:

TPS-34 is a tactical early-warning radar for use in forward air defence systems. Said to be the first tactical radar to utilise the V-beam 3-D technique.

The radar provides long-range three-dimensional data on high-speed aircraft and missiles from battlefield sites. It can be transported by helicopter in units averaging less than 200 kg in weight and can be assembled and operating in less than eight hours from touchdown.

STATUS:

In service in the US and British armed forces.

MANUFACTURER:

Sperry Gyroscope Division, Great Neck, NY, USA

2517.153
AN/TPS-43 TACTICAL 3-D RADAR

DESCRIPTION:

AN/TPS-43 is a lightweight air transportable S-band radar designed for use with manned aircraft or SAM batteries in a wide variety of tactical environments. It provides solid 3-D cover to 170 nm on a fighter aircraft such as the F.102 and measures heights to within ±305 metres of true target height at 100 nm by signal amplitude comparisons in six channels. Extensive clutter rejection and ECCM features are incorporated in the design, including a digital coherent MTI system, pulse-to-pulse frequency agility, jamming analysis and transmission selection (JATS), coded pulse anti-clutter system (CPACS) and sidelobe suppression. Later models, up to AN/TPS-43D, include equipment refinements and increased operational capability.

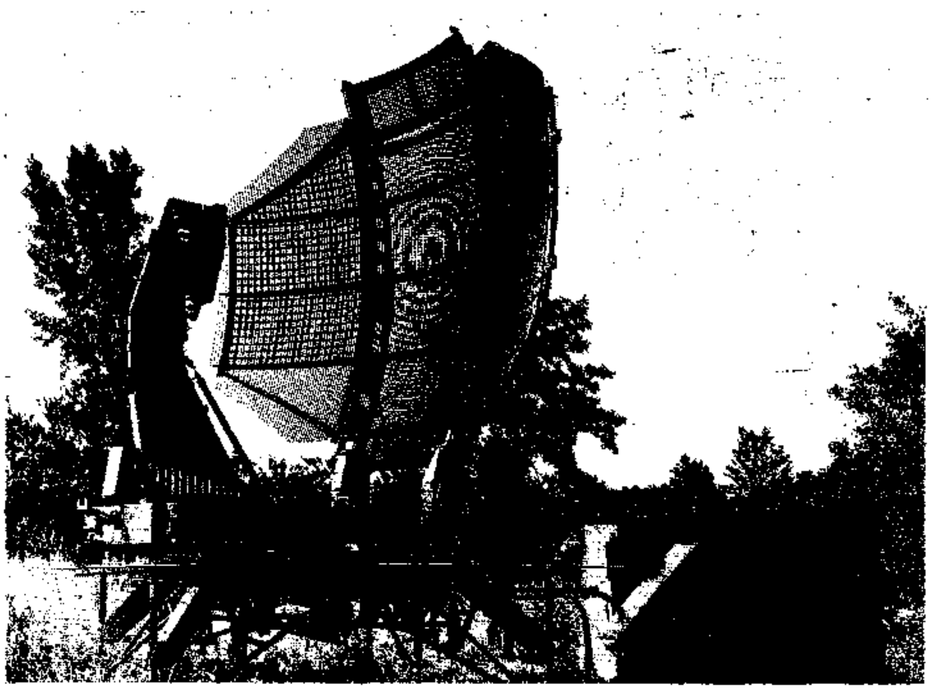
For ease of air shipment the equipment divides simply into two pallet loads each of less than 1,600 kg. One load comprises the shelter unit, transmitter receiver and displays, the other consists of the antenna assembly, the feed and ancillary equipment. The entire equipment can be packed into two 2½-ton trucks for road transport.

To minimise weight light alloys are used wherever possible in the main mechanical structures and microminiaturisation techniques are used where possible in the electronic circuits. A linear beam twystron tube is used for the transmitter: this incorporates the advantages of both the klystron and the TWT and results in reduced complexity in the transmitter circuits.

The feed array design is based on those of earlier Westinghouse-built radars. Among its features are the use of a stripline matrix to form the height-finding beams: IFF feed integral with radar feed and consisting of dipoles on each side of the radar feed plus a printed circuit radiator mounted on the back of the feed to act as the sidelobe reference antenna; use of this latter antenna during the dead time between transmitter pulses is available for the JATS function.

CHARACTERISTICS:

Range: Solid 3D coverage on fighter aircraft to 170 nm or more
Data rate: 10 seconds (6 rev/min antenna)
Elevation coverage: 0° to 20°
Electrical characteristics:
Power output: 4 MW peak, 6.7 kW average



AN/TPS-43 Radar

Frequency: 2,900-3,100 MHz in 16 discrete steps (with pulse-to-pulse agility)
Pulse duration: 6.7 microseconds
Antenna gain: Transmit, 36 dB; Receive, 40 dB
Azimuth beamwidth: 1.1°
IFF Azimuth beamwidth: 4.0° (or sum/difference ISLS antenna)
Noise figure: 5 dB
Prime power: 40 kW, 400 Hz 120/208V
Mechanical Characteristics:
Weight: 3,200 kg (two 1,600 kg units) to 4,200 kg
Transport: C-130 aircraft (0.23 by volume), two M-35 trucks, two sets of transporters, or two helicopter loads
Road speeds: Up to 96 kmh
Air lift altitudes: Up to 15,000 metres
Siting requirements: 6 × 10.5 m clear area on slope of 10% or less
Reaction time: 50 minutes with a 6-man team
Wind resistance: Operate to 52 knots, survive 92 knots (tied down)
Operating altitude: Up to 3,000 metres above sea level
Operating temperature: −40°F to 125°F (−40°C to +52°C)
Other:
MTBF: 235 hours
MTTR: 0.75 hour
Outputs to: Three 120 metre cables with storage reels
Operations centres PPI: AN/UPA-62 40 cm CRT for air control and monitoring
IFF/SIF equipment: AN/UPX-23 Interrogator Set and AN/UPA-59A Active/Passive Decoder
Transmitter tube: Linear beam Twystron
Air Conditioner/heater: A/E32-18

MANUFACTURER:

Westinghouse Defence and Electronic Systems Centre, Baltimore, Maryland, USA.

2518.153
AN/TPS-44 TACTICAL SURVEILLANCE RADAR (ALERT)

DESCRIPTION:

AN/TPS-44 is a lightweight, solid-state, transportable L-band air surveillance radar. It was designed for use anywhere in the world as the sensor for the Forward Air Control Post of the US 407L System (TACS).

The equipment comprises a transportable equipment shelter (containing the electronic equipment including IFF) and a palletised antenna. It can be transported by helicopter, aircraft and all forms of surface transport and it is said that it can be put into operation after transport in less than one hour.

Main features of the equipment are set out in the accompanying table.

DEVELOPMENT:

Prototypes of the equipment were submitted to the USAF and successfully passed all tests. Following this the equipment was put into production, and by October 1968 25 systems had been delivered to the USAF.

CHARACTERISTICS:

Antenna:
Type:
Search: Modified parabolic
IFF: Integral with search radar feed system and reflector
Aperture: Search:
Horizontal: Greater than 45 metres
Vertical: Greater than 2.7 metres
Beam width (one-way): Search and IFF:
Horizontal: 3.8°
Vertical: 8° with cosecant squaring from 7° to 27°
Polarisation:
Search: Horizontal
IFF: Vertical
Type of feed: Search and IFF: Horn
Beam pattern Search and IFF:
Horizontal: Conventional fan beam (cosine between 3-dB (points), side lobes 25-dB down back lobes 30-dB down
Vertical: Conventional fan beam with cosecant squaring
Scan:
Azimuth: 0 to 15 rev/min, clockwise in automatic, or manually searchlighting, clockwise or counter clockwise
Elevation: Manually adjustable, −3° to +6°
Transmitter:
Power:
Peak: 1 MW, or greater
Average: 1.12 kW at 800 0.745 kW at 533,

1.12 kW at 26 /
Pulse Repetition Frequency:
Manually selectable: 800, 533, 267
Momentary selectable: ± 10 microsec stagger on 800 PRF
Frequency: 1.25 to 1.35 GHz, continuously tunable over full range by local or remote tuning control
Tuning rate: 1 MHz per second
Pulse: Width automatically selected when PRF is selected.
1.4 microsec for 800 PRF
1.4 microsec for 533 PRF
4.2 microsec for 267 PRF
Rise time: 100 nanosec. max
Receiver:
Noise figure: Typically 3 dB, overall
Dynamic range: 65 dB
Choice of IF: logarithmic, linear, or wideband limiting
Signal Processing:
MTI:
(a) Analogue type
(b) Signal delay line canceller
(c) Cancellation ratio – typical 40 dB
(d) Subclutter visibility –30 dB searchlighting, 20 dB scanning (6 rpm)
(e) FM IF delay line processor with phase locked tracking loop detector, video cancellation
VSI: Uses same processor as MTI
Feedback factor typical 0.97
Accuracy:
Range: 0.33 nautical mile on 267 PRF; 0.1 nautical mile on 800 and 533 PRF
Azimuth: + 1°
Type of information displays:
(a) PPI
(b) A-scope
(c) Output jacks and cabling provided for remote displays

MANUFACTURER:
Westinghouse Defence and Electronic Systems Centre, Baltimore, Maryland, USA.

2519.153
AN/TPS-48 3-D TACTICAL RADAR

DESCRIPTION:

AN/TPS-48 is an updated version of the AN/TPS-27 (**2515.153**) and, so far as is known, has been created only by modifying models of the earlier radar.

Principal differences are:
(1) Weight and size reduction. Whereas AN/TPS-27 requires nine M-35 trucks to put it on the road AN/TPS-48 requires only two.
(2) Field assembly time reduced from 150 man-hours to about six.

The compact modified radar is housed in two compact modular shelters.

DEVELOPMENT:
Westinghouse received a contract from the USAF to modify eight of their AN/TPS-27 radars to the new standard.

MANUFACTURER:
Westinghouse Aerospace and Electronic Systems, Baltimore, Maryland, USA.

2520.153
AN/TPS-61 TACTICAL SURVEILLANCE RADAR

DESCRIPTION:
AN/TPS-61 is an air-transportable L-band tactical radar for airfield surveillance, gap-filling and similar functions for which a transportable radar may be required.

Important features of the equipment are high-quality MTI circuits, built-in IFF/ATCRBS capability and a high-performance lightweight PPI display. MTI circuits include a digital MTI system and CPACS circuits. The display is the AN/UPA-62 Indicator Group which Westinghouse have developed for the USAF and which is an exceptionally compact 16-inch (406 mm) display with a very wide range of facilities.

DEVELOPMENT:
Produced in the summer of 1969 for test by USAF and USMC

CHARACTERISTICS:
Performance:
Range: Solid 2D coverage up to 87 nm on fighter-sized aircraft
Data rate: 6-12-15 rpm (10 second, 5 second, 4 second)
Elevation coverage: 24,000 metres, cosecanted to 45°
Electrical Characteristics:
Power output: 100 kW, Peak, Average 2.2 kW
Frequency: 1,250-1,350 MHz 0.24-0.222 metres
Pulse duration: 26 microsec/compressed to 2 microsec
Antenna gain: 28.5 dB
Azimuth beamwidth: 2.7°
Receiver noise figure: 3.5 dB
Prime power: 15 KVA, 400 Hz, 3-phase
Mechanical Characteristics:
Weight: 1,700 kg
Transport: C-130 Aircraft, M-35 truck, 1 UH-1 Helicopter
Road speeds: Up to 95 kmh
Reaction time: 30 minutes with 4-man team
Wind resistance:
Non-operating: 90 knots and ice up to 2 radial inches
Operating: 52 knots and ice to 0.5 radial inch
Operating altitude: Up to 10,000 ft above sea level
Non-operating: Up to 50,000 ft above sea level
Temperature:
Non-operating: –62°C to +71°C (–80°F to +160°F) for periods of storage and exposure up to 180 days
Operating: –40°C to +52°C (–40°F to +125°F)
Antenna dimensions: Vertical 2.14 metres
Horizontal: 5.49 metres
Shelter construction: Standard military S280 shelter. Dimensions, 373 cm long, 203 cm wide, 211 cm high
Other:
MTBF: 450 hours
MTTR: 0.28 hour
PPI: 406 mm AN/UPA-62
Air conditioner/heater included

AN/TPS-61 Radar. Cutaway drawing showing display arrangement

MANUFACTURER:
Westinghouse Defence and Electronic Systems Centre, Baltimore, Maryland, USA.

2535.153
AN/TPX-42 IFF/ATCRBS GROUND EQUIPMENT

DESCRIPTION:
AN/TPX-42 is an advanced secondary radar system comprising interrogator/responsor, data-processing and display equipment. It is being supplied to US military and civilian authorities for civil/military air traffic control and military defence purposes. There are several different possible configurations of the equipment depending on specific application, fixed and mobile RAPCONs, fixed and mobile GCAs, RATCCs, and civil air terminals.

Main units of the system are the Antennas, the SSR Interrogator/Receiver, the Synchronizer/Coder, the Interference Blanker (Defruiter), the Video Signal Processor, the Indicator Data Processor, and the Display Consoles.

Coded pulse trains appropriate either to the Mark X IFF/SIF or to the ATCRBS system are transmitted by the interrogator which is triggered by the Synchronizer/Coder; the latter providing either internally generated pulses or pulses connected down from associated primary radar.

The Defruiter accepts the incoming signals from the Receiver and applies automatic three-mode interlace defruiting. It can operate over a wide PRF range of from 25 to 1,000 Hz. The Defruiter output is applied to the Video Signal Processor which standardises and decodes all replies in the interrogator coverage area (active decoding). The VSP also identifies potential garble situations, detects true target position for range and azimuth, correlates and validates identity and altitude codes, and combines all this information into a single message for each aircraft once per antenna revolution.

These messages are received by the display processor which converts and corrects the altitude code according to the prevailing conditions, converts the polar radar coordinates into Cartesian coordinates and provides the converted data to the displays together with memory data for display of aircraft tracks. The displays present synthetic position symbols in accordance with the processed radar video together with numeric codes for identity and altitude plus aircraft tracks and other data as required.

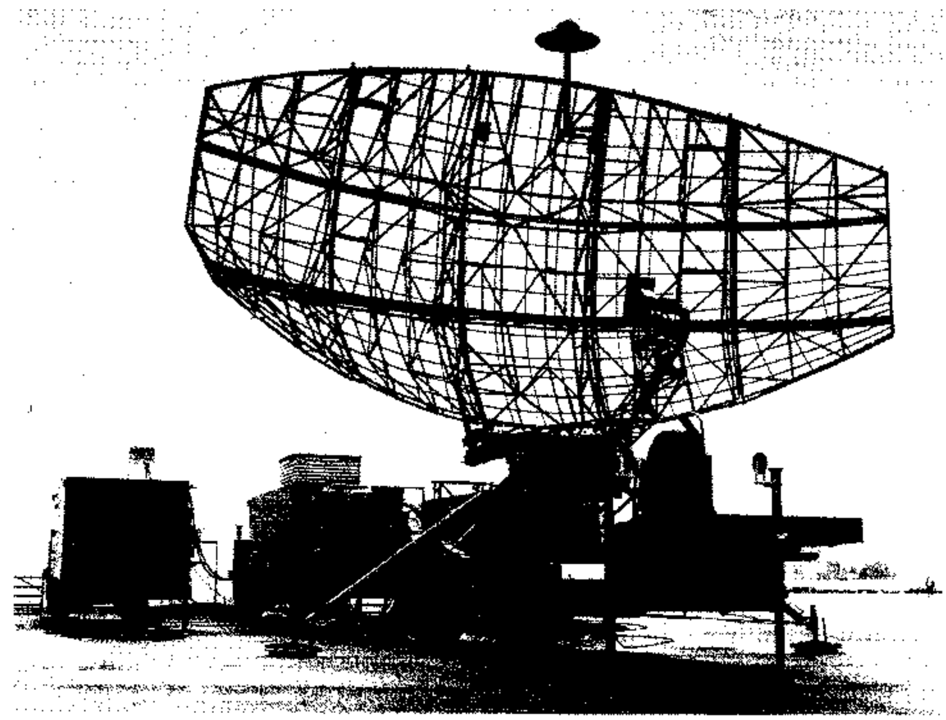
STATUS:
In production. A contract for 304 military systems was placed with AIL in October 1969. Civil systems are also on order for the FAA.

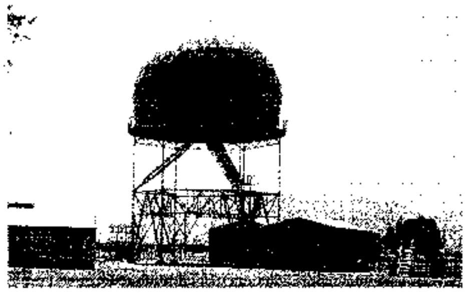
MANUFACTURER:
AIL Division of Cutler-Hammer Inc., Deer Park, Long Island N.Y. USA.

2547.153
AN/VPS-2 RANGING RADAR
DESCRIPTION:
This coherent doppler MTI radar is the range sensor of the Vulcan forward area air defence system (**2850.131**). Targets are acquired and tracked optically in this system but high-speed range and range rate data are required as inputs to the lead computing sub-system.
The axis of the radar antenna is servoed to the optical line of sight. The sight case and gun bore are physically fixed in alignment; but the sight reticle, which defines the optical line of sight, can move relative to the sight cage and is controlled by a gyro. As the gunner tracks the target, the angular tracking rate and the radar-measured range and range rate are computed to predict future target position and then to control the sight reticule, introducing between the optical and firing axes the lead angle and super elevation required for successful target engagement.
Although primarily directed by optical means, the AN/VPS-2 radar has an automatic search and lock-on characteristic so that it tracks the target accurately.
CHARACTERISTICS:
Search range: 5,000 m
Tracking capability: 15 m/sec to 310 m/sec
Subclutter visibility: 40 db or better
STATUS:
Operational. The radar was developed under a US Government contract placed in March 1966. The first prototype was completed in the same year and the equipment entered US Army service in 1969.
MANUFACTURER:
Lockheed Electronics Company, Route 22, Plainfields, N.J. 07060, USA.

2844.153
AVADS FIRE CONTROL RADAR
DESCRIPTION:
This radar is used with the Automatic Vulcan Air Defence System (AVADS – **2843.131**) and is a modification of the AN/VPS-2 range-only radar (**2547.153**), used with the earlier Vulcan system (VADS – **2850.131**).
The purpose of the modification is to enable the radar to track in angle as well as in range. As modified, it consists of a rear-feeding, low side-lobe, polarised twist, cassegrain reflector protected by a fibreglass front plate; a gearless, gyro-stabilised electrical drive mechanism; and signal processing and interface electronics, most of which are the same as have long been successfully used in the VPS-2.
Like the VPS-2 the AVADS radar is a pulse doppler system working in X-band and has an operational range span of 200-5,000 metres.
STATUS:
Evaluated by US Army. Decision on procurement awaited
MANUFACTURER:
AVADS prime contractor: General Electric Company, Lakeside Avenue, Burlington, Vermont 05421, USA.

2499.153
HIPAR (HIGH POWER ACQUISITION RADAR)
DESCRIPTION:
HIPAR (High Power Acquisition Radar) is designed specifically for use with the United States Army's improved Nike Hercules surface-to-air missile system. The improved Nike Hercules system is deployed in key areas in the United States and overseas as a defence against high-performance aircraft, air-to-ground missiles, and tactical ballistic missiles. HIPAR was developed as an integral part of the system to provide significantly increased detection capabilities. It supplies long-range coverage and extremely precise azimuth data on small supersonic targets.
In addition to long range, the high-gain narrow-beam antenna used by HIPAR provides high-angle coverage. Its high-altitude coverage is said to be appreciably better than that of most present-day acquisition or surveillance radars.
To permit the full detection capabilities of the high-gain antenna to be realised despite the presence of enemy jamming, what are said to be unique moving target indicator (MTI) and receiver circuits have been developed for use with HIPAR. These circuits employ anti-jamming techniques that are said to provide capabilities not previously possible with conventional MTI techniques.


HIPER (High Power Acquisition Radar)


HIPER (High Power Acquisition Radar)

Both static and mobile HIPAR systems have been produced for the Army's use in both United States and Europe. The mobile version, which uses the same electronics and components as the static version, is said to be the highest-powered mobile radar of its kind in the free world. An important feature of the antenna for the mobile version is its ability to be changed quickly from cosecant-squared coverage to fan-beam coverage.
Mobile HIPAR is transported on five flatbed trailers and can be emplaced by Field Army personnel after minimum training.
STATUS:
Operational
MANUFACTURER:
General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.

2783.153
RCA PORTABLE BATTLEFIELD RADARS
DESCRIPTION:
Two miniaturised battlefield radars have been developed by RCA for the detection of moving people or vehicles in poor visibility conditions.
Both radars operate in X-band. The smaller, 2019M2, has a transmitter-receiver unit weighing only 1 kg and the complete radar weighs only 4 kg with batteries capable of 12 hours uninterrupted operation. The larger radar, 4019M2, has three times the range capability of the smaller equipment and has a transmitter receiver weighing only 3.6 kg; and the complete radar with accessories weighs only 6.35 kg.
The 2019M2 radar can detect a man at a distance of 500 metres – with a range accuracy of 6 metres – and features single 3-control operation. Of modular construction it has an indicated MTBF of 5,000 hours. It is well suited to small unit deployment; the lightweight transmitter-receiver can conveniently be mounted directly on such weapons as the M16 rifle, the M60 machine gun, the M79 grenade launcher and the M67 recoilless rifle. Thus mounted the radar will give fire control data direct to the weapon user.
The 4019M2 is a more sophisticated equipment. In particular it features a look/listen acquisition mode in which it is possible for the operator to range on one target while continuing to look for others. This radar is also suitable for unmanned operation and can be used in quantity to set up a perimeter warning system. For this purpose the radar can be tripod-mounted, but for other operations the transmitter-receiver is quite light enough to be held in the hands if required.
CHARACTERISTICS:

	2019M2	**4019M2**
Frequency:	8,750 MHz	8,750 MHz
Detection range: (on 0.5 sq m target)	500 m	1,500 m
Location range:	500 m	2,500 m
Range resolution:	25 m	25 m
Target speeds detected:	1.74 km/h	1.74 km/h
Signal output display:	Doppler aural only	Doppler aural and visual alarm
Power consumption: (at 24 V DC)	3 W	5 W

Height (approx):	23 cm	20 cm
Width (approx):	33 cm	33 cm
Depth (approx):	10 cm	13 cm

Weight (approx):		
Transmitter-receiver:	1 kg	3.6 kg
System:	4 kg	6.4 kg

MANUFACTURER:
RCA, Government and Commercial Systems, Moorestown, New Jersey, USA.

2791.153
SAFEGUARD MISSILE SITE RADAR
DESCRIPTION:
The Missile Site Radar (MSR) of the Safeguard ABM system (**2798.131**) is a large multiple phased-array S-band equipment. In the original Safeguard proposals there was provision for up to twelve of these radars strategically located across the contiguous United States: it now seems fairly certain, however, that there will be only one such radar deployed operationally in the area and that any subsequent requirement for operational facilities similar to those provided by the MSR will be met by the deployment of a different radar (see **2806.131** and **2792.153**).

A prototype installation of the MSR has been operating at Meck Island in the Kwajalein Atoll since September 1968 and has been used in conjunction with the Spartan and Sprint (**2811.131** and **2812.131**) missile trials. The operational installation is nearing completion near Nekoma, North Dakota, close to the Spartan launch site, within 25 km of the four Sprint launch sites and some 40 km south-west of the Perimeter Acquisition Radar (PAR – **2790.153**). The radar is housed in a truncated reinforced concrete pyramid some 23 metres high and mounted on a square reinforced concrete underground building about 70 metres square and 16 metres high. A circular phased array about 10 m in diameter is mounted on each of the four faces of the pyramid which are directed towards the four points of the compass: each array contains 5,002 phase shifters and the radar has a detection range of more than 300 nm (550 km).

Targets will normally be detected at long range by the PAR which will then programme the MSR accordingly. For an exo-atmospheric interception a Spartan missile may be launched on command from either PAR or MSR as circumstances dictate, but in either case the MSR tracks both target and missile and commands the missile on to the required interception course. For an endo-atmospheric interception the MSR system commands the launch of a Sprint missile from one of the four launch sites and controls the interception.

STATUS:
At the time of writing the MSR is at its installation test stage. Components and subsystems are being evaluated and the integrated system is being tested by satellite tracking. Handover to the US Army is scheduled for October 1974 and initial operational capability for June 1975.

MANUFACTURER:
Raytheon Company, Equipment Division, Wayland, Massachusetts 01778, USA.

2790.153
SAFEGUARD PERIMETER ACQUISITION RADAR
DESCRIPTION:
The Perimeter Acquisition Radar (PAR) of the Safeguard ABM system (**2798.131**) is a very large phased-array equipment of which it was originally intended to build a chain to provide ABM data for all the contiguous United States. It was intended that most of these radars would consist of a single radiating array and associated equipment, but a few would have had more than one array. The original intention has been progressively whittled down, however, and the radar now constructed near Cavalier, North Dakota, seems likely to be the only one to be deployed operationally.

This radar has a single radiating face pointing northwards with an azimuth coverage of about 120° and a missile detection range believed to be about 1,800 nm (3,300 km). The face is mounted on the sloping side of a reinforced concrete structure some 30 metres high and having a square base with a side of about 61 metres. The array consists of some 6,600 dipole elements which have been reported as radiating at 442 MHz with a power of 1.1 kW each. The array is roughly octagonal and about 30 m wide.

Associated with the radar is an elaborate computer system which calculates the trajectory and impact point of any hostile target detected by the radar and generates information either to programme the Missile Site Radar (**2791.153**) some 40 km to the south-west or to launch a Spartan interceptor missile (**2811.131**) from the 30-missile launch field co-located with a 16-missile Sprint (**2812.131**) launch field near the MSR. Time for the PAR to determine the trajectory of a detected re-entry vehicle is believed to be about three seconds.

STATUS:
Hardware installation and test virtually complete. Software should be complete and handed over to give an initial operational capability by June 1975.

MANUFACTURER:
Prime contactor for the PAR – General Electric Company, Syracuse, New York, USA.

2792.153
SITE DEFENCE RADAR
DESCRIPTION:
An important item in the US Site Defence ABM system (**2806.131**) is a new phased-array radar which will be supplied by the General Electric Company. This radar will perform functions generally similar to those required of the Safeguard MSR (**2791.153**) but limited to endo-atmospheric interception with the Sprint II missile (**2807.131**).

The Site Defence radar will be substantially smaller than the MSR: the area of each of its four phased arrays is said to be only one-fifth of that of each of the MSR arrays; and from sketches that have been published it appears that the complete radar and computer installation will be in the region of one-tenth of the size of the MSR. The radar uses ferrite phase shifters, dipole radiating elements and shadow grid travelling-wave tubes. The associated data processing hardware and software is also much less elaborate, and therefore cheaper, than that which was specified for the MSR.

STATUS:
Development. System integration testing for the whole Site Defence system is scheduled to begin at Kwajalein in 1977

MANUFACTURER:
General Electric Company, Syracuse, New York, USA

THE UNION OF SOVIET SOCIALIST REPUBLICS

2860.153
BACK NET GCI RADAR
DESCRIPTION:

An early Russian GCI and a predecessor of Barlock (**2861.153**) the radar known to NATO as Back Net has a six-feed antenna system similar to that of Barlock.

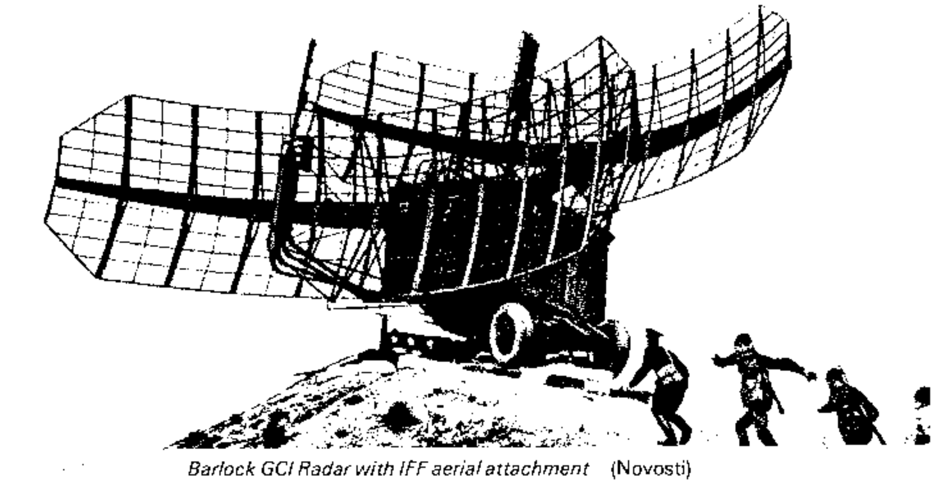
Multiple feeds are widely used in Russian surveillance and GCI radars. Part of the reason for this is the possibility of increasing the total radiated power within the confines of component limitations; but another reason is the possibility of using such antenna systems to provide some form of height information.

Other predecessors of Barlock include Big Bar A (**2862.153**) and Big Mesh (**2863.153**) both of which also have six-feed antenna systems.

2861.153
BARLOCK GCI RADAR
DESCRIPTION:
This large ground control interception (GCI) and search radar is a trailer-mounted equipment that has two large truncated paraboloid reflectors with clipped corners

Operating frequencies of the radar are in the S-band. Each of the reflectors is fed by three feeds so that a total of six stacked beams results, each beam having a power output in the region of IMW. These beams enable the radar to be used as a height indicator. Individual frequency bands for the stacked beams are:

2695 – 2715 MHz
2715 – 2750 MHz
2815 – 2835 MHz
2900 – 2990 MHz
2990 – 3025 MHz
3080 – 3125 MHz



Barlock GCI Radar with IFF aerial attachment (Novosti)

Known to the Russian forces as P-50 this radar has a p.r.f. of 375 pulses/second and pulse widths of 1.8-3.1 microseconds for the S-band transmission and 2,4 microseconds for an L-band identification (IFF-type) secondary radar transmitter that is often found in association with Barlock.

Range capability of Barlock is about 300 km, range accuracy is about 90 metres and angular accuracy about 0.5 degree. The entire trailer body rotates for azimuth scanning at rates up to about 12 rev/min.

STATUS:

Known to have been in operational use for at least 12 years.

2862.153
BIG BAR A GCI RADAR
DESCRIPTION:

A GCI radar with a six-feed antenna system similar to that of Barlock (**2861.153**). See also entry for Back Net (**2860.153**) above.

2863.153
BIG MESH GCI RADAR
DESCRIPTION:

A GCI radar with a six-feed antenna system similar to that of Barlock (**2861.153**). See also entry for Back Net (**2860.153**) above.

2864.153
DOGHOUSE ABM RADAR
DESCRIPTION:

One of several large fixed phased-array radars deployed by the Russian authorities for missile detection. Doghouse is the NATO name given to a radar with a very large array antenna.

Complicated signal processing is used in the installations to which these large antenna arrays belong. It is believed that this is an area where Russian technology is somewhat weaker than, say, that of the USA; and in support of this view it has been pointed out that such signal processing techniques are not much used in smaller Russian radar installations and that this may be because they have decided to apply limited resources first and foremost to the solution of such critical problems as strategic missile defence.

Principal known use of the Doghouse radar is as the intermediate range radar of the Moscow ABM complex. It accepts targets from the long-range Hen House radar (**2879.153**) and hands them on to the Try Adds (**2948.181**) radars. Doghouse operates in the VHF band at around 100 MHz – hence the need for the very large phased array to achieve a sensible beamwidth. It is said to be capable of radiating a peak power upwards of 20MW and to have a p.r.f. of 50 pulses/sec – which is broadly consistent with its reported range of some 1500 nm (about 2,800 km).

STATUS:

Operational in the Moscow ABM network.

2866.153
FAN SONG MISSILE CONTROL RADARS
DESCRIPTION:

Fan Song is the NATO code-name given to a family of compound radar installations that have been developed for use with the Guideline (US code SA-2) surface-to-air missile (**2942.131**).

Five of these radars have so far been identified (by suffix letters A to E) and common to all of them are the detection and tracking of the target, the command guidance of the missile and the tracking of the missile. It is said that these radars can handle up to six targets at once and guide three missiles at a time. It appears, however, that the missile must pass through the guidance beam within a few seconds (reportedly 6) of launch if it is to be acquired and steered towards the selected target. A further problem appears to be a limitation in the amount of steering information that the missile is capable of receiving from the ground station. Nevertheless, the Russian forces have kept Guideline (in various versions) in service for many years and it has been used in action successfully by the North Vietnamese, although possibly expensive in operation, therefore, the system as a whole would appear to be effective.

Details of some of the Fan Song series are given below. All members of the series contain as a major element a track-while-scan radar which scans a designated sector with two flapping fan beams radiated from two orthogonal antenna systems. The flapping motion has a sawtooth profile and uses the electromechanical system known as the Lewis scanner. The "fan" in the code-name refers to these fan beams and the "song" to the bird-like sound of the demodulated radiation from these radars.

STATUS:

Fan Songs of various kinds are in service with Guideline missiles in the U.S.S.R. and satellite and client countries.

2867.153
FAN SONG B MISSILE CONTROL RADAR
DESCRIPTION:

Fan Song B is an S-band member of the Fan Song series (see **2866.153** above). Radiation from its two Lewis scanners is at 2,965-2,990 MHz for one and 3,025-3,050 MHz for the other: peak power output is in the region of 600 kW and the equipment has a first-time-round range capability of between 60 and 120 km.

The equipment is trailer-mounted and the scanned sector can be changed by rotating the trailer and tilting the whole superstructure. The sector scanned is about 10 degrees high and 10 degrees wide, these dimensions being the approximate fan beam width, the beam width in the scanning direction being only about 2 degrees for each beam.

A small parabolic antenna, mounted at one end of the horizontal Lewis scanner is used to transmit UHF command guidance signals to the missile.

2868.153
FAN SONG E MISSILE CONTROL RADAR
DESCRIPTION:

Fan Song E is a C-band member of the Fan Song radar series (see **2866.153** above). Similar in many respects to Fan Song B (**2867.153**) its main differences are the frequency of the radiation from the Lewis scanners and the fan beam (and hence the sector) dimensions. The beams in Fan Song E are about 7.5 degrees wide in the fan and about 1.5 degrees wide in the scanning direction, carrier frequencies are 4,910-4,990 MHz and 5,010-5,090 MHz and peak power is about 1.5 MW. Unambiguous range is 70-145 km.

In addition to the antenna for the command guidance signals, which is similar to that of Fan Song B, Fan Song E has two further parabolic dishes mounted on top of the horizontal Lewis scanner. One of these is horizontally and the other vertically polarised and their purpose is to provide a LORO (Lobe On Receive Only) feature. This is an ECCM technique in which the scanning action of the Lewis scanner is restricted to the receive channel by diverting the transmitted signal, which otherwise would be radiated from the scanner, into a dummy load. This signal is then replaced by a signal from one of the parabolic dishes (the other being for use with the other Lewis scanner) of sufficient power to operate the whole system.

The reason for adding the LORO facility is that by monitoring the Lewis scanner radiation an enemy pilot can tell roughly whether or not he is the prime focus of the attention of the ground forces. If he is, he can employ deceptive electronic counter-measures (DECM) to confuse the radar – such countermeasures typically involving an apparent shift of target angle.

STATUS:

C-band Fan Song radars are in widespread use with Guideline missiles. A particular installation of Fan Song E is that with the Guideline missile on the cruiser *Dzerzhinski* – currently the only known shipborne installation of the missile.

2871.153
FIRE CAN FIRE CONTROL RADAR
DESCRIPTION:

This S-band trailer-mounted radar appears to have been derived from the American SCR-584 radar that was extensively used during the latter years of the Second World War and which was supplied to the Russian forces by the USA. A typical wartime application of the SCR-584 radar was its use on the "Diver" gunsites that were set up on the East coast of Britain to combat the V.1 attack. The radars then were used with 3.7 inch (94 mm) AA guns and the electronic predictor. The Russian radar appears to be used with smaller 57 mm and 85 mm guns.

Fire Can operates at a frequency of 2,700 to 2,900 MHz, has a pulse width of 0.3 to 0.8 microsecond and a p.r.f. of 1,840-1,900 pulses/sec. Peak operating power is believed to be about 300 kW.

Like the SCR-584, the Fire Can antenna is a parabolic dish, perforated to reduce weight and windage, that is mounted on a pedestal on top of the flat roof of the radar trailer. Power is radiated from a rotating dipole feed driven from the rear of the dish and signals from the common T/R system are used, in the tracking mode, to operate a lock-follow system that produces tracking accuracies of about 1.6 minutes of arc in azimuth and 2 minutes in elevation.

The radar can also be operated in a search mode with the antenna rotating continuously in azimuth and nodding in elevation. In this mode the antenna, which has a diameter of about 150 cm, produces a pencil beam with an effective beam width of about 5 degrees. In this mode all received signals are displayed on a PPI but the dipole feed is driven all the time so that the operator can switch rapidly from search to track.

It is believed that Fire Can can acquire targets (search mode) at a maximum range of about 80 km and track them from about 35 km. Tracking accuracy in range is said to be about 13-15 metres.

STATUS:

In service. It is reported that some 75 of these radars were at one time deployed for use in North Vietnam.

2872.153

FIRE WHEEL FIRE CONTROL RADAR

DESCRIPTION:

Fire Wheel is the NATO code-name for another SCR-584-derived fire control radar similar to Fire Can and Whiff (**2871.153** and **2893.153**).

2873.153

FLAP WHEEL FIRE CONTROL RADAR

DESCRIPTION:

Flap Wheel is the NATO code-name for a conical scan radar that is believed to have much the same range of operating frequencies as Gun Dish (**2876.153**). It is used to provide fire control data for 130 mm AA guns.

2874.153

FLAT FACE TARGET ACQUISITION RADAR

DESCRIPTION:

Flat Face is the NATO code-name of a radar known in Russia as the P-15. It is a vehicle mounted acquisition radar that is used in conjunction with the Low Blow missile control radar (**2884.153**) and the Goa surface-to-air missile (**2938.131**).

This radar operates in the UHF band and radiates its signals from two elliptical paraboloid reflectors each measuring about 11 × 5.5 metres. The radar has a range capability of about 250 km with a range accuracy of about 90 metres and an angular accuracy of about 0.5 degrees. Frequency bands are about 810-850 MHz and 880-950 MHz, p.r.f.'s are 200-800 pulses/sec and 600-680 pulses/sec. Vertical beamwidth is about 5 degrees and horizontal about 2 degrees. Peak power is about 400 kW.

STATUS:

Operational in Egypt and Vietnam – where 40 Flat Face radars have been reported. Deployed generally with Goa missile.

2875.153

GAGE ACQUISITION RADAR

DESCRIPTION:

Gage is the NATO code-name for an acquisition radar that is used in conjunction with the Yo-yo missile control radar (**2895.153**) which in turn is used with the early Russian surface-to-air missile Guild (**2944.131**). Operating frequency is believed to be about 3GHz and peak power about 2MW.

2876.153

GUN DISH FIRE CONTROL RADAR

This broad-band fire control radar is used in conjunction with the quadruple 23 mm AA gun mounting on the ZSU-23-4 SP AA vehicle (**5548.103**). This vehicle is used by the AA battalions of the armoured and mechanised divisions of the Red Army and of other Warsaw Pact armies. The NATO code-name "Gun Dish" is obviously prompted by the appearance of the ZSU-23-4 vehicle.

Designed as it is to oppose low-level aircraft attacks the system of which Gun Dish is a part has to have a short reaction time. The guns can be slaved to the radar in elevation and are mounted, in the ZSU-23-4, in a rotatable turret on which the radar is mounted also and which contains a fire-control computer.

It is believed that Gun Dish operates over a wide band of frequencies – from X-band to the lower K-band frequencies.

Gun Dish Fire Control Radars with 23 mm AA guns on ZSU-23-4 SP AA vehicles (Novosti)

2877.153

HEN SERIES EARLY WARNING RADARS

DESCRIPTION:

Several exceptionally large early warning radars observed by American reconnaissance have been given a series of names containing the word "Hen". First to be so named was Hen House (**2879.153**); others whose names have been reported are Hen Egg, Hen Nest and Hen Roost. Few details have been received concerning these radars: the notes below summarise the available information.

Hen Egg

Operating frequency around 2GHz. Peak power around 3 MW. Pulse width 5-15 microseconds: p.r.f. up to 300 pulses/sec. These figures suggest the high mean power of about 5 kW per beam.

Hen Nest

Operating frequency about 800 MHz. Peak power about 3.5 MW.

Hen Roost

Operating frequency not definitely known but thought not to be less than 500 MHz. Peak power similarly believed to be about 5 MW. 2 × 2 degree beam.

STATUS:

All these Hen radars – and probably several others – are believed to be operational; although it is quite possible that some of them are only experimental designs (albeit used operationally) that may well not be repeated.

2878.153

HEIGHTFINDING RADARS

DESCRIPTION:

Several basically similar nodding height-finder radars have been identified and named by NATO. The generic code-name is Cake, and variants on this basic concept are known by such names as Patty Cake, Rock Cake and Sponge Cake.

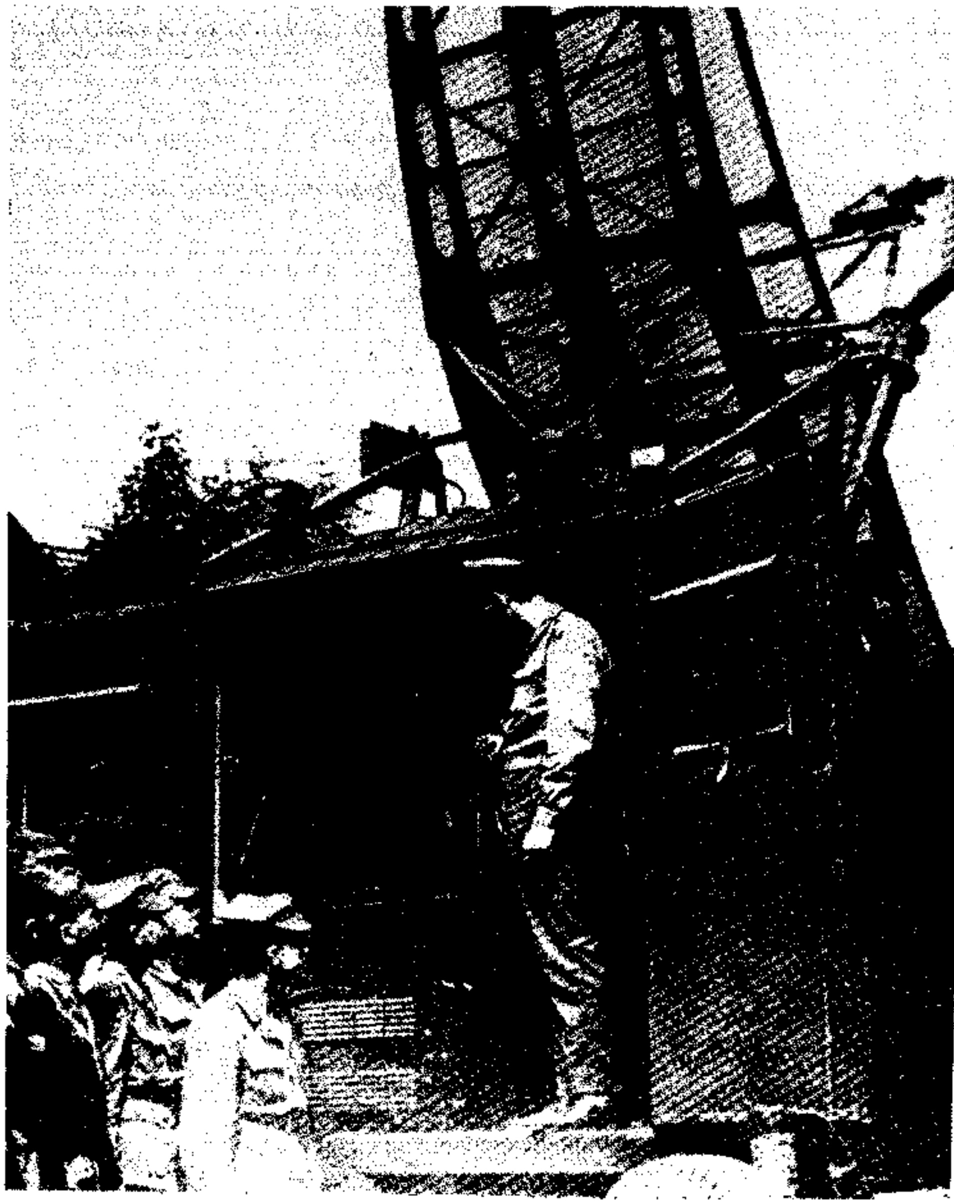
These radars, with their large, peel-shaped nodding antennas typically radiate beams with a width of some 3.5 degrees in the vertical plane. Nodding frequency is typically about 30-40 cycles/min and range is upwards of 200 km. One such radar, Sponge Cake, has a range in the region of 300 km, a range accuracy of about 2 km

500 metres, both at a range of 200 km.

All appear to operate frequencies somewhat above 2 GHz and to have peak powers around 3 MW.

STATUS:

Operational.



Cake series heightfinding radar

2879.153

HEN HOUSE ABM RADAR

DESCRIPTION:

This is the name given by the US authorities to a very large Russian array that was first detected in the late 1950's and was at that time thought – if indeed it was a radar – to be part of a detection tracking and control network for satellites.

Subsequently, however, it was discovered that these enormous radars perform an important early warning and tracking function in the Russian ABM weapons system, providing radar coverage comparable with that planned for the US Safeguard (**2798.131**) system. No details of the radar are known other than that the antenna array is exceptionally large – perhaps as much as 300 metres long and 20 metres high. This billboard array is said to be inclined at about 45° from the vertical.

It is reported, however, that the performance of Hen House is comparable with that of the FPS-50 detection radars (**2511.153**) of the American BMEWS system (**2525.181**) – i.e. a detection range in the region of 3,200 nm (about 6,000 km) and a track-while-scan capability. It is believed to operate on about 150 MHz and has been reported as having a variety of p.r.f.'s from 25 to 100 pulses/sec, variable pulse widths, a complicated beam scan pattern with two beams scanning in azimuth, two scanning in elevations and one scanning in a circular pattern. Peak power is believed to exceed 10 MW.

STATUS:

Hen House radars have been reported as being operationally deployed near Irkutsk, near the Barents sea and in Latvia not far from the Baltic. See also general notes on the "Hen" series (**2877.153**).

2880.153

KNIFE REST A EARLY WARNING RADAR

DESCRIPTION:

Knife Rest radars, as they are known to NATO, have the Russian designation P-10. They were the forerunners of the Spoon Rest radars (**2889.153**).

Knife Rest A has an operating frequency band of 70-73 MHz, radiates about 100 kW peak power, has a pulse width somewhere between 4 and 12 microseconds and horizontal and vertical beam widths in the region of 20-25 degrees. Range capability is somewhere around 350 km.

STATUS:

Operational – certainly in Vietnam – although the more modern Spoon Rest is deployed in the same theatres.

2881.153

KNIFE REST B & C EARLY WARNING RADARS

DESCRIPTION:

General characteristics of these early warning radars are similar to those of Knife Rest A (**2880.153**) except that the range capability is lower at only about 90 km. Knife Rest B is shown to operate in the frequency band 83-93 MHz.

STATUS:

Knife Rest B is certainly operational in Vietnam.

2937.153

LONG TRACK SURVEILLANCE RADAR

DESCRIPTION:

Long Track is the NATO code-name for a tactical surveillance radar used with surface-to-air weapon systems as an early warning/putter-on.

Long Track is commonly associated with the Ganef missile system (SA4 – **2934.131**); and since this missile is one of the longer-range AA weapons is the Russian inventory it may be assumed that Long Track has a substantial range, despite the fact that it operates in the X-band (American I-band).

STATUS:

Operational, certainly with SA-4 missile and possibly elsewhere. Used for SA-4, in conjunction with the Pat Hand fire control radar (**2936.153**).

2884.153
LOW BLOW TRACKING AND MISSILE CONTROL RADAR

DESCRIPTION:

Low Blow is the NATO code-name given to a family of X-band radars used with land-based Goa (US code AS-3) missiles (**2938.131**). These radars are not the same as those used with ship-borne Goa missiles which are known as Peel Group radars (**1323.253**). The name Low Blow reflects the ability of the radar to guide the missile towards low flying targets through heavy clutter.

Like the Fan Song series (**2866.153**) the Low Blow radars use pairs of electromechanically scanning trough antennae mounted orthogonally, but to improve low-angle performance the troughs are mounted at 45 degrees from the horizontal. It appears, too, that the troughs are not Lewis scanners but a form of organ-pipe scanner.

Carrier frequencies of the Low Blow family lie in the 9,000-9,400 MHz band, p.r.f. between 1,750 and 3,500 pulses/sec with unambiguous range correspondingly lying between 40 and 85 km. Radiated beamwidth is in the region of 12 degrees in the fan and 1.5 degrees in the direction of scan. Pulses are between 0.25 and 0.5 microseconds in duration and peak power output is around 250 kW.

STATUS:

Operational with Goa missiles. Commonly associated with Flat Face (**2874.153**) or Squint Eye (**2891.153**) acquisition radars.

2936.153
PAT HAND FIRE CONTROL RADAR

DESCRIPTION:

Little information is available on this radar which is used in conjunction with the SA-4 (Ganef – **2934.131**) surface-to-air missile system. Pat Hand is, of course, a NATO code-name.

In normal operation the Pat Hand radar is put on by the Long Track surveillance radar (**2937.153**). It acquires and tracks the target, provides command signals to guide the missile and tracks the missile by a secondary radar process using a missile-borne beacon transponder. Pat Hand works in the upper C-band (American H-band).

STATUS:

Operational with SA-4 missiles.

2964.153
SCORE BOARD IFF RADAR

DESCRIPTION:

Score Board is the NATO code name for an IFF-type ground interrogator used by the Russian forces. Presumably a very early equipment it has an aerial array consisting of two horizontal rows of two radiators per element, the two double rows being mounted one above the other to give a 4-row array of what appears (in some poorly reproduced pictures) to be a total of 32 dipole radiators. The whole is mounted on a rectangular rotatable framework.

STATUS:

Apparently operational.

2889.153
SPOON REST A EARLY WARNING RADAR

DESCRIPTION:

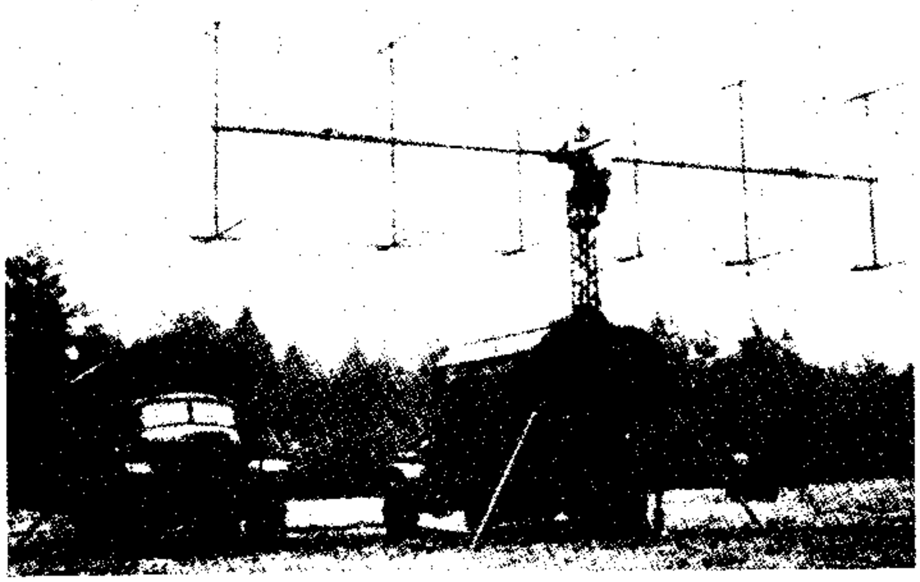
Known in Russia as the P-12, the radar known to NATO as Spoon Rest A is an early warning radar that is used sometimes in conjunction with the Fan Song radars (**2866.153**) and the Guideline surface-to-air missile (**2942.131**).

This is a VHF radar working in the 147.161 MHz band and radiating at about 350 kW peak from a Yagi array. Range capability is up to about 275 km and antenna beamwidths are around 2.5 degrees in the vertical and something over 1 degree in the horizontal plane.

The radar is a heavy one and is mobile in two vehicles – one carrying the generator and the other the antenna array and the radar cabinets.

STATUS:

Operational – certainly in Vietnam, where 34 sets are believed to have been used operationally, and in Egypt where one was captured by the Israeli forces.



P-12 Spoon Rest radar

2891.153
SQUINT EYE ACQUISITION RADAR

DESCRIPTION:

This air target acquisition radar is used in place of Flat Face (**2874.153**) and in conjunction with the Low Blow missile control radar (**2884.153**) and the Goa surface-to-air missile (**2938.131**) in circumstances in which good low altitude cover is required.

STATUS:

Operational.

2885.153
STRAIGHT FLUSH FIRE CONTROL RADAR

DESCRIPTION:

Straight Flush is the NATO name given to the radar and command guidance system used with the SA-6 Gainful – (**2930.131**)surface-to-air missile system. It is believed that the system performs the following functions –

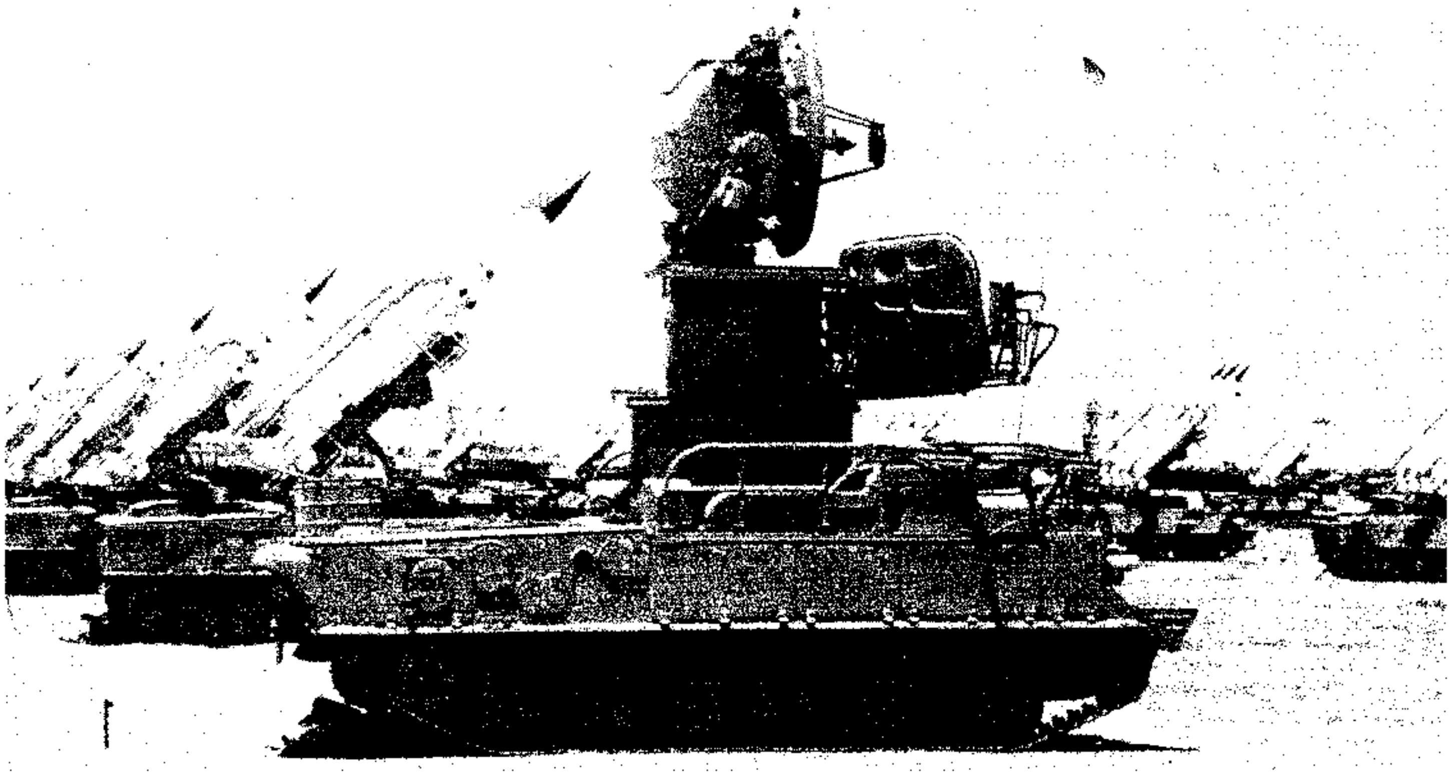
Limited search
Low-altitude detection/acquisition
Target tracking and illumination
Missile radar command guidance
Secondary radar missile tracking.

Reports of the frequencies used for these functions have not been entirely consistent. It seems, however, that the first three functions are performed in C-band (American G and H bands) the low altitude function being performed at about 5GHz and the high-altitude functions at about 6GHz. Target tracking (and probably illumination) is an X-band (American I-band) function at around 8GHz and so probably is the command link, while the secondary radar response for missile tracking is probably at a rather lower frequency.

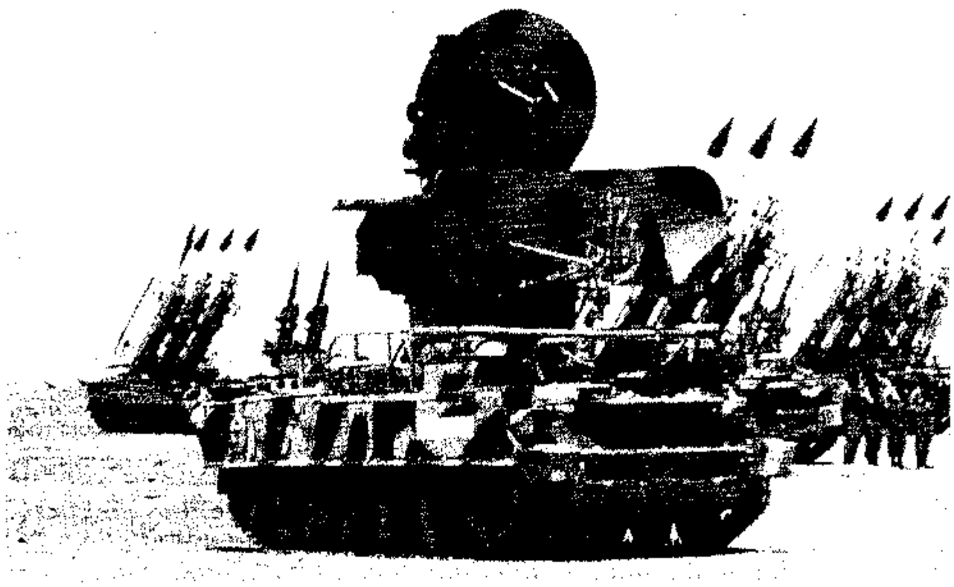
The arrangement of the system can be seen in the accompanying pictures. The upper, tracking, radar aerial assembly is assumed to be able to rotate independently of the lower aerial and it is further assumed that the two aerials and associated apparatus can be rotated relative to the carrying vehicle on a turntable which is presumably located at the top of the circular turret on which the whole assembly is mounted. Examination of the original photographs suggests that the lower aerial may be pivoted so as to execute a sector scan of some kind and there is some indication that it can be tilted up or down – presumably to compensate for vehicle attitude. These observations are consistent with the assumed functions listed above: the combined radar superstructure is probably too massive for any kind of continuous circular search process; and the arrangement probably provides for a slow circular search into an associated sector scan, the circular motion being halted when a target is located and resumed only if the target starts to move out of the sector.

The feed arrangements of both aerials are interesting. The lower aerial appears to have two feeds (which can be seen more clearly in the original pictures than in the accompanying reproductions) the upper one consisting of a single horn – which presumably produces a low angle pencil beam – and the lower feed comprising two or possibly three horns which may well produce a slightly shaped high-cover beam. There could be more sophistication to it than this but if so it is not obvious or obviously likely. The use of two separate feeds, however, is consistent with the suggestion that the low and high-altitude patterns are radiated at different frequencies.

There is, however, some additional waveguide in this feed which is not explained by what has been said above. It appears to be for a higher radiation frequency (than C-band) and could be for one of the other functions (command link or secondary radar – more probably the former). Finally it looks as though both parts of the main feed have a quarter-wave-plate circulariser in front of them. If this is a correct reading of the photographs it tends to date the technology of the equipment: a radar of this sort built in the West ten or more years ago would have used waveguide



Straight Flush fire control radar and SA-6 Gainful missiles. In the background can just be seen a van-mounted radar with two aerials mounted one above the other. This is presumably the early-warning radar of the complete SA-6 system (Photo: Sava Haery / SIPA Press)



Straight Flush fire control radar. Note the pairs of AFV-mounted SA-3 (Goa) missiles in the background (Photo: Sava Haery / SIPA Press)

circularisers. It also looks as though the third (higher-frequency) feed bypasses the plate – which makes sense.

Turning now to the upper aerial, the function of the tripod-mounted device projecting in front of the dish is not clear. The remainder of the assembly is fairly evidently a conical scanning system using a rotating feed driven by a motor in the housing at the rear of the dish. This housing also almost certainly contains the microwave transmitter-receiver stages to avoid the need for multiple rotating waveguide joints.

Two of the struts supporting the projecting 'device' appear to be simple metal rods or tubes secured to the face of the dish: the third (bottom) strut, however, is different, fairly certainly passes through a hole in the dish and could be a waveguide. The way in which the upper struts meet the 'device' seems a little clumsy if they are no more than supports however, and while it may be that the 'device' is yet another aerial of some sort, we incline to the view that it is either another quarter-wave plate or a beam-spoiler for some operational purpose and that the bottom strut is merely a kind of push rod (hence the need to go through a hole – a waveguide would not) for moving the 'device' into and out of the way.

Apart from the microwave stages of the tracking radar it seems probable that the bulk of the radar electronics is housed in the bin-shaped structure beneath the tracking radar pedestal. The turret may be assumed to house the displays and control gear.

STATUS:

Operational. The accompanying pictures were taken in Egypt in June 1974 at a parade celebrating the 7th anniversary of the Six-Day War. Radars of this type were used with Gainful missiles in the 1973 Arab-Israeli War.

2892.153
TOKEN EARLY WARNING AND GCI RADAR

DESCRIPTION:

This S band early warning and GCI radar is similar to the US CPS-6B radar (the first V-beam radar). Like Barlock (**2861.153**) it has twin truncated parabolic mesh reflectors. Five beams are produced; and in the GCI role it has a range of about 150 km and can measure to within 0.5 degree in azimuth and 300-1,500 metres in elevation. In the early warning role it has a range of 250-300 km and a range accuracy of about 1 km.

2893.153
WHIFF FIRE CONTROL RADAR

DESCRIPTION:

This is a van-mounted S-band gunfire control radar. Like Fire Can (**2871.153**) it is derived from the American SCR-584 equipment that was supplied to Russia during the Second World War.

Construction and performance are generally similar to those of Fire Can. The antenna gain of Whiff, however, is somewhat greater.

2895.153
YO-YO MISSILE CONTROL RADAR

DESCRIPTION:

An early missile control radar, Yo-Yo is used to control the Guild (**2944.131**) surface-to-air missile (US designation SA 1).

It is reported that this radar can track more than 30 targets at a time. Flapping beam techniques are used for target tracking and the radar uses six rotating antennas to cover a scanning area of some 70 degrees both in azimuth and in elevation. Operating frequency is around 3GHz and peak power around 2MW.

NAVAL RADAR

DENMARK

1575.253
TERMA NAVIGATION RADAR

DESCRIPTION:

The Terma navigational radar system is designed to form an integral part of the total radar system on board naval vessels. A multi-display system capable of operating in various master/slave combinations is available. The operational mode is selected on either display by illuminated push-buttons indicating all possible operational modes as well as the actual operating mode for each display. The system includes features such as true motion, moving target indication, logarithmic IF-amplifier, and electronic-counter countermeasure (ECCM) equipment. All units are built up as a modular system using accessible plug-in modules making the radar equipment easily serviceable.

SCANNER UNIT:

The antenna is a horizontally-polarised X-band slotted wave-guide antenna with narrow beam and low side-lobe level. The antenna feed system (including a waveguide rotary joint) offers a low standing wave ratio at the input flange. Two scan rates may be selected by electronic switching of the drive system. The scanner position information is given through synchro transmitters and heading marker signal. The unit is driving rain proof and a de-icing system is included.

RECEIVER-TRANSMITTER UNIT:

The transmitter tube is a pulsed magnetron which is controlled from a solid-state magnetic modulator. Two pulse repetition rates and two pulsewidths may be selected individually. The modulator is divided into two separate assemblies with common input and output circuits, one for long and one for short pulse. The trigger assembly synchronises the total system and selects automatically internal or external synchronising mode. A trigger-pulse shaper and delay assembly perform compensation for transit times in the wave-guide and receiver system. The RF system is integrated in one assembly and includes the wave-guide duplexer, the T-R switch, the IF mixer, the AFC mixer, and the solid-state local oscillator.

DISPLAY UNIT:

In this unit, a plan position indicator with a circular 30 cm cathode ray tube is used. The flat-faced front of the unit includes all operation controls, and a light filter in front of the CRT permits daylight operation without a viewing hood.

General performance characteristics:
Scanner Unit:
Antenna: 2.1 m slotted waveguide
Scanner rotation: Switchable between 24 and 48 r.p.m. ± 10 per cent at 60 Hz, or 20 and 40 rpm. ± 10 per cent at 50 Hz input frequency
Horizontal beamwidth: Less than 1 degree within 3 dB points
Vertical beamwidth: 20 degrees within 3 dB points
Polarisation: Horizontal
Gain Better than 32 dB with respect to isotropic radiator

Receiver/Transmitter Unit:
Transmitter:
Frequency: Fixed within 9,375 ± 30 MHz
PRF:
Short pulse: Nom. 4,000 Hz ± 200 Hz
Long pulse: Nom. 2,000 Hz ± 200 Hz
Pulse length: 0.06 ± 0.01 / microsec, or 0.6 ± 0.1 / microsec
Peak power: 20 kW ± 1 dB measured at the output flange

STATUS:

Development was carried out in co-operation with the Swedish Navy, and was completed in 1972.

MANUFACTURERS:

Terma Elektronisk Industry A/S, Finlandsgade 12, 8200 Arhus N, Denmark.

FRANCE

1894.253
DRBC 32 NAVAL RADAR

DESCRIPTION:

The DRBC 32 designation embraces a family of X-band fire control radars, of which there are at least five variants (denoted by suffix letters running from A to E) in use in French Navy ships, and which are associated with a variety of director units. The latter may or may not include optical direction facilities. Weapons associated with these directors normally are either 100 mm or 57 mm guns.

A stabilised mount is usual for DRBC 32 installations and, in all but the DRBC 32 A, the radar dish is protected by a radome attached to the antenna assembly itself. The 'A' model, as seen on the helicopter-cruiser, *Jeanne d'Arc*, has exposed circular reflector and feed assemblies. However, the DRBC 32 A as seen on anti-submarine T47 class escorts do have a protective radome for the antenna. The *Aconit* anti-submarine corvette is fitted with the DRBC 32 B. The C70 class corvettes, the *Colbert* and the *Duperré* have the DRBC 32 C, and the only known DRBC 32 D installation is aboard the *Tourville*. The A69 class of Avisos now in construction are to be fitted with the DRBC 32 E.

1593.253
DRBI 10 3D NAVAL RADAR

DESCRIPTION:

The DRBI 10 is a three-dimension, S-band naval air surveillance radar for search and interceptor control functions. It is believed to be a naval version of the land-mobile radar Picador (TH.D 2200), Entry No. **2119.153**, which in turn evolved from the TH.D 1940. Performance data quoted in the following paragraphs refer to those obtained for the Picador.

All three of these radars employ a 3.4 × 3.4 m scanner with Robinson-type feed arrangements by means of which the pencil beam is moved in the vertical plane as the antenna rotates in azimuth. The combination of the two motions produces a displacement of the beam in space which corresponds to a saw-tooth motion, enabling height information on detected targets to be obtained. Range is quoted by the manufacturers as between 100 and 140 nautical miles against a fighter aircraft size target.

The transmitter/receiver is of solid-state design, except for RF tubes, and the transmitter uses a continuously tunable magnetron to give a nominal output between 1 and 2 MW. The receiver has a low-noise parametric amplifier and two receiver chains for ECCM. These are a Lin/IAGC chain and a constant-false-alarm rate chain, automatically switchable according to the environmental situation. A single transmitter, or two in frequency diversity can be employed and there are provisions for IFF.

Operator facilities include: azimuth selection (azication), low altitude blanking, antenna rotation control (continuous, sector scanning, manual pointing, etc).

DEVELOPMENT:

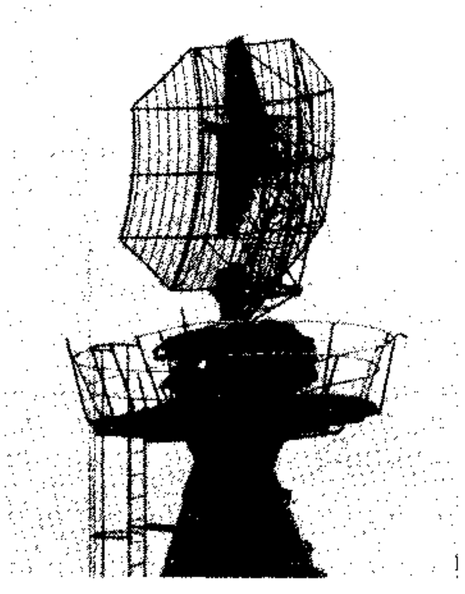
Development was carried out in the 1960s, and the prototype TRS 2200 Picador was completed in 1968.

STATUS:

The only known fittings are aboard French vessels. These include the carriers *Clémenceau* and *Foch*, which each have two; the helicopter carrier *Jeanne d'Arc*; the guided missile cruiser *Colbert*; experimental ship *Ile d'Oléron*; and four T53 Class aircraft direction destroyers.

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92, Bagneux, France.



DRBI 10 three-dimensional radar

1889.253
DRBI 23 NAVAL RADAR

DESCRIPTION:

The DRBI 23 naval radar is an L-band (23 cm) three-dimensional air search and target designation radar forming the main detection element of the French Navy Masurca surface-to-air missile system (Entry No. **1177.231**). Transmitter peak power is quoted as several MW, and it incorporates a carcinotron oscillator. Six amplification stages are provided, these being capable of virtually identical gain at any frequency within the range of the carcinotron oscillator.

The aerial, which is protected by a large radome, is of the inverse Cassegrain type. An array of feed horns directs radiation to a semi-reflective parabolic mirror which in turn returns the energy to a flat plate reflector. This imparts a 45-degree polarisation change which permits the formed beams to pass through the semi-reflector. Vertical angular information is obtained by the use of monopulse techniques, this data being processed to provide corrected height information on aircraft targets. This information, together with plan position data, is available for use in the ship's action data system and weapons systems. Stabilisation against ship's motion is incorporated, and the antenna assembly includes an IFF antenna unit. The system provides for auto plot extraction and the DRBI 23 is interfaced with a digital computer. Associated with it are the Masurca missile tracking and guidance radar groups DRBR 51.

STATUS:

In service in the French Navy missile frigates *Suffren* and *Duquesne*.

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222-Bagneux, France.

1890.253

DRBR 51 NAVAL RADAR

DESCRIPTION:

The DRBR 51 radar group provides for the tracking and missile guidance functions of the French Navy's Masurca surface-to-air missile system (Entry No. **1177.253**). Search and target designation facilities are provided by the DRBI 23 three-dimensional air search radar (Entry No. **1889.253**). The DRBR 51 is a multi-mode equipment and associated with the antenna assembly is a television camera for optical tracking of low-flying targets. The complete system provides for the control of both versions of Masurca missile, the Mk 2 Mod 2 command to line-of-sight model and the Mk 2 Mod 3 semi-active radar homing model. The modes of operation of the two types are summarised below.

When firing the Mk 2 Mod 2 radio command Masurca, the main antenna of the DRBR 51 group is used to track the target and also measure the angular displacement of the missile relative to the line-of-sight to the target. Another dish antenna transmits the necessary command signals to the missile to keep it on the line-of-sight. A third antenna having broad beam characteristics is used for the initial missile gathering phase. Command signals are transmitted at frequencies in the 7 cm band, and two missiles may be simultaneously controlled. There are two 5 cm radar tracking channels, "Blue" and "Yellow", one for each missile and each radio command Masurca round is equipped with a 5 cm transponder to facilitate missile tracking.

When firing the Mk 2 Mod 3 radar homing version of Masurca, the main dish of the DRBR 51 operates as target tracker and X-band illuminator.

STATUS:

The missile cruiser, *Colbert*, and the two missile frigates, *Suffren* and *Duquesne*, each have two DRBR 51 systems.

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222-Bagneux, France.

1893.253

DRBV 13 NAVAL RADAR

DESCRIPTION:

The DRBV 13 naval radar is a pulse-doppler equipment, believed to operate in the S-band. It is stated to be a multi-mode radar providing both search and tracking facilities for the SENIT action data automation system installed in the Aconit corvette, which is the only vessel known to be fitted with the DRBV 13. The antenna array and turning gear are completely enclosed by a large plastic radome, itself mounted atop a prominent structure which is presumed to house the associated electronics, in an almost amidships location. No technical or performance data have been obtained.

1892.253

DRBV 20 NAVAL RADAR

DESCRIPTION:

The DRBV 20 is a long-range search radar operating in the metric wave-band. Two aerial outfits are employed. The smaller, DRBV 20 A, version is installed in a variety of French Navy vessels and can be identified by its large open lattice antenna, of rectangular outline, slightly curved and with a horizontal array of dipole feed elements. The larger, DRBV 20 C, is fitted on French aircraft carriers and has a flat, rectangular antenna array comprising three horizontal rows of dipole feed elements. No performance or other details of technical characteristics have been obtained.

STATUS:

The DRBV 20 A is installed in the Tartar – armed T47 escorts (four in class); the two escort leaders, *Cassard* and *Chevalier Paul*, and the E50 fast escort *Corse*. The DRBV 20 C is fitted in the aircraft carriers *Clemenceau* and *Foch* and on the missile cruiser *Colbert*.

1891.253

DRBV 22 NAVAL RADAR

DESCRIPTION:

The DRBV 22 is a conventional naval search radar, probably having an L-band operating frequency and possibly incorporating dual-beam (high- and low-cover) facilities in some cases. It is widely fitted, both in French Navy vessels and in the ships of other countries. Different versions that have been identified are the DRBV 22 'A', 'C' and 'D' models.

The antenna assembly is very similar in appearance to the American SPS-6 and SPS-12 radars (Entries Nos. **1744.253** and **1566.253**, respectively) but the French equipment can be readily distinguished from both US radars by the two supporting stays for the feed horn that are attached to the upper edge of the reflector of the DRBV 22 radar.

STATUS:

Known fittings in French Navy vessels include:

DRBV 22 A: five T47 anti-submarine escorts; four T53 escorts; four E50 fast escorts; 14 E52 fast escorts; nine 'Aviso' escorts; the helicopter-carrier *Arromanches;* and the corvette *Aconit*.

DRBV 22C: the experimental ship *Ile d'Oléron*

DRBV 22 D: the helicopter-cruiser *Jeanne d'Arc;* the missile tracker ship *Henri Poincaré*.

Ships of several other nations have been fitted with the DRBV 22, in most, if not all, cases the 'A' version.

1594.253

DRBV 23 NAVAL SURVEILLANCE RADAR

DESCRIPTION:

The DRBV 23 is an L-band (23 cm) long-range naval air search and surveillance radar, similar in appearance to the Jupiter naval radar (Entry No. **1236.253**). The most readily discerned external difference is the prominent tubular horizontal supports for the DRBV 23 scanner, compared with the lighter structure of the Jupiter.

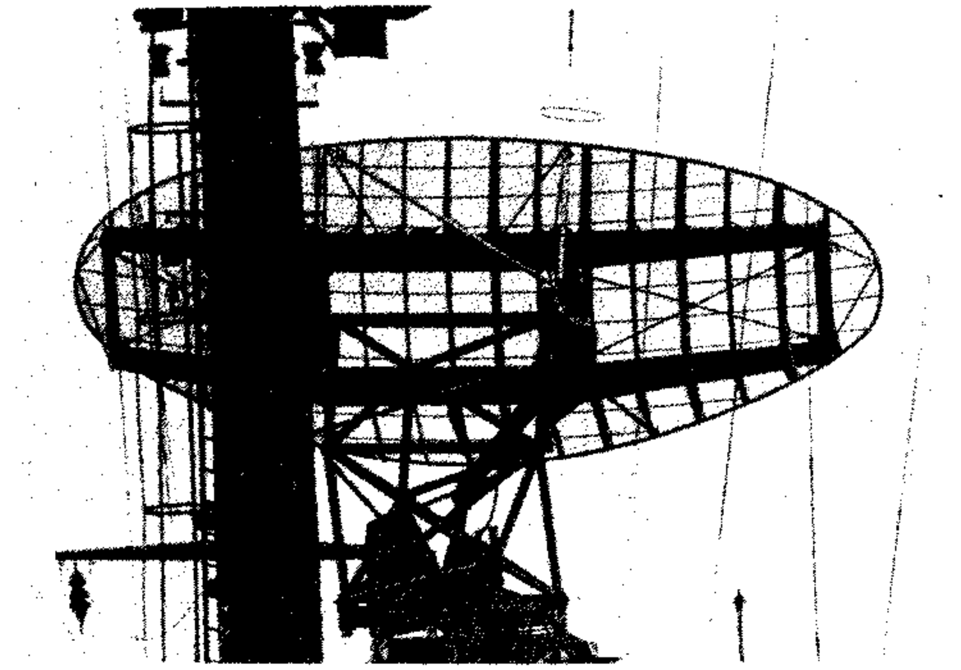
Two versions have been identified, the DRBV 23 B and DRBV 23 C, the former being that fitted in aircraft carriers of the French Navy, and the latter being a solid-state version fitted in the *Colbert*.

STATUS:

The only known fittings are on the following French Navy ships: the aircraft carriers *Clémenceau* and *Foch*, helicopter carrier *Jeanne d'Arc*, and the *Colbert*.

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.



DRBV 23 L-band air surveillance radar on the French command cruiser De Grasse

1062.253

TRITON SURVEILLANCE RADAR

DESCRIPTION:

C-band, 5 cm, air and surface surveillance radar for shipboard mounting. Used for surveillance and target designation functions in the Thomson-CSF Vega Series of ships' fire control systems (which see). In these systems, Triton is used either on its own or in conjunction with either the Castor or Pollux tracking radars. It may also be used alone as a navigational radar. The various fire control systems in this series provide for the operation of guns, guided torpedoes, and surface-to-surface missiles, and combinations of these weapons.

The antenna is of the non-stabilised type, with a broad radiation lobe in elevation to counteract the effects of ship's motion.

Solid-state circuitry, based on printed circuit boards and silicon semi-conductor devices, is used in construction, the only vacuum devices being the magnetron, klystron and CRT. The last of these is normally a 35 cm diameter unit.

Operating frequency is in the C-band and transmitter peak power is quoted as 200 kW. A low-noise microwave amplifier and three reception channels are provided in the receiver section of the T/R unit. Transmitter features include variable transmission frequency, variable PRF and two pulse-lengths. It can also be supplied with a linear digital MTI facility.

DEVELOPMENT:

Private venture, started in 1967. First prototype was completed in 1968.

Triton Characteristics:

Frequency: C band

Peak power: 250 kW

Stabilised or non-stabilised antenna:

Three receivers: linear, anti-jamming, anti-clutter.

Dimensions and Weight:

Antenna weight: 170 kg

Transmitter receiver: 1,507 mm × 1,000 mm × 700 mm

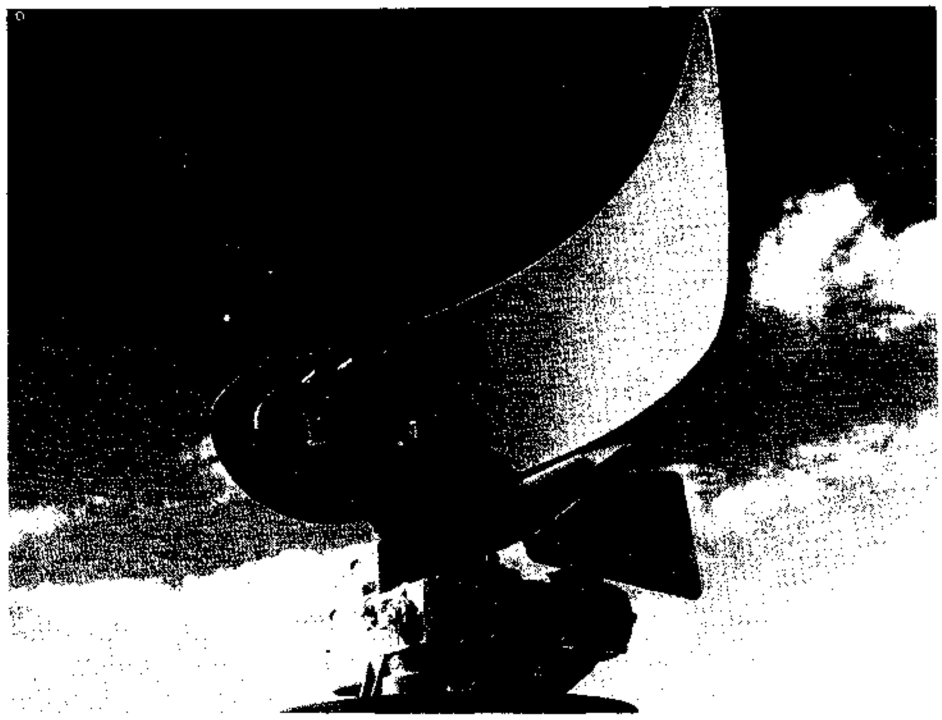
Range: Air target (fighter): 30 NM Surface target: horizon

STATUS:

The Triton radar is in production for use in Vega fire control systems being supplied to French and foreign services.

MANUFACTURERS:

Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222-Bagneux, France.



Triton naval surveillance radar

1063.253
CASTOR TRACKER RADAR

DESCRIPTION:

Shipborne doppler filter tracker radar used in the Thomson-CSF Vega series of naval fire control systems operates in X band and allows two types of operation:

(a) full doppler operation for both acquisition and range

(b) classic operation, non-doppler

Doppler filtering operation gives the radar special capabilities for acquisition and tracking of small, low flying air targets, in the presence of clutter echoes of diverse kinds. Non-doppler operation assures the presentation of accurate splash plotting data, enabling knowledge of fire errors on sea targets through observation of the splashes

Solid state circuitry and digital techniques are employed.

This lightweight tracking radar usually operates in conjunction with a Triton 5 cm surveillance and target designation radar equipped with MTI receiver.

Castor II Characteristics:

Monopulse radar:

Frequency: X band (tunable)

Peak power: 36 kW

Range finder: 0 to 15 and 0 to 30 km

Display: A, R, E or B

Doppler f...ering: 2 modes (anti-clutter, anti-rain)

Acquisition modes: fully automatic and semi-automatic

Dimensions and weight

Antenna weight: 450 kg

Transmitter: 1,915 × 600 × 750

Receiver: 1,080 × 600 × 390

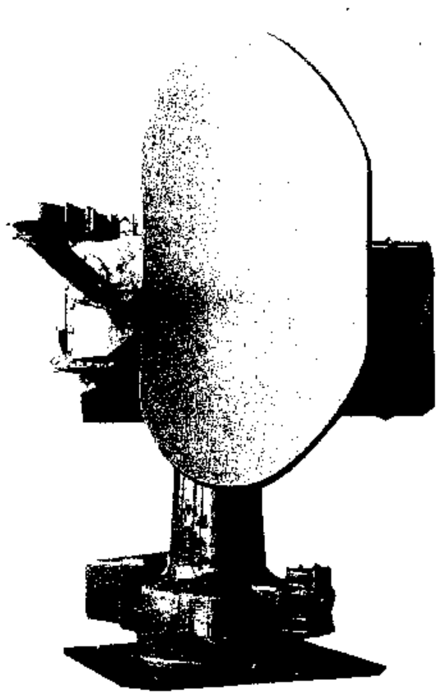
Fire control console: 1,915 × 600 × 600 mm (with F.C computer)

STATUS:

The non-doppler version has been in production since 1972, and the doppler Castor prototype was completed in 1974.

MANUFACTURERS:

Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins 92222-Bagneux, France.



Castor tracker radar head

1064.253
POLLUX TRACKER RADAR

DESCRIPTION:

Shipborne tracker radar used in the Thomson-CSF Vega Series of naval fire control systems. It exists in both conventional and pulse-doppler forms. Usually operates in conjunction with a Triton 5 cm surveillance and target designation radar. Mainly for gun control operations.

The Pollux radar operates on a frequency in the X-band, 3 cm region, and is a fast conical scan tracker radar. Circular polarisation is employed. Solid-state circuitry, using silicon semiconductors, is employed, and peak transmitter power is quoted as 200 kW. Range finding capability extends to 30 km, and target acquisition is stated to remain reliable to 20 km under the most adverse weather conditions.

The doppler version is equipped with digital doppler filter for acquisition and tracking. Two doppler filtering modes and a non-doppler operating mode are provided.

DEVELOPMENT:

Started in 1968 as a private venture. First prototype completed in 1969.

Pollux Characteristics:

Conical scanning radar:

Frequency: X band

Circular polarisation:

Peak power: 200 kW

Range finder: 0 to 30 km

Precision:

Range: 20 m

Azimuth: 1 mrd

Display: type A/R, A/B or A/E

Doppler version:

Peak power: 30 kW

Range finder: 0 to 15 and 0 to 30 km

Fixed-echo rejection ratio: 30 dB

Minimum target speed: 20 m/s

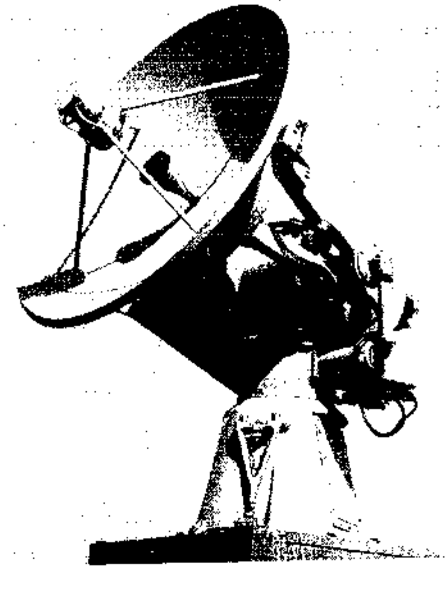
Dimension and weight:

Antenna weight: 450 kg

Transmitter and Servo Cabinet: 1,850 mm × 600 mm × 600 mm

Receiver Cabinet: 1,850 mm × 600 mm × 600 mm

Fire Control Console: 1,850 mm × 600 mm × 600 mm (computer included)



Pollux tracking radar

STATUS:

Production commenced in 1969 with entry to operational service planned for 1970. Details of users have not been revealed but contracts for Vega fire control systems have been placed by both French and foreign navies. The doppler version prototype was completed in 1973.

MANUFACTURERS:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

1687.253

SEA TIGER II 45 SURVEILLANCE RADAR

DESCRIPTION:

Sea Tiger is a shipborne S-band combined surveillance radar, which can be used in the Thomson-CSF Vega Series of ship's fire control systems. Intended to equip medium-tonnage ships, it is designed to perform the following functions in a very severe clutter and jamming environment:

(a) air surveillance
(b) surface surveillance
(c) target designation for weapon systems (guns; missiles)

Visibility in clutter is achieved through the use of complementary techniques such as circular polarisation, pulse compression, doppler filtering, and an anti-clutter reception chain.

The Sea Tiger radar comprises the following elements:

(1) A double-curvature aerial with switchable circular/linear polarisation and integrated IFF aerial.
(2) A roll-stabilised turntable.
(3) A transmitter with coherent amplifier chain emitting frequency-modulated pulses (pulse compression) over a wide frequency range.
(4) A receiver with multiple reception chains: MTI, lin, log, CFAR. The MTI is a digital linear device whose characteristics, associated with the stability of the amplifier chain, make it possible to detect a missile in the most severe clutter environment.

CHARACTERISTICS:

Operational performance:

Detection range: 60 nm on a 2-m^2 (fluctuating) target with Pd = 50%

Altitude detection: 50,000 ft (15,240 m)

Elevation pattern: cosecant up to 50°

Sub-clutter visibility: greater than 42 dB

First blind speed: Mach 2

Antenna:

Gain: 29 dB

Polarisation: circular/linear, switchable

Rotation speed: 12 and 24 rpm

Stabilisation: roll stabilisation better than ±0.5°

Transmitter: frequency agility, pulse compression average power 1 kW

Receiver: noise figure better than 3.5 dB, 4 different reception chains – MTI, LIN, LOG, CFAR anti-clutter

STATUS:

Derived from the Tiger radar (Entry No. **2156.153**). Prototype under development.

MANUFACTURERS:

Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222-Bagneux, France.

1236.253

JUPITER NAVAL AIR SURVEILLANCE RADAR

DESCRIPTION:

The Jupiter is an L-band (23 cm), long-range air surveillance radar with a peak transmitter output power of 2 MW with a 2.5 microsecond pulse and a PRF of 450 pulse/second. The aerial measures 7.5 × 3 metres and has two rotation speeds 7.5 and 15 RPM. Weight is approximately 1,000 kg. Both primary and secondary (IFF) radar channels are provided by the one aerial system. Beam width at half power points of the primary radar pattern is 2.5 degrees or less. The primary radiation pattern gives a cosecant-squared diagram up to 50 degrees elevation.

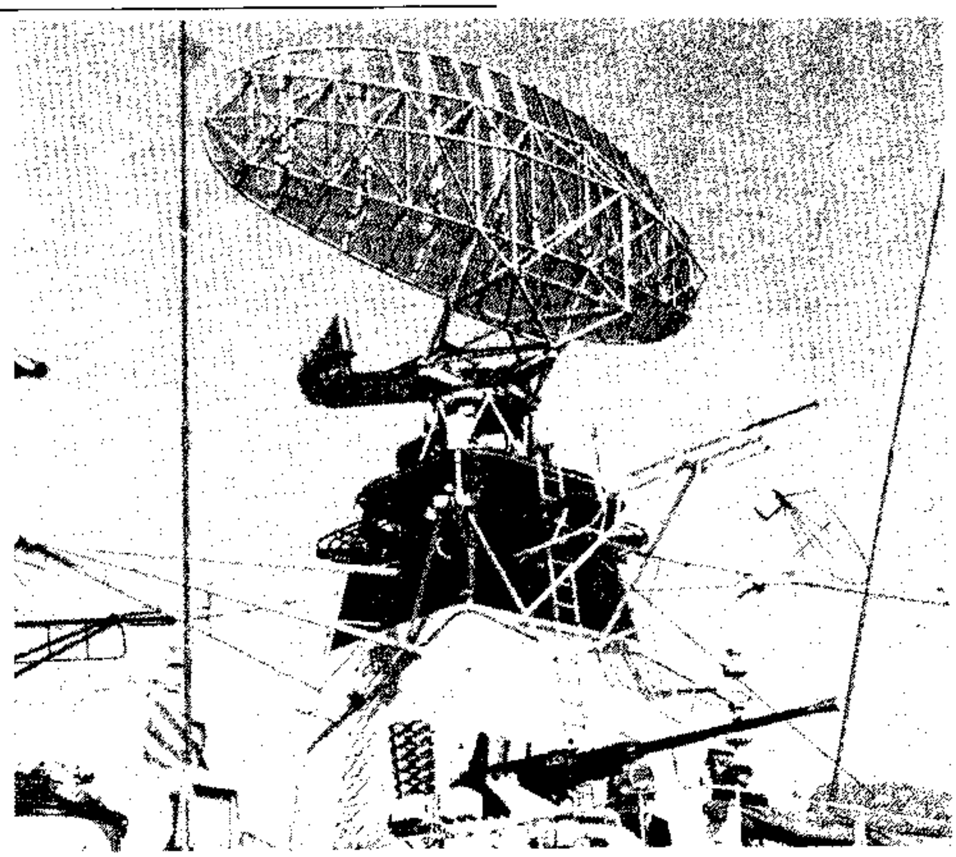
Range performance figures quoted give detection out to at least 200 km on a fluctuating target of 2 m^2 cross-section with a detection probability of 50 per cent, and under the same conditions a target with 10 m cross-section can be observed out to 275 km.

Solid-state circuitry is used throughout, with the exception of the microwave stages, and a fixed-frequency, water-cooled magnetron is used in the transmitter. Comprehensive signal processing facilities are incorporated to provide maximum protection from natural interference (such as sea clutter) and ECM.

The receiver section provides multiple reception chains: wide dynamic range receiver and anti-clutter circuits for surface surveillance and detection of low-speed targets. Jupiter is produced in both non-MTI and MTI versions. The latter is equipped with a linear digital MTI receiver for operation in clutter environment.

STATUS:

The Jupiter is in use with medium and large vessels of the French Navy, as the DBRV 23 (Entry No. **1594.253**) with different antenna, and on the South African frigates.



Jupiter long-range air surveillance radar on South African Navy frigate President Kruger

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

1237.253

SATURNE II-30 (TRS 3043) NAVAL SURVEILLANCE RADAR

DESCRIPTION:

The Saturne II-30 is a medium-range air and surface surveillance and target designation radar designed for use on medium-size naval vessels. It is an S-band equipment, and uses a 1 MW (peak) transmitter to provide cover out to 115 km. Aerial dimensions are 3 × 1.15 m, and the scanner rotation rate is either 10 or 20 RPM. Beam-width in azimuth at the 3dB points is 2 degrees. Linear or circular polarisation can be selected. IFF facilities can be added. The scanner is mounted on a stabilised turning-gear platform.

The transmitter/receiver is a solid-state equipment, and the transmitter offers variable frequency operation and two different pulse lengths.

The reception chain offers: a logarithmic with anti-sea clutter channel, and a CFAR channel. Provision is made for the addition of a digital linear MTI. A microwave amplifier is included in the receiver section, which has a noise figure of better than 4dB.

MANUFACTURER:

Thomson-CSF, Division Radars de Surface, 1 rue des Mathurins, 92222-Bagneux, France.

1688.253

ELI 4 IFF INTERROGATOR

DESCRIPTION:

The LMT ELI 4 is a shipboard secondary surveillance radar interrogator for IFF functions in association with transponders carried by friendly aircraft and ships. The equipment is designed for either rack mounting or independent installation. Apart from one tube, the ELI 4 is of solid-state design and extensive use of digital ICs is made. A number of the sub-assemblies are pluggable and are common to other interrogator versions such as the ground-based ER-116-A, and the airborne ER-115-A and NR-AI-5-A.

CHARACTERISTICS:

The ELI-4 incorporates a coder, a transmitter and a receiver.

Peak radiated power: Selectable: 0.5, or 2 kW

Transmission Frequency: 1,030 ± 0.5 Mc/s (±0.2 optional)

Receiver Sensitivity: –83 dBM

Receiver Frequency: 1,090 Mc/s
Possible modes: 1, 2, 3/A and C. Mode 4 with suitable coder and decoder
Interlacing facilities: Up to 4 SIF modes. Permanent self-monitoring of all operational characteristics
Size: 200 × 510 × 600 mm
Weight: 25 kg
Power supply: 115 V 400 Hz 3 phase 120 W
MANUFACTURER:
Le Matériel Téléphonique, 46-47, Quai Alphonse Le Gallo, 92103 Boulogne Billancourt, France.

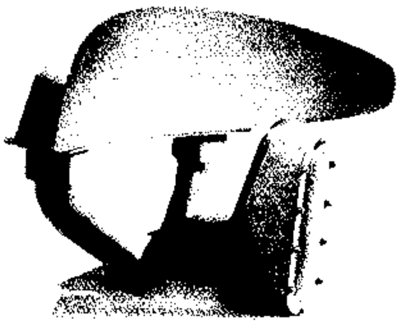
1240.453
CALYPSO II (TH.D 1031) SUBMARINE RADAR
DESCRIPTION:
The TH.D 1030 Calypso II is an X band radar specially designed to provide surface surveillance and navigation facilities for submarines. The installation comprises two units, aerial head and transmitter/receiver and display cabinet, having a combined weight of 350 kg. The aerial is mounted on a periscope mast, and its dimensions are 1 m in span and 48 cm in height.

The transmitter/receiver and display unit is transistorised and peak power is 70 kW, the mean power being 12 to 30 watts, depending upon the duty cycle. Pulse widths are 0.15 and 0.5 microseconds, and the PRF is variable. This feature, plus provision for manual or automatic variation of the radar operating frequency, provide a valuable ECCM capability. Other ECCM features are incorporated in the receiver section, which provides a variety of signal processing options.

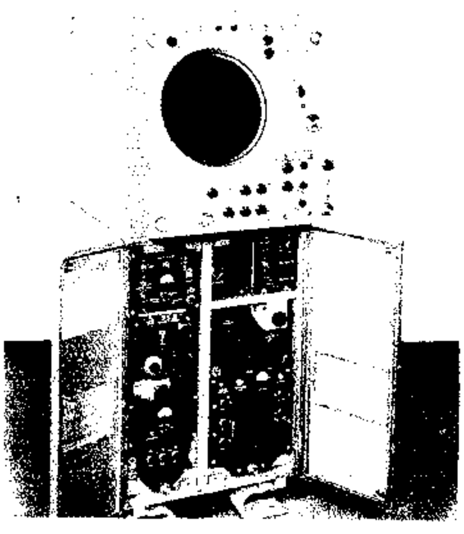
The transmitter provides four transmission modes, at either normal or reduced power, thus offering facilities for maximum security and operational flexibility. The four modes are: continuous transmission, short burst transmission (1.0 and 0.1 second), sector scan transmission, and transmission into a dummy load. The last of these enables the radar to come into operation immediately the aerial is above the sea surface, or following a period of radar silence.

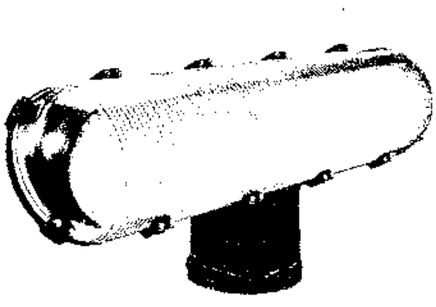
The detection range of the radar is principally limited by the radar horizon and typically is 10 nautical miles against a surface target of escort vessel size or above. The Calypso II also has an air surveillance capability and can provide detection of an ASW aircraft at ranges out to 15 nautical miles at heights up to 2,000 metres.

A 25 cm diameter PPI display and an A-scope presentation are provided at the operating console, the former having three range-scale settings, off-set, and marker facilities. The operating control for transmission mode, manual frequency variation etc are on this unit.


Scanner of the TH.D 1030 Calypso II submarine radar. Span is 1 metre

The TH.D 1031 is derived from the TH.D 1030, and is intended for larger submarines. The principal differences are the use of a display remote from the transmitter/receiver unit, and the provision of an antenna on the optical attack periscope to provide target range data for weapon systems. The latter facility is intended for use when the approach to the target has been made by means of sonar.
DEVELOPMENT:
The TH.D 1030 was developed by Thomson CSF in the mid 1960s and the first prototype was completed in 1968.
STATUS:
At May 1970, over 20 sets had been produced for the French and German Navies.
MANUFACTURER:
Thomson-CSF, Division Radars de Surface, 1, rue des Mathurins, 92222-Bagneux, France.


Calypso II transmitter/receiver and display unit

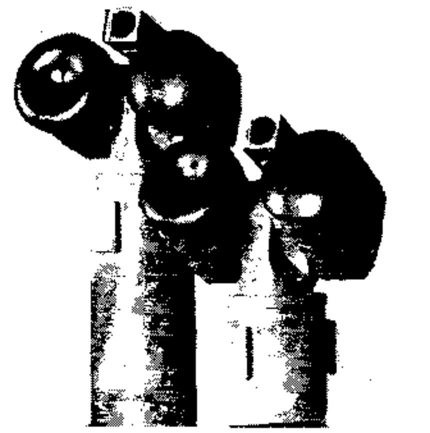

Alternative antenna for Calypso II submarine radar

INTERNATIONAL

1578.253
EX 77 MOD 0 DIRECTOR GROUP
DESCRIPTION:
This radar group provides search, target designation, tracking, and illumination for the NATO Sea Sparrow point defence missile system, which is under development by Belgium, Denmark, Italy, the Netherlands, Norway, and the USA (Entry No. **2770.231**). As such, the EX 77 Mod 0 director group forms part of the EX 91 Guided Missile Fire Control System; EX 91 Mod 0 has a single director group, and the EX 91 Mod 1 has dual directors. Each group has separate antennas for transmission and reception, the dishes of which are protected by radome covers. The radar receiver is carried on the receive antenna unit. The antennas share a common mounting on the EX78 Mod 0 Missile Director Pedestal. An on-mounted television camera is also provided.

Operation is probably in the X-band, and in general, the EX 77 Mod 0 resembles the RTN-10 radar proposed for Sea Sparrow by Raytheon. A somewhat similar mode of operation to that described in Entry No. **1245.253** might therefore be expected.

The receiver is the responsibility of the Danish Terma Company, and this unit's functions include clutter filtering, ECM channel, signal conversion and amplification. The EX 83 Mod 0 Radar Set Console has search and tracking displays, status and fault indicators, radar operating controls, and built-in test equipment. Operating controls provide for such functions as scan pattern selection, ECM facility selection, check-out etc. The transmitter Group EX73 Mod 0 provides RF power for search, acquisition and tracking in air and surface models target illumination and modulation for the Seasparrow missile; rear reference signal for missile tuning; local oscillator for the receiver; and range reference for radar target data processor provides target detection, doppler tracking, range tracking, and angle track signals; visual and aural indications to the radar set console; ECCM; and test functions.
DEVELOPMENT:
Development was initially undertaken in the late 1960s by Raytheon, and subsequently on a joint basis by companies in four of the six nations which now form the NATO Seasparrow group. The four were Denmark, Italy, Norway and the USA.
STATUS:
In early 1972 the radar had reached an advanced stage of engineering development.


Dual EX Mod 0 Director Group radars for NATO Seasparrow missile fire control system

MANUFACTURERS:
Raytheon, USA – Main contractor
Terma, Denmark – Radar receiver
Selenia, Italy – Consoles
Kongsberg Vaaenfabrikk, Norway – Radar pedestal and fire control computer.

ITALY

1700.253
RAN-2C NAVAL RADAR
DESCRIPTION:
The RAN-2C is a dual-purpose surveillance radar, operating in the C-band, and intended for use as the main radar on small vessels such as corvettes or as the secondary equipment on larger ships. The two main functions are to provide data for surface plots and simultaneously to provide air warning facilities. The radar uses a single coherent transmitter and a single antenna unit (G2), which is roll and pitch stabilised, but two receiver systems. One receiver is employed for surface operation and the other for air operation. The transmitter transmits in two RF bands, with different PRF and pulse-length, to provide for complete dual operation. In addition, frequency agility during the time on target is performed to take

advantage of the diversity effect and for ECCM purposes. The air warning channel has a very effective MTI and a CFAR receiver. The surface surveillance channel is provided with a logarithmic receiver with FTC. The design ensures good CFAR performance under varying conditions and the characteristics of C-band operation at low evaluation angles and a high clutter cancellation ratio, provide high performance against low-level targets such as aircraft or missiles

STATUS:
The RAN-2C is in current production.
MANUFACTURER:
Selenia-Industrie Elettroniche Associate, SpA, Via Tiburtina, Km 12,400, 00'3 Roma, Italy.

1364.253
RAN-3L NAVAL RADAR

DESCRIPTION:
The Selenia RAN-3L is a long range, early warning radar, specifically designed for service in naval vessels in the frigate/destroyer/cruiser class.
The radar is of advanced design and provides air/surface warning and target identification for a modern shipborne defence system. A double curvature reflector with double channel IFF/radar feed is used (G 11) and scanner stabilisation can be provided (G12). A high-power coherent transmitter is employed, and the receiver features include a frequency programmer, Stalo, and quadrature IF channels. The main feature of this radar is the capability to operate in the presence of active or passive interference with minimal degradation of performance. Digital techniques are extensively used through the processing circuitry to provide stable and reliable operation.
The maximum detection range is about 200 nautical miles and the vertical coverage extends to more than 30,000 metres. Operations in the L-band.
DEVELOPMENT:
Development was started in 1968 under Italian Navy contract.
STATUS:
Development is in progress and entry into service is planned in 1974. A number of these equipments will be supplied to the Italian Navy and to foreign navies.
MANUFACTURER:
Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12,400, 00131 Roma, Italy.

1527.253
RAN-7S NAVAL RADAR

DESCRIPTION:
The Selenia RAN-7S is a medium-power naval radar operating in the 10cm band and specifically designed for installation in corvettes, frigates and destroyers. The equipment is suitable for dual function application to both air and surface target warning operations, and solid-state construction (with the exception of a few high-power circuit elements), ensures high reliability. The basic design allows for a number of optional facilities, thus providing for a range of operational capabilities and phased expansion of overall performance. By the adoption of optional items the RAN-7S is available in four configurations.

(1) Basic
(2) With ECCM
(3) With Digital MTI
(4) With integrated ECCM/DMTI and signal processing

An additional facility which can be incorporated with any of the above configurations is automatic variation of the operating frequency. Operational capabilities of the Basic RAN-7S are air warning, aircraft direction, surface surveillance, and navigation.
To meet varying operational and installation requirements, three antenna arrangements are available:

(1) The G6 antenna, comprising a double curvature reflector with added high angle coverage.
(2) The G8 antenna with modified cosecant-squared pattern and remotely controlled elevation adjustment.
(3) The G8 antenna with stabilised mounting platform.

IFF can be integrated with all three.
A modified cosecant-squared beam pattern is used to provide good cover to high altitudes. Pulse-width can be either 1 microsecond for air detection, or 0.5 microsecond for surface surveillance. Horizontal beamwidth is 1.4 deg, these values have been chosen to provide good resolution of surface targets and very good air search performance. In the latter role, range is in excess of 100 km, with cover extending up to 12,000 metres. The high discrimination needed for surface search is ensured by the use of the shorter pulse duration. In the interests of high performance in the air detection role, in the presence of a high clutter environment (land returns, chaff, rain, etc) Selenia has evolved a completely new and effective digital MTI system. This has been termed by the developers as a "pseudo-non-coherent" MTI, and is available as an optional sub-system which can be either original fit or added later. A special ECCM kit is a further option, and this provides the radar with a Constant False Alarm Rate (CFAR) characteristic under a number of jamming conditions.
DEVELOPMENT:
The RAN-7S was developed in 1970 from the Selenia ATCR-3T series of land-based air defence radars.
STATUS:
In current production. The antenna system has been supplied to the Danish Navy.
MANUFACTURER:
Selenia-Industrie Elettroniche Associate SpA, Radar Division, Via Tiburtina Km 12, 400 Roma, Italy.

1699.253
RAN-10S NAVAL RADAR

DESCRIPTION:
The RAN-10S is an advanced S-band coded radar for combined air and surface surveillance. The radar design philosophy is the same as that of the RAN-3L early warning radar (Entry No. **1364.253**), and a number of items are common to both systems. Basic characteristics that the two radars share include:
Improved accuracy and resolution due to time compression of the radiated waveform.
Good sub-clutter visibility in natural or hostile interference.
Clutter cancellation simultaneous with RF agility.
CFAR.
The G10 antenna assembly provides for simultaneous air and surface search and is a roll-stabilised parabolic cylinder reflector with double channel radar/IFF feed. The transmitter is a medium power coherent equipment, and the receiver incorporates a parametric amplifier, frequency programmer, quadrature IF channels, and digital processing.
The RAN-10S is intended for fitting in vessels of medium tonnage such as corvettes, frigates, or fast destroyers. Typical operational roles include air warning, tactical air control, helicopter direction, surface surveillance, navigation, and anti-ship missile direction.
STATUS:
In development.
MANUFACTURER:
Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina Km 12,400, Roma, Italy.

1365.253
RAN-11 L/X NAVAL RADAR SYSTEM

DESCRIPTION:
The RAN-11 L/X is a shipborne integrated radar system specifically designed for installation in small ships such as corvettes, patrol and coastal gunboats, torpedo boats or missile boats.
The system is composed of an L-band transceiver for air warning and an X-band transceiver for low altitude cover and surface surveillance.
Doppler filtering and pulse compression are used in the L-band receiver channels to provide an extremely high sub-clutter visibility and CFAR characteristic. Digital processing is used and solid-state techniques are employed. The L-band processed video is suitable for mixing with another video signal without degradation, and the two radars may therefore simultaneously feed the same display. The X-band portion of the equipment is the RTM-13X transmitter/receiver.
The aerial system, which is roll and pitch stabilised, operates in both X- and L-bands and includes an IFF antenna
The system is extremely compact, light in weight and designed to stand up to the environmental conditions experienced in small naval vessels. The detection range is about 100 km for the L-band radar, and the range coverage of the X-band radar extends up to 35 km, according to manufacturer's figures.
DEVELOPMENT:
Development was started in 1969.
STATUS:
The equipment is currently being manufactured on behalf of certain European navies. Production of a substantial number of equipments is planned.
MANUFACTURER:
Selenia-Industrie Elettroniche Associate SpA Via Tiburtina Km 12, 400, Roma, Italy.

1701.253
RAN-13X NAVAL RADAR

DESCRIPTION:
The RAN-13X Mod 2 is an X-band radar, basically for surface search, and additionally for low-flying target acquisition. The equipment uses the same RTM-13X transmitter receiver of the RAN-11L/X (Entry No. **1365.253**), and thus has common logistic requirements with the Orion fire control radar (entry No. **1368.253**). The combination of X-band operation, narrow beamwidth and relatively high power, yields greatly improved detection capability at low elevation angles. A high scanning rate reduces reaction time. The RAN-13X is intended for use as the main radar aboard fast patrol boats, missile boats, and vessels up to corvette size, or as a complementary equipment to larger ships' principal radars.
The G15 antenna assembly comprises a double curvature reflector with dual IFF/radar feeds, and a stabilised mounting. Other features include: single knob RF tuning, multiple reception channels and remote control of scanner elevation coverage angle.
STATUS:
The RAN-13X is in current production.
MANUFACTURER:
Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina Km 12,400, Roma, Italy.

1367.253
ORION RTN-16X NAVAL RADAR

DESCRIPTION:

The ORION RTN-16X is an X band monopulse radar for integration with gun or missile fire control systems. Operational functions of the equipment include: autonomous search, automatic acquisition, air target tracking, surface target tracking, optional missile guidance and splash spotting. Displays appropriate to these functions are provided.

The equipment has been designed with the purpose of maintaining the same operational characteristics and procedures of the ORION RTN-10X. The well proven units of the RTN-10X are used extensively throughout the design in order to standardise the equipments and to ensure the same order of reliability.

STATUS:

The prototype has been successfully tested, and the equipment has reached the production and delivery stages.

DEVELOPMENT:

Started in 1969 as a private venture.

MANUFACTURER:

Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina Km 12,400, Roma, Italy.

1368.253
ORION RTN-10X NAVAL RADAR

DESCRIPTION:

The ORION RTN-10X is a conical-scan pulse radar operating in the X-band. It has been especially developed for one man operation, and installation with gun or missile fire control systems in naval vessels. Specifically, the Orion is used in conjunction with Selenia equipment (see Albatros system) or with other equipment (El San Giorgio, Ferranti, Galileo etc.). Operational range is about 40 km.

The antenna system consists of a slatted parabolic reflector and feed, with integral trunnion box, mounted on an elevation over train director. Elevation coverage is plus 90 to minus 30 degrees. The trunnion box contains the feed drive motor for high-speed conical scanning, and the assembly which performs the target acquisition scanning mode. The unit is fitted to accept a CCTV camera and camera control unit.

The equipment is, with the exception of CRTs and a few special tubes, of solid state design. The range tracking and timing system employs digital techniques, resulting in a greatly improved dynamic response, together with high accuracy and stability. Controls and monitoring instruments for the complete system are located in the operating console. This arrangement allows the operator to monitor the functioning of the apparatus and simultaneously observe the signals displayed on the CRTs.

Acquisition of a target is initiated by external designating input sources. The radar then switches to the acquisition phase and upon detection of the target, automatic tracking is started. As an alternative, the radar can perform an autonomous search programme, in this way further complementing the surveillance system with the low altitude detection capability inherent to the Orion equipment.

Much consideration has been given in design to the reliability of the radar and to the rapid location of faults, and the equipment is provided with built-in monitoring instruments and quick connection plugs and sockets. An optional performance monitor unit is also available which further extends quick checking capabilities.

The equipment is supplied either in its basic configuration or in an improved version, in order to provide a scaled performance to meet specific operational, environmental and installation requirements.

The basic version, as well as the radars already in service, can be given, when deemed necessary, the more advanced capabilities of the improved version by the adoption of modification kits. The additional facilities can be selected from among the following:

(1) Frequency Agility.
(2) Pulse Doppler processing
(3) Special ECCM processing

DEVELOPMENT:

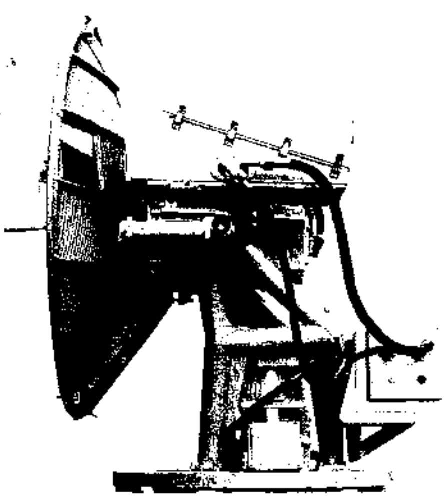
The development of the Orion series started in the early 1960s on behalf of the Italian Navy. Significant improvement in technology and design has been successfully introduced into the original project. The last series, which is named Orion-10X, was developed in 1970 and series production began in 1972.

STATUS:

This radar has been extensively supplied to the Italian Navy and to many foreign navies. In series production.

MANUFACTURER:

Selenia-Industrie Elettroniche Associate SpA, Via Tiburtina Km 12,400, Roma, Italy.



Orion RTN-10X radar antenna director

1704.253
SEA HUNTER SEARCH RADAR

DESCRIPTION:

The Sea Hunter fire control system (Entry No. **1552.281**) is notable for the ingenious co-mounted, but independent search and tracking radars, both of which are carried on the four-axis stabilisation system (pitch, roll, azimuth, and elevation) from which the system designation 'Sea Hunter-4' is derived. This entry is concerned with the search radar, which is the lower of the two carried on the combined mount. The tracker radar is described in Entry No. **1705.253**, which radar is also used on separate mountings, either for use with a Sea Hunter-4 system or in conjunction with other search/target designation radars. The Sea Hunter search radar is not normally fitted separately.

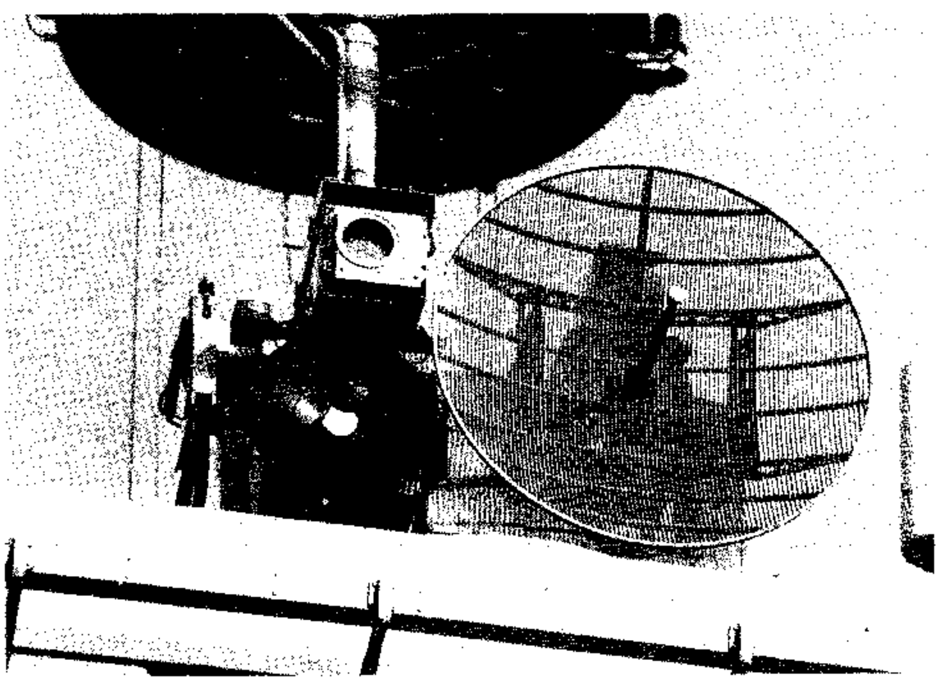
The operating frequency is in the X-band and transmitter power is 180 kW. Pulse length and PRF are adjustable. The receiver incorporates all the normal measures against natural and man-made interference. The antenna has a shaped cylindrical reflector illuminated by an end fed slotted waveguide feed to produce a cosecant-squared radiation pattern for air and surface search and splash spotting. Antenna span is about 2 metres, and high rotation rates are employed.

STATUS:

In production and fitted in vessels of several navies.

MANUFACTURER:

Contraves Italiana SpA, 995 Via Tiburtina, 00156 Roma, Italy.



Sea Hunter 4 track and search radar antenna mounting with TV camera and command transmitter antenna dish

1705.253
SEA HUNTER TRACKING RADAR
DESCRIPTION:

The Sea Hunter tracking radar is an X-band equipment forming part of the Sea Hunter 2 and Sea Hunter 4 fire control systems (Entries Nos. **2371.281** and **1552.281**). In the former system it is not associated mechanically with a search radar, but in the latter case it is carried on a combined stabilised mounting with the Sea Hunter search radar (Entry No. **1704.253**).

The Sea Hunter tracking radar has a 100 cm diameter circular parabolic dish antenna, and helical and horizontal scan patterns are provided for air target search. After target acquisition, tracking is automatic. The receiver incorporates full measures against natural clutter and ECM, and 'track-while-scan' facilities are an optional addition to the system.

STATUS:

In production and fitted on vessels of several navies.

MANUFACTURER:

Contraves Italiana SpA, 995 Via Tiburtina, 00156 Roma, Italy.

1702.253
3 RM SERIES NAVAL RADARS
DESCRIPTION:

The 3RM Series are X-band navigation and surface warning radars, with some air target capability. The antennae used are of the slotted waveguide type and provide horizontal beamwidths from 0.8 to 2.0 degrees, depending upon the antenna length, and a vertical beam pattern of 26 degrees, shaped to 40 degrees. Scanner rotation rate is 25 RPM. Two transmitters are available, with outputs of 7kW or 20kW. The display unit has a 9-in (23 cm) diameter PPI.

3RM Characteristics:
Frequency: 9,375 MHz
Peak Power: 7kW or 20 kW
Antenna: Slotted waveguide
Rotation rate: 25 RPM
Pulse length/PRF: 0.05 microsec/6,000 Hz
0.15 microsec/3,000 Hz
0.5 microsec/1,500 Hz
1.5 microsec/750 Hz
Receiver: linear, lin-log
Display: 23 cm PPI; eight ranges 0.25 to 40 nm

STATUS:

In production and fitted to ships of a number of navies, and notably on the West German fast patrol boats of the 143 and 148 classes. The Italian Navy missile hydrofoil, P420-Swordfish, is fitted with the 3RM 7-250 version, which has a different antenna and a second 250 kW transmitter.

MANUFACTURER:

SMA-Segnalamento Marittimo ed Aereo, Via del Ferrone-Soffiano, PO Box 200-50100 Florence, Italy.

1703.253
SPQ-2D NAVAL RADAR
DESCRIPTION:

The SPQ-2D is a medium power X-band radar whose principle of operation is based on time shared transmission of long and short pulses to achieve simultaneous video signals with high sensitivity for surface search and short-range air search, or with high resolution for navigation and close-in control. The last feature is particularly appropriate for rescue operations and the direction of ASW helicopters.

The SPQ-2D equipment is currently integrated as the target designation radar in various electronic combat systems.

Two control units which include all the operational controls of the radar permit use of remote or local controlling facilities by either CIC or EW operators. The SPQ-2D is designed for IFF compatibility and there is provision for 'Beacon' operation in conjunction with an X-band transponder. Among the optional addition facilities which are available are: track-while-scan operation at an antenna rotation rate of 40 rpm; frequency agility; pulse doppler MTI at S-band integrated with the X-band for sea-skimmer detection; and varying modes of operation.

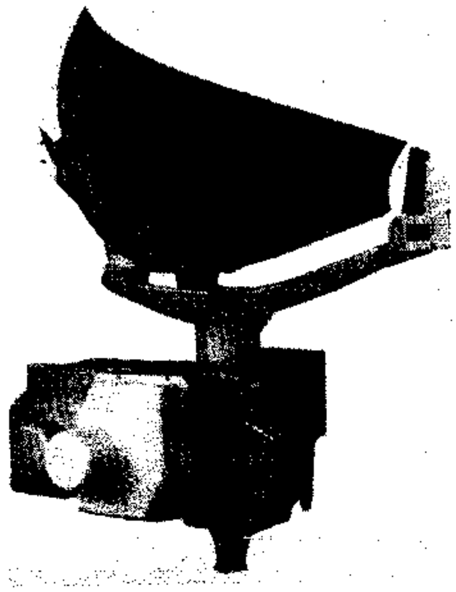
The antenna assembly is produced in both stabilised and non-stabilised forms. The reflector is a double-curvature lattice and mesh structure of about 3 metres span, and is illuminated by a feed horn carried by an underslung support boom.

STATUS:

The SPQ-2D has been in production for several years and is fitted on ships of several navies including the Italian Navy, Canadian Navy (DDH 280 frigates), and the Venezuelan Navy.

MANUFACTURER:

SMA-Segnalamento Marittimo ed Aereo, Via del Ferrone-Soffiano, PO Box 200-50100 Florence, Italy.



SPQ-2D antenna group with stabilised mount

THE NETHERLANDS

1554.253
DA.05 NAVAL SURVEILLANCE RADAR
DESCRIPTION:

The DA.05 is an S-band surveillance radar for shipboard applications, and provides for air surveillance, surface warning, target designation for fire control radars and weapon director systems. A solid-state transmitter/receiver is used, a tunable magnetron providing for operation on any one of six pre-set frequencies. Facilities are provided for an on-mounted secondary radar (IFF) antenna on the main radar scanner. The latter is constructed of stainless steel to permit operation in adverse salt and exhaust environments.

Performance characteristics have not been revealed. Operational features include high discrimination; medium-range air cover and good surface detection; two rates of antenna rotation; optional circular polarisation; low-noise receiver; MTI with digital cancellation and optional digital video correlator; digital video processor; automatic test facilities.

MANUFACTURER:

Hollandse Signaalapparaten, Hengelo, Netherlands.

1257.253
SIGNAAL NAVAL HEIGHT-FINDER RADAR
DESCRIPTION:

This is a nodding type height-finder radar for use in conjunction with a naval air surveillance radar. No technical details have been released, but this equipment is similar to the land-based Type SGR 109 radar and is probably a naval version of it. The following details apply to the Type SGR 109.

Operating frequency is in the S-band, and transmitter peak power is 400 kW. Two pulse lengths, 0.5 or 1.5 microseconds are employed, with a PRF of 1,000 pulse/sec for the former and 500 pulse/sec for the latter. Rotational speed for the scanner is 60 deg/sec, and two rates of vertical scanning are provided: 50 scans per minute over a sector of −2 to + 8 degrees, and 20 scans per minute over a sector of—2 to +50 degrees. The elevation sector scan is varied automatically with range.

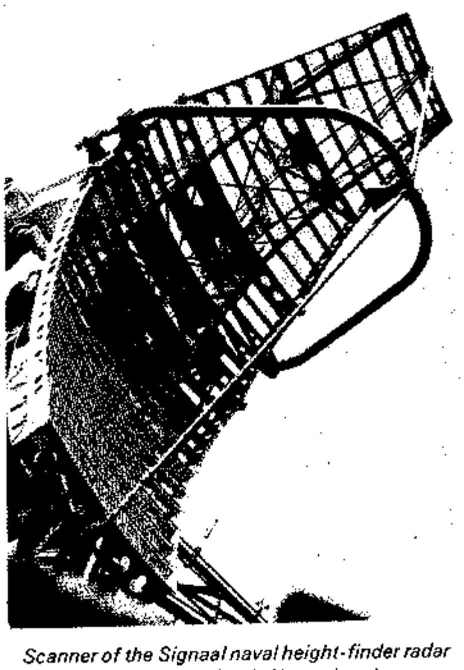
Range performance is up to 150 nautical miles (280 km), and coverage in height extends to about 36,000 metres. Up to six targets per minute at random within 360 degrees azimuth can be handled.

Anti-jamming measures include STC (Sensitivity Time Control), FTC (Fast Time Constant), adjustable PRF, video filter and anti-paralysis techniques.

The SGR 109 has a wider scanner than that of the naval height-finder shown in the accompanying illustration, so that the horizontal beam width is likely to be rather greater than the two degrees of the SGR 109.

STATUS:

The only known installation of this radar is on board the Argentinian aircraft carrier *25 de Mayo*.



Scanner of the Signaal naval height-finder radar
(Royal Netherlands Navy photo)

MANUFACTURER:

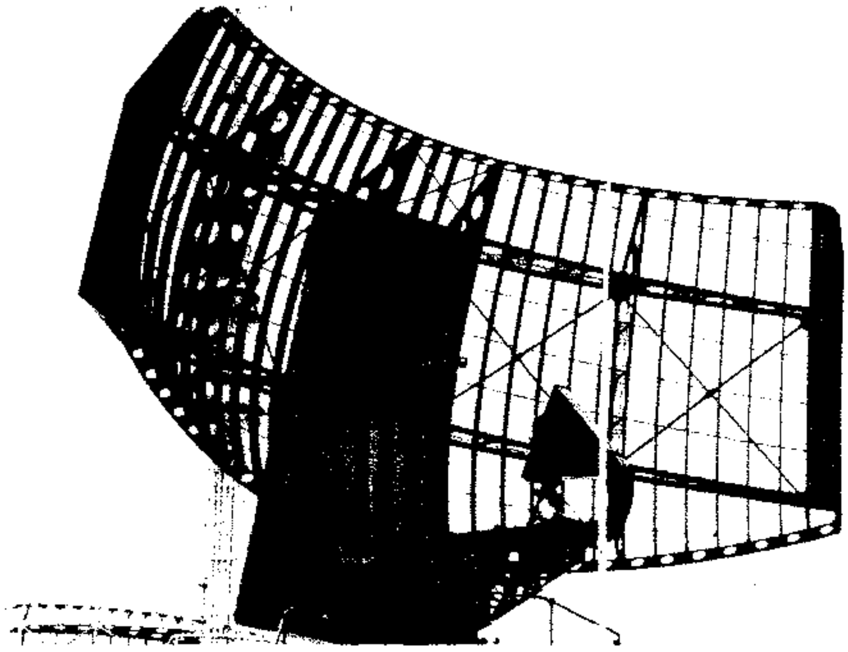
Hollandse Signaalapparaten, Hengelo, Netherlands.

1256.253
LW.02 NAVAL AIR SURVEILLANCE RADAR
The LW.02 is an L-band (23 cm), high-power long-range air surveillance radar for use on vessels of frigate size or above. Peak transmitter power is 500 kW and maximum detection range about 100 nautical miles. Vertical cover extends to 18,000 metres.

A double curvature reflector measuring 7 metres by 2.9 metres is used and a distinguishing feature of this radar is the large 'trunk' at the rear of the centre section of the scanner. There is also an LW.03 version of this radar, the only known difference between the two models being in the scanner rotation rates. The LW.02 rate is between one and ten RPM, and the LW.03 5 or 10 RPM.

STATUS:
Royal Netherlands Navy vessels fitted include the cruisers *De Ruyter* and *De Zeven Provincien*, frigates of the "Van Speijk" class and the "Holland" and "Friesland" classes of anti-submarine destroyers. Foreign vessels fitted include W. German, "Hamburg" class destroyers and the training ship *Deutschland*. "Swedish Holland" class destroyers and the cruiser *Gota Lejon*, the Canadian support ship *Protecteur*, the Argentinian aircraft carrier *25 de Mayo*, two Colombian, ex-"Holland" class destroyers, the Malaysian frigate *Hang Jebat*, and Australian "River" class escorts. A number of new-buildings are to be fitted.

MANUFACTURER:
Hollandse Signaalapparaten, Hengelo, Netherlands.

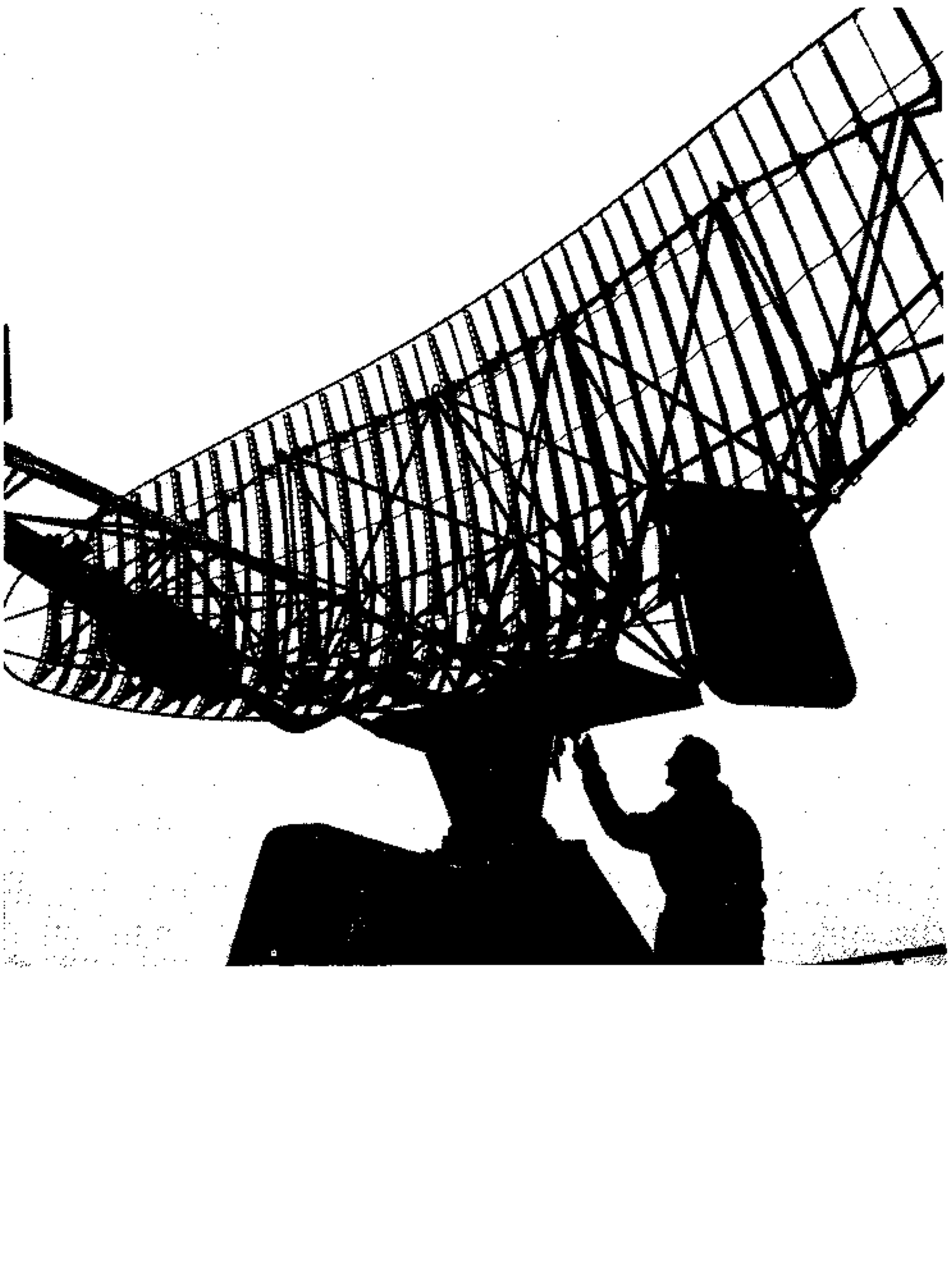

Signaal LW.02 long-range air surveillance radar aerial. Scanner in background is for Signaal target designator radar (Royal Netherlands Navy Photo)

1553.253
LW.04 NAVAL AIR SURVEILLANCE RADAR

DESCRIPTION:
The LW-04 is a long-range air surveillance radar operating in the L-band. Although designed for shipboard installation, this radar is equally suited for shore-base operation. To permit siting in adverse naval environments, the scanner reflector is constructed of stainless steel to enable operation in salt and exhaust gas environments. The transmitter/receiver is of solid-state design and uses a ceramic thyratron and a tunable magnetron. Facilities for the integration of secondary surveillance radar (IFF) are provided.

Performance characteristics have not been released. Operational features include high discrimination; two scanner rotation rates; optional circular polarisation; operation of any of six pre-set frequencies; low-noise receiver; MTI with digital cancellation, pulse interference suppression; built-in automatic test facilities.

MANUFACTURER:
Hollandse Signaalapparaten, Hengelo, Netherlands.


Signaal LW.04 naval surveillance radar antenna.

1258.253
SIGNAAL SURFACE WARNING AND NAVIGATION RADAR

DESCRIPTION:

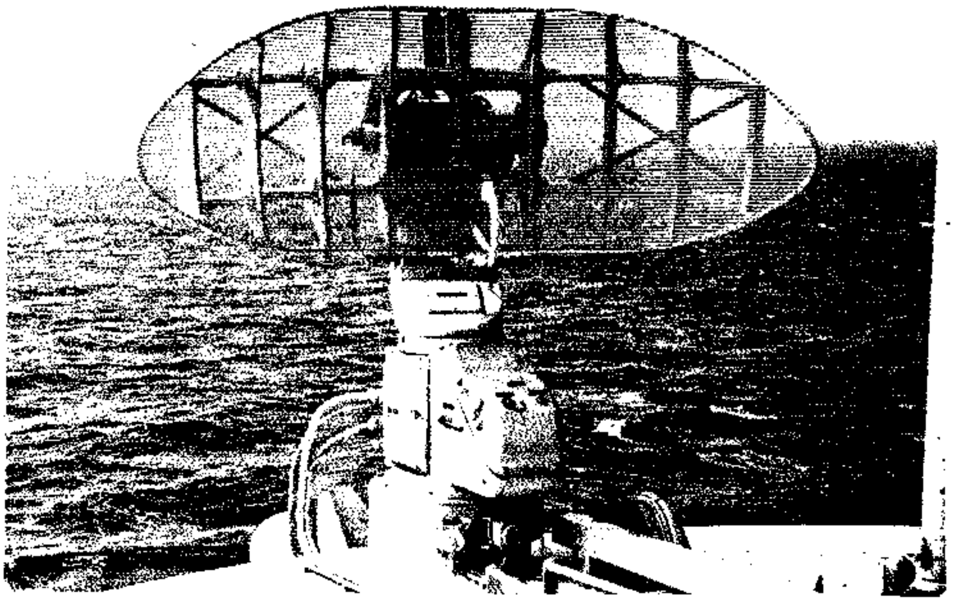
This is a conventional ship's surface warning and navigation radar operating in the X or C-band. The aerial system consists of a normal horn radiator and paraboloid section reflector. The waveguide arrangements behind the reflector suggest that there is some provision for adjusting the elevation angle of the aerial to a limited extent. No details have been made available.

STATUS:

Radars of this type have been extensively supplied to the Royal Netherlands Navy and foreign navies.

MANUFACTURER:

Hollandse Signaalapparaten, Hengelo, Netherlands.



Signaal surface warning and navigation radar (Royal Netherlands Navy photo)

1555.253
ZW.06 SURFACE SEARCH AND NAVIGATION RADAR

DESCRIPTION:

The ZW.06 is an X-band naval surface search and navigation radar providing surveillance, navigation, helicopter control, and limited air surveillance facilities. Of compact and lightweight construction, it is suitable for installation on very small vessels. The transmitter/receiver is of solid-state design, and the scanner is of stainless steel construction to permit siting in adverse environments.

Operational features include: surface cover to radar horizon; air coverage sufficient for helicopter guidance; high resolution for navigation; provision for integration of helicopter transponder systems; sector scan facility; digital video processor. Anti-clutter measures and ECCM provisions include: circular polarisation; logarithmic receiver with pulse length discrimination; sensitivity time control; suppression of non-correlated pulses; tunable transmitter; sector scan transmission (sector can be varied between 10 and 160 degrees).

Signaal ZW.06 surface search and navigation radar antenna

ZW.06 Specification:

Antenna: Parabolic reflector 2.9 m wide, 1.2 m high, with off-set feed horn
Polarisation: Horizontal or circular, selectable
Vertical beamwidth: 19 degrees at —3dB
Horizontal beamwidth: 0.9 degrees at —3dB
Side-lobe level: —23dB
Gain: 31 dB
Rotation speed: 24 rpm
Maximum windspeed: 170 km/h
Transmitter:
Type: Tunable magnetron
Frequency band: 8,600-9,500 MHz
Reciever:
Overall noise: 12dB
Intermediate frequency: 60 MHz
Receiver channels: Linear, or logarithmic with PLD. Pulse interference suppression on both channels.

MANUFACTURER:

Hollandse Signaalapparaten, Hengelo, Netherlands.

1590.253
SIGNAAL M20 SERIES FIRE CONTROL RADAR

DESCRIPTION:

This radar is the principal sub-system of the Signaal M20 Series of naval fire control systems, and in its full form consists of two radars sharing a common stabilised mount and housed in a near-spherical radome. In certain installations, the upper, target tracking and illumination radar only is used, in which case a hemispherical radome is employed. In the double installation, the tracker/illuminator is carried above the search radar, with the gimbal and stabilising assembly in between. The general arrangement can be seen from the accompanying illustration.

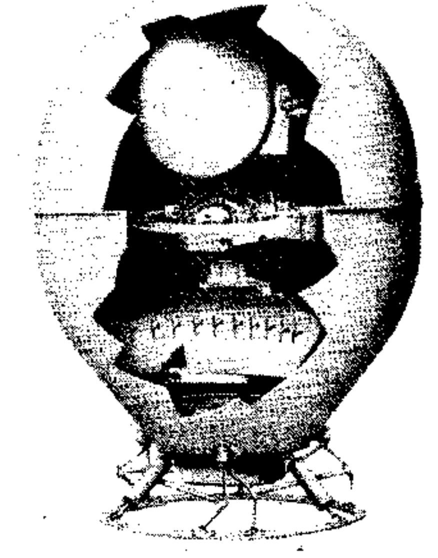
No performance details have been obtained, but the search radar apparently operates in the X-band, and the target tracker/illuminator may be either X-band also, or possibly dual frequency such as K-band with X-band for illumination. The version illustrated is as used in the WM27 fire control system which is capable of directing gun fire against air or surface targets and control of one surface-to-surface missile. Two targets can be tracked automatically and simultaneously.

STATUS:

The M20 series of fire control radars is widely fitted and details of known installations are given in the M20 Series Fire Control Systems entry (No. **1259.281**) in Section One of this edition of Jane's Weapon Systems.

MANUFACTURER:

Hollandse Signaalapparaten, Hengelo, Zuidelijke Havenweg 40, PO Box 42, The Netherlands.



Signaal M20 Series fire control radar

1589.253
SIGNAAL 3D MULTI-TARGET TRACKING RADAR

DESCRIPTION:

The Signaal 3D Multi-Target Tracking Radar (MTTR) is an advanced air search and target tracking radar capable of handling upward of 100 aircraft tracks. A very high data rate is assisted by the use of an antenna array consisting of back-to-back pairs of parabolic reflectors and planar electronically scanned antennas, all four of which have common turning gear. IFF/SIF secondary radar can be integrated with the MTTR. The parabolic dishes are used for search and the electronic-scan antennas for target tracking. High and low cover is provided. Beam steering and data extraction are performed by an SMR Series digital computer.

Operational functions include: long range search; search information with high data rate for low-flying aircraft; search information with high resolution of close in air targets; automatic position and height information; simultaneous tracking of over 100 aircraft targets; target designation facilities for other systems. No performance or other technical details have been obtained. Estimated diameter of the parabolic dishes is in the region of 6.0 metres. Both land and naval uses are likely, and the latter is understood to incorporate full stabilisation.

DEVELOPMENT:

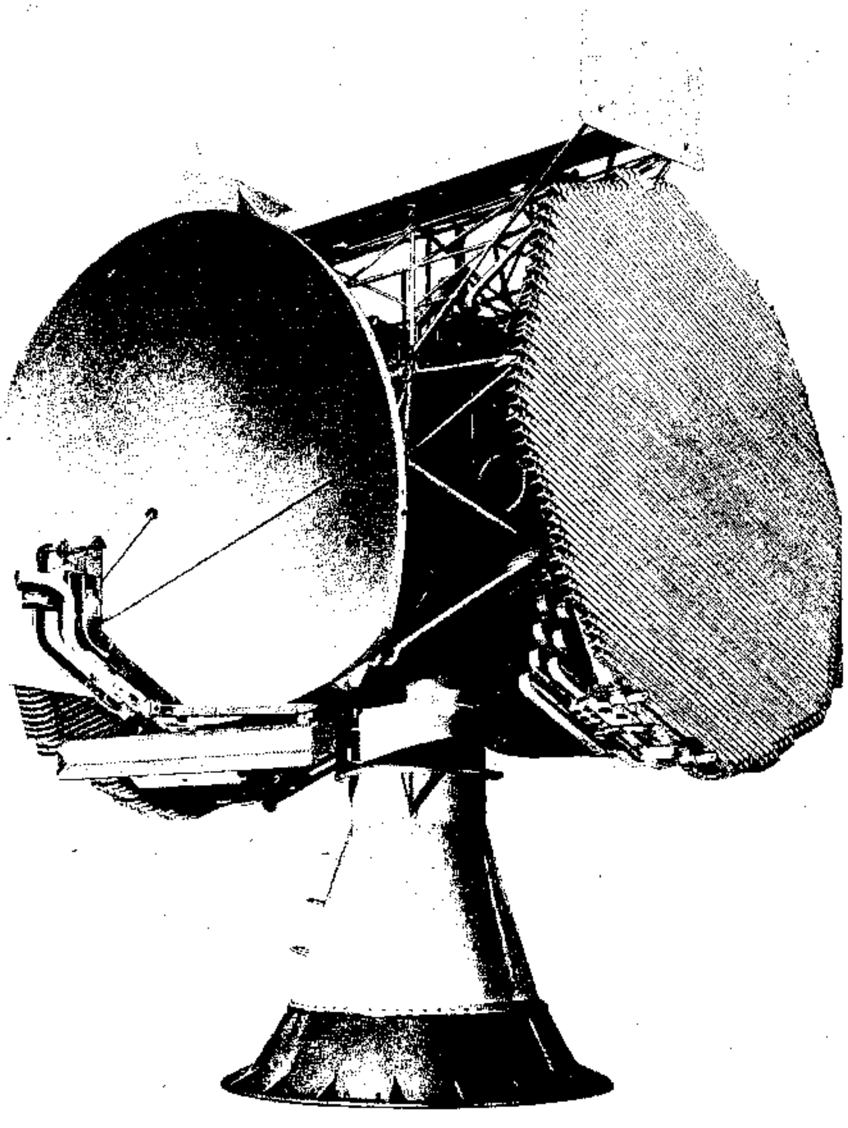
Development has been in progress since the late 1960s under sponsorship of the Netherlands Ministry of Defence. At one stage a radar of this description was the subject of a joint UK/Netherlands project, and the radar was to have been fitted to RN Type 82 Class vessels, but the UK subsequently withdrew from the programme.

STATUS:

The 3D MTTR forms one of the major sensors of the SEWACO action information and fire control system for a new class of Royal Netherlands Navy guided weapon frigates. There are no other known fittings at this stage.

MANUFACTURER:

Hollandse Signaalapparaten, Hengelo, Zuidelijke Havenweg 40, PO Box 42, The Netherlands.



Antenna array of Signaal 3D MTTR

1591.253
SIGNAAL M40 SERIES FIRE CONTROL RADAR

DESCRIPTION:

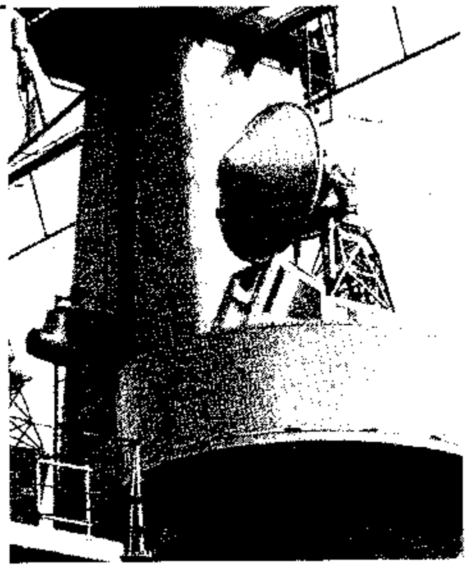
The M40 Series fire control radar is a conventional X-band tracking radar which is widely used for gun fire control and direction of the Seacat missile. The scanner is mounted above the operator's cab and rotates with it to provide azimuth motion. Separate elevation motion is provided. This radar is used in two M40 Series Fire Control systems mostly, the M44 for Seacat operation, and the M45 for guns. The transmitter/receiver is housed below decks, and there is a separate waveguide pressure-drier. No other details have been obtained.

STATUS:

M40 Series radars are extensively fitted to vessels of several navies. Details of known fittings appear in the M40 Series FCS entry (No. **1261.281**) in Section One of this edition of Jane's Weapon Systems.

MANUFACTURER:

Hollandse Signaalapparaten, Hengelo, Zuidelijke Havenweg 40, PO Box 42, The Netherlands.



Signaal M40 Series fire control radar and optical director

SWEDEN

1546.253
9 GR 600 RADAR TRANSMITTER/RECEIVER

DESCRIPTION:

This X-band, 200 kW broad-band, frequency-agile transmitter/receiver equipment is the basis of a number of Swedish Philips radar systems. Used with the 9 GA 300 antenna it forms the Subfar radar (Entry No. **1545.453**); with the 9 GA 205 it is employed in the Mareld coastal radar; with the stabilised 9 GA 202 antenna it forms the search radar element of the TORCI (Entry No. **1541.281**), 9 LV 200 (Entry No. **1542.281**), and Seafire (Entry No. **1543.281**) naval fire control systems; and it can also be used with the 9 GA 203 antenna for general shipboard applications.

9 GR 600 SPECIFICATION:

1008Transmitter:

Frequency range: Random pulse-to-pulse frequency shift up to 450 MHz in the band 8,700-9,500 MHz

Pulse peak power: 200 kW

PRF: 2,000-3,000 Hz

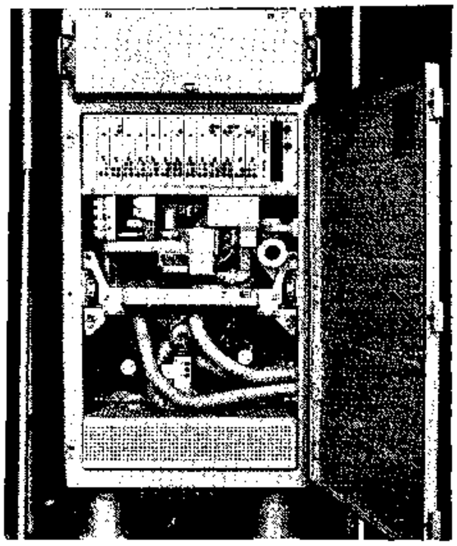
Pulse width: 0.2 to 1.5 microseconds

Output valve(s): One or two spin-tuned magnetrons

Receiver:

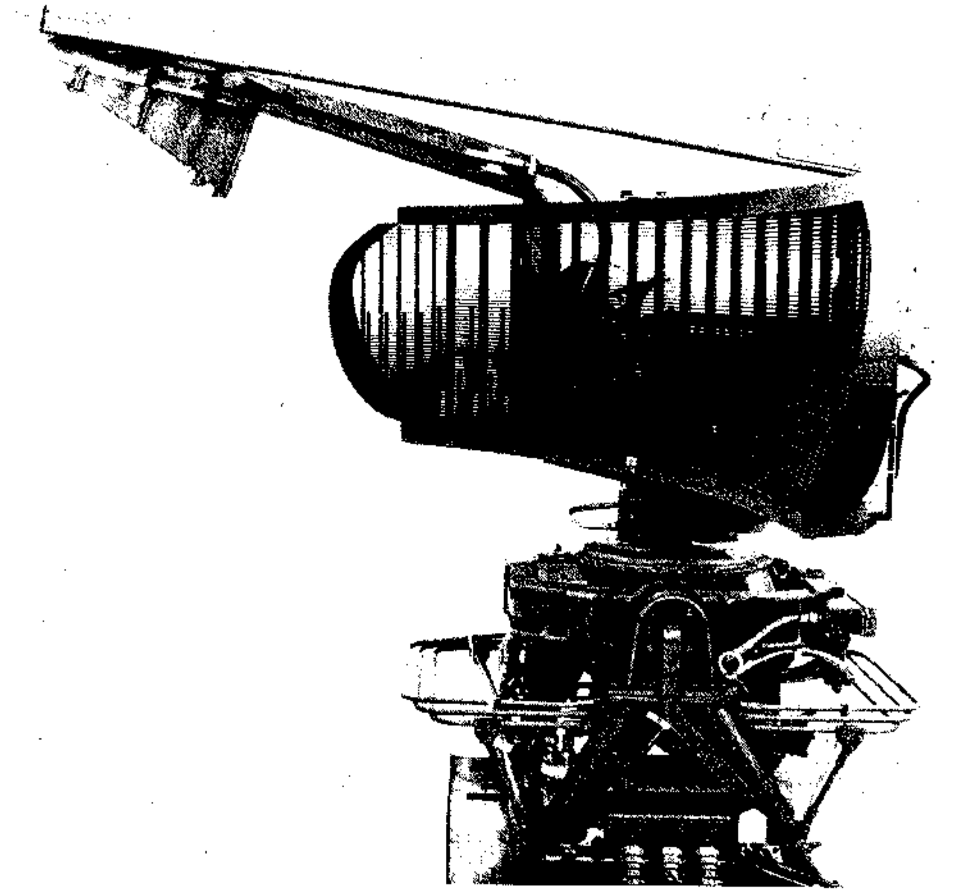
Frequency range: 8,500-9,600 MHz

Bandwidth: 3 and 8 MHz, matched to pulse length



9 GR 600 frequency X-band transmitter / receiver

Noise: 10 dB, average. 8 dB with low-noise preamp
Receiver characteristics: lin and log, log/lin, STC
Optional features: Image rejection mixer-preamplifier; Dicke-fix receiver; pulse length discriminator; IAGC; narrow-band jamming suppression; spectrum analyser; passive ECM mode; frequency programming circuits
Antenna 9 GA 202:
Type: Parabolic, horn-fed, stabilised
Frequency band: 8.5-9.5 GHz
Rotation: Up to 60 RPM
Beamwidth: Horizontal – 1.1 deg, vertical – 4 deg.
Gain: 37 dB
Sidelobes: 28 dB
Stabilisation limits: Roll –50 deg, pitch –30 deg.
Spiral scan: Up to +20 deg. (Optional)
Aperture: 2,100 × 560 mm
Weight: 135 kg, plus 25 kg with spiral scan unit
Antenna 9 GA 203:
Type: Quarter cheese, unstabilised
Frequency band: 8.5-9.6 GHz



9 GA 202 stabilised X-band antenna for search and fire control

Rotation: Up to 60 RPM
Beamwidth: Horizontal 1.4 deg, vertical 30 deg.
Gain: 28 dB
Sidelobes: 25 dB
Aperture: 1,600 × 75 mm
Weight: 90 kg
Antenna 9 GA 300:
Type: Parabolic, unstabilised, submarine
Frequency band: 8.5-9.6 GHz
Rotation: Up to 24 RPM
Beamwidth: Horizontal 2.4 deg, vertical 20 deg.
Gain: 29 dB
Sidelobes: 20 dB
Aperture: 1,000 × 140 mm
Weight: 85 kg
MANUFACTURER:
Philips Teleindustri AB, Fack, 175-20, Järfälla-1, Sweden.

1547.253
9 LV 200 TRACKING RADAR

DESCRIPTION:

This is a Ku-band frequency-agility naval fire control radar forming part of the 9 LV 200 fire control system (Entry No. **1542.281**) in which it is used with an X-band search radar. The main role is that of target tracking for gun fire control, and the radar is a monopulse equipment with stabilised antenna and a Cassegrain scanner system. The radar mounting also carries a TV camera for additional tracking facilities. A feature of the mounting is a new type of direct drive hydraulic motor capable of a slewing speed of 85 deg/sec, and an initial acceleration of 500 deg/sec^2.

Specification:
Type: Ku-band frequency-agile monopulse
Frequency range: Random pulse-to-pulse in Ku-band
Magnetron type: Philips YJ 1320
Pulse peak power: 65 kW
PRF: About 2,000 Hz
Pulsewidth: About 0.2 microseconds
Receiver noise: 11 dB
Antenna:
Beamwidth: 1.3 deg (at 3 dB points)
Gain: 40 dB
Sidelobes: 22 dB
MANUFACTURER:
Philips Teleindustri AB, Fack, S-175 20, Järfälla-1, Sweden.

Director radar antenna assembly of a 9 LV 200 fire control system with TV camera equipment

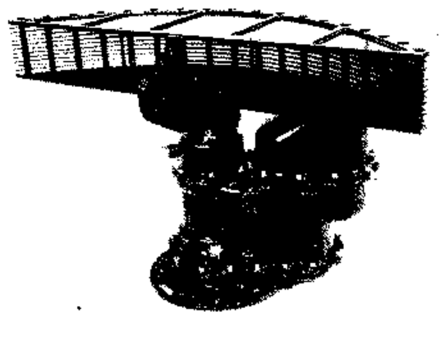
1545.453
SUBFAR SUBMARINE RADAR

DESCRIPTION:

The Subfar equipment is an air and surface search radar for submarines and comprises the Philips 9 GA300 antenna with a 9 GR600 transmitter/receiver. Subfar is the principal sensor in the 9 TCI 210 submarine torpedo fire control system (Entry No. **1544.481**).

The GA 9 300 antenna is designed for mounting on a submarine's radar mast and is unstabilised. It is of parabolic (half cheese) configuration with aperture dimensions of 1,000 × 140 mm. The horizontal beamwidth is 2.4 degrees, and 18-20 degrees vertically, at the 3dB points in both cases. Weight, with turning gear, is about 85 kg, and the rotation speed is 24 rpm. The combined reflector and turning gear unit enhances bearing accuracy by eliminating error sources such as torsional effects in the radar mast.

The 9 GR 600 transmitter is an X-band, frequency-agile system having a pulse peak power of 200 kW. Weight of the equipment is 200 kg. The transmitter frequency range provides for random pulse-to-pulse frequency shift up to 450 MHz in the band 8,700 to 9,500 MHz, and the



9 GA 300 antenna of subfar submarine radar corresponding range for the receiver is 8,500 to 9,600 MHz. PRF is variable between 250 and 3,000 pulses/second, and pulse widths of 0.15 to 1.5 microseconds can be accommodated, extendable to 2.5 microseconds to special order.

Linear/logarithmic, variable STC and differentiation circuitry is standard, and there is a comprehensive list of optional features, which includes:

Tunnel diode low-noise preamplifier
CFAR circuitry
Instantaneous AGC
Pulse length discriminator
Narrow-band jamming suppressor
Image rejection mixer-preamplifier
Additional magnetron as 'hot spare'
Passive ECM mode

Operational facilities provided are, surface target detection and tracking (continuous or programmed); limited air search; radar navigation; and passive ECM mode. The system can also be used for short duration transmission in sectors of between 10 and 180 degrees.

MANUFACTURER:
Philips Teleindustri AB, Fack, 175 20, Järfälla-1, Sweden.

THE UNITED KINGDOM

1571.253
COSSOR NAVAL IFF

DESCRIPTION:

The current range of Cossor naval IFF systems is the 800 Series, comprising three versions, IFF.800, IFF.825 and IFF.825M. The first of these is the standard equipment for general applications and the other two are miniaturised versions for special applications.

IFF.800:

Basic units of this system are the CRS.329 transmitter/receiver (interrogator); antenna assembly CRS.320, CRS.380, or CRS.381; and CRS.383 high-speed antenna switch. Optional items are: remote control unit, relay unit, and auxiliary transmitter/receiver. The CRS.329 is of modern, solid-state design throughout apart from the final transmitter amplifier. Integrated circuits are extensively used, and all pulse timing employs digital techniques. This unit is available as either a single cabinet assembly or as separate sub-units for assembly into standard racks. The CRS.381 antenna is a lightweight unit of 335 cm span, and suitable for direct mounting onto a primary radar scanner, or separately, with its own turning gear.

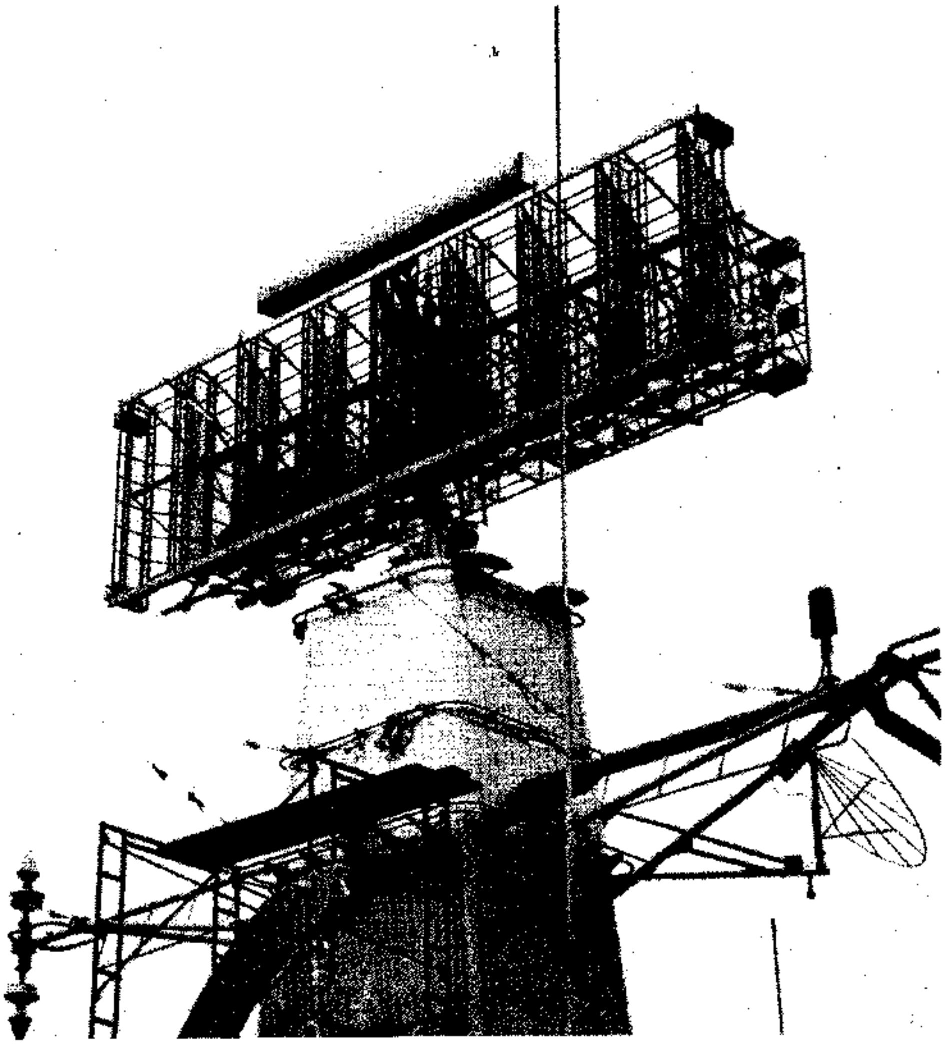
Facilities provided include IFF Mk.10 (SIF) operation with 4096 Codes, where appropriate, on Modes 1, 2, 3/A, and C; 3-pulse side-lobe suppression; video processing includes Active/Passive decoding, de-fruiting, de-garbling, emergency code facilities. Manual and automatic self-test facilities are incorporated.

IFF.825:

The Cossor IFF.825 has been designed for applications in surface-to-air missile systems which incorporate displays. The decoder is suitable for computer driven operation.

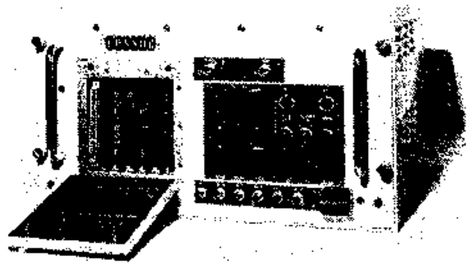
IFF.825M:

The Cossor IFF.825M is a rugged, miniaturised IFF.Mk10(SIF) equipment, designed to meet the operational requirements of Fast Patrol Craft. It conforms to the NATO document STANAG 5017 and DEF specification 133 (Table N1). I.S.L.S. is provided for modes 2 and 3/A.



Cossor CRS-381 IFF antenna mounted on Type 965 long-range radar antenna aboard the RNZN ship Canterbury

Specification:
Interrogator:
Transmitter:
Frequency: 1030 MHz (nominal)
Power: Minimum 250 watts
Pulse spacing:
Mode 1 P1 – P3 $\pm$ 0.1 microsec
Mode 2 P1 – P3 5 s $\pm$ 0.1 microsec
Mode 3/A P1 – P3 8 s $\pm$ 0.1 microsec
ISLA P1 – P2 2 s $\pm$ 0.1 – 0.15 microsec
Rise Time: × 0.1 microsec
Duration: 0.8 $\pm$ 0.1 microsec
PRF: 300 Hz (nominal)
Receiver:
Frequency: 1090 MHz $\pm$1.5 MHz
Bandwidth: 8.5 MHz $\pm$1.5 MHz (at 3dB points)
Sensitivity: –101 dBW (for 10 dB sig/noise ratio)
Swept gain: Provided as standard
Self Test: Manual and Automatic
Remote Control: Facilities provided
Power Requirements:
IFF 825
240V $\pm$6%: 48-50 Hz: 50 VA
IFF 825M
115V$\pm$ 6%: 400 Hz:50VA
Mechanical Dimensions:
Height: 27.0 cm
Width: 53.3 cm
Depth: 38.1 cm
Weight: 40.8 kg

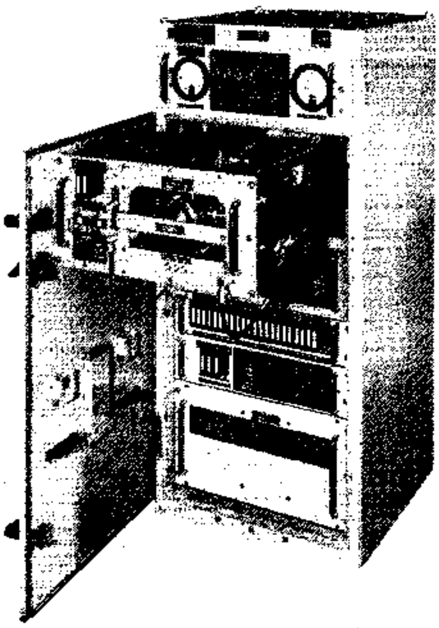


Cossor IFF.825 miniaturised transmitter/receiver

STATUS:

Since its introduction in 1969, the Cossor IFF.800 has been sold to the Royal Navy, Commonwealth and other navies, and at least 55 systems have been supplied.

MANUFACTURER:
Cossor Electronics Ltd, The Pinnacles, Harlow, Essex, England.



Cossor IFF.800 transmitter/receiver

1563.253
MRS3/GWS22 FIRE CONTROL RADAR

DESCRIPTION:

The MRS3/GWS22 is standard Royal Navy equipment for the direction of guns (MRS3) and Seacat missiles (GWS22). The initial application was to gunfire control for quick-firing medium guns of 3-, 4.5-, and 6-inch calibres. Following application of the system to the Seacat system, the MRS3/GWS22 has been the subject of steady modification and can be seen in several forms.

Each MRS3 comprises the director, and below deck, a control console and predictor. The director platform is unstabilised but compensations for ship's motion are derived from a Sperry gyro unit containing two gyros. One of these initiates aim-off and the other provides stabilisation data. The arrangement of equipment on the platforms differs between the several versions of the system; the target tracking radar is mounted to one side of the centre line, and is generally of standard configuration. Beside this are positions for operators (one or two) and with or without protective cabins, while other installations are designed for remote operation. The latest version is equipped with a Marconi television system aligned with the radar bore sight for missile guidance.

Target designation can be provided by a number of methods, including radar, optical, or from a ship's action information system. Air or surface targets can be engaged, and the director radar may be operated in a target acquisition mode.

DEVELOPMENT:

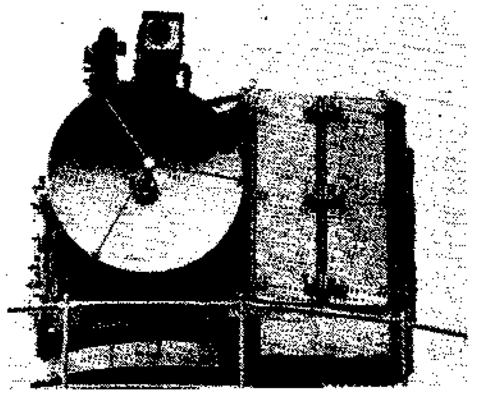
Development was carried out in the 1950s by Sperry in collaboration with the Admiralty and a number of other contractors. As stated, the equipment has undergone considerable further development since entry into service.

STATUS:

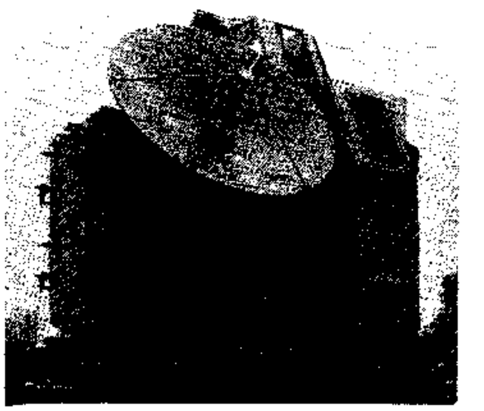
The MRS3/GWS22 has been extensively fitted in the Royal Navy on ships of the "County", "Leander", "Daring" and "Tiger" Classes, and on aircraft carriers. A number of Commonwealth and other navies are equipped with the system, including ships of the Australian, Indian, New Zealand, and Chilean navies. Production is continuing. A large contract for the modernisation of RN MRS3 systems was awarded to Sperry in late 1973.

MANUFACTURER:

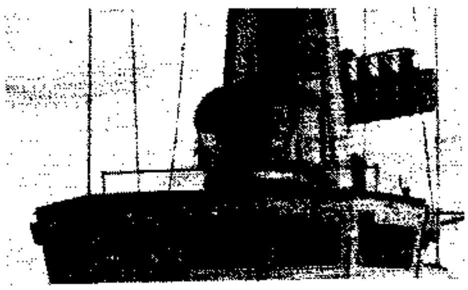
Sperry Gyroscope Division, Sperry Rand Ltd, Bracknell, Berks, England.



GWS22 Seacat fire control radar with Marconi television guidance equipment mounted



MRS3 director radar unit with protective cab



Early type MRS3 gun fire control radar with canvas hood. Antenna of Type 965 air surveillance radar can be seen also

1751.253
AWS-2 NAVAL RADAR

DESCRIPTION:

The Plessey AWS-2 Naval Surveillance Radar is a high performance and extremely versatile S-band surveillance radar designed for installation on vessels of the destroyer, frigate and corvette classes. The AWS-2 will detect small aircraft at a range of the order of 60 nautical miles at a height of 25,000 feet. The equipment can be readily integrated into a ship's gun or missile fire control systems. Features of the equipment include:

(1) A diversity transmitter/receiver configuration which provides instantaneous standby operation, and under normal conditions improves the probability of detection of a given target compared to a single transmitter system. Diversity operation, by virtue of the frequency separation of the two transmitters, provides additional protection in an ECM environment.
(2) A dual PRF/pulse width facility, which, in conjunction with a dual aerial rotation rate, provides flexibility in choice of operating roles.
(3) Multi-characteristic ECCM receiver to optimise operation in the prevailing radar conditions.
(4) A variable polarisation facility which enables the radar performance to be optimised under precipitation conditions
(5) Tunable magnetrons which enable the RF frequency to be altered to eliminate mutual interference with associated vessels.
(6) Ability to be either the master or slave timing source.
(7) Capable of being integrated with an on-mounted IFF system.

The equipment fills the following operational roles:—

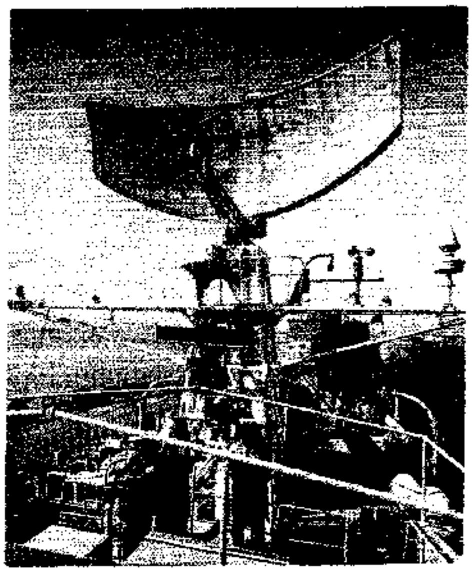
(1) Air warning with high altitude cover
(2) Aircraft control
(3) Surface warning
(4) Air and surface target indication.

The aerial system consists of a horn-fed, double curvature reflector mounted on turning gear which provides an aerial rotation rate of 10 or 20 revolutions per minute. The horn and the variable polariser form an integral part of the RF feed and are supported by a boom arm. An IFF aerial and an SLS switch may be fitted on the reflector. The all up weight of the aerial system excluding the IFF equipment is 742 kg. The metal reflector has a horizontal aperture of 5,055 mm and an accurately contoured surface of 9,300 mm^2. The feed horn is fin-loaded to give it particular characteristics which are important for variable polarisation. The design enables an ellipticity ratio of better than 1dB to be achieved. The calculated integrated cancellation ratio obtained when operating in the circular polarisation condition is approximately 20 dB.

The transmitter/receiver provides S-band RF pulses of 1.5 microsecs or 0.35 microsecs duration at repetition frequencies of 300 pps and 1,000 pps respectively. The receiver system incorporates a parametric RF amplifier for low overall system noise factor and reliability. A solid-state S-band local oscillator is fitted. With the exception of the magnetron, thyraton and parametric amplifier pump klystron, the whole of the transmitter/receiver uses solid-state devices.

The receiver fitted to the AWS-2 is designed to minimise the effect of interfering signals by rejecting all those whose characteristics differ from the transmitter pulse, and at the same time to provide all the essentials of a modern receiver.

In the receiver the functional circuits can be selected individually to provide the following modes with the transmitter operating on long pulse:—



Plessey AWS-1 naval radar head

(1) A linear receiver.
(2) A linear receiver with video differentiation (FTC)
(3) A logarithmic receiver
(4) A logarithmic receiver with video differentiation (FTC).
(5) A logarithmic receiver with pulse length discrimination (PLD).
(6) A Dicke-Fix receiver.
(7) An ECCM receiver (logarithmic with PLD, gated by quantised Dicke-Fix).

The receiver is optimised for use in the long pulse (1.5 microsec) transmitter condition, on short pulse (0.35 microsec) the receiver characteristics available are those at (1) to (4) inclusive above. Choice of receiver characteristics is made at the radar control unit, sited in the operations room.

Plessey AWS-2 Characteristics:
Aerial:
Horizontal aperture: 505 cm
Vertical aperture: 198 cm
Polarisation: Variable 45 deg linear to circular
Speed: 10/20 rev/min (switchable)
Gain: 32 dB
Horizontal beam width: Not more than 1.5
Vertical beam width: Cosec° to 40 deg
Weights and Dimensions:
Aerial reflector:
Height: 198 cm
Width: 505 cm
Turning radius: 274 cm
Weight: 262 kg
Transmitter/receiver:
Transmitter:
Frequency: For two transmitters in the bands 2,700-2,900 MHz and 3,000-3,100 MHz respectively
Magnetron peak power: 750 kW nominal (measured at a duty cycle of 0.0006)
Pulse duration and PRF: 1.5 microsecs ±10% at 400 pps or 0.35 microsecs ± 10% at 1,000 pps
Receiver: Parametric RF amplifier, balanced crystal mixer, pre-amplifier and main receiver
Overall noise factor: Better than 4.5 dB
Intermediate frequency: Centred on 30 MHz

DEVELOPMENT:
Started as a private venture in 1956, the AWS series are essentially naval versions of the AR-1 and AR-15 land-based air surveillance radars. The first prototype was completed in 1960, and entry into service followed soon afterwards.

STATUS:
Radars from the AWS series are in operational use by an undisclosed number of navies.

MANUFACTURERS:
Plessey Radar, Station Road, Addlestone, Weybridge, Surrey, England.

2419.253
PLESSEY NAVAL IFF Mk 10 (SIF)

DESCRIPTION:
This equipment is designed to provide a range of integrated systems with comprehensive facilities for IFF Mk 10 with SIF. Being modular in design, the particular requirements of widely varying types of surface warship can be met. Ships which are fitted with IFF interrogation facilities are able to distinguish between friendly and hostile ships and aircraft, and by the incorporation of suitable decoding (SIF) equipment, positive identification can be made of specific categories of friendly forces, or of individual units, according to the manner of use.

Similar in general principle to the IFF/SSR interrogation and decoding equipment described in Entry No. **2418.153**, it is packaged specifically to suit naval applications and meets the requirements of DEF 133 for protected shipborne equipment. It differs significantly from the equipment mentioned in Entry No. **2418.153** in as much as a smaller antenna for the interrogator is fitted. Because a naval IFF system must function from ship-to-ship as well as from ship-to-air, a transponder is also included in the equipment. The transponder is non-operative when the interrogator of the same equipment is transmitting. The basic naval IFF system incorporates, in a single equipment cabinet, the interrogator and transponder with all the associated power supplies, local control facilities and common decoding equipment. External to the cabinet, but included in the package are an omni-directional antenna for the transponder, and a directional antenna for the interrogator, which is normally mounted on the surveillance radar aerial. Also external to the equipment cabinet are the individual manually controlled passive decoding units, which are fitted in the operations room adjacent to those displays whose operators require selective decoding facilities.

By operation of press-button controls, the following data can be displayed:

(a) Raw video: unprocessed IFF replies from all targets, appearing as multiple 'slashes' at random range intervals determined by the reply code.
(b) Bracket decode: processed IFF replies from all responding targets, appearing as a single 'slash' coincident with the primary target echo.
(c) Selective decode: processed IFF replies from selected codes (up to three per decoder), appearing as a double 'slash' super-imposed on the primary target.
(d) Emergency: receipt of a reply bearing the emergency Mk 10 (SIF) codes will cause a distinctive multiple broad 'slash' to appear on the display on the appropriate bearing, and the emergency indicator lamp on the control panel will operate. The decoder will also respond to emergency transmissions, from basic Mk 10 IFF and civil SSR equipments.

Active decoding facilities which complement those provided by the passive decoding can also be accommodated.

An omni-directional Aerial Type AS177 of RN approved design, manufactured by CEG/AEI is supplied for operation with the transponder. It is a compact unit weighing 3.5 kg and is fitted on the ship's yard.

Directional aerials of various sizes and characteristics, according to the application, are supplied for use with the main surveillance radar antenna. The choice depends on the physical characteristics of the primary radar with which the IFF system is associated, and on the range of the primary radar.

A typical aerial is type AS2189/U of Litton manufacture. This is a 1.9 m unit weighing 25.5 kg and is suitable for mounting on the Plessey AWSI surveillance radar antenna. A side-lobe suppression switch is incorporated in the assembly to ensure effective operation with freedom from spurious returns. Alternative facilities suitable for other types of primary sensor (e.g. Royal Navy Type 965) are also available.

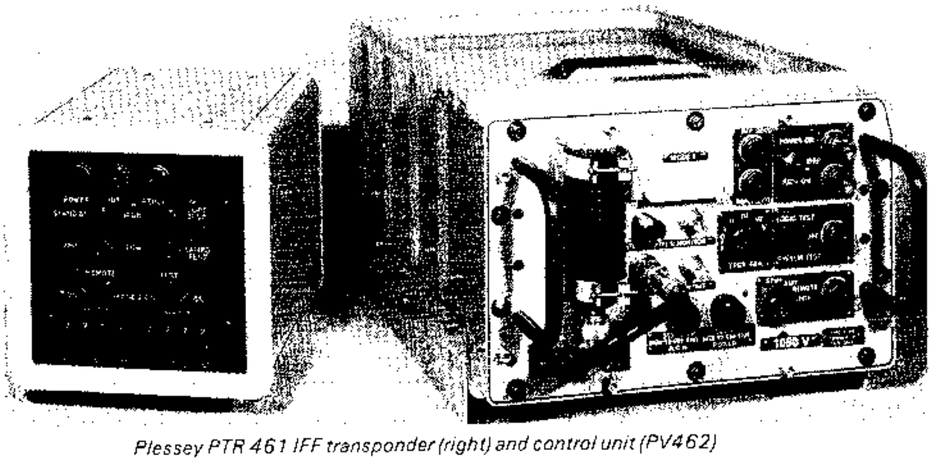
DEVELOPMENT:
Development of the equipment began in 1966 and a steady production programme is now established.

STATUS:
Export orders totalling over £250,000 have been recorded and include fittings in NATO vessels.

MANUFACTURER:
Plessey Radar Ltd, Addlestone, Weybridge, Surrey, England.

1896.253
PTR 461 SHIPBORNE IFF TRANSPONDER

DESCRIPTION:
The PTR461 transponder operates on Modes 1, 2 & 3/A and provides a means of ship identification in response to interrogation by ground, shipborne or airborne secondary radars. It is in general accordance with the Military Mark 10 (SIF) requirements defined in NATO Stanag 5017. The design techniques employed put great emphasis on ease of maintenance but retain, wherever possible, the highly reliable modules of the Plessey PTR446 airborne transponder. The PTR461 transponder includes its own monitoring facilities to allow fault-finding down to module level, which is accomplished using only an oscilloscope and multi-meter.


Plessey PTR 461 IFF transponder (right) and control unit (PV462)

A digital shift register replaces the conventional delay lines in the encode and decode circuits, thus providing time delays independent of temperature variations. Integrated circuits are used for the logic circuit, logarithmic response, i.f. amplifier and video processing circuits.

The transponder operates in conjunction with the control unit PV462 which may be installed remotely from the transponder. The code controls for Modes 1 and 3/A are housed on the control unit and the code control for Mode 2 is situated on the transponder. The self-test facility can be controlled from either unit, and both units contain lamps which allow the transponder performance to be monitored.

The transponder PTR461 is derived from the lightweight transponder PTR446 and uses common modules which give a logistic compatibility. The control unit is designed to fit into the Versatile Console System (VCS).

PTR461 Characteristics:
Power output:
Nominal power output: 24dBW
Minimum power output: 23dBW
Maximum power drop during first 1000hr 1.5dBW
Typical output power after 2000hr 21dBW
Pulse rate: 1200 replies/sec each containing up to 14 reply pulses (Note: The 'x' pulse is not normally used).
Triggering sensitivity (Min): −72 to 80dBm
Dimensions:
Transponder:
Width: 308.6 mm
Height: 220.8 mm
Depth: 392.4 mm
Weight approx: 12.25 kg
Control Unit:
Width: 152.4 mm
Height: 152.4 mm
Depth: 161.9 mm
Weight approx: 1.35 kg

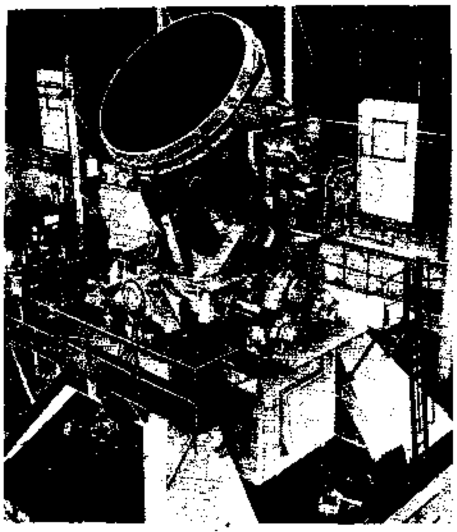
MANUFACTURER:
Plessey Avionics & Communications, Ilford, Essex, England, IG1 4AQ.

1752.253
RN TYPE 901 RADAR
DESCRIPTION:

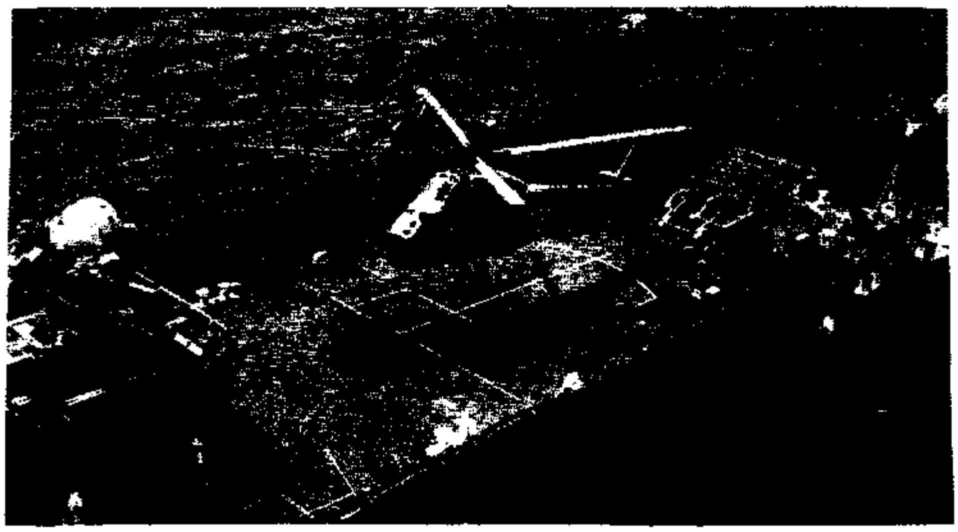
The Royal Navy Type 901 radar equipment provides target tracking and missile guidance for the Seaslug shipborne surface-to-air missile system (Entry No. **6003.231**). Each of the eight RN "County" Class guided missile destroyers is fitted with a single Type 901 radar, forward of the helicopter deck, for use with the twin Seaslug launcher aft. A stabilised mount is provided and the right-hand side of the director head carries equipment for initial 'gathering' of the beam-riding Seaslug missile. No performance details of the Type 901 have been released. Operation at C-band frequencies is probable.

MANUFACTURER:

Marconi Radar Systems Ltd, New Parks, Leicester, England, LE3 1UF.



Type 901 radar during manufacturer's tests



Aft end of "County" Class destroyer showing Seaslug launcher, and Type 901 missile guidance radar forward of helicopter deck

1559.253
RN TYPE 909 RADAR
DESCRIPTION:

The Royal Navy Type 909 radar provides target tracking and illuminating facilities for the Sea Dart, GWS-30 air defence missile (Entry No. **6004.231**). This weapon has an anti-ship capability, and the radar is stated to be suitable for gun laying also, so that a surface target capability must be assumed. The antenna is of the Cassegrain type and has a diameter of 2.44 metres. A small dome mounted near the upper edge probably houses an associated IFF antenna. On board ship, the complete antenna assembly will be protected by a cupola radome. The radar head and the office cabin, containing transmitter/receiver unit and associated electronics, are constructed as a single pre-fabricated assembly to reduce installation and replacement time and to enable functional testing before fitting.

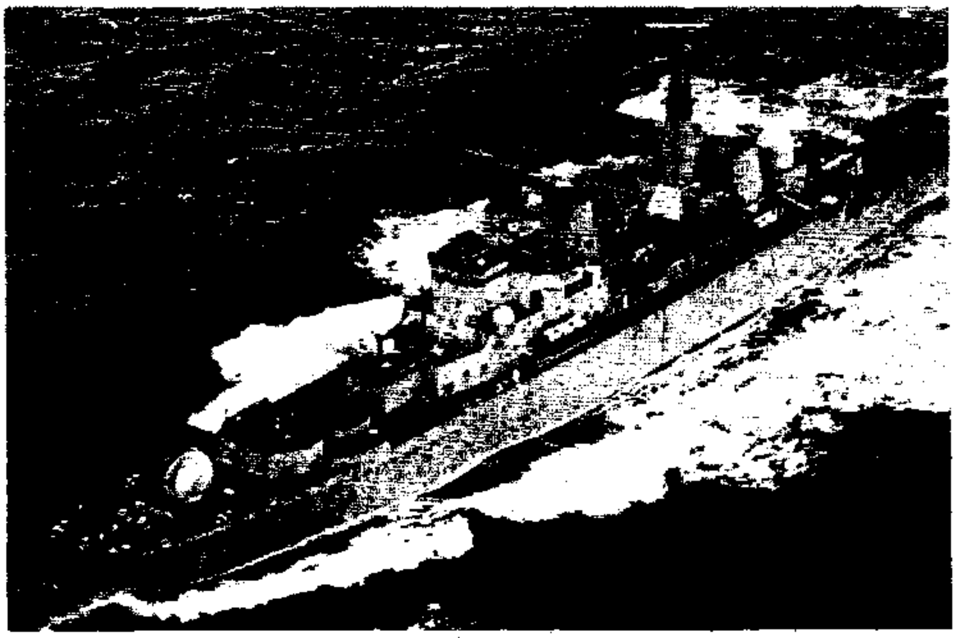
Few technical particulars have been revealed. A C-band operating frequency range is likely and a high transmitter power can be expected. It has been stated that elaborate ECCM are incorporated to counter both active and passive ECM. A photograph appears with the Sea Dart missile entry.

STATUS:

The Type 909 has been specified for Type 42 destroyers for the Argentinian and British Navies, and for the RN Type 82 destroyer. Each ship will have two radars of this type, mounted in fore and aft radomes. Full production had started in 1971.

MANUFACTURER:

Marconi Radar Systems Ltd, New Parks, Leicester, England LE3 1UF



The Type 82 destroyer HMS Bristol. *Forward Type 909 Sea Dart missile guidance radar is not yet fitted with protective radome as is the aft Type 909. Dual array AKE(2) Type 965 search radar can be seen, with Type 992Q atop mast. Radomes beside bridge contain communication satellite aerial dishes* (Royal Navy)

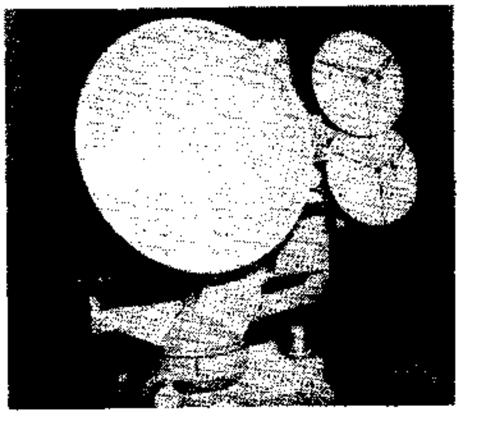
1562.253
RN TYPE 910 RADAR
DESCRIPTION:

The Type 910 is the radar tracking element of the GWS 25 Seawolf point defence missile system. It is used with, and receives target designation data from, the Types 967 and 968 air and surface surveillance radars (Entry No. **1561.253**). Few technical details have been released, but X-band operation and a Cassegrain antenna are likely. The Seawolf uses command to line of sight guidance, and the arrangement of antennas suggests that the main tracking radar is flanked by horns and dishes for guidance and telemetry functions and IFF. A closed circuit TV camera system is associated with the radar.

Information from this tracker could be used for gun control also, and the TV tracker on the same pedestal could also be employed for gunnery purposes.

MANUFACTURER:

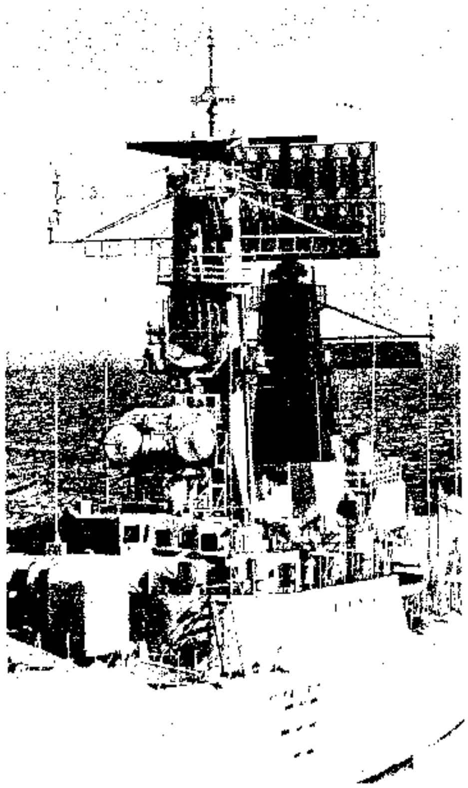
Marconi Radar Systems Ltd, New Parks, Leicester, England LE3 1UF.



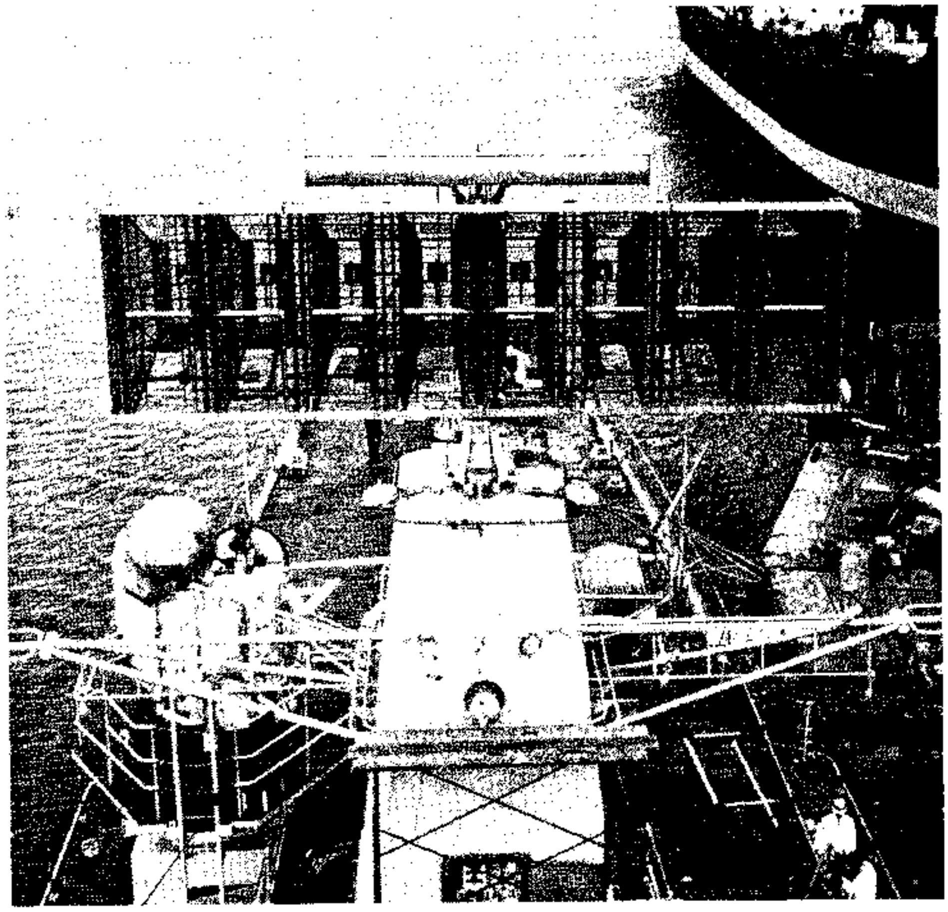
RN Type 910 Seawolf target tracker and missile guidance radar

1558.253
RN TYPE 912 RADAR
DESCRIPTION:
Type 912 is the Royal Navy designation for the Selenia Orion RTN-10X fire control radar fitted to RN ships. It is an X-band equipment, conical-scan pulse radar, and the mounting arrangements include facilities for a closed-circuit television system for acquisition and missile gathering functions. More details will be found in Entry No. **1368.253** among the Italian entries of this section.

1560.253
RN TYPE 965 RADAR
DESCRIPTION:
The Type 965 is the standard long-range air search radar of the Royal Navy and is widely used on ships of sizes ranging upward from frigates. The operating frequency range lies in the metric wavelength band and output powers in the megawatt range are assumed. In addition to air surveillance, the Type 965 fulfils target designation functions for guided weapons systems, and integrated IFF Mk 10 facilities are provided.



HMS Salisbury, *showing Type 965 search radar with double aerial outfit AKE (2). Other radars shown are the Type 277 nodding height finder above the 'Plane-5' radar gun fire director. Type 993 S-band search radar, and what is possibly a Type 992 mounted aft* (Royal Navy)



Close-up view of Type 965 AKE-1 antenna array, with Cossor IFF antenna on upper edge

The Type 965 employs a lecher-line oscillator as the RF power source, modulated by the output of a resonantly charged discharge line. The modulator is a hydrogen thyratron of the self replenishing type. To avoid interference with communications, extensive filtering is applied before the RF is fed to the air dielectric feeder and antenna. The receiver is basically a conventional superhet, with AFC and a specially designed low-noise cascode RF amplifier stage. Both linear and logarithmic IF amplifiers can be selected. Duplexing is by means of a hybrid ring arrangement of lengths of tuned co-axial cable.

The antenna array consists of a row of eight dipoles, each at the rear of a 'horn' formed of metal mesh, the whole having a characteristic 'bedstead' appearance. The complete antenna scanner assembly may consist of either one or two such groups, and both versions are extensively employed. An IFF antenna is usually mounted on the upper edge of the primary array.

STATUS:
The Type 965 has been in production for several years and is widely deployed in both single and double array forms by the Royal Navy, and is fitted in single array configuration of RNZN Type 12 Leander class frigates.

MANUFACTURER:
Marconi Radar Systems, Ltd, New Parks, Leicester, England LE3 1UF.

1561.253
RN TYPES 967 AND 968 RADARS
DESCRIPTION:
The Royal Navy Type 967 is an air surveillance radar which can be integrated with the Type 968 surface surveillance radar to form a very compact medium-to-short range defence radar. They will provide high performance facilities to fulfil the requirements of air and surface warning, search and target designation, from sea level to high elevation angles. These radars with the Type 910 Target tracker and missile guidance radar form the radar group for the Seawolf anti-aircraft and anti-ship-missile weapon, GWS 25 (Entry No. **2442.231**).

The waveguide antennas for both radars are mounted back-to-back in a common housing carried by a single fully-stabilised mount. The whole will be protected by a radome. No technical details have been revealed but operating frequencies are probably in the X- or C-bands. Extensive precautions have been taken to limit the effects of sea clutter and ECM. The system has its own digital processor, a Ferranti FM 1600 series computer. A high rotation rate for the scanner is probable.

Scanner and stabilisation arrangements of RN Type 967/968 for Seawolf point defence system. Separate antennas for surface and air search contained in a common housing

MANUFACTURER:
Marconi Radar Systems Ltd, New Parks, Leicester, England LE3 1UF.

1253.253
RN TYPE 975 RADAR

DESCRIPTION:

The Type 975 is a lightweight, X-band, high definition surface warning radar designed for fitting on frigates, coastal and inshore minesweepers, and other naval craft of similar size. Its primary function is navigation, but in some installations it is specially adapted for mine hunting in conjunction with a suitable plot and underwater detection equipment. This version is designated Type 975ZW, and incorporates true motion displays and provision for marking sonar targets on the display.

Transmitter power is 50 kW (nominal), and either a 182 cm or 304 cm slotted waveguide scanner is used. Two models of display unit are available, JUC/1 and JUC/2. The former is a water-tight unit with magslip range and bearing, and the latter has synchro range and bearing transmission. Seven range scales provide displays of 0.75 to 48 nautical miles. Minimum detection of the radar is less than 32 metres, and bearing accuracy is within one degree.

STATUS:

This radar has been extensively fitted to ships of the RN and other navies, and although now superseded by the Type 1006 (Entry No. **1394.253**), many Type 975 units are still in use.

MANUFACTURER:

Kelvin Hughes Division of Smiths Industries Ltd, New North Road, Hainault, Ilford, Essex, England.

1254.253
RN TYPE 978 RADAR

DESCRIPTION:

The Type 978 is a 3-cm navigation radar designed for fitting on frigates and larger ships. The scanner used is a 'double-cheese' type unit with the upper section used for transmission, and the lower for reception. Transmitter design is conventional, employing a blocking oscillator trigger circuit, hard valve modulator and a magnetron. The receiver incorporates automatic frequency control to compensate for magnetron frequency drift. Logarithmic amplification and differentiating circuits are incorporated to improve performance in adverse conditions such as rain or sea clutter.

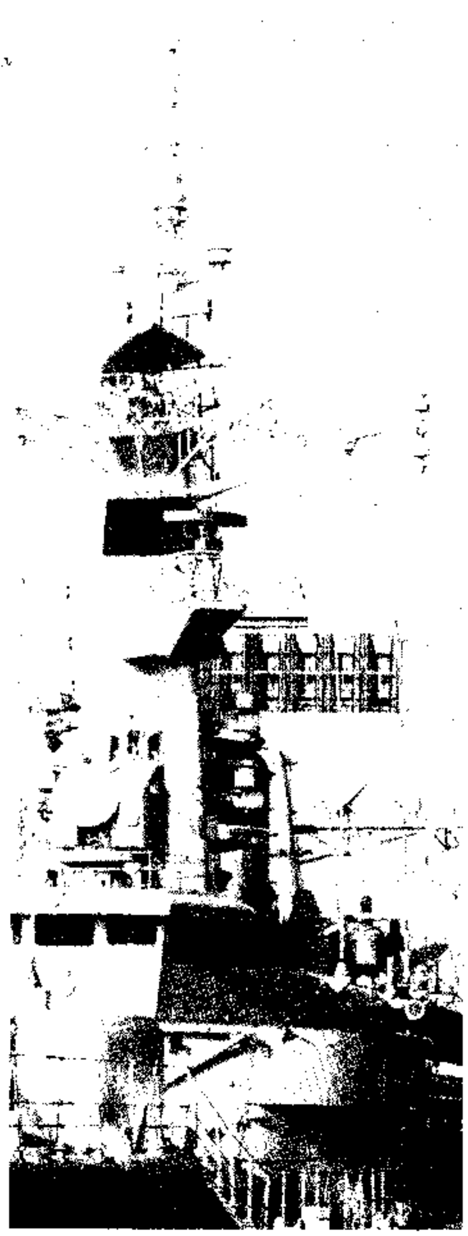
The main display is a PPI presentation with true motion facilities, and to this can be added Optical Plotting Attachment (OPA), an optical mixing device to permit the addition of tactical information to the display. A further display can also be used with the Type 978 where more accurate range and bearing data is required. This is a B-scope display, allowing any part of the PPI picture to be expanded for closer examination.

DEVELOPMENT:

Development took place in the 1950s, as a successor to the Type 974. Over 1,000 of the latter radar have been supplied to more than 50 navies.

MANUFACTURER:

Decca Radar Ltd, Decca House, Albert Embankment, London SW1, England.



This picture of aerials on HMS Andromeda *shows (top-to-bottom): various DF and EW units on mast, Type 993 'quarter-cheese' scanner, Type 978 navigation radar, Type 965 long-range search radar with IFF (aft of mast), and MRS3 fire control radar director* (Royal Navy)

1041.253
TYPE 984 NAVAL AIR SURVEILLANCE RADAR

DESCRIPTION:

Few details of the Type 984 have been released, but its general configuration and those statements which have been made enable some conclusions to be drawn concerning its operation.

The antenna system consists of a number of primary energy sources stacked in the vertical focal plane of a 4.267 metre diameter microwave lens. The energy from each scanner (source) is collimated by the lens and forms a narrow pencil beam in space. As with an optical lens system, the angle at which the beam emerges from the lens depends on the angular off-set of the source from the optical axis. The scanners are disposed, vertically, about the optical axis and hence produce a number of beams at different angles of elevation. The action of the scanners is to move each energy source, at high speed, through a small angle thereby swinging the beams through the same angle. The scanners are synchronised so that all the beams'scan upward at the same time, the time between the beginning and end of the scan cycle being correlated with elevation.

In this way a series of separate scans are swept in elevation, at plan data rate, thus making it possible to extract height and PPI data.

A further, fixed, beam at low elevation provides long range early warning of approaching targets.

The transmitters and receivers are mounted on a framework supported on trunnions at the rear of the antenna assembly, or nacelle, which is itself stabilised on a second pair of trunnions, thus providing stabilisation of the optical axis against ship's motion.

Special display arrangements were evolved for the Type 984 and there was provision for the presentation of either 'raw' data or processed information in the form of a 'tactical' display. The latter consists of eight-figure groups encircling each target position. The figures give information as to size, category, height, etc. Switches enable the number of targets displayed to be selected according to any of their parameters.

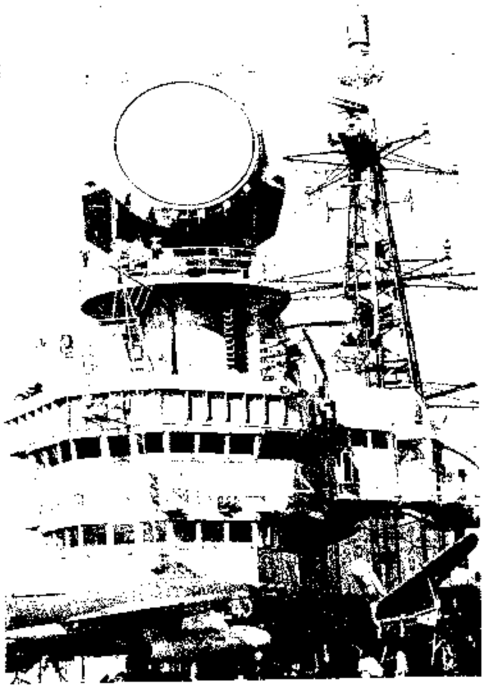
Subsequent Type 984 installations have been made on vessels equipped with computer based action data automation systems, providing an opportunity for further sophistication of radar data handling.

STATUS:

The only known operational installations of the Type 984 are on board British aircraft carriers. First to be fitted was HMS *Victorious*, prior to recommissioning in 1958. Other vessels since equipped are HMS *Eagle* and *Hermes*.

DEVELOPMENT:
The Type 984 radar is the result of a collaborative programme between The Marconi Co and the Admiralty Surface Weapons Establishment. Work on the project is believed to have started about 1950.

MANUFACTURERS:
Marconi Radar Systems Ltd, New Parks, Leicester, England LE3 1UF.
Admiralty Surface Weapons Establishment.



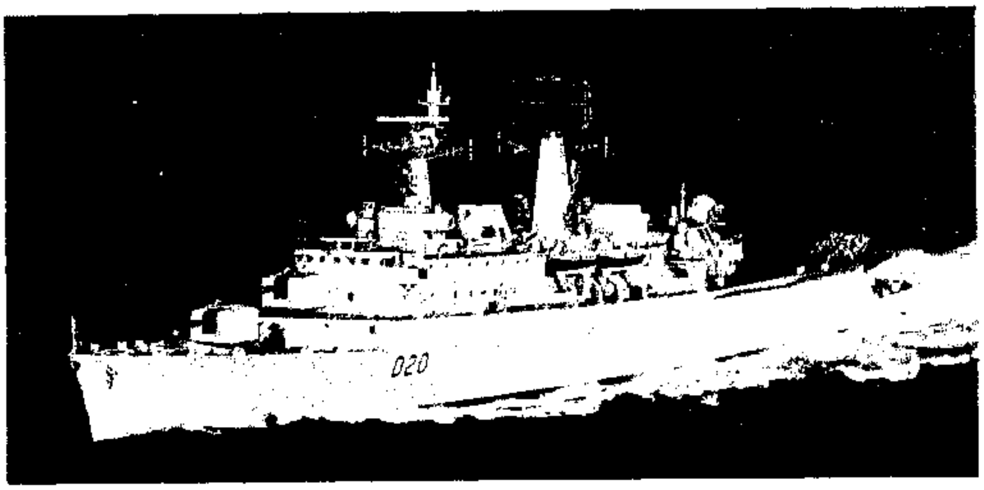
Type 984 air defence radar on board HMS Hermes

1753.253
RN TYPE 922 Q RADAR

DESCRIPTION:
The Royal Navy Type 992 Q radar is a fully stabilised 10 cm (S-band), high-power pulse radar equipment, fitted in destroyers and frigates. It is a prime source of surface/air target information for the Action Information Organisation system, and provides space-stabilised output data which can be synchronised in pulse and rotation with that of other radars fitted in the ship. It is of solid-state electronic construction apart from certain circuit elements which retain vacuum tube devices.

STATUS:
Fitted in RN "County Class" guided missile destroyers.

MANUFACTURER:
Marconi Radar Systems Ltd, New Parks, Leicester, England LE3 1UF.



HMS Fife. *Radar fit is the same as for HMS* Glamorgan, *shown nearby. Also visible in this picture are Type 277 height-finder aft of mainmast and Type 901 Seaslug guidance radar by helicopter deck* (Royal Navy)

"County" Class destroyer, HMS Glamorgan, with Type 992Q Scanner on foremast. Below is Type 978 navigation radar, and MRS-3 radar director over bridge. Mainmast has Type 965 search radar with AKE (2) aerial outfit. Note ECM arrays

1394.253
RN TYPE 1006 RADAR

DESCRIPTION:
The Type 1006 Radar and the associated displays and aerial outfits form a high definition navigation radar system which meets the operational and reliability requirements of the Royal Navy. Interface standards with certain existing naval equipments have been maintained. Throughout the design and development of the equipment emphasis has been placed on the reliability, accessibility and ease of maintenance of the equipment. The equipment will be fitted in both submarine and naval surface vessels and in ships of the Royal Fleet Auxiliary. The Type 1006 will be the standard X-band navigational radar of the Royal Navy and is replacing three obsolescent radar systems now in service. The Type 1006 is designed to metric standards. It is in full production.

Aerial Outfit AZJ:
The surface role aerial outfit consists of a 2.4 metre slotted waveguide linear array rotated at 24 rpm by a turning mechanism. The array has a horizontal beamwidth of 1° and low side lobe levels to give good bearing discrimination. The vertical beamwidth of 18° gives good performance in conditions of roll and pitch. The rotational speed is maintained in wind speeds up to 100 knots by an AC driving motor which also ensures a low magnetic signature. Aerial bearing data is provided by a coarse/fine 400 Hertz synchro system which also includes bearing rate information from a 400 Hertz tachogenerator. To ensure operation in severe weather conditions a pneumatic aerial de-icing system is available. This is effective down to −30° centigrade. To meet special ship fitting requirements the aerial outfit may be inverted and mounted on the underside of a mast spur.

Aerial Outfit AZK:
This aerial outfit consists of a 3.1 metre slotted waveguide linear array rotated by the same type of turning mechanism as outfit AZJ. It is used when the improved bearing discrimination given by the 0.75° beamwidth is required. The increased aerial gain also improves the range performance of the radar system. The remaining details of outfit AZK are similar to those for AZJ.

Transmitter-Receiver (Surface):
The equipment is non-thermonic with the exception of the magnetron, and operates at a frequency of approximately 9,445 MHz. The solid state modulator, which may be externally

synchronised, provides three pulse lengths at two repetition frequencies to drive the magnetron which is coupled directly to the RF head. The advanced broadband design of the RF head ensures the best obtainable minimum range under adverse waveguide conditions. The three pulse lengths of 80, 250 and 750 nanoseconds ensure good short range discrimination and long range performance. A Gunn diode local oscillator is controlled by an AFC with tuning indication, the IF generated is fed to a combined linear/logarithmic receiving system. The linear video is used for navigational radar displays and the logarithmic video is used for weapon system data extraction. The receiver bandwidth is automatically optimisted for the transmitter pulse length in use.

A high-isolation waveguide switch and dummy load is provided to allow the transmitter-receiver to be run under radar silence conditions. The mechanical coupling of the on/off switch to the waveguide switch ensures the protection of the mixer crystals when the system is not powered. Multiple outputs of sync and video enable up to four displays to be operated directly without the need for signal retransmission units.

Transmitter-Receiver (Submarine):
In order to be compatible with the existing submarine aerial system a variant of the transmitter-receiver operating at 9,650 MHz is available. It is otherwise identical to the surface role equipment. The design of the RF head prevents damage to the equipment from massive waveguide reflections which occur if the aerial is submerged whilst transmitting.

Display Unit JUD:
This unit is non-thermionic with the exception of the cathode ray tube. The display unit uses a rotating scanning coil system to provide range scales from ½ to 64 data miles. The unit uses a 31 cm (12 inch) cathode ray tube. Fixed coils provide off-centring facilities up to 75 per cent of a radius from either an external true motion unit or from internal sources. Display presentation is normally North-stabilised. An adjustable electronic range marker is provided whose range is displayed on neon numeric indicators. The crystal controlled range marker system has two range scales FINE and COARSE; either may be set to YARDS or DATA MILES. The range strobe is continuously variable; it is independent of the display range scale. It shows:

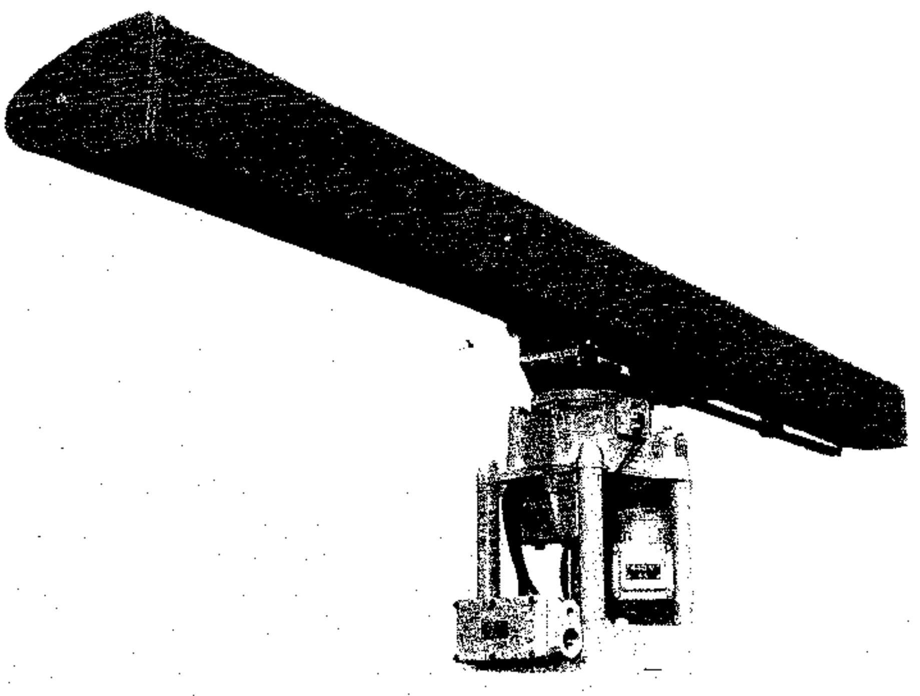
Fine/coarse	Yards/Miles
fine	yards
fine	miles
coarse	yards
coarse	miles

Range increments	Maximum marker range
5 yards	10,000 yards
0.005 data miles	10 data miles
50 yards	100,000 yards
0.05 data miles	64 data miles

A mechanical parallel line cursor and an electronic bearing marker are provided. The position of the bearing marker is displayed on neon numeric indicators with an accuracy of +½°. Readings may be taken of both true and relative bearing. The information from the range and bearing markers is available in Binary Coded Decimal form for remote display or feeding to ancillary equipment. The display will accept heading line, radar video and three channels of auxiliary video information. Front panel switches allow the selection of the auxiliary video channel to be displayed. The range switch will normally control the transmitter pulse length. An overriding Pulse Length Selection control may be used to override the range switch pulse length selection to give medium or long transmitter pulse lengths.

A flat face anti-parallax reflection plotter is available. Nine range scales are provided, covering ½ to 64 Data Miles.

Display Unit JUD(2):
The facilities of the display have been extended for surface role applications to operate in conjunction with computer systems such as CAAIS (Computer Assisted Action Information System). Additional symbol writing coils and amplifiers are provided together with pulsed off-centring amplifiers to enable the display of interscan symbolic data on appropriate range scales from analogue information inputs. Outputs of the range scale setting are provided for the alignment of ancillary equipment.



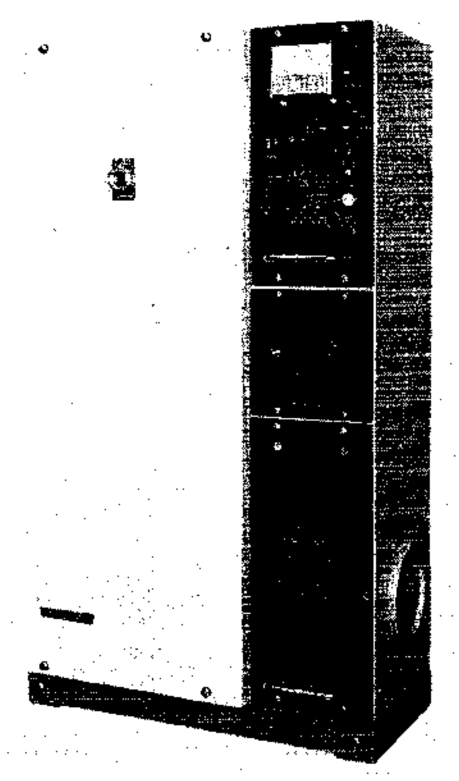
Type 1006 radar antenna head

True Motion Outfit QAB:
The Outfit QAB is a solid state electro mechanical computer for the provision of true motion presentation on the Radar 1006 JUD Display.

Submarine Use:
The Type 1006 is compatible with the Submarine Bridge Display which is primarily used to assist conning when submarines enter or leave harbour.

No details of the submarine antenna system have been obtained.

DEVELOPMENT:
Development began in 1969, and the Type 1006 radar and the associated displays and aerial outfits have been developed by Kelvin Hughes in collaboration with ASWE.



Type 1006 transmitter/receiver

STATUS:
Sea trials were conducted during 1970 aboard HMS *Grenville* and HM Submarine *Otus*. The Type 1006 radar has been in series production for the Royal Navy and other navies since 1971.

MANUFACTURER:
Kelvin Hughes, New North Road, Hainault, Ilford, Essex IG6 2UR, England.

1895.253
S604 HN NAVAL RADAR

DESCRIPTION:
The S604 HN is a long range surveillance radar operating in L-band and designed to give optimum performance in a jamming environment. The aerial comprises a single curvature cosecant squared reflector with linear squintless feed to give low side lobes. The 2.3 MW peak power oscillator is a variable frequency magnetron, vapour cooled to ensure constant temperature. Magnetron frequency is governed by a crystal controlled STALO – frequency pulling is eliminated by the incorporation of a ferrite isolator between magnetron and duplexer; and frequency pushing by a modulator pulse stabilising circuit. The receiver chain includes a parametric amplifier with a noise figure of 2.8 dB.

The equipment incorporates a digital signal processor giving moving target indication (MTI), clutter constant false alarm rate (CFAR) control and pulse repetition frequency discrimination. Pulse repetition frequency stagger is provided on the trigger system which can supply outputs for a complete ship's radar system.

S604 Characteristics:
Aerial Assembly:
Aperture: 5.5 m × 1.83 m
Frequency: 1,250 to 1,365 MHz
Azimuth Beamwidth: 3.2° (at 1,330 MHz)
Elevation Beamwidth: Cosec² to 45°
Sidelobes: —30 dB in horizontal plane
Gain: 28 dB (at 1,330 MHz)
Weight (Aerial & Pedestal): 1,350 kg
Transmitter/Receiver:
Output Power: 2.3 MW peak

Frequency: 1,250 to 1,310 MHz (tunable) or 1,305 to 1,365 MHz (tunable)
Parametric Amplifier:
Noise Figure: 2.8 dB
Weight: 1,250 kg
Single Processor:
MTI: double cancellation digital
PRF Stagger: 6-period
PRF Discrimination:
Video Outputs: Analogue and digital suitable for driving Plot Extractors

STATUS:
The land version of this radar is in series production, but no details of shipboard installations have been obtained.
MANUFACTURER:
Marconi Radar Systems Ltd, New Parks, Leicester, England.

1508.253
ST 801/2 NAVAL TRACKING RADAR

DESCRIPTION:
The ST 801 is a lightweight X-band monopulse search and tracking radar for the direction of small and medium calibre guns, and for target tracking in guided missile systems. It is intended for use against air or surface targets, and the weight and dimensions of the system are appropriate to installation on *all* classes of vessel from patrol boats upwards. The ST 801 is designed to interface with, and be controlled by, a weapons system computer. The type ST 802 is the autonomous version of ST 801 and includes facilities and additional equipment for independent operation and control in systems not equipped with a central computer complex.

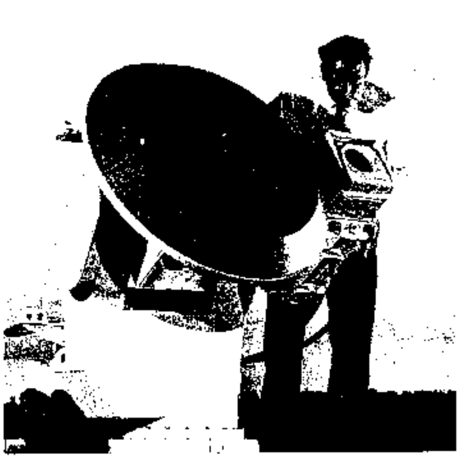
The radar director head is a 2-axis mount carrying a 1 m diameter antenna, and optionally, a TV camera. The mount is controlled by electric servos in azimuth and elevation, with stabilisation of the sight line during tracking by means of rate gyros. The aerial is of the twist Cassegrain type and is one metre in diameter. A four-horn monopulse feed and comparator provide three separate RF outputs (sum, elevation difference and training difference signals) for processing in the IF receivers to produce acquisition and auto-follow data. Accurate angular data results from the combination of a 2.4 deg pencil beam and monopulse signal processing. With TV camera, the director head weighs 532 kg.

The X-band transmitter incorporates a tuneable magnetron, and a short pulse length is used in the interests of range resolution and tracking accuracy. The receiver employs monopulse tracking and embodies features such as the tuneable magnetron, monopulse signal processing, MTI, passive tracking of targets using ECM, and CFAR, to reduce the effects of counter measures. MTI (coherent on receive) is available as an option, this providing discrimination against sea clutter when tracking small, low-flying targets.

OPERATION:
Weapons which can be associated with the ST 801 include Seacat, Exocet, The Mk VIII 4.5 in gun, and the 40 mm automatic gun. Acquisition of air or surface target is automatic, following target designation by search radar or other means. After acquisition, the target is automatically tracked and appropriate data supplied to weapon systems. The ST 801 antenna head is able to rotate continuously in azimuth at 20 rpm, and this feature in conjunction with the optional MTI is of value in providing additional surveillance cover at low elevation.

If the TV sub-system is fitted, it may fulfil either of two distinct roles, depending upon the weapon system employed. With command line-of-sight missiles, the TV system will permit automatic missile gathering after launch, from a below-decks position. Alternatively it may be used as a back-up to radar tracking in either daylight or low light-level mode.

STATUS:
The ST 801 is a private venture development in collaboration with L. M. Ericsson, and has been proposed to a number of navies with the lightweight Seacat missile system.



Scanner assembly of ST 801 with television camera installed

ST 801 radar installation showing arrangement of above and below deck equipment

MANUFACTURER:
Marconi Radar Systems Ltd, New Parks, Leicester, England, LE3 1UF.

1754.253
S810 SERIES NAVAL SURVEILLANCE RADARS

DESCRIPTION:
Four models of the series, S810, S811, S815 and S816, are comprised of various combinations of two sizes of scanner, and two transmitter/receiver equipments. These are summarised in the table of characteristics.

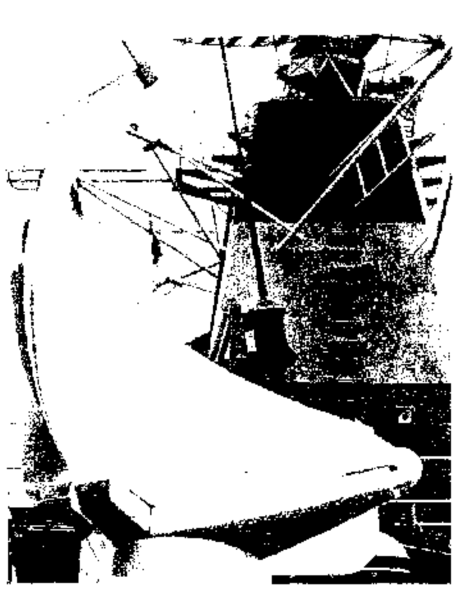
Marconi Naval Radar Type S810 is a lightweight stabilised X-band surveillance radar, suitable for fitting in small warships down to the size of fast patrol boats where there are limitations of space and weight. X-band gives good performance against surface targets, a major requirement for fast patrol craft, whilst satisfactory coverage is maintained against air targets by the use of a stabilised aerial in a radome, with vertical cosec^2 beamshape. A narrow horizontal beam width ensures accurate target indication data for pointing weapons and for putting-on a tracking radar.

Detection of surface targets such as fast patrol boats is horizon limited and strike aircraft of 4m^2 can be detected at ranges in excess of 20 km with the S810 and S811 models, and up to 30 km with the S815 and S816 radars. A digital MTI system is available (S810 and S815) to enhance the system performance against small high-speed targets in clutter and the magnetron transmitter is tunable to counter ECM.

S810 Series radars use a pulse transmitter with a typical peak power output of 200 kW, of the same design as in the lightweight search/tracker Radar Type ST 801 (Entry No. **1508.253**), resulting in a reduction in the on-board spares if both radars are fitted in a ship. In all versions, the receiver provides either logarithmic or linear video for the operational displays.

Radars of this range can also operate as the ship's navigation radar, where space and weight restrictions on the masthead limit the number of aerials. An optional additional short pulse/low power transceiver can be fitted to give the resolution necessary for inshore navigation.

The aerial head, stabilised in roll and pitch, rotates at 20 rev/min and is enclosed in a radome for protection and minimum weight. The elliptical reflector used in the S810 and S811 measures 1.2 m wide by 0.45 m high and that of the S815 and S816 2.5 m by 0.9 m. Both types are constructed of glass-reinforced plastic. A single horn feed is located at the focus of the reflector which is contoured to provide a narrow horizontal beam and a cosec^2 vertical beam. The turntable consists of an aluminium alloy centre tube and outer casing, azimuth bearing and azimuth drive and data units. The complete aerial/turntable assembly is supported on a stable platform controlled to within ½° of the vertical reference for roll angles up to 25° and pitch angles up to 10°, with acceleration up to 30° per second per second. The 1.8 m or 3.5 m diameter radome which encloses the whole aerial assembly is constructed of a 12 mm thick sandwich of glass reinforced plastic and



Scanner of S810 naval surveillance radar

Characteristics:	S810	S811	S815	S816
Aerial				
Type	Stabilised cosec^2	Stabilized cosec^2	—	—
Horizontal beamwidth	2.2°	2.2°	1.1°	1.1°
Vertical beamwidth	cosec^2 to 30°	cosec^2 to 30°	cosec^2 to 30°	cosec^2 to 30°
Gain	30 dB	30 dB	33 dB	33 dB
Polarisation	Horizontal	Horizontal	Horizontal	Horizontal
Rotation rate	20 revs/min	20 revs/min	20 revs/min	20 revs/min
Dimensions	1.25 m by 0.45 m	1.25 m by 0.45 m	2.5 m by 0.9 m	2.5 m by 0.9 m
Radome:				
Dimensions	1.8 m dia by 1.22 m high from 1.41 m base dia		3.5 m dia by 2.5 m high from 3.0 m base dia	
Stable Platform:				
Type	2-axis stabilised			
Accuracy	± ½° of vertical reference for ± 25° roll and ± 10° pitch and acceleration 30° sec^2			
Total Masthead Weight	200 kg	200 kg	450 kg	450 kg
Transmitter:				
Type	X-band	X-band	X-band	X-band
Frequency	Tunable magnetron 8.6 - 9.5 GHz			
Peak power	200 kW	200 kW	200 kW	200 kW
Pulse repetition	3000 Hz or 4400 Hz	1500 Hz	3000 Hz or 4400 Hz	1500 Hz
Pulse length	0.33 µs	0.6 µs	0.33 µs	0.6 µs
Receiver:				
Type	Pulse Doppler		Pulse Doppler	
Signal processing	Logarithmic Linear MTI	Logarithmic Linear	Logarithmic Linear MTI	Logarithmic Linear

foam.

The transmitter employs a tunable magnetron operating within the frequency band 8.6 to 9.5 GHz and delivers a typical peak power of 180 kW. All components are solid state except the magnetron and the hydrogen thyratron in the pulse modulator.

Two receiver channels, one logarithmic, the other linear, are provided. The required channel is selected by a switch located near the PPI display. MTI processing is available in S810 and S815 models, the digital MTI filter being a double canceller employing shift-register storage and feedback. The radar operates with a staggered PRF in the MTI mode in order to overcome the disadvantages of 'blind speeds'. Compensation is provided for ship and wind velocity. When clutter cancellation is not required, the MTI can be switched out and the radar then operates with an unstaggered pulse-repetition frequency.

The Type 812 is another model of this series, and is a naval surveillance radar with MTI specially designed for the detection of low-flying missiles and aircraft, in that it incorporates doppler processing to reduce sea clutter, and has a pencil beam aerial on a stabilised two-axis mount.

MANUFACTURER:
Marconi Radar Systems Ltd, New Parks, Leicester, LE3 1UF, England.

THE UNITED STATES OF AMERICA

1245.253
RAYTHEON RTN-10 FIRE CONTROL RADAR

DESCRIPTION:

The RTN-10 is a combined search and tracking radar, designed principally for use in conjunction with Sea Sparrow III missiles for defence of ships from low-level aircraft attack. Operating frequency is assumed to be in the X-band for compatability with the Sea Sparrow III passive radar homing guidance system. The RTN-10 can be used with either the R-308 or R-204 ship-board Sea Sparrow launcher systems.

The configuration of the RTN-10 radar is somewhat unusual. Two rectangular scanner housings are carried on either side of a central trunnion supported by a short cylindrical mount. The scanners can be rotated about the horizontal axis (as a pair), and the whole assembly can be rotated in azimuth. The manufacturers state that the weight is low enough (approx 300 kg) to permit mast mounting to increase the effective radar horizon. Overall dimensions are 165 cm span and 122 cm height. Scanner motion limits in elevation are minus 30 degrees, and plus 90 degrees.

The complete system consists of the radar and an operator's console. The former unit contains the transmitter/receiver. The operator's console has a CRT display for the display of signals during search or tracking, with azimuth information presented horizontally and speed vertically. Target radial velocity and range data are displayed by counter-type indicators. Controls are provided for radar operation and weapon control. Details of the operation of the RTN-10 appeared in the 1973-74 Jane's Weapon Systems.

STATUS:

Little definite information has been released concerning applications of this system, but it is believed that development was largely influenced by a Canadian requirement. The RTN-10 radar is also embodied in the land-based Sparrow III/M-113 weapon system.

MANUFACTURER:
Raytheon Company, Ship Missile Systems, Bedford, Mass. 01730, USA.

1749.253
SPG-49 RADAR

DESCRIPTION:

The AN/SPG-49 radar is the guidance radar for the naval surface-to-air missile systems Terrier and Talos. With the former system it is associated with the SPG-55 fire control radar, and in the Talos system it is used in conjunction with the SPG-56. No performance characteristics have been released but range is estimated to be at least 100 km.

The two SPG-49/SPG-56 radar fire control groups for the Talos missiles on the USS Long Beach (US Navy)

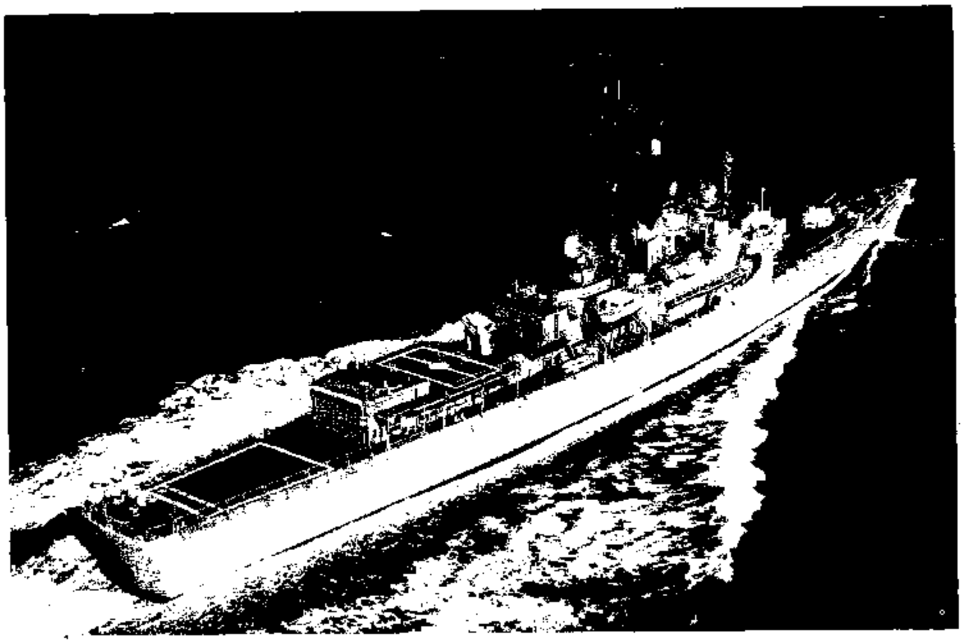
STATUS:
In service with the US Navy since the early 1960s.
MANUFACTURER:
Sperry, USA.

SPG-49 / SPG-56 radar groups (US Navy)

1247.253
SPG-51 RADAR
DESCRIPTION:
The AN/SPG-51 radar forms a major element of the American Mk 73 gun and missile director system (which see), being intended mainly for use with the Tartar surface-to-air missile (which see), for which it fulfils target tracking and missile guidance functions. Operating frequency is probably in the X-band. A circular parabolic dish reflector with off-set horn feed is used, and this, together with the transmitter/receiver, is mounted on a gearless power drive turning gear produced by General Electric.

The radar line of sight can be rotated continuously in train, and can be elevated from minus 30 degrees to plus 83 degrees relative to the deck plane. Initial pointing information is supplied to the SPG-51 by a search and target designator radar. This information is received via the Mk 73 director's Mk 118 computer which generates a search pattern for the SPG-51 until target acquisition is accomplished. Automatic tracking is then initiated and the SPG-51 feeds angle error and range information to the Mk 118. The computer generates fire control data for transmission to gun mounts and missile launchers. It also provides missile seeker angle data.

STATUS:
The SPG-51 is widely used on USN vessels, and development proceeded through A, B and C versions. The last of these had reached prototype stage by July 1969, and the others were then operational.



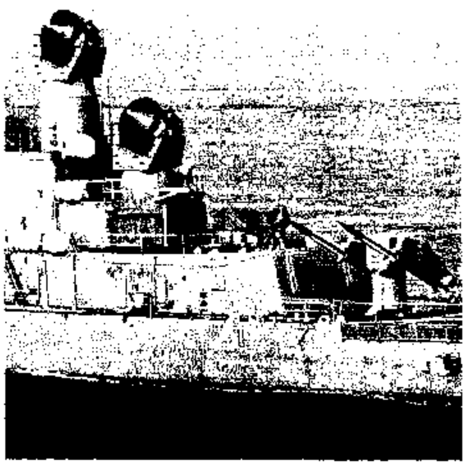
The guided missile escort, USS Julius A. Furer. *SPG-51 missile guidance radar is aft of funnel* (US Navy)

MANUFACTURER:
Raytheon Company, Bedford, Mass, 01730, USA.

1748.253
SPG-55 RADAR
DESCRIPTION:
The AN/SPG-55 radar is the C-band fire control radar for the shipborne Terrier surface-to-air missile system, and associated equipments are the SPA-44 CW target illuminator, SPG-49 guidance radar, and the SPQ-5 long-range tracking radar. Range of the SPG-55 is believed to be of the order of 50 km and the transmitter power about 50 kW.

Two SPG-55 Terrier fire control radars are mounted atop bridge house of USS Sterett. *Other radars are SPS-48 3-D search radar aft of SPG-55s, SPS-40 on aft 'mack', and X-band fire control director* (US Navy)

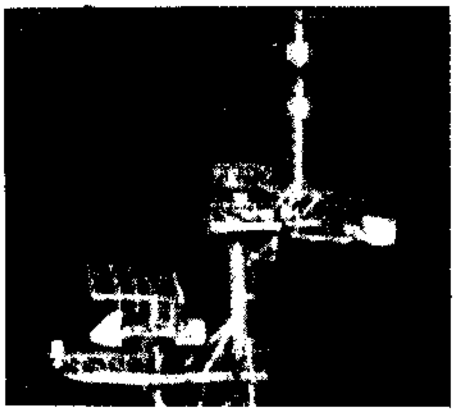
STATUS:
The SPG-55 equipment entered production in 1960 and has since been fitted to Terrier-fitted ships of the US Navy and foreign navies.
MANUFACTURER:
Sperry, USA.


Terrier missile installation on board guided missile frigate USS Dahlgren. *SPG-55 missile guidance radars can be seen forward of the missile installation.* (US Navy)

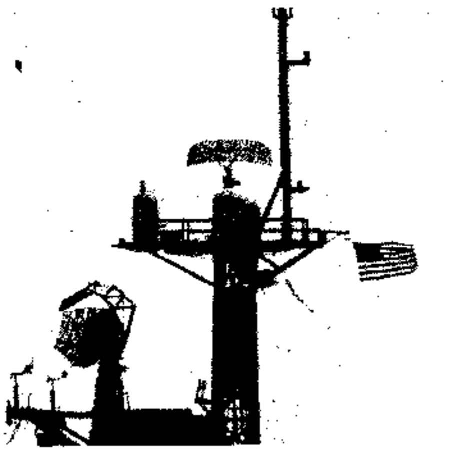
1750.253
SPG-56 RADAR
DESCRIPTION:
The AN/SPG-56 is a C-band missile guidance radar used in conjunction with the SPG-49 (Entry No. **1749.253**) for control of the Talos naval surface-to-air missile system. No performance details have been released but range is estimated to be at least 100 km. Target illumination is carried out by the SPG-49 while tracking and missile guidance is the function of the SPG-56.
STATUS:
In US Navy service since the early 1960s.
MANUFACTURER:
Sperry, USA.

1744.253
SPS-6 RADAR
DESCRIPTION:
The AN/SPS-6 is a naval air surveillance radar, operating in the L-band of the radar spectrum and having an output of the order of 500 kW. Approximate range of the equipment is 100-200 km. The SPS-6 is widely used on ships of the US Navy and numerous other nations and has been in service for about 20 years. During this period various versions, denoted by suffix letters to the designation, have been evolved. These differ in transmitter/receiver and antenna details.
A successor is the SPS-12 (Entry No. **1566.253**) which can be very similar, but which is distinguished from the SPS-6 by the absence of balancing vanes to the rear of the scanner reflector.
STATUS:
In addition to the various classes of USN vessels fitted with the SPS-6 it is used by the navies of Italy, Japan, Spain, Taiwan, Turkey and Venezuela.
MANUFACTURERS:
Westinghouse, Bendix.

SPS-6 radar is on tripod platform of escort USS McMorris (US Navy)


SPS-6 surveillance radar on the American escort USS Lester. *Upper scanner is for SPS-10 radar* (US Navy)

1564.253
SPS-10 RADAR
DESCRIPTION:
The AN/SPS-10 is a surface search radar operating at C-band frequencies. The scanner is of open lattice construction and is illuminated by a horn feed supported by a boom projecting from beneath the lower edge of the scanner. The transmitter/receiver is mounted below decks, so that radar head weight is minimised, thus permitting mounting as high as possible on the ship's upperworks. Approximate dimensions are span 5 metres and depth 1.8 metres. No performance specifications have been disclosed.
STATUS:
The SPS-10 has been in service for about 10 years and is extensively fitted on US Navy ships, and vessels which have been passed on to friendly navies by the USN.
MANUFACTURER:
Sylvania Electronic Systems, Needham, Massachusetts 02194, USA.


The American escort, USS Bagley, *is seen here with SPS-10 search radar (top) and SPS-40* (US Navy)


SPS-10 surface search radar antenna

1536.253
SPS-12 RADAR

DESCRIPTION:

The AN/SPS-12 is a powerful (between 0.1 and 1.0 MW) long-range air search radar operating in the L-band. A parabolic open lattice scanner is illuminated by a large horn feed supported by a boom projecting from the lower edge of the reflector.

In general appearance it is very similar to the SPS-6 (Entry No. **1744.253**), from which it probably evolved, but the SPS-12 does not have the balancing vanes behind the reflector which are a feature of the SPS-6.

No performance details have been published.

STATUS:

The SPS-12 is extensively fitted on US Navy ships, and those of other navies, including Brazil, Canada, Japan, Greece, Italy and Venezuela.

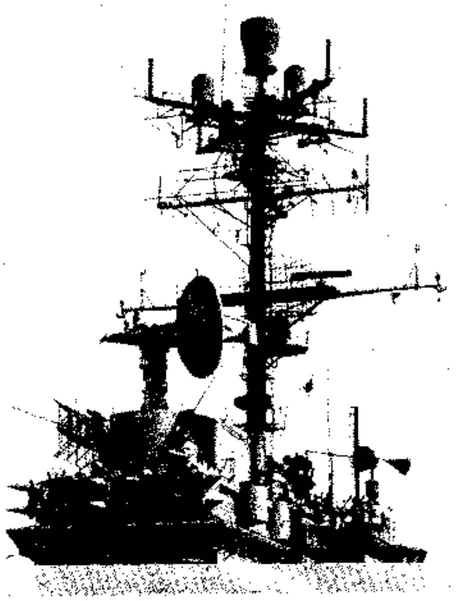
MANUFACTURER:

RCA, Moorestown, New Jersey, USA.

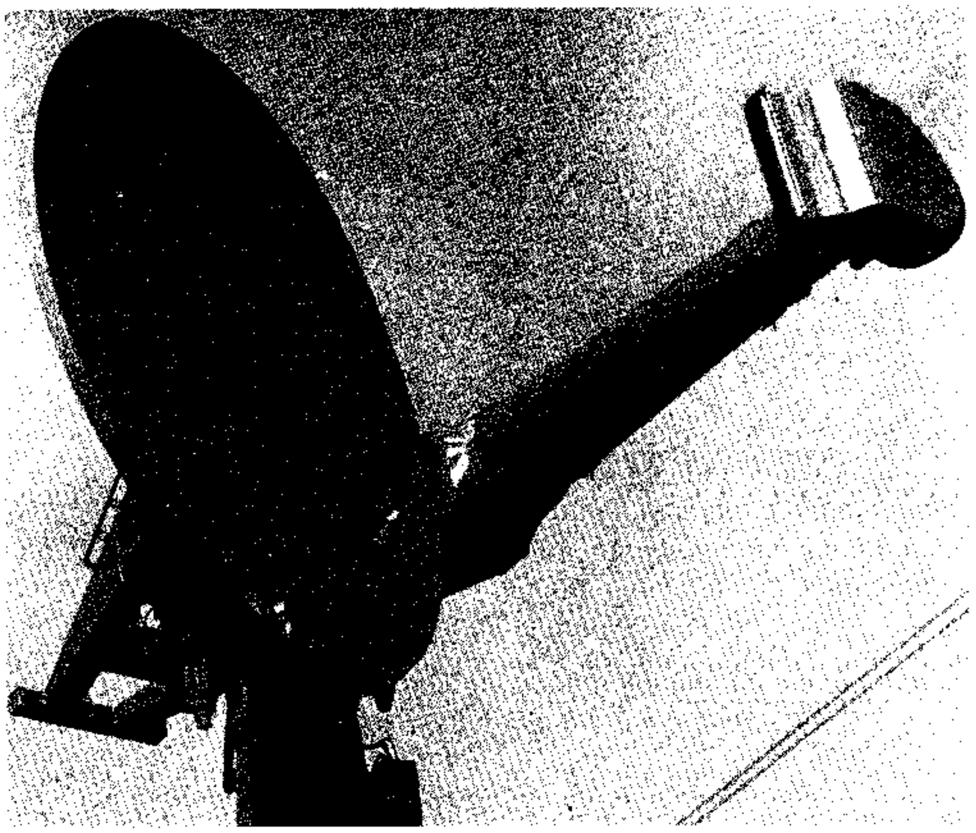
1745.253
SPS-30 RADAR

DESCRIPTION:

The AN/SPS-30 is a long-range three-dimensional radar fitted in certain aircraft carriers and some guided missile ships of the US Navy. Among its features are a high-gain antenna of characteristic configuration (see illustration), broad-band frequency operation, and high power output. The antenna is mechanically stabilised against ship's motion, with compensation for roll and pitch. It is stated to provide range, bearing and height information on multiple airborne targets with 'extreme' accuracy. Although primarily a high-grade height-finding radar, the SPS-30 is capable of being used for additional tasks such as long-range air search and target designation.



Another view of the SPS-30 height-finding radar on a USN aircraft carrier



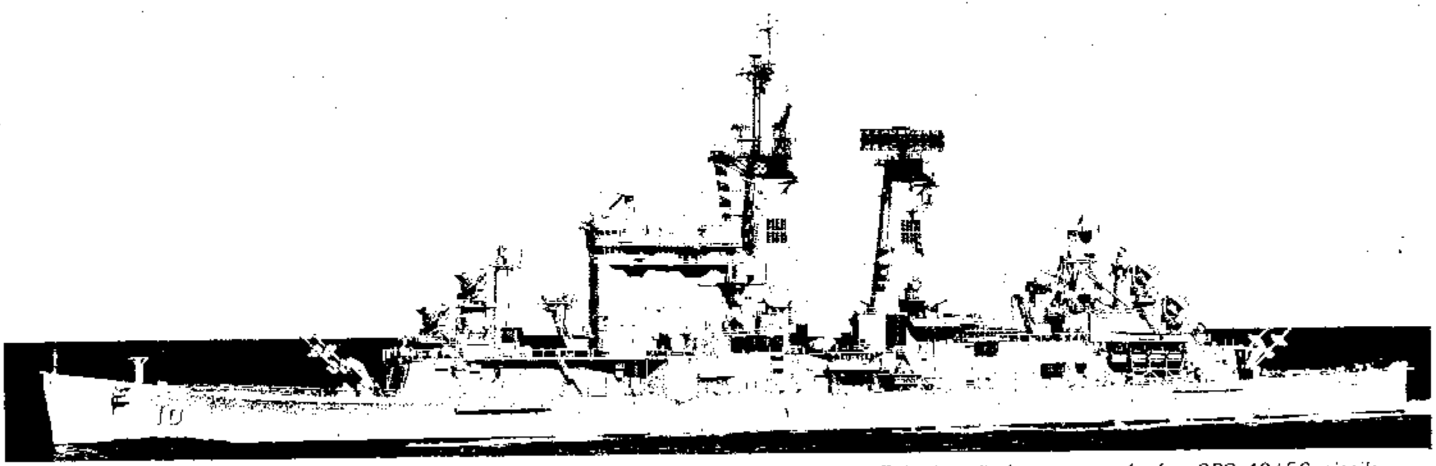
SPS-30 3-D radar head

STATUS:

The SPS-30 was introduced into US Navy service in the early 1960s and is carried on many aircraft carriers and some guided missile ships.

MANUFACTURER:

General Electric Company, Heavy Military Electronic Systems, Syracuse, New York.



The original print of this illustration reveals at least 20 radars on the USS Albany. *Fore and aft Talos installations account for four SPG-49/56 missile guidance groups, with which are associated two SPS-30 height-finders, and four X-band trackers; port and starboard missile launchers have two SPG-51 guidance radars; at the base of the after funnel, on each side is an X-band director radar for gunfire control; search radars include SPS-43, SPS-39 and SPS-10; several navigation and pilotage radars are fitted* (US Navy)

1250.253
SPS-32 (SCANFAR) RADAR

DESCRIPTION:

The AN/SPS-32 is a completely fixed array ship's air and surface surveillance radar, using four large flat arrays mounted on the vessel's superstructure and electronic scanning to provide 360 degree three-dimensional coverage. Dimensions of each panel are 6 metres high × 12.2 metres wide, and the weight 47,700 kg. It is used as a long-range detector and target designator radar in conjunction with the AN/SPS-33 tracking radar (which see), also an electronically scanned equipment. Both are used with the NTDS, Naval Tactical Data System. Beam steering is controlled by a digital computer which also provides for electronic compensation for ship's pitch and roll. A fan-shaped beam is employed.

DEVELOPMENT:

No constructional details have been released, but the period during which this equipment was developed suggests that beam steering is accomplished by a delay switching technique rather than the programmed switching of a massed array of individual radiating elements which is a feature of later electronic scanning radars.

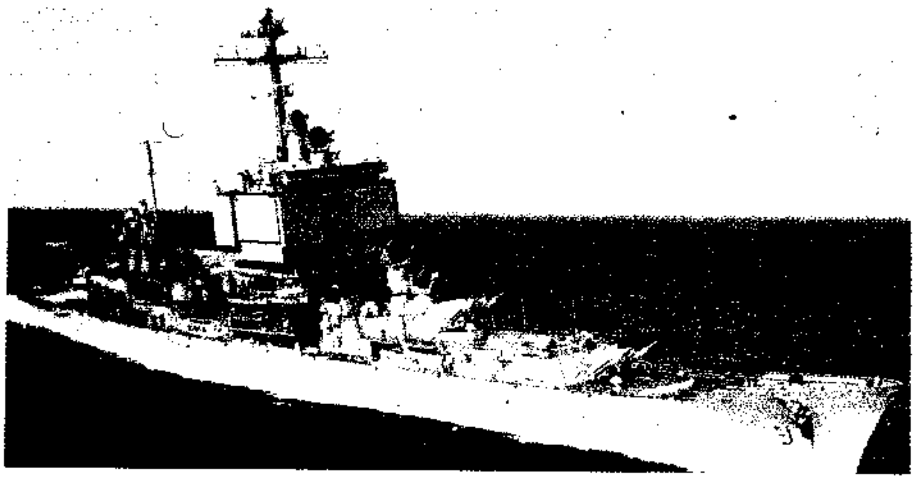
The first Hughes development programmes in this area were initiated in 1954, with the MPS-23 transportable ground-based radar, and in 1955 with the SPS-42 shipboard radar. Both these used mechanical rotation for azimuth cover. Development of the SPS-32 began in 1956.

STATUS:

SPS-32/SPS-33 installations have been made on the nuclear-powered missile cruiser USS *Long Beach*, the carrier USS *Enterprise*, and the nuclear-powered frigate USS *Bainbridge*. Recent photographs of the last of these vessels show no evidence of the characteristic 'bill-board' arrays, however, and possibly these have been removed to permit the test installation of a later electronic scanned radar, the AN/SPS-72. In August 1969, it was announced that Hughes had received a $2.6 million contract to start work in 1970 on the up-grading of the radar installation in the USS *Long Beach*.

MANUFACTURER:

Hughes Aircraft Company, Culver City, California, USA.



"Bill-board" aerial arrays of the SPS-32 and SPS-33 surveillance and tracking radars on the USS Long Beach. *Horizontal arrays are the SPS-32 and the vertical arrays are for the SPS-33*

1251.253

SPS-33 (SCANFAR) TRACKING RADAR

DESCRIPTION:

The AN/SPS-33 is a companion radar to the air and surface detection radar, SPS-32 (which see). It uses similar technology, the main difference being that the beam form used is of the 'pencil' type for the tracking of targets designated by the SPS-32. Dimensions of each panel are 7.62 metres high × 6 metres wide, and the weight about 122,600 kg. Control of beam steering and tracking is controlled by a digital computer, and target tracking information obtained by the SPS-33 is available for input to the NTDS Naval Tactical Data System for the direction of missiles.

DEVELOPMENT:

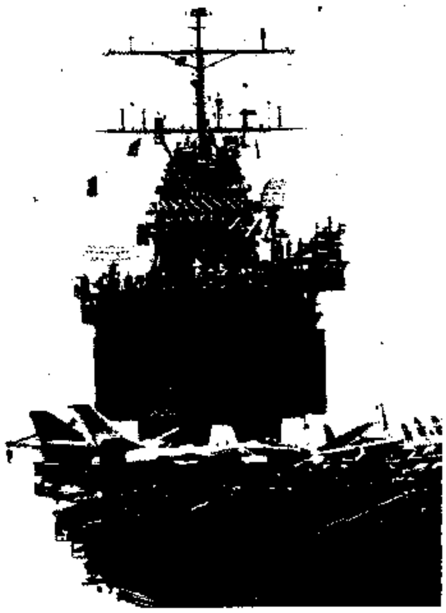
Development was started shortly after that of the SPS-32 and the two programmes subsequently progressed in parallel.

STATUS:

This is essentially the same as that of the SPS-32 and is described in the entry for that equipment.

MANUFACTURER:

Hughes Aircraft Company, Culver City, California, USA.



The nuclear-powered aircraft carrier USS Enterprise. *Planar arrays for SPS-32 and SPS-33 electronically scanned radars are prominent. Note also the elaborate ECM arrays above, and the SPS-6 to the left.* (US Navy)

1565.253

SPS-37 RADAR

DESCRIPTION:

The AN/SPS-37 is a metric wavelength, long-range air surveillance ship's radar of conventional design. The antenna consists of lattice structure with an open mesh reflector, and supporting an array of 28 dipoles arranged in four horizontal rows of seven. The upper edge of the scanner usually carries an associated IFF antenna. Approximate dimensions of the SPS-37 array are: span 6.0 metres, and height 3.3 metres. No performance details have been disclosed.

DEVELOPMENT:

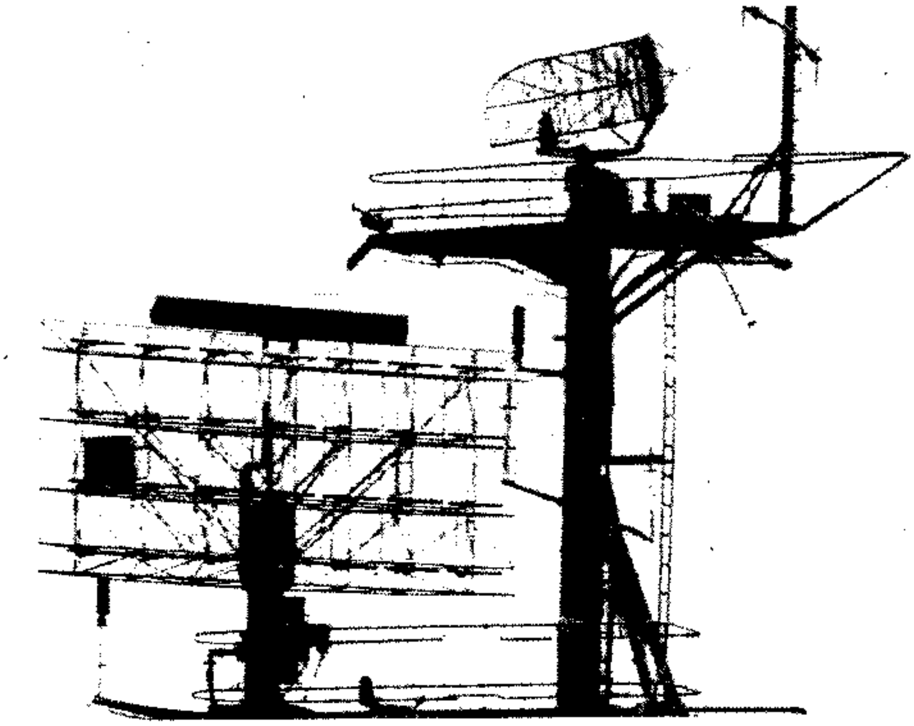
Development took place in the early 1950s.

STATUS:

The SPS-37 entered service in 1958 and production ceased in 1962. It is widely fitted on ships of the US Navy and of some friendly navies.

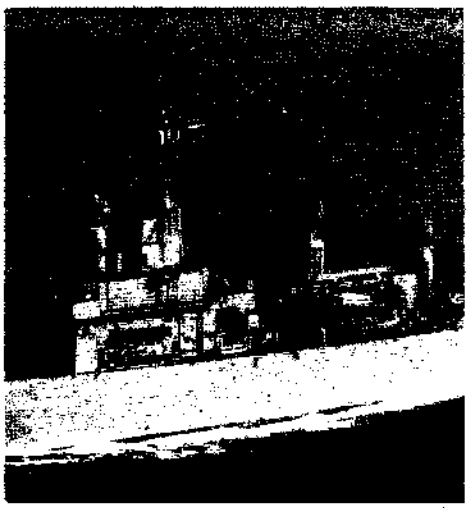
MANUFACTURER:

Westinghouse Defence and Electronic Systems Centre, Baltimore, Maryland, USA.

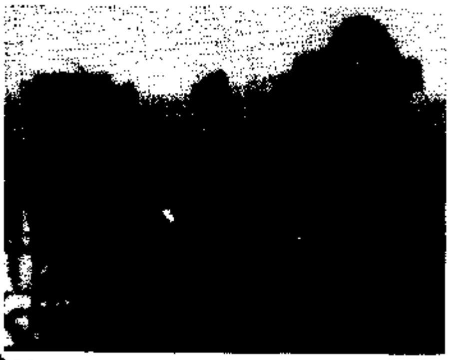


SPS-37 naval air surveillance radar antenna (left), *with on-mounted IFF. The upper radar is an SPS-10 surface search unit*

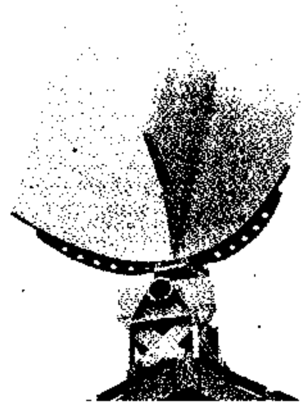
1249.253
SPS-39 (FRESCAN) RADAR
DESCRIPTION:
The AN/SPS-39 is a ship-borne three-dimension radar for air surveillance, using mechanical rotation for azimuth coverage and electronic scanning for beam steering in the vertical plane. The aerial reflector is a partial cylinder formation with its axis tilted at about 15 degrees from the vertical. Vertical scanning is achieved by automatic switching of stacked radiators carried in a faired structure in the centre of the reflector. Plan position, and target height information is provided by the SPS-39. Compensation for ship's pitch and roll is applied by electronic processing of the radar beam switching and signals received. Range is between 200 and 300 km, and the antenna weight is about 1,270 kg.
DEVELOPMENT:
Development was carried out in the early and mid-1950s with entry into service about 1959-60.
STATUS:
The SPS-39 has been extensively fitted in various classes of guided missile ships of the US Navy, and is also in use by the Italian Navy. Some American vessels originally fitted with SPS-39 have since been equipped with the later SPS-52 (which see Entry No. **1248.253**).
MANUFACTURER:
Hughes Aircraft Company, Culver City, California, USA.



Radars fitted in DLG 18, USS Worden, *include three SPG-55 missile guidance radars, SPS-39 three-dimensional search radar, SPS-37 and SPS-10 search radars* (US Navy)

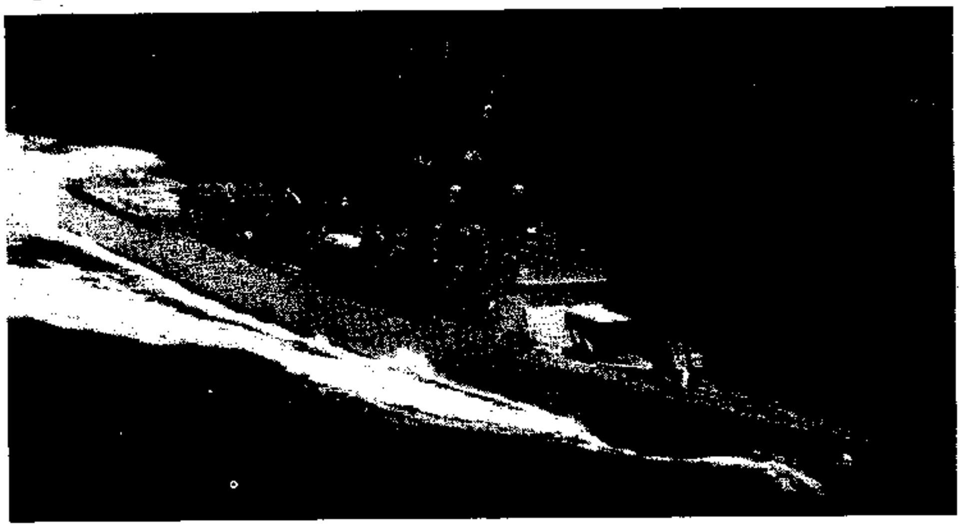


SPS-39 three-dimensional radar array (left) and SPS-8 height-finder (right). (US Navy)

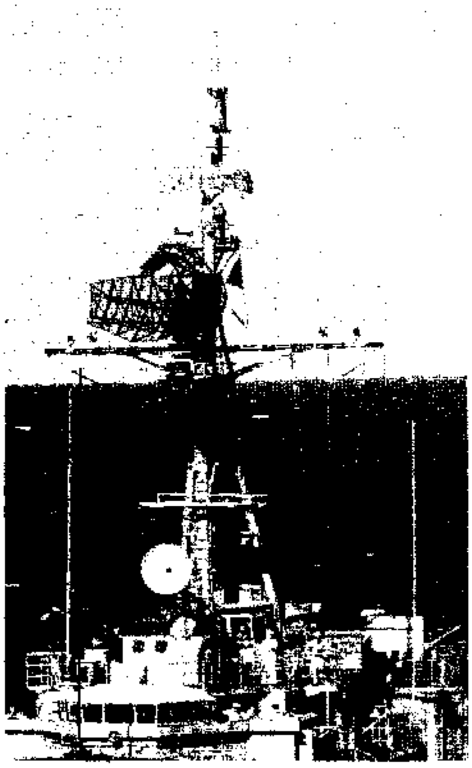


Scanner of the three-dimensional AN/SPS-39 naval air surveillance radar

1746.253
SPS-40 RADAR
DESCRIPTION:
The AN/SPS-40 is a naval search and surveillance radar for the detection of air targets at long and medium ranges. Official performance data have not been released but operation in the S-band is probable and a transmitter power of about 1 MW may be expected. The reflector is of open lattice construction and has somewhat irregular, angular outlines. A prominent characteristic is the use of an over slung, lattice construction boom to support the feed assembly.
STATUS:
The SPS-40 was first introduced into US Navy service in the early 1960s and is now seen on numerous classes of ship of all sizes from escorts upward. It has subsequently been fitted in ships of other navies, among them those of West Germany, Australia and Spain.
MANUFACTURER:
Lockheed Electronics, USA.



The USN escort USS O'Callahan *with its SPS-40 search radar facing the camera* (US Navy)

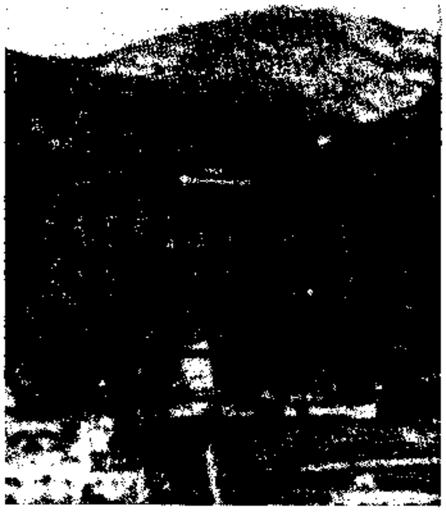


SPS-40 search radar, with smaller SPS-10 scanner above

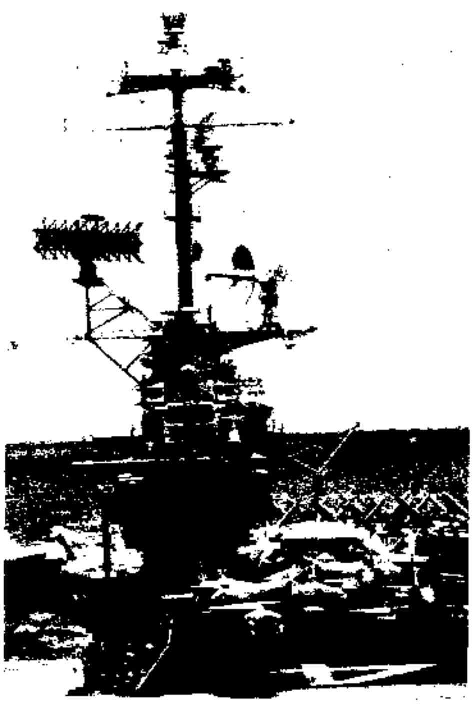
1747.253
SPS-43 RADAR
DESCRIPTION:
The AN/SPS-43 is a high-power, very long-range search radar, probably operating at metric wavelength frequencies and using a transmitter output of 1 to 2 MW. The large (about 10 metres span) antenna assembly is of open lattice construction of rectangular aspect, but with a characteristic 'side-ways-W' profile in side elevation. The upper edge of the array generally carries an on-mounted IFF antenna.

This collection of US naval radars includes the SPS-43 (upper right), with on-mounted IFF; X-band fire control radar (lower right); SPS-10 search radar, above SPS-43; SPS-30 height-finder (centre); SPS-52 three-dimensional radar (left)

STATUS:
The SPS-43 has been in operational service with the US Navy since the early 1960s and is fitted to many of the larger ships of the US Navy.
MANUFACTURER:
Westinghouse Defence and Electronic Systems Centre, Baltimore, Maryland, USA.

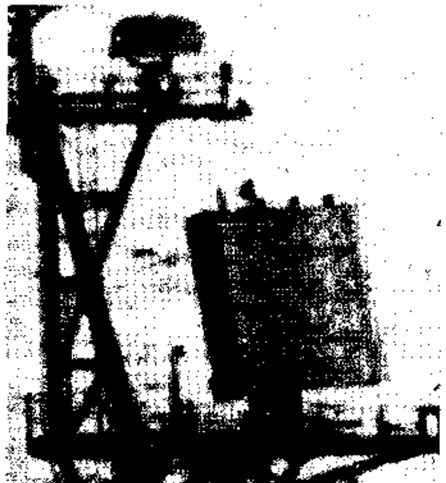


SPS-43 search radar scanner

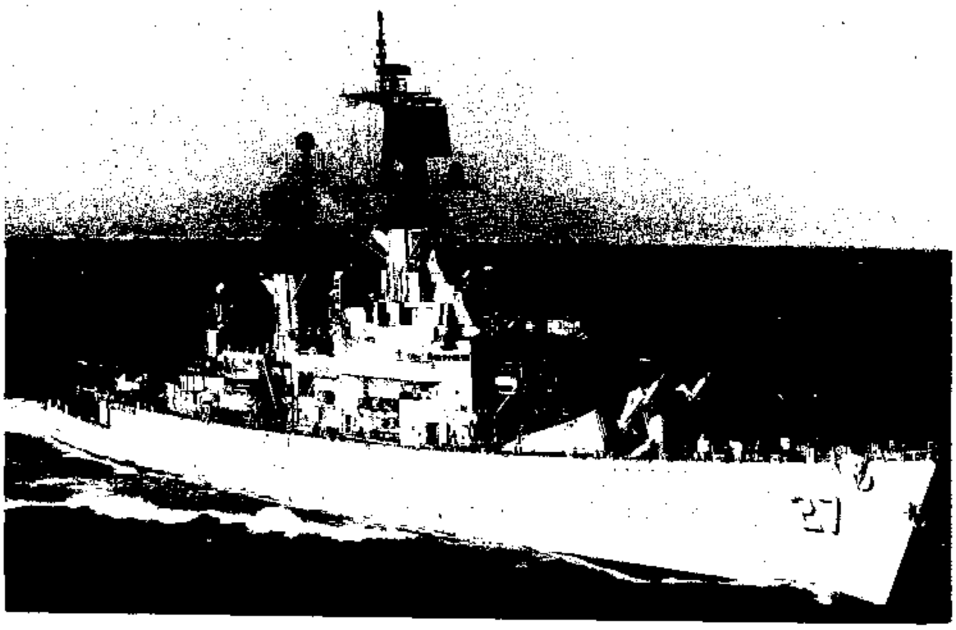


Multiplicity of aerials on the island of US Aircraft carrier, USS Oriskany, *include SPS-43 search radar, left, and SPS-30 height-finder to right* (US Navy)

1252.253
SPS-48 AIR SURVEILLANCE RADAR
DESCRIPTION:
The AN/SPS-48 is a three-dimensional, long-range air surveillance radar for ship-board applications. It uses a combination of mechanical scanning in azimuth and electronic beam steering in elevation to provide plan position and height information on aircraft targets. Operating frequency is believed to lie within the S-band.
In general appearance and in operating principles the SPS-48 is similar to the SPS-52 (which see). Several features enable the two types to be distinguished, however. The SPS-48 is somewhat larger, and there is only one 'end-plate' to the flat aerial array, on the left side when facing the aerial. The scanner is of square proportion, compared with the oblong configuration of the SPS-52. In most installations, the SPS-48 has an on-mounted IFF aerial at its upper edge, whereas with the SPS-52 the IFF is normally mounted at the lower edge.
STATUS:
The SPS-48 is fitted to surface-to-air missile carrying vessels of several classes of the US Fleet.
MANUFACTURER:
ITT-Gilfillan, Inc, 7821 Orion Avenue, Van Nuys, California 91409, USA.



SPS-48 planar array three-dimensional radar with on-mounted IFF, and SPS-10 scanner above



Flat antenna of SPS-48 three-dimensional air search radar is prominent in this picture of USS guided missile frigate, DLG-27. Also visible are SPS-37 and SPS-10 surveillance radars, and SPG-55 missile guidance radars (US Navy)

1248.253
SPS-52 RADAR
DESCRIPTION:
The AN/SPS-52 is a ship's air surveillance, three-dimensional radar, providing both target position and height information. Three-dimension coverage from a single scanner is achieved by a

US guided missile destroyer, USS Goldsborough, *showing SPS-52 antenna mounted on after stack, SPS-40 and SPS-10 on foremast, two SPG-51 missile fire control radars aft, and X-band director above bridgehouse* (US Navy) combination of electronic and mechanical scanning. The beam is scanned electronically in elevation, while azimuth cover is achieved by conventional mechanical rotation of the aerial head.

The scanner assembly consists of a flat planar array, flanked by two flat end-plates, the whole being tilted at an angle of about 18 degrees from the vertical. This is probably necessary to provide the required high cover from the electronically scanned elevation beam.

The array is thought to be composed of rows of slotted waveguide radiators, end fed from a 'concertina' waveguide system running the length of one side of the array. Beam forming and steering in the vertical plane is probably accomplished by selective switching of the feed to each row of slots, under control of the digital computer which forms part of this radar. The SPS-52 is assumed to be an S-band equipment, and on this basis there are probably about 60 horizontal rows of radiating slots.

STATUS:

The SPS-52 replaces the SPS-39 on certain vessels of the USN "Charles F. Adams" class of guided missile destroyers (DDG); and the three ships of this class in the Royal Australian Navy, *Brisbane, Hobart*, and *Perth*, all carry the SPS-52. Other USN ships fitted include some of the "Coontz" class of guided missile frigates (DLG). The Italian guided missile carrier, *Vittorio Veneto*, has been fitted with the SPS-52, and this radar has also been ordered for Spanish guided missile destroyers.

MANUFACTURER:

Hughes Aircraft Company, Fullerton, California, USA.

SPS-52 three-dimensional radar planar array (right), with view of rear of SPG-51 fire control radar (left)

1697.253
SPS-55 NAVAL RADAR

DESCRIPTION:

The SPS-55 is modern solid-state surface search and navigation radar developed as a replacement for the SPS-10. It is designed for service on ships of destroyer size or above. Operational uses are: the detection of small surface targets from ranges of less than 50 metres to the radar horizon; navigation and pilotage; tracking of low-flying aircraft and helicopters, detection of submarines at snorkel and periscope depth.

A lightweight aerial (less than 90 kg) has a low profile configuration to minimise installation space requirements, and consists of a back-to-back, end-fed, slotted array with both linear and circular polarisation. The horizontal beamwidth is 1.5 degrees, and beam squint compensation is used to optimise bearing accuracy over the operating frequency range. Vertical beamwidth is 20 degrees.

The transmitter/receiver subsystem is housed below decks in a single cabinet, and is capable of operating at any selected frequency in the band from 9.05 GHz to 10 GHz. Two pulse widths (1.0 and 0.12 microsecs) are available and can be selected from the front panel. The minimum peak transmitter output is 130 kW.

The SPS-55 set does not normally include its own display, and a separate control unit is provided to permit remote operation of the transmitter/receiver and scanner subsystems.

SPS-55 Characteristics

Aerial:

Rotation rate: 16 rpm

Polarisation: Circular or linear

Horizontal beamwidth (3 dB): 1.5 degree

Gain: 31 dB

Transmitter:

Frequency band: 9.05 GHz to 10 GHz

Peak power: 130 kW

PRF/pulse width: 750 PPS/1.0 microsec; 2,250 PPS/0.12 microsec

Receiver:

Type: Low-noise RF amplifier, image-suppression filter mixer

IF: 90 MHz

Bandwidth: 1.2 MHz (long pulse), 10 MHz (short pulse)

Receiver processors: Linear logarithmic, FTC, variable sensitivity time control

DEVELOPMENT:

Development as replacement for SPS-10.

STATUS:

In production and installed in some USN ships.

MANUFACTURER:

Cardion Electronics, Woodbury, New York, 11797, USA.

1359.253
SPS-58 NAVAL RADAR

DESCRIPTION:

The AN/SPS-58 is an L-band, pulse-doppler air search and target acquisition radar, designed to operate with the USN Point Defence Surface Missile System, but capable of use with a variety of other weapons. A major design consideration has been the achievement of good low elevation angle performance, high data rate and clutter rejection characteristics to meet the threat of low flying aircraft attacks. An integral IFF system is included in the SPS-58 system.

The transmitter is mostly of solid-state design, but with klystron power amplifier stages. Modular construction is employed and built-in test facilities are provided. By using a digital doppler filter for signal processing, it is claimed that high sub-clutter visibility is achieved, and level and channel adjustments are eliminated.

Provision has been made in the design for the addition of further facilities such as automatic target designation to weapons systems, or the application of adaptive radar techniques.

STATUS:

The SPS-58 is the latest naval radar of those developed by Westinghouse, and is in current production. The SPS-58 has completed operational evaluation and is service approved by the US Navy.

MANUFACTURER:

Westinghouse Defence and Electronic Systems Centre, Baltimore, USA.

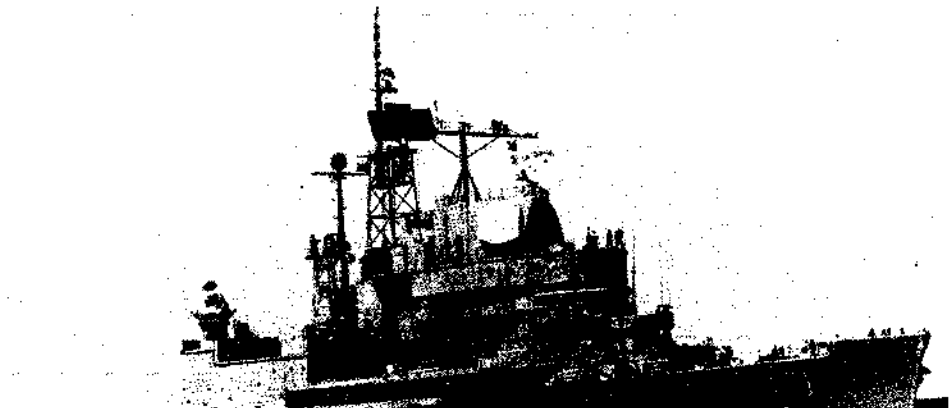
1570.253
SPY-1 MULTI-FUNCTION ARRAY RADAR

DESCRIPTION:

The AN/SPY-1 is an electronically-scanned fixed array radar under development for the US Navy Aegis fleet air defence missile system, and generally known by the acronym MFAR (Multi-Function Array Radar). It will operate in the S-band, and the output is several megawatts. The Raytheon transmitter will serve several parallel channels simultaneously. The phase scanned arrays will be mounted in pairs on each ship, two on the forward deckhouse and two on the after deck-house, to provide all-round radar cover. Each array has 4,100 discrete elements, and measures 3.65 × 3.65 metres. These elements are controlled by AN/UYK-7 digital computers to produce and steer multiple radar beams for target search, detection and tracking. The MFAR also tracks ship's own missiles fired against hostile targets. It also has the function of providing target designation data for the Raytheon target illuminating radars which direct the semi-active homing missiles employed in the Aegis system.

DEVELOPMENT:

The SPY-1 radar is under development by RCA, the Prime contractor for the overall Aegis system,



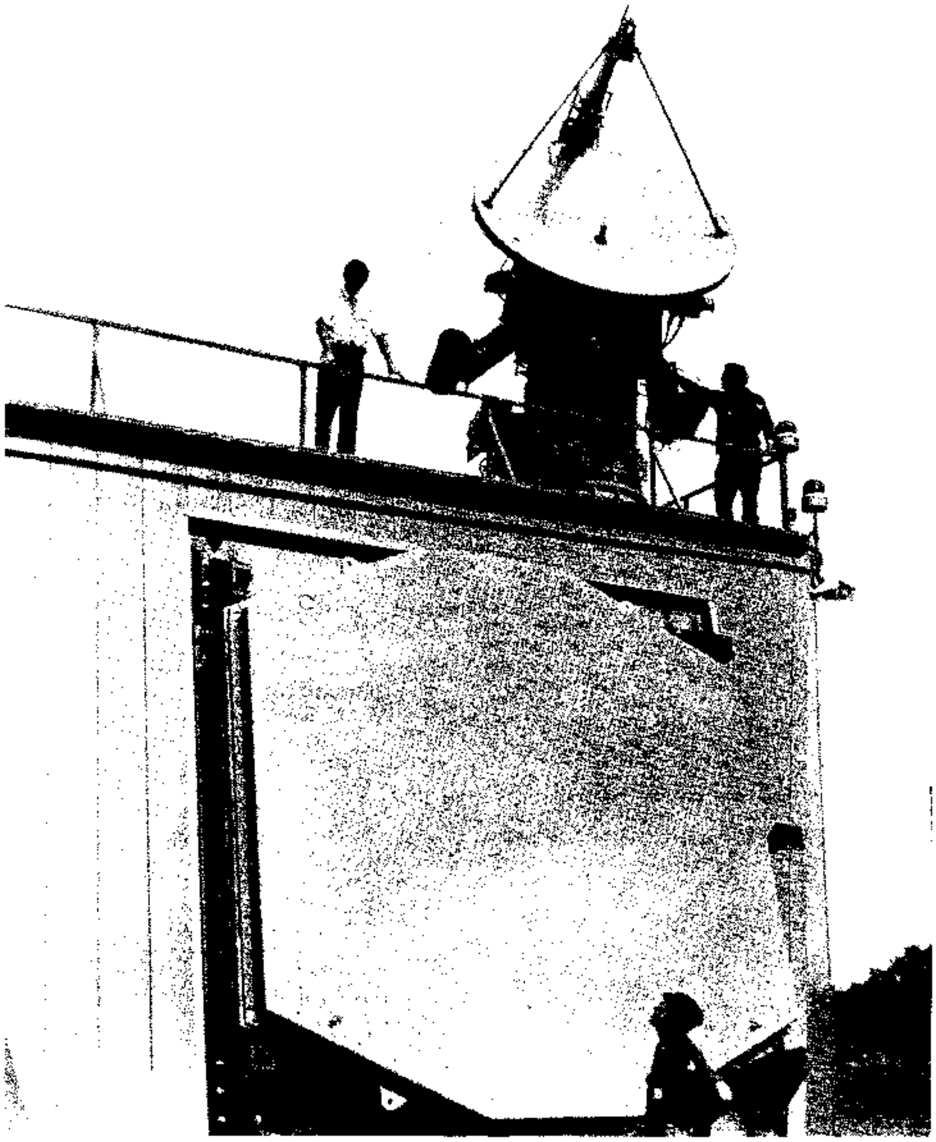
USN test ship USS Norton Sound *with SPY-1 phased array radar mounted on deckhouse above bridge. The small antenna just above and to right of the array face is slaved to the SPY-1 and illuminates the target during the interceptor missile's terminal homing phase* under a contract awarded in 1969. The antenna array began tests in August 1972, and by April 1973 the transmitter and array were integrated for further tests before embarking on full scale testing with other elements of the Aegis system.

By early 1974 land-based tests of the radar had been completed and the array was moved from RCA's Moorestown, New Jersey, test site to Long Beach Naval Shipyard, California for installation in the USS *Norton Sound* in preparation for sea trials. On May 1, 1974 it was announced that while operating in the USS *Norton Sound*, the SPY 1 had detected and automatically gone into the tracking mode to track more than 20 aircraft flying over the Pacific.

MANUFACTURERS:

RCA Missile and Surface Radar Division, Moorestown, New Jersey 08057, USA – SPY-1 antenna array.

The Raytheon Company, Wayland, Massachusetts, USA – SPY-1 high power transmitter.



The SPY-1 phased array at the Moorestown test site, with SPG-51 weapon direction radar above

THE UNION OF SOVIET SOCIALIST REPUBLICS

Note on Soviet Radar Designations

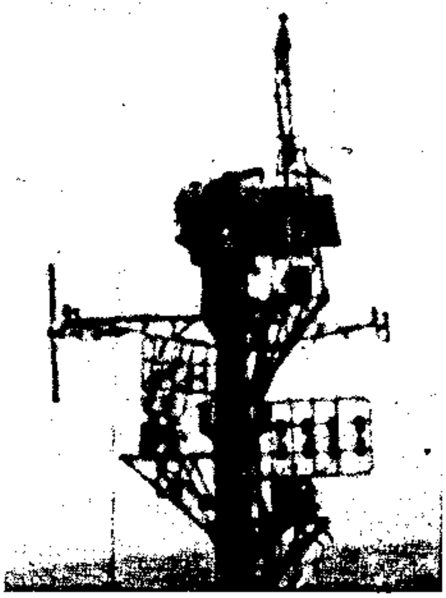
Jane's Weapon Systems has been officially informed that NATO designations for Soviet equipment are classified information, and it is not NATO policy to confirm, deny, or divulge such designations publicly. Consequently, all such published data must be regarded as unconfirmed and possibly subject to later amendment. Despite this, and because of the wide currency certain of these designations have acquired, where it is felt that NATO names can be assigned to equipments with reasonable certainty, *Jane's Weapon Systems* will adopt this practice. In those cases where a radar's NATO designation is unknown or uncertain, a *Jane's* name will be used until it has been identified.

On the following pages Soviet radars for which sufficient information has been secured to make possible an adequate description are covered by individual entries, other Soviet radars which have been identified but for which reliable data is lacking will be found in the list of naval radars (**1332.254**) in Section Four of this volume.

1329.253
SQUARE TIE NAVAL RADAR

DESCRIPTION:

Square Tie is a small lightweight search radar, probably operating in the X-band to provide short range air and surface search facilities. It is extensively fitted on Soviet vessels of the "Osa" class armed with anti ship missiles. The scanner is an elliptical paraboloid reflector illuminated by an overhung horn feed. Functions will include target detection and tracking for anti-ship missile direction and possible target designation for the Drum Tilt gun fire control radar carried by "Osa" class craft.



The masthead radar antenna group of an Osa I missile boat showing the Square Tie search radar and two other arrays believed to be designated Square Head. IFF or directional command link antennas for the Styx missile are possible functions for the latter

1595.253
SQUARE HEAD NAVAL RADAR
DESCRIPTION:
The antenna of this system consists of a broadside array of dipoles with a rectangular reflector/support frame measuring about 1.4 metres high by 2 metres wide. It was originally thought to be a long wavelength search radar of modest power, but later evidence suggests that its function is either that of an IFF interrogator antenna, or as a directional array for the transmission of guidance signals to surface-to-surface missiles. It is most frequently seen on Soviet missile carrying boats of the "Osa" class (but apparently not on craft of this class of the navies of countries friendly to the USSR), and these generally have two such arrays carried on sponsons fore and aft of the tubular mainmast. Some "Kotlin" class destroyers of the Soviet fleet carry four, and Square Head has been seen on vessels of the "Skory" class.

1897.253
POP GROUP FIRE CONTROL RADAR
DESCRIPTION:
Pop Group is the NATO code-name for the fire control radar group associated with the Soviet Navy's SAN-4 surface-to-air missile system (**2954.231**). The name probably has its origin in the fact that the launcher for this missile system pops up' from a silo-type housing preparatory to launching.

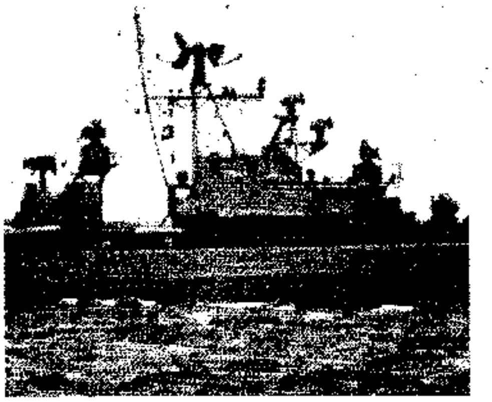
Few details have been obtained regarding the configuration or operation of the Pop Group radar as it is generally covered by canvas shrouds whenever photo-reconnaissance is a likely possibility.

However, it is known that at least two aerials are used for radar functions, with possibly a third antenna for the transmission of command signals to the missile. The arrangement appears to consist of a cube-shaped container with sides of about 2.2 metres in which is probably housed the bulk of the electronics such as transmitter/receiver units, power supplies, and turning gear, and on the top of this is a trainable radar head assembly. The latter unit, so far as can be ascertained from the limited evidence available, has a solid reflector parabolic antenna which is probably for target search and which may rotate independently of the rest of the radar head (which, as noted above, can be trained in azimuth). On the front face of the head are two circular arrays that are assumed to be for target tracking and missile guidance. Operating frequencies are likely to lie in that part of the spectrum contained within the C to X-band region.

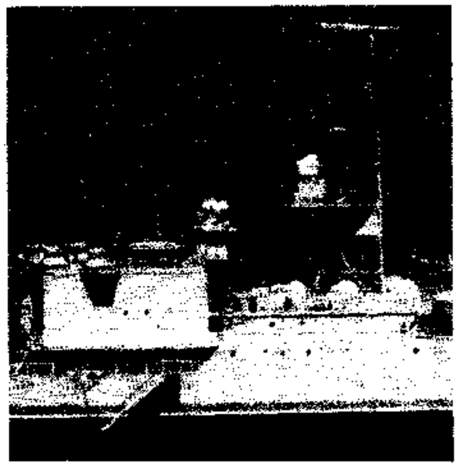
Since Pop Group was first detected on Soviet "Nanuchka" Class missile frigates in the late 1960s, it has been fitted to an increasing number of types of vessel of widely differing sizes. Another development is that whereas on the "Nanuchka" Pop Group was associated only with the SAN-4 missile system, in later fittings it apparently is also capable of directing small calibre automatic gun turrets as well to form a close-in air defence weapon system.

"Nanuchka" class ships have a single Pop Group installation on top of the bridge housing, and a similar arrangement is employed in the "Grisha" escorts, the SAN-4 launcher 'bin' being located in the forecastle on both types of vessel. The "Krivak" missile destroyers have SAN-4 installations fore and aft, with a Pop Group radar for each system, one on top of the bridgehouse and the other on a raised mounting amidships. "Kara" class missile cruisers have two SAN-4 systems, located one on each side of the mast and with their associated Pop Group radars a few feet aft in each case. Also adjacent to the Pop Group radars are two automatic anti-aircraft gun turrets on each side, and these would appear to be directed by the Pop Group radars to form (with the SAN-4 missile launchers) port and starboard integrated close-in autonomous air defence weapon systems.

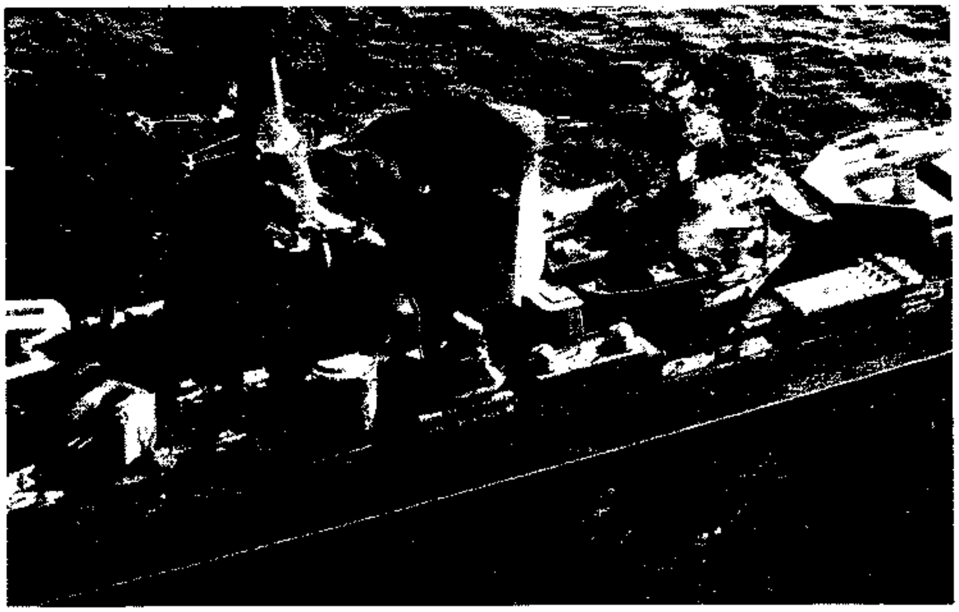
In the case of the converted "Sverdlov" cruisers, the largest vessels equipped with SAN-4, various arrangements exist. *Zhdanov* had its SAN-4 silo fitted in place of the original 'X' 152 mm gun turret, and the associated Pop Group radar was installed on a platform attached to the aft mast. The *Admiral Senyavin* has its SAN-4 installation incorporated in the helicopter hangar, with the Pop Group in the same position as on the *Zhdanov*. In the former ship, however, there are four automatic AA gun turrets mounted adjacent to the SAN-4 system. Associated with these guns are two Drum Tilt fire control radars. The exact relationship and operating arrangements made for the three radars, four turrets and twin SAN-4 launcher are not known but it is a reasonable assumption that they are intended for collective use to provide integrated air defence facilities.



Midships area of a "Krivak" class destroyer. The two Pop Group radar systems for the fore and aft SAN-4 installations are above the bridgehouse (right) and on the platform immediately aft of the slender lattice mast. Two Eye Bowl radars for surface-to-surface missile guidance are mounted above and behind the forward Pop Group. Aft of the other Pop Group, an Owl Screech fire control radar for the after turrets can be seen. Mounted on the tripod mast is the Head Net C height-finder search radar



The modified "Sverdlov" class cruiser, Admiral Senyavin. The top of the helicopter hangar has four automatic AA gun turrets and the top of the silo-type SAN-4 missile launcher projects through the hangar roof. Two Drum Tilt gun fire control radars are mounted on short towers and Pop Group SAN-4 guidance radar is carried on platform near base of tripod mast. Top of mast supports a pair of conical horn antennas for communications



The midships area of the "Kara" class cruiser, Nikolayev, showing the 'bin' type launcher for the SAN-4 missile system at the base of the mast. Shrouded Pop Group radar for this system is to right of SAN-4 mount. On top of mast is Top Sail surveillance radar, and numerous electronic warfare antennas protected by radomes can be seen on the mast structure. Complicated radar group to right of funnel is Head Light for the SAN-3 surface-to-air missile system the launcher for which is on extreme right

1319.253
HEAD NET B AIR SURVEILLANCE RADAR
DESCRIPTION:
This is a dual installation of the Head Net A radar (Entry No. **1318.253**) in which two scanners are mounted in a back-to-back configuration. One is tilted at an angle of about 15 degrees in elevation, in relation to the other scanner to provide separate high and low cover. Operating frequency probably lies within the S-band of the spectrum, although L-band is a possibility also.

Functions of the radar are air search and surveillance, and target designations for the fire control radars carried for the direction of surface-to-air missiles and guns.

This radar has been seen on a "Krupny" class destroyer (No. 229 – since renumbered), but does not appear to be in widespread use. The general mechanical arrangement is very similar to the Head Net (Entry No. **1320.253**), which is also a back-to-back system using dual Head Net A arrays, and it is possible that individual vessels have been converted from one version to the other. Latest information is that of the five "Krupny" class ships, *Gnevnyi* now has Head Net C and the others have a Head Net A. There are no known Head Net B installations.

1330.253
DRUM TILT FIRE CONTROL RADAR
Description:

This is a pedestal-mounted fire control radar which probably provides acquisition and tracking functions only for anti-aircraft guns. It is housed in a weather-proof container which is attached to the scanner assembly. Operating frequency is almost certainly in the X-band. It is principally fitted aboard "Osa" class missile boats, on a platform between the two aft missile launchers, for the direction of four 25 mm AA guns carried by these craft. Other craft fitted are Soviet "Shersen" class torpedo boats; "Stenka" class coastal escorts; and submarine chasers.

Soviet "Osa" class missile boats showing Square Tie search radar atop tubular mast, Drum Tilt gun fire control radar aft, and Square Head antennas on sponsons fore and aft of mast

1326.253
SUN VISOR FIRE CONTROL RADAR
Description:

Sun Visor is identified as a solid paraboloid scanner fixed to the front of a spherical shaped gun fire director station. Two types of director have been identified carrying this type of radar. These have the NATO code names Round Top and Wasp Head, and in the former the radar is carried near the top of the unit compared with a lower location on Wasp Head, which is stabilised. Span of the dish is estimated at approximately 2.2 metres, and the depth at 1.3 metres. Operating frequency is probably X- or C-band. The reflector is illuminated by a dielectric-enclosed feed carried on a solid boom structure projecting from over the upper edge of the reflectors. The disposition of these components suggests that surface target detection is the principal role of this radar.

Sun Visor control radar

Port and starboard Sun Visor fire control radar installations can be seen on the right of this photograph of a Sverdlov class cruiser. Also visible are five Egg Cup radars on gun turrets

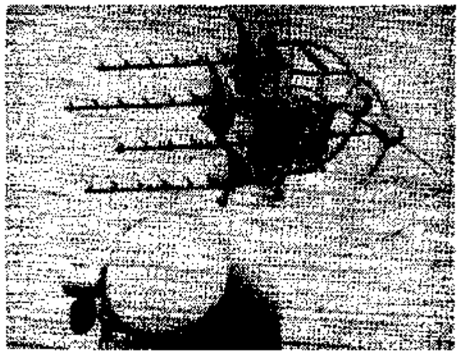
The fire director units on which Sun Visor is mounted are capable of 360 degrees rotation, but since they are manned units incorporating optical range-finding equipment also, it is unlikely that it is normally used for target search and surveillance on a continuous basis. A more likely mode of operation is for target co-ordinates to be passed to the system by another of the ship's radars and for the former to operate in a target acquisition and lock-on role to provide either range and bearing data for blind firing or to assist the operator in the training of optical sighting systems.

Sun Visor has been seen on certain vessels of the "Krupny" class of GMDs, the "Kanin" class, "Kotlin" class, and "Tallin" class, and "Sverdlov" class cruisers.

156.253
CYLINDER HEAD FIRE CONTROL RADAR
Description:

Cylinder Head is the NATO designation for a now obsolete, or obsolescent, gun director system based on an optical rangefinder. On top of the turret there is an array of four Yagi-type VHF/UHF antennas, presumably added to supplement the optical target information. The array apparently trains with the turret but has provision for independent motion in elevation. Cylinder Head directors are used in conjunction with the aft guns of Soviet "Skory" class destroyers and "Kola" class escorts.

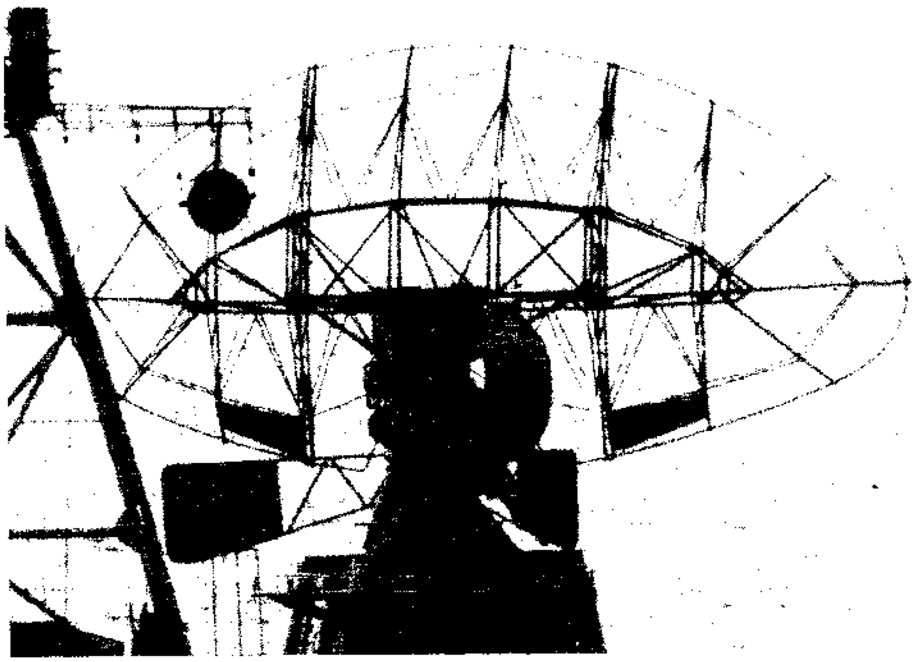
Yagi antenna array of Cylinder Head gun fire control system



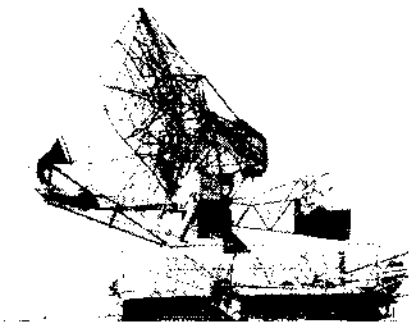
1608.253
BIG NET SEARCH RADAR
DESCRIPTION:

Big Net is a very large, long-range air surveillance radar operating in either the S or L band. The open lattice reflector is of elliptical parabolic form, illuminated by an underslung horn feed, carried on a solid boom. Behind the reflector are two balance vanes.

According to the latest information, all four of the "Kresta I" class of guided missile cruisers carry Big Net, on which ships it is mounted over the funnel. Some of the "Kashin" class of guided missile destroyer are fitted with this radar, in which cases it is mounted on a pylon type mast aft of the forward funnel. The cruiser *Dzerzhinski* has also been seen with Big Net.



Big Net long-range search radar installation on radar picket ship



Big Net long-range search radar

1605.253
FAN SONG E NAVAL RADAR
DESCRIPTION:

This is a shipboard version of the Guideline surface-to-air missile fire control and guidance radar (Entry No. **2868.153**) which is widely used by Soviet land forces. In place of the mobile housing used on land, the shipboard installation is mounted on a stabilised gun mount.

Fan Song E operates in the C-band range of frequencies. The antenna array consists of horizontal and vertical scan Lewis antennas, and three circular parabolic dishes. Two of the latter are for LORO (Lobe On Receive Only) ECCM, and the third dish is for command guidance purposes. Operation of Fan Song E is described more fully in Entry No. **2868.153**.

The only known fitting of this radar is on the Soviet Cruiser *Dzerzhinski*, on which ship the Fan Song E is mounted on a platform aft of the after funnel and forward of the twin Guideline missile launcher.

1607.253
HAIR NET NAVAL RADAR
DESCRIPTION:

Hair Net is a medium-range general purpose search and surveillance radar providing air and surface cover facilities. The antenna is of lightweight lattice construction with a reflector straight sides and upper edge but with a pronounced curve on the bottom edge. The horn feed is carried on a boom projecting from the lower edge of the reflector and supported by stays connected to the reflector. The typical Soviet balance vanes behind the scanner are a feature of this radar.

Hair Net does not appear to be widely fitted. Among fittings reported are the Soviet cruiser *Kirov*, and vessels of the "Tallin" and "Kotlin" classes.

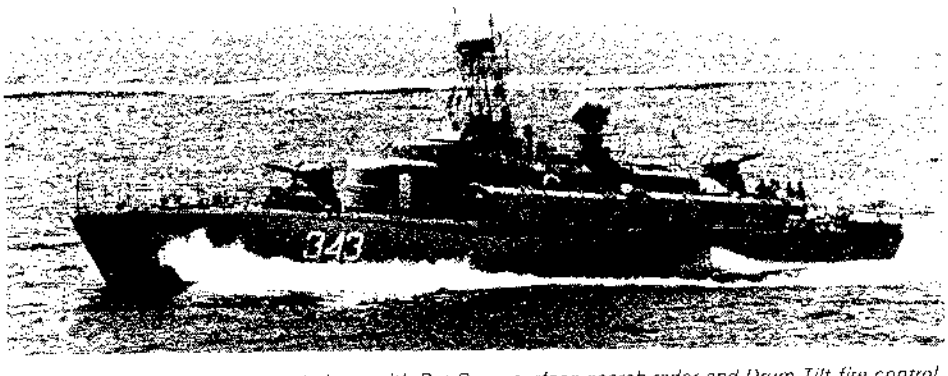
1609.253
PLINTH NET SEARCH RADAR
DESCRIPTION:

Plinth Net is a medium-range general-purpose search radar with an elliptical lattice reflector illuminated by an underslung boom-mounted feed horn. There are no balance vanes behind the scanner. The turning gear is housed in a tapered cylindrical mounting, from which the NATO name for this radar is derived. No reliable details of fittings for Plinth Net can be obtained and it is presumed obsolete.

1612.253
POT DRUM NAVAL RADAR
DESCRIPTION:

Pot Drum is a small surface search radar, probably operating in X-band and protected by a flat, slightly domed, radome from which its NATO code name is derived. Diameter of the radome is about 1.5 metres and the unit is typically installed at the mast head of small patrol boats. This radar is probably of conventional design with the possible exception of a rather higher than usual rate of scanner rotation and the inclusion of ECCM and perhaps a passive direction finding mode of operation. The transmitter/receiver is housed below decks. The display unit has a small CRT display (about 15 cms), so that short range operation of the radar is likely. In addition to surface target detection, Pot Drum probably is used for pilotage purposes also and may have a limited air warning capability.

Coastal escorts of the "Stenka" and "Kronstadt" classes are fitted with Pot Drum, as are torpedo boats of the "Shershen" class, some "P6" class boats, and the "Pchela" class of hydrofoil craft.



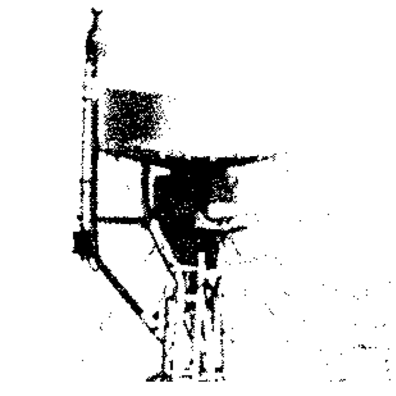
Soviet "Shershen" class torpedo boat with Pot Drum surface search radar and Drum Tilt fire control radars for guns

1613.253
POT HEAD NAVAL RADAR

DESCRIPTION:

Pot Head is similar in appearance to the Pot Drum surface search radar (Entry No. **1612.253**) but is slightly smaller with an estimated diameter of 1.2 metres. Another distinguishing feature is that the top of Pot Head is flatter than that of Pot Drum. The operating frequency is probably in the X-band and the main function will be that of surface target detection, with pilotage and limited air warning facilities as supplementary capabilities.

Fittings appear to be confined to torpedo boats of the "P6", "P8", and "P10" classes operated by the Soviet and East German Navies.



Pot Head short-range surface radar with IFF antenna

1324.253
SCOOP PAIR SURFACE TARGET RADARS

DESCRIPTION:

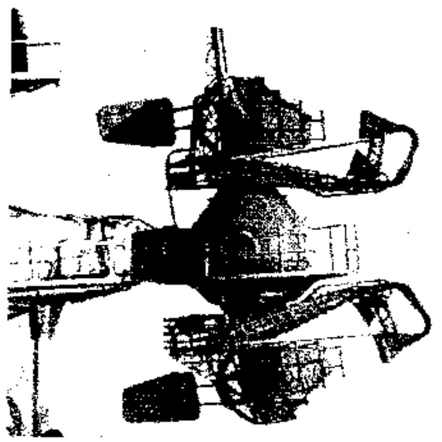
This radar system is a feature of Soviet vessels equipped with Shaddock surface-to-surface missile launcher tubes. It consists of two apparently identical radars mounted above and below a spherical housing supported at the end of a sponson. Photographs indicate that these sponsons, which are aligned with the ship's fore-and-aft axis, may include provision for rotating the radar group to provide stabilisation against roll motion, and there may also be pitch stabilisation but this is not known for certain.

The scanners are of open lattice construction and of essentially elliptical paraboloid form, although the contours are rather angular. They have quite a high span/depth ratio and the former dimensions is estimated at approximately 4.2 metres. They each have the typical Soviet balance vanes behind the scanners, in this case of almost square outline. Each scanner is illuminated by a double horn assembly carried on a boom, coming from beneath the scanner in the case of the upper radar of the group, and above in the case of the lower radar. The disposition of the horns suggests that they are arranged to provide maximum elevation coverage from the combined pair of radars. A further possibility for the use of double horns is that they are associated with special signal processing equipment to provide optimum target detection in the presence of sea clutter returns.

It is not known if the two radars comprising the Scoop Pair group are rotated in azimuth independently, although there is no mechanical reason why they should not.

Probable functions include surface search and target detection to provide range and bearing data for the Shaddock missile fire control system, and tracking of the missile after launch.

All Shaddock carrying Soviet vessels appear to be equipped with one or two Scoop Pairs, depending upon the Shaddock launching arrangements. "Kresta I" class guided missile cruisers have a single installation, high on the main 'tower', and this serves two twin launchers below, and on each side of the bridge. "Kynda" class ships have two groups, fore and aft, each serving a four-tube launcher.



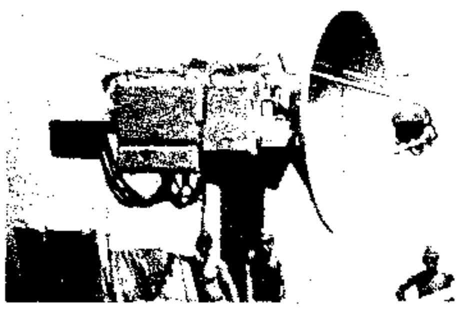
Scoop Pair radars for surface-to-surface Shaddock missiles. The projection above the upper scanner could be for IFF. The scanners can be seen to employ a solid reflector in front of which is a parallel grid, presumably to improve clutter rejection

1325.253
HAWK/OWL SCREECH FIRE CONTROL RADARS

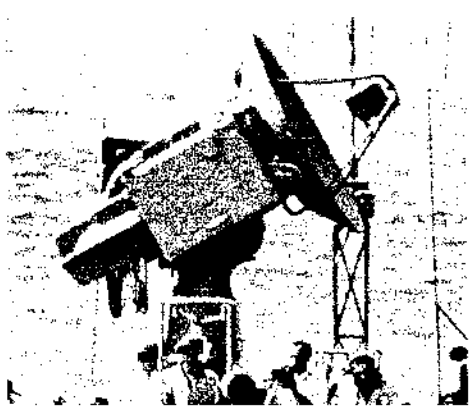
DESCRIPTION:

Owl Screech and Hawk Screech are fire control radars of conventional design, widely used in many classes of Soviet vessels. They are distinguished by a circular dish scanner, behind which are mounted fairly bulky housings which are assumed to contain transmitter and receiver, and probably turning and stabilisation gear. The complete radar is pedestal mounted. The scanner has a central feed supported by a four-leg structure. Feed arrangements could incorporate a rotating dipole to provide a conical-scan search pattern. Dish diameter is approximately 2 metres, with Owl Screech somewhat larger than Hawk Screech, and the operating frequency is probably in the C-band although X-band is also a possibility.

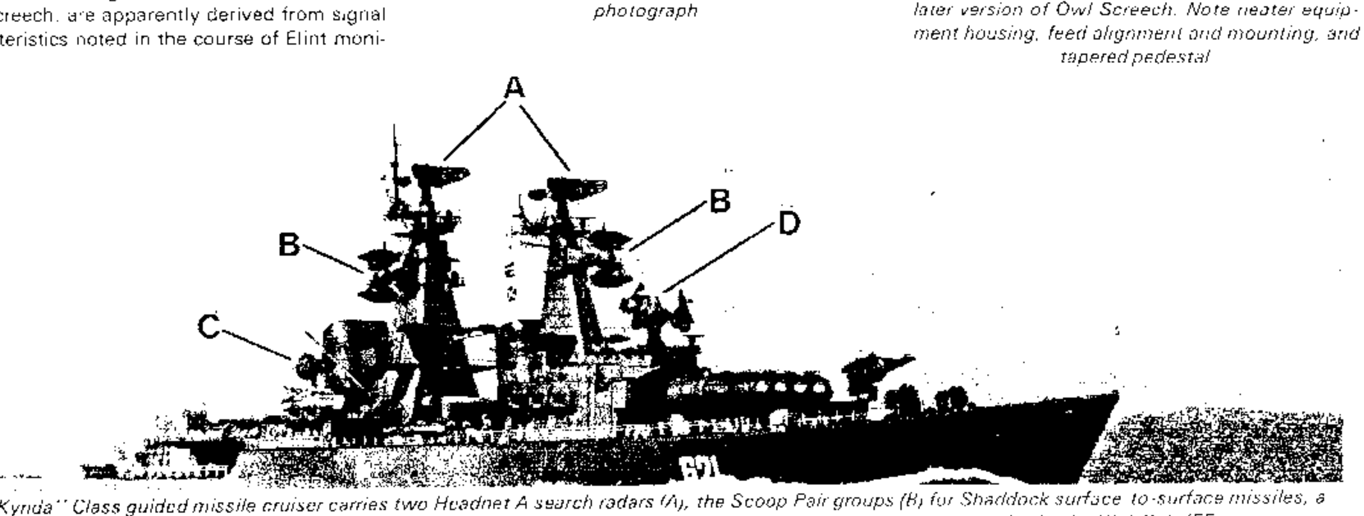
The NATO designations, Hawk Screech and Owl Screech, are apparently derived from signal characteristics noted in the course of Elint moni-



Gun fire control radar believed to carry the NATO designation Owl Screech. Note the angled feed housing, numerous separate equipment housings behind the reflector, tubular pedestal, and feed mounting, which distinguish this radar from that known as Hawk Screech, shown in an adjacent photograph



Gun fire control radar believed to carry the NATO designation Hawk Screech. This is thought to be a later version of Owl Screech. Note neater equipment housing, feed alignment and mounting, and tapered pedestal



"Kynda" Class guided missile cruiser carries two Headnet A search radars (A), the Scoop Pair groups (B) for Shaddock surface-to-surface missiles, a Peel group installation (D) for surface-to-air missiles, and an Owl Screech gun fire control radar (C). What is assumed to be the High Pole IFF antenna can be seen on the aft tower. Also visible are several pilotage and navigation radars and DF loops

toring. They appear to refer to two versions of the same basic radar, and close examination of photographs of this equipment does reveal external differences to support this. These visible variations do not as yet permit positive identification of either with one of the NATO names.

The two most obvious physical differences between the two types are in the arrangement of equipment behind the dish and in the mounting of the feed. One version, tentatively identified as Owl Screech, appears to be the earlier and the hardware behind the dish is contained in more numerous housings, giving a less tidy appearance than in the other version. Also, the four legs of the feed support are fixed to the dish at points nearer its centre than in the newer radar. The pedestals also differ, the older (Owl Screech?) being tubular, and the newer (Hawk Screech?) being slightly tapered. In the photographs studied by *Jane's Weapon Systems* it has been noticed that the feed housing in the Owl Screech version is at an angle of about 45 degrees, whereas in the other version it is orthogonally mounted. This may be a clue to the signal characteristics of the two types. There is one other feature, which is less obvious, that distinguishes the two types. That believed to be Hawk Screech has a small aperture in the dish, on the centre line and near the upper edge. This could be for a closed-circuit TV camera, and there is a small housing on the rear of the reflector. This could be used for optical target acquisition.

The principal function is that of gun fire director against aircraft targets, although this type probably also has a certain capability against surface targets, and possibly splash detection.

Classes of Soviet vessel seen equipped are: "Kynda" GMDs (2 sets), "Kashin" (2), "Krupny" (2), "Kotlin" (1 or 2), "Kildin" (2), "Tallin" escorts (2), "Mirka" escorts (1), and "Lama" class missile supply ships (2). Weapons associated with these various classes include: twin 76 mm anti-aircraft guns, quadruple 57 mm AA guns, twin 100 mm dual-purpose guns.

1606.253
HIGH LUNE NAVAL HEIGHT-FINDER RADAR

DESCRIPTION:

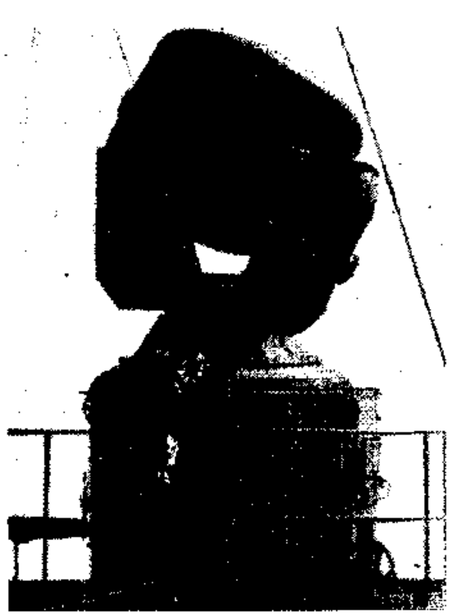
The High Lune is a shipboard height-finding radar of the nodding type, and the probable operating frequency is in the S-band. Nodding height-finders are seldom fitted on Soviet vessels, possibly because of the effects of ship's motion on the data obtained and High Lune is probably an adaptation of one of the Cake series of Soviet land-based radars. The reflector is a large (5 to 6 metres) elliptical assembly of lattice construction. It is not known if a stabilised mount is provided. The only known installation is on the cruiser *Dzerzhinski*, where it is used with the Fan Song E for operation of the Guideline high-level anti-aircraft missile system fitted on that vessel.

1611.253
MUFF COB FIRE CONTROL RADAR

DESCRIPTION:

The Muff Cob fire control is similar in general appearance to the Drum Tilt fire control radar (Entry No. **1330.253**), but the former has provision for elevation motion, being supported by a trunnion yoke carried on the traversing mounting. The operating frequency is probably in the C- or X-band part of the spectrum. Some drawings of Muff Cob show what appears to be an on-mounted TV or optical tracking subsystem, but this has not been confirmed.

In all the installations of Muff Cob studied, this radar is employed for gun fire control purposes only. On the helicopter carriers *Moskva* and *Leningrad* there are two Muff Cobs mounted high on each side of the main superstructure for direction of the twin 57 mm guns on either side of these ships. Both "Kresta I" and "Kresta II" classes of guided missile cruiser have two Muff Cobs each, carried on platforms on the sides of the funnel. These are for control of twin 57 mm guns on each side of "Kresta I" ships and twin 57 mm guns and two twin 30 mm guns on each side of "Kresta II" vessels. Some of the "Ugra" and "Lama" classes of support ships have two Muff Cob installations, and there are single fittings on ships of the "Poti" class of coastal escorts. The "T58" class of fleet minesweepers carry a single Muff Cob on top of the bridge house. Some "Polnocny" amphibious landing craft carry a Muff Cob for direction of twin 30 mm anti-aircraft guns.



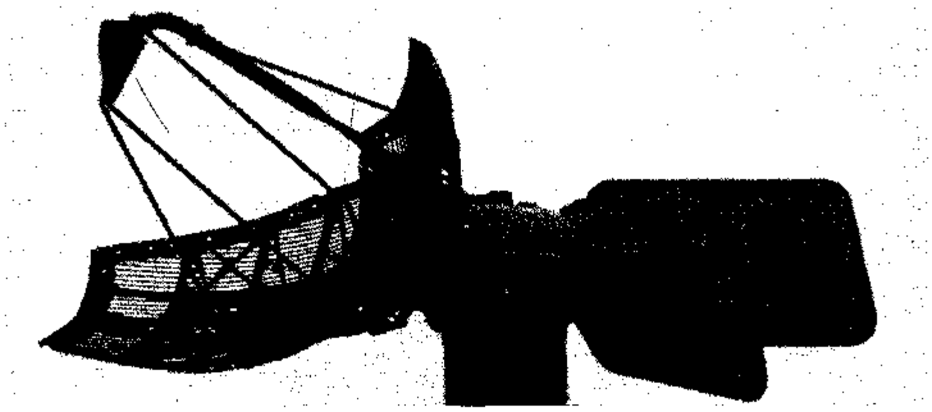
Muff Cob fire control radar

1322.253
SLIM NET SURFACE WARNING RADAR

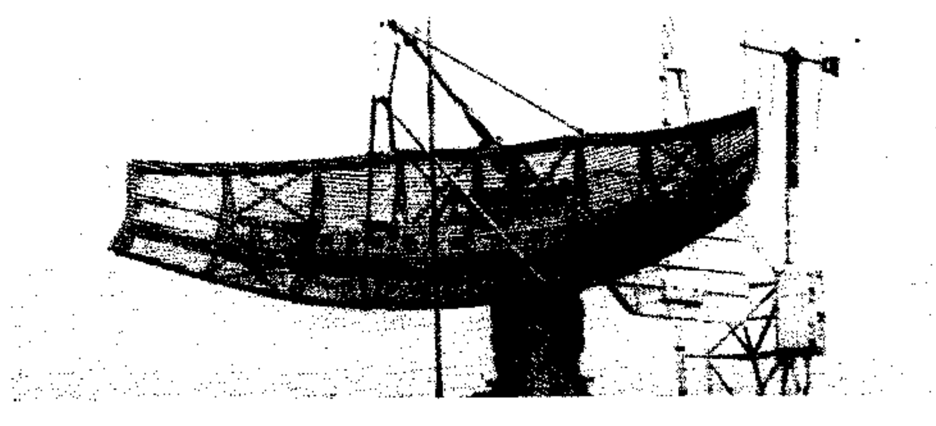
DESCRIPTION:

Slim Net is a surface warning, high definition, radar of generally conventional naval design, plus the typical Soviet characteristic of balancing vanes behind the scanner. The scanner is of open lattice construction and approximately 5.5 metres span and 1.8 metres maximum depth. The general shape is of a tapered rectangle, and the balance vanes also are rectangular. The horn feed is mounted on a boom overhanging the scanner. Operating frequency probably lies within the S-band of the spectrum.

Vessels seen with this radar include some ships of the "Kildin" class of guided missile destroyers (in which it may be associated with the Strela surface-to-surface missile launcher); "Kotlin" class destroyers; and "Tallin" class destroyers. In all three cases it is carried on top of the rear tripod mast. It is believed that some "Riga" class and "Peyta" class escorts have been equipped.



Slim Net search radar

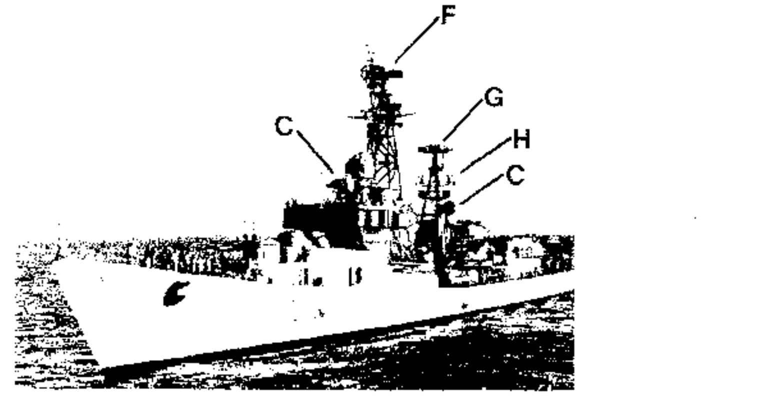


Slim Net scanner assembly, with Yard Rake rotating Yagi array (right)

1321.253
FLAT SPIN SURVEILLANCE RADAR
Description:

This is similar in general configuration to the Head Net A air surveillance radar but has a number of distinguishing features. It appears to be of approximately the same size but the scanner is more angular and deeper than that of Head Net A. The two 'butterfly' balance vanes are square tipped instead of round and are closer set to the mounting. The feed arrangements also differ, being carried on a shorter boom. Operating frequency is probably L- or S-band.

Among vessels fitted are certain of the "Riga" class of escorts, on which it is mounted on the mast; and certain "Kotlin" class destroyers.



"Kildin" class GMD with Flat Spin search radar (F), Slim Net radar (G), two Hawk / Owl Screech fire control radars (C), Square Head antennas (H), are mounted on the sponsons of both masts

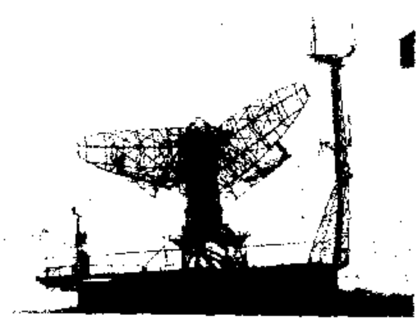
1320.253
HEAD NET C AIR SURVEILLANCE RADAR
Description:

This radar is apparently a back-to-back combination of two Head Net A scanners (Entry No. **1318.253**), similar to Head Net B (**1319.253**) but with the significant difference that one of the scanners has its aperture (i.e. its 'span' dimension) tilted from the horizontal by approximately 30 degrees. This has the effect of displacing the resulting fan-shaped elevation beam by the same amount from the vertical. This beam, in combination with the vertical beam produced by the companion scanner, thus provides the means for height-finding by the so-called 'V-beam' technique, such as is used in the American AN/TPS-34.

There are important differences, however, in the way in which these two radars employ this principle, apart from other variations between them. The most significant is that the US equipment has both beams (slant and vertical) radiating along a common azimuth, rotating in synchronism, whereas in the Head Net C the beams are separated in azimuth by 180 degrees – as a result of the back-to-back configuration employed.

In practice, the vertical beam fulfils the search function and the operator selects a target for which height data is required, and by placing a marker on this target (or similar technique) this places a range gate in the second (inclined) beam and excludes other targets. Computation to give a height readout can be performed by analogue or digital methods.

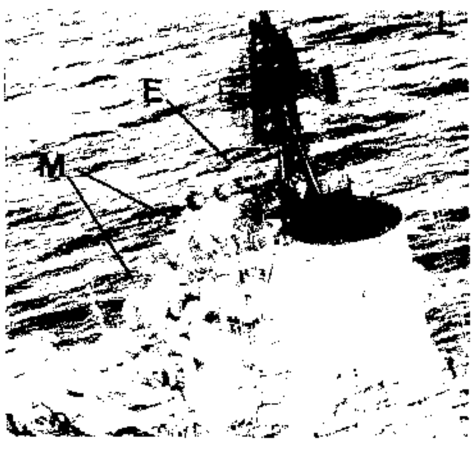
This radar has been seen on both "Kresta I and II" classes of guided missile cruisers, the *Moskva* and *Leningrad* cruiser helicopter ships, some "Kashin", "Kanin" and "Krupny" GMDs, and "Kotlin SAM II" GMDs. The newest class of vessel to carry Head Net C is the "Krivak" general purpose leader type.


Head Net back to back three-dimensional air-surveillance radar on "Kresta II"

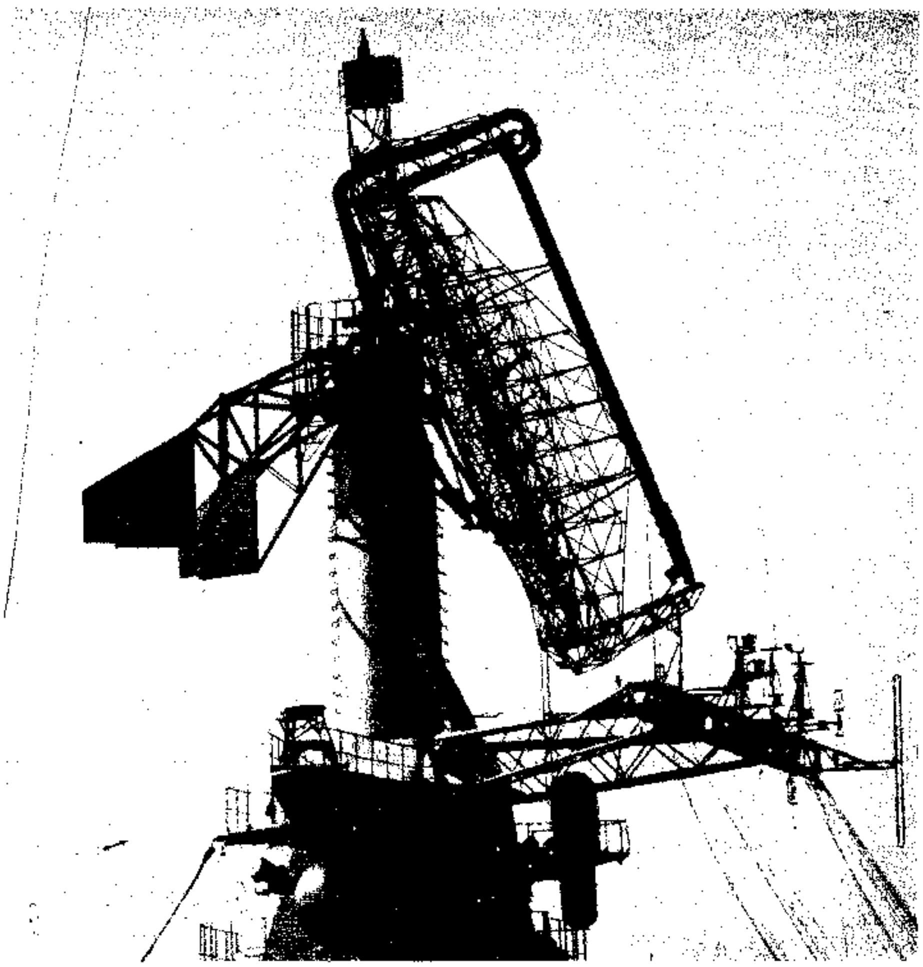
1327.253
TOP SAIL THREE-DIMENSIONAL RADAR
Description:

Top Sail is a very large air surveillance radar, first seen on the Soviet cruiser helicopter carrier, *Moskva*, and the sister ship *Leningrad*, but later on the new "Kresta II" and "Kara" classes of guided missile cruisers. In all installations the radar is mounted at the highest point of the vessel, in the case of the "Kresta II" class on a large diameter tubular pedestal atop the principal tower, and on the helicopter cruisers supported by a tubular tripod. In the "Kara" installation the scanner surmounts a typically Soviet pyramid shaped structure amidships.

The scanner is of ylindrical cross-section, the axis of which is tilted from the vertical at an angle of about 20 degrees. It is of lattice construction



The Top Sail air surveillance radar installation (L) on the carrier helicopter vessel, Moskva, also carried are Head Net C back to back radar (E) and Head Light group missile control radars (M)


Top Sail long-range air surveillance radar installation on "Kresta II" class missile cruiser. Note also the "thimble" radomes protecting Electronic Warfare antennas, NATO designation Side Globe

and has a frontal aspect of rhombic shape (estimated 5.5 m sides), with 'cropped' corners. Illumination of the reflector is by a linear radiating element located parallel to the reflector's cylindrical axis, and supported top and bottom. The feed appears to be from the upper end. It may consist of multiple horns to provide three dimensional air target data by the 'stacked beam' method, or some form of electronic scanning in elevation (such as the ridged waveguide) may be used to achieve the same result. Operating frequency is probably in the L-band with high transmitter power.

The photograph of a "Kresta II" Top Sail antenna shows what appears to be a second system of waveguide, of smaller dimensions than the main system, apparently feeding a horn at the top of the main illuminator. This might indicate dual band operation facilities for some purposes. There is a subsidiary antenna fixed to the top of the Top Sail scanner which could be for IFF. In addition to the two plates which are the most prominent feature of this secondary antenna there are also three dipoles. Near the bottom of the illuminator of the main Top Sail are what could be a similar group of three dipoles. The function of these elements has not been ascertained.

In all three classes of vessel equipped with Top Sail it is associated with similar radars, a Head Net C back-to-back 'V-beam' set, and Head Light group missile fire control director radars. The Top Sail is probably used for long range air surveillance and target designation.

1328.253
HEAD LIGHT GROUP
DESCRIPTION:

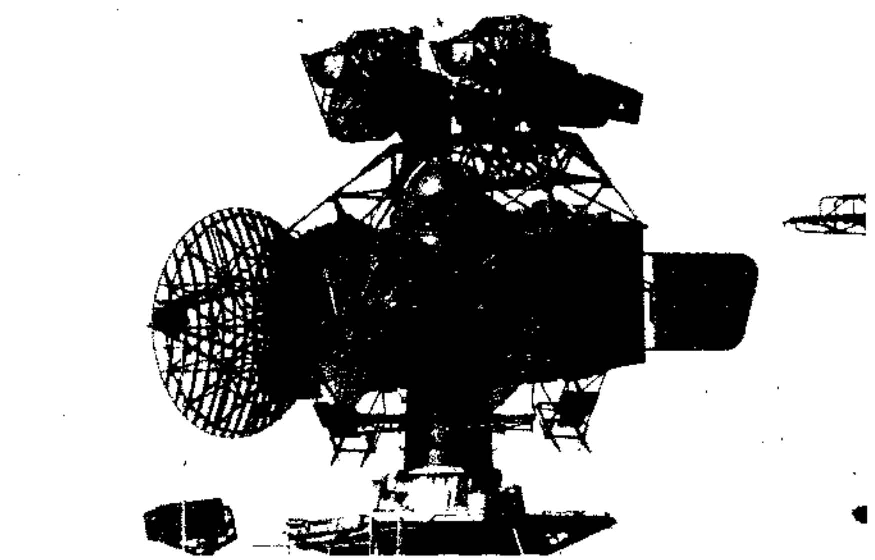
This group of radars was first seen on the cruiser helicopter carrier, *Moskva*, but has subsequently made its appearance on the "Kresta II" and "Kara" classes of guided missile cruisers. Two of these groups of radars are fitted, fore and aft on the "Kresta II" and "Kara" vessels, and two forward on the *Moskva*. In very general configuration, and possibly function to some degree, this group resembles the Peel Group missile control radar group for Goa surface-to-air missiles on other Soviet vessels. The Head Light group consists of a group of four radars, apparently comprising two identical pairs of equipment combined on a common mounting. There is a fifth, smaller dish, possibly fulfilling a command link or IFF function.

The four main reflectors of the group are circular dishes, of open mesh construction, one small and one large to each pair, with the smaller in the upper position, and all being disposed symmetrically about the central mounting pillar. Estimated dish sizes are 1.8 metres and 3.8 metres. The electronics for each radar, transmitter/receiver etc, are carried behind the individual reflectors and the whole assembly of four radars as supported from the top of the pedestal turning gear on a yoke structure of triangulated tube construction.

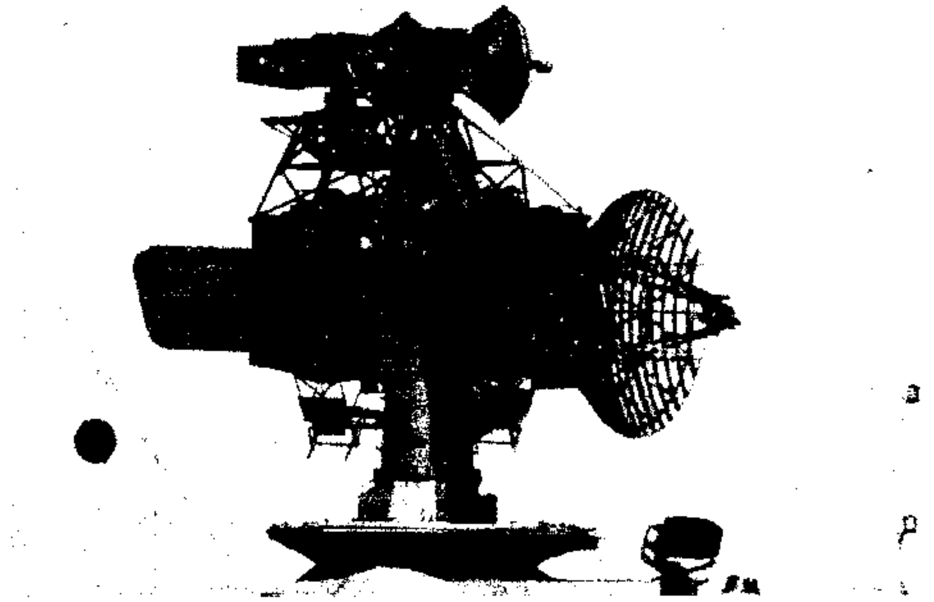
The whole assembly rotates in azimuth, and can also move in elevation. The two upper radars also appear to have provision for individual movement in both axes, possibly limited, and the dynamic balancing vanes fitted to them, could support this suggestion.

The upper dishes have unusually large feed arrangements which may be of the Cassegrain type, and the larger dishes appear to be front fed. Operating frequencies are probably X- and C-bands, respectively.

On the *Moskva* and *Leningrad* there is one Head Light group to each of two surface-to-air missile launchers, each for two missiles. On "Kresta II" class ships there is one Head Lamp group associated with similar launchers fore and aft. The arrangement on "Kara" class ships is similar.



The aft Head Light radar group on board a "Kresta II" Class guided missile cruiser. Note also the smaller surface search radar



The forward Head Lamp radar group of the "Kresta II" class guided missile cruiser

1331.253
STRUT CURVE SEARCH RADAR
DESCRIPTION:

Strut Curve is a medium range general purpose search radar, probably operating in the S-band to provide both air and surface search facilities. An elliptical lattice reflector is used, illuminated by a horn feed carrier by a boom projecting from the lower edge of the scanner. The boom is supported by two struts which attach to stays at the upper edge of the reflector. Somewhat unusual for Soviet naval radars, the Strut Curve has no balance vanes behind the reflector.

Soviet vessels fitted with Strut Curve include the "Poti" class of escorts and certain support ships.

Strut Curve search radar

Strut Curve antenna profile

1323.253
PEEL GROUP FIRE CONTROL RADAR

DESCRIPTION

This group comprises four distinct radars on a common mounting and is almost certainly associated with the Goa surface-to-air armament of Soviet vessels. All four scanners are of solid-reflector construction and of elliptical paraboloid shape. There are two large and two small scanners in each group, one each of each size being disposed with its major axis horizontal and the other vertical.

The central mounting has noticeably rounded proportions and appears to provide a common axis about which the group rotates in azimuth, and the forward side of this mounting is another large housing providing for rotation of the group in elevation. It cannot positively be ascertained if this provides for separate elevation rotation of the individual elements of the group. Viewed from the front, the large vertically disposed scanner is to the right of the central mounting and the other three scanners are to the left of it.

Although unrestricted rotation of the individual vertical and horizontal elements of the Peel Group is unlikely, sector scanning is probable for the performance of air target tracking. Target designation is probably provided by one of the Head Net series of air surveillance radars, and the Peel Group does not seem to have been designed to give a search capability.

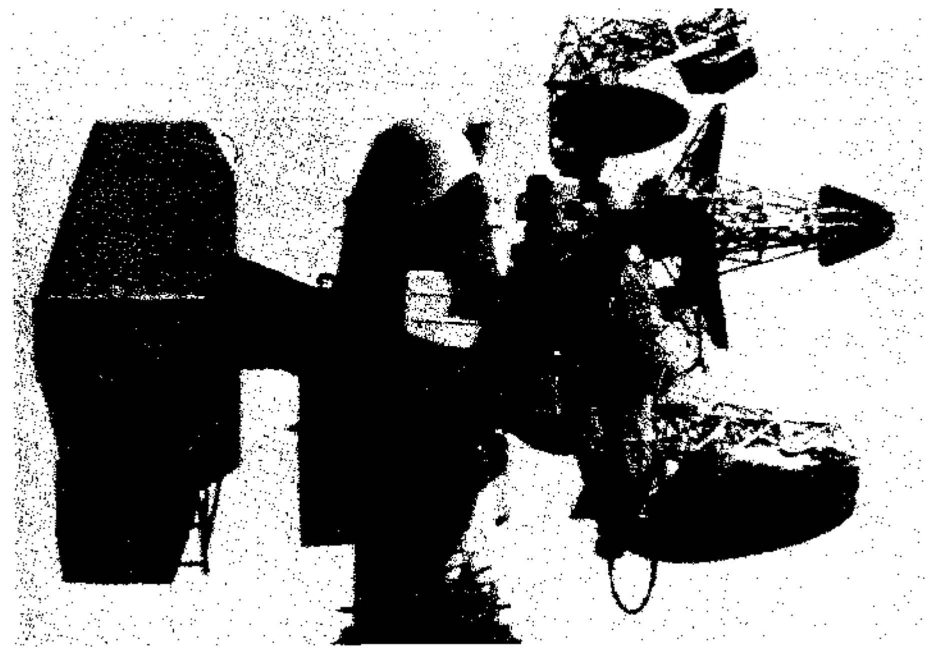
The feed arrangements are a matter of some conjecture. Those of the two smaller scanners are distinguished by large offset boom-mounted illuminator housing boxes the shape of which seems to suggest that they contain multiple horns. One feasible explanation for this is that a monopulse tracking technique is used, with separate radars for each co-ordinate, azimuth and elevation. Operating frequency of the two smaller radars of the group is probably in the X-band.

The feeds of the two larger radars, which probably operate in C-band, are smaller than those of the other two radars of the group and are not offset. The feed housings are of cylindrical form and may contain devices such as a quarter-wave plate to provide circular polarisation as an aid to higher weather penetration.

Information is too limited to draw firm conclusions concerning the functions of the individual elements of the Peel Group in tracking the target and directing the missile. A likely assessment is that the two larger scanners are employed for the longer range target acquisition and 'coarse' tracking, while the two smaller scanners provide precision tracking.

Between the large vertically oriented scanner and the central mounting a further unit of uncertain function is located. This could be a radiator for guidance signals to the missile until its own homing system comes into operation. It is also a reasonable assumption that some provisions for IFF are made within the system.

The normal deployment arrangements associate one Peel Group unit with one dual Goa surface-to-air missile launcher. "Kresta I" class guided missile cruisers have two installations, one forward above the bridge and the other aft, atop a short tower, and "Kashin" class GMDs are similarly fitted. The "Kynda" class GMDs have a Peel Group installation above the bridge, and on "Kotlin" class GMDs there is a Peel group on a square, tapered tower amidships.



Peel Group radar used on various classes of Soviet vessel for control of Goa surface-to-air missiles

1318.253
HEAD NET A AIR SURVEILLANCE RADAR

DESCRIPTION:

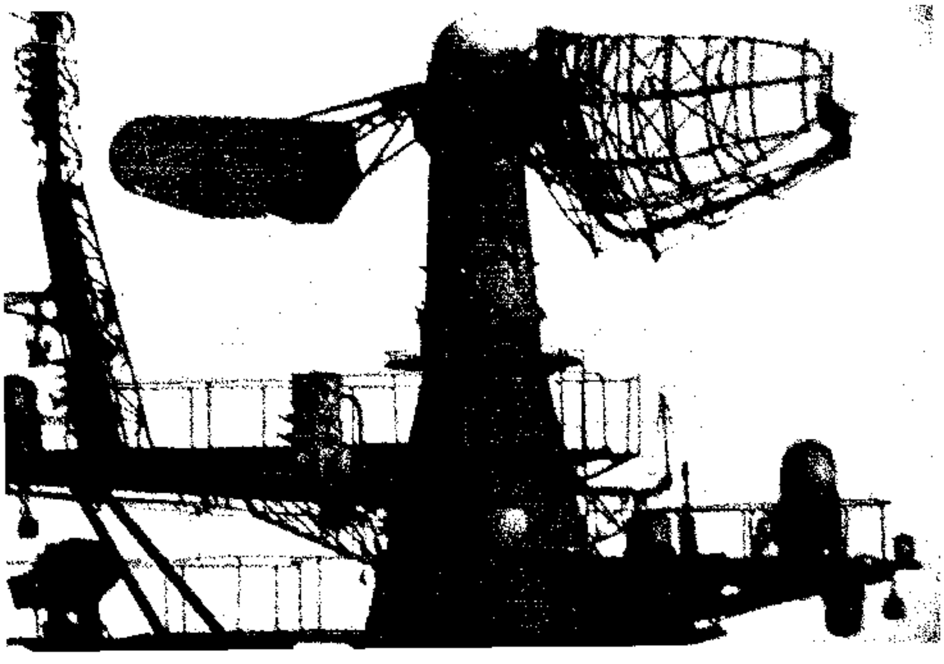
This appears to be the most widely fitted of the numerous radars employed by the Soviet Navy, and appears to be of fairly conventional construction. It has a large (about 6 m × 1.5 m) elliptical paraboloid reflector of open lattice construction. This is illuminated by a horn feed carried by a boom projecting from below the lower edge of the scanner. An unusual visual feature, compared with practice outside the USSR, is a pair of prominent 'butterfly' vanes extending behind the scanner which are for dynamic balancing.

The scanner mounting is also quite distinctive and has a rather 'lighthouse' like appearance, being quite regular and with a domed top. It is possible, though considered unlikely, that this accommodates some form of scanner stabilisation against ship's motion. It is possible that a relatively high rotation rate is employed.

Operating frequency is in either the L- or S-band, probably the latter. No details of the radiated power are available.

The principal function of the Head Net A is assumed to be air search and surveillance and it can be expected to provide target designation facilities for other, fire control radars for guns and missiles, carried by the vessel.

It is normally mounted on a mast-top location, or other high positions, and both single and double installations have been seen on various classes of Soviet vessel. "Kynda" and "Kashin" class guided missile destroyers have one on each of the two masts, the "Krupny" class GMD No 700 has a single installation on the mainmast; and a similar arrangement is used on certain "Kotlin" class destroyers.



Head Net A surveillance radar. Note also various ECM housings

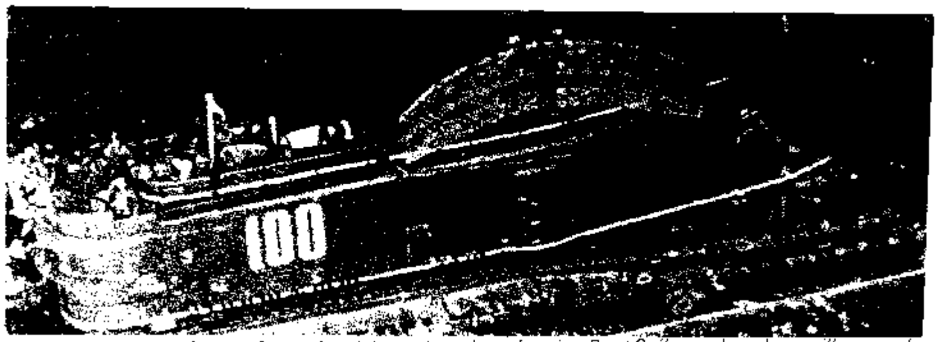
Head Net mountings and scanners are also employed in two types of dual installations. One is a back-to-back configuration (Entry No. **1319.253**) with one of the scanners at a larger elevation angle (about 15 degrees more than the companion scanner) to provide separate high and lower cover aerials. The second dual configuration (Entry No. **1320.253**) is also a back-to-back arrangement, but in this case one scanner is tilted laterally from the horizontal with the probable objective of providing a three-dimensional capability.

1507.253
BOAT SAIL SUBMARINE RADAR

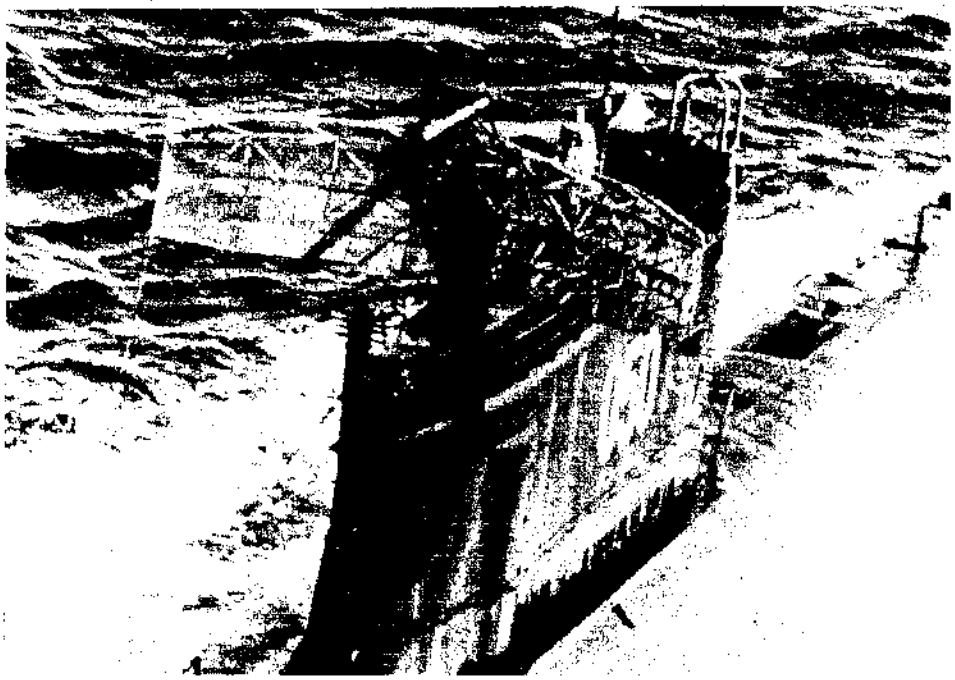
DESCRIPTION:

This is the search and surveillance radar employed on Soviet "W" Class/Canvas Bag radar picket submarines. The electrical and radio frequency characteristics of this equipment are probably fairly conventional, and the operating frequency is likely to lie within the S- or L-bands, and US sources have stated that pulse-width and PRF values are similar to those employed by American surface radars.

The mechanical problems entailed in making seaworthy what is essentially a surface vessel radar when installed on a submarine are the areas of greatest interest. From the photographs obtained it appears almost certain that there is no provision for retracting the scanner assembly into the conning tower for submerged passage. The waveguide feed is protected inside a heavy tube, at the scanner illuminating end presumably equipped with a sealing valve mechanism. It is not known if there are arrangements for folding the scanner to reduce drag when cruising submerged, though this would be an obvious advantage.



Soviet "W" Class/Canvas Bag radar picket submarine, showing Boat Sail search and surveillance radar. Note also partially retracted Stop Light passive receiving antenna ahead of Boat Sail scanner



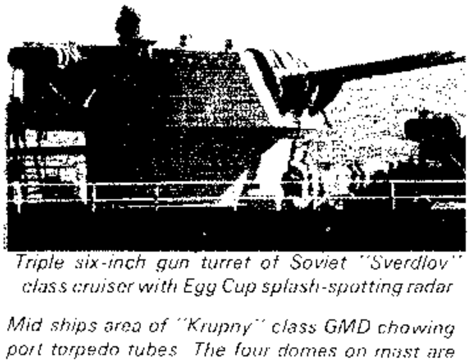
Boat Sail submarine radar installation on board a Soviet "W" class/Canvas Bag radar picket submarine. Note the Stop Light broad - band passive receiving antenna forward of the Boat Sail scanner. This retracts into the conning tower before submerging. There is a DF loop ahead of the Stop Light

1614.253
SKIN HEAD NAVAL RADAR

DESCRIPTION:

The Skin Head radar is principally associated with Soviet torpedo boats and its function is assumed to be surface target detection for use in association with torpedo fire control systems. Its appearance is characterised by a thimble shaped dome from which the NATO code-name is derived, and generally a mast head mounting. Diameter of the radome is estimated to be about 0.8 metres. The nature of the scanner assembly inside is not known but a high rotation rate is assumed. Operating frequency is probably in the X-band.

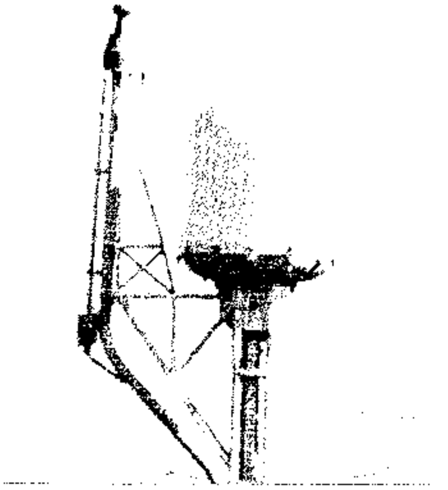
Although Skin Head is mostly associated with torpedo boats of the "P4" and "P6" classes, used by the Soviet and friendly navies, the 152 mm gun turrets of Soviet "Sverdlov" cruisers carry a radome of similar proportions (NATO code-name Egg Cup) which suggests that the same radar may be used for fall-of-shot measurement or other purposes on these ships.

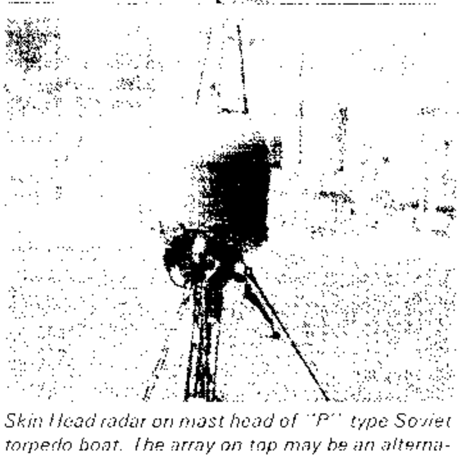


Triple six-inch gun turret of Soviet "Sverdlov" class cruiser with Egg Cup splash-spotting radar

Mid ships area of "Krupny" class GMD showing port torpedo tubes. The four domes on mast are possible alternative housings for electronic warfare equipment. Radar is Hawk Screech for gun fire control

Skin Head radar used for surface target detection on Soviet torpedo boats. Small antenna is for IFF



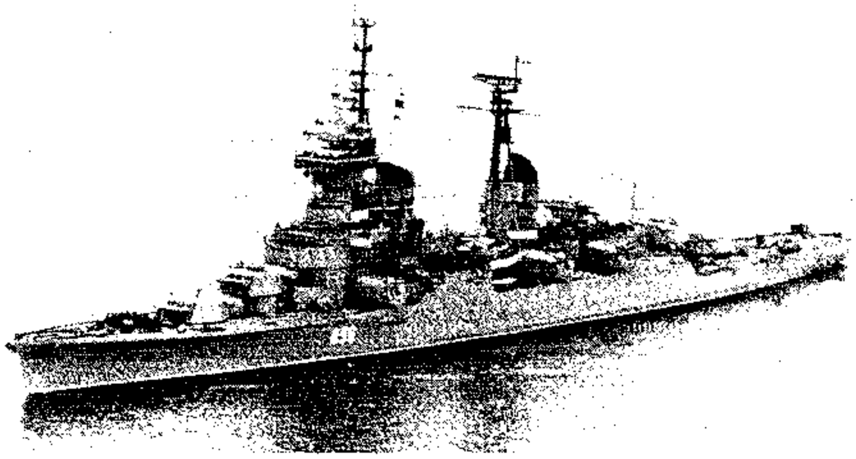


Skin Head radar on mast head of "P" type Soviet torpedo boat. The array on top may be an alternative IFF antenna

1610.253
TOP TROUGH SURVEILLANCE RADAR

DESCRIPTION:

Top Trough is one of the newest Soviet naval radars, and is apparently a high discrimination surface target detection system. The only known installations are on ships of the Soviet "Sverdlov" class of cruisers, presumably to provide target designation facilities for the 6 in (152 mm) surface guns, and 3.9 in (100 mm) dual purpose guns fitted on these vessels. At the time of printing this edition, not all ships of the class had been fitted, but known fittings include the ships carrying pennant numbers 818, 856 and 890.

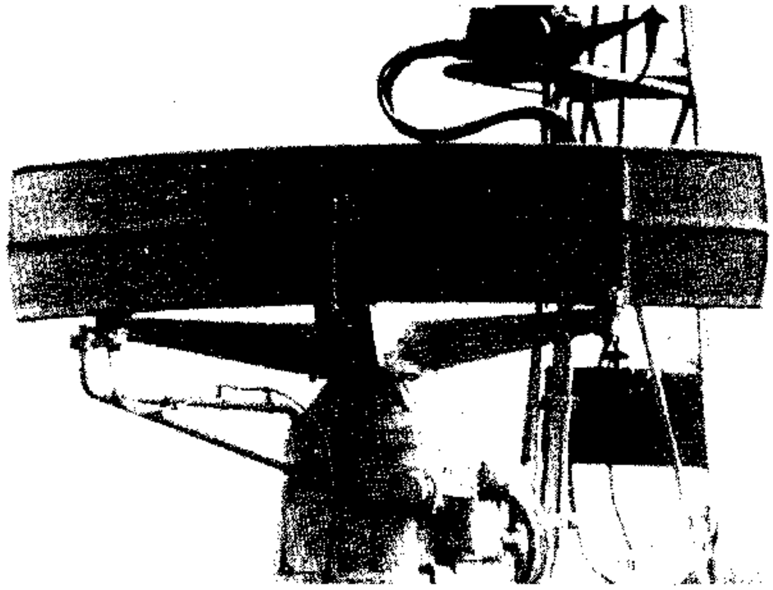


The Soviet "Sverdlov" class cruiser. Mikhail Kutuzov, *showing Top Trough radar on aft mast. Knife Rest (Uda-Yagi) antenna for air warning can just be discerned forward of aft gun turrets*

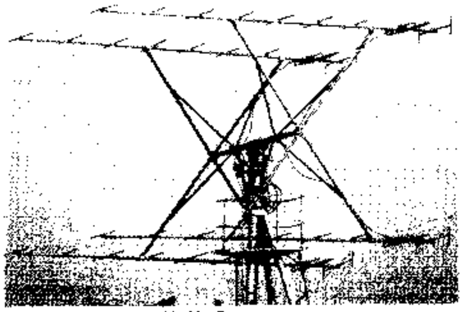
1900.253
OTHER SOVIET NAVAL RADARS

GENERAL:

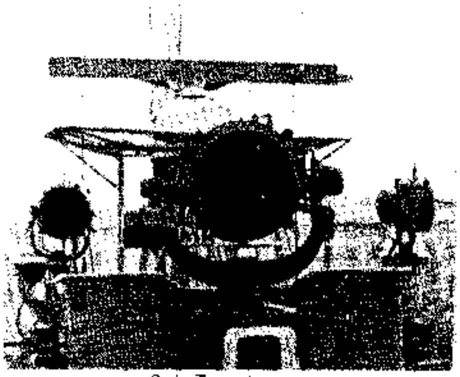
Photographs have been obtained of a number of other radars fitted to ships of the Soviet Fleet additional to those described in the preceeding entries. Insufficient information is available to make possible individual entries, but the photographs are reproduced to assist readers with identification.



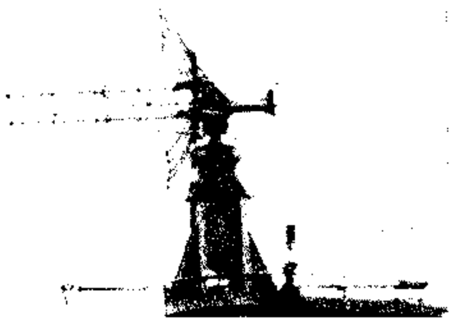
Ball Gun



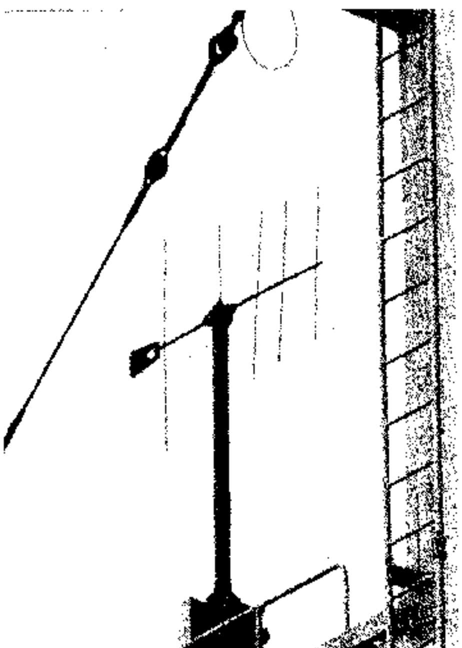
Knife Rest



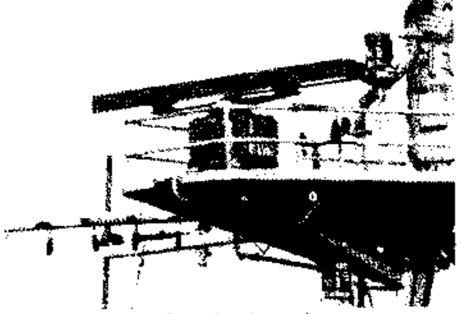
Spin Trough



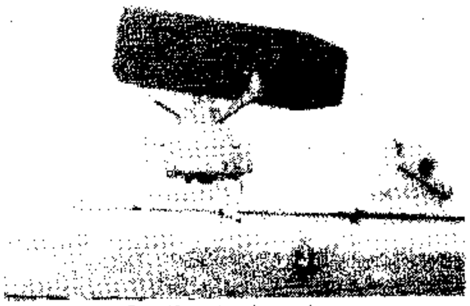
Sea Gull on Sverdlov cruiser



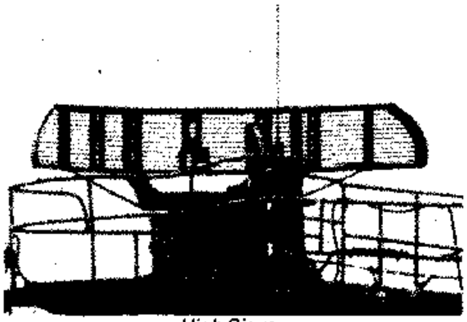
Yard Rake



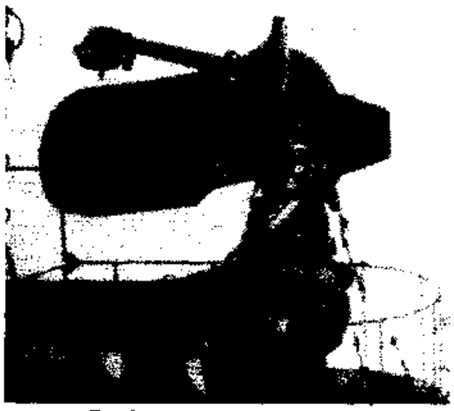
Don-2 navigation radar



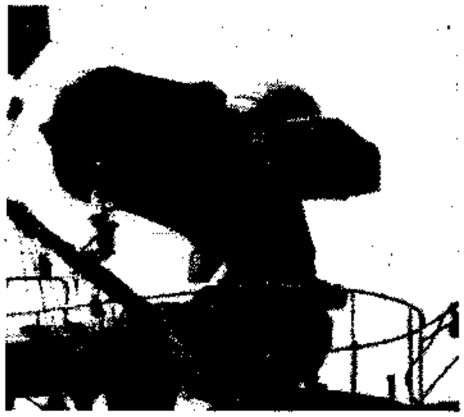
Don K navigation radar



High Sieve



Top Bow gun fire control radar



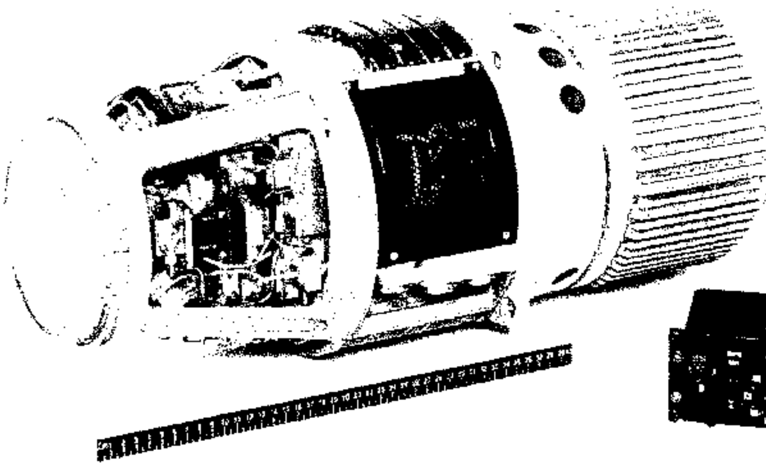
Top Bow

AIRBORNE RADAR

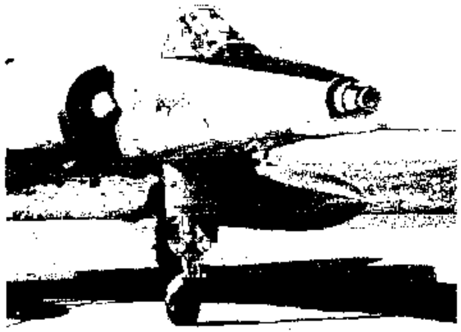
FRANCE

1793.353
ORB-31 AIRBORNE RADAR
DESCRIPTION:
The ORB 31 designation covers a series of X-band radars for use on helicopters or small aircraft, and the main functions are surface vessel detection, navigation, and also as a weather radar. The range of equipment includes two transmitter/receivers (12 and 30 kW), and several antenna options, from which installations appropriate to a variety of missions can be assembled. A typical system employs two transmitter/receivers, one for long range detection and the other for target tracking, two display units for pilot and observer, respectively, and a stabilised antenna.
DEVELOPMENT:
The ORB-31 was developed from the ORB-3 which was a license-built version of an Ekco weather radar.
STATUS:
The ORB 31 has been selected for use in French WG 13 helicopters.
MANUFACTURER:
Omera-Segid, 49, rue Ferdinand Berthoud, 95 Argenteuil, France.

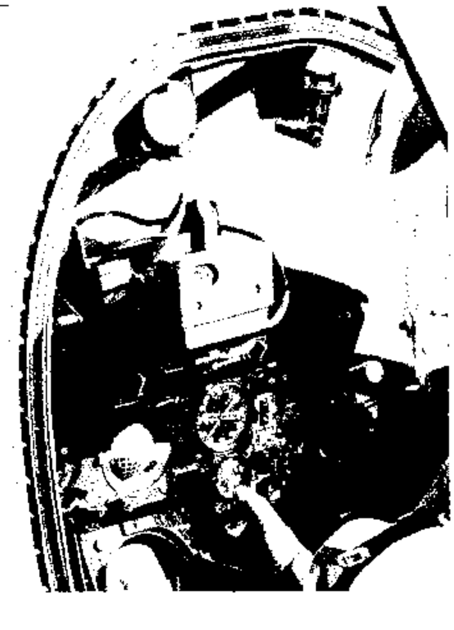
1211.353
AIDA II FIRE CONTROL RADAR
DESCRIPTION:
The Aida II fire control radar is a miniaturised equipment designed for installation in light interceptors and aircraft with restricted accommodation in the nose. It is also suitable for pod mounting. It performs automatic search, acquisition and range tracking of targets (air or sea) within a cone of 18 degrees. It can also supply the surface range in the boresight axis. Used with a gyroscopic gun sight it will supply all the data necessary for interception and attack by guns, rockets, bombs or missiles, namely: range of the target or ground, angular position of an air or sea target with respect to the boresight axis, gravity drop and sensitivity corrections for air-to-air firing.
The aerial is fixed, and is of the lens type, giving a beamwidth of 18 degrees. Lens diameter is approximately 15 cm. Operating frequency is in the X-band, and transmitter power is between 80 and 100 kW. Overall weight of the system, with radome, is about 30 kg. Length is 65 cm, and maximum diameter 23.5 cm. The radar is mounted in the aircraft by a single nut 26 cm in diameter, and there is a metal ferrule supporting the radome attached to the airframe.
The radar is contained in a ventilated housing, with forced air circulation. Integrated circuits are used in the electronics, which include a magnetron as the microwave power source. The electronics are packaged in a number of interchangeable sub-assemblies – aerial and microwave sections, modulator/transmitter, receiver, search and range tracking circuits, sensitivity and gravity drop correction computer, power supply, and safety circuits. Built-in test facilities are provided.
The modular design of Aida II is also used to make available two optional versions of this radar. Version A provides for air-to-air and surface-to-air ranging without measurement of target angular position, and this model does not have Module 2 (air to ground ranging and off-axis angles). Version B provides for air-to-air and air-to-surface ranging (without angular target measurement) and air-to-ground ranging, this model being obtained by adding Module 1 to the 'A' version of


Aida II lightweight airborne ranging radar

Aida II.
The design also allows for the radar's use with missile firing and bombing computers. The former has provision for the control and firing of infra-red Sidewinder, AS-20, AS-30 and other missiles, in the air-to-air and air-to-surface modes, depending upon the missile used. The latter computer permits the processing of data necessary for bombing against sea or land targets.
DEVELOPMENT
The Aida II is a successor to the Aida fire control radars fitted in French Navy Etendard IV aircraft, and development work is understood to have commenced in the mid-1960s.
STATUS:
No details of production plans are known. Aida II has been installed in a Mirage 5 (the simplified version of the Mirage III), and another possible vehicle for this radar is the Jaguar strike aircraft. In 1971 an agreement was reached between EMD and Emerson Electric Company, in the USA, which gives the latter sales and manufacturing rights for Aida II in the US, Canada and US Military Assistance Programme markets. In return, EMD has rights to Emerson APQ-153 (Empire) and Emair radars outside those markets.
MANUFACTURER:
Electronique Marcel Dassault, 55, quai Carnot, 92-Saint Cloud, France.


Aida II radar installation in Mirage 5 aircraft

1051.353
CYRANO II AIRBORNE ATTACK RADAR (RA 537)
DESCRIPTION:
Airborne AI radar providing search, tracking and air to air interception modes, plus air to ground modes and terrain mapping. Monopulse, X band, set employing a Cassegrain scanner and with a transmitter peak power of 200 kW. Liquid-cooled and housed in a pressurised radome nose-cone. Head-down CRT and electro/optical head-up display pilot information displays are provided.
OPERATION:
Two scan patterns are available for the search phase of an attack, the broad sector scan covering plus and minus 60 degrees in azimuth and the reduced sector, plus and minus 30 degrees. This pattern can subsequently be changed to elliptical scanning for automatic lock-on to the target. When the target has been acquired, radar data is fed to an analogue computer which generates demand signals for presentation on HUD to provide the pilot with guidance for the optimum intercept conditions. The computer also calculates weapon firing time and generates break off guidance demand signals for presentation to the pilot.
For missile attacks, the radar interception computer ensures that the approach is such that the target cannot be beyond the radar detection volume. Missile collision is sought at the optimum firing time which is calculated by a second computer designated the firing zone computer.
A fourth scan pattern is employed for ranging in both the air-to-air and air-to-surface modes. In this the beam follows a circular pattern, centred on the aircraft axis.
Scan patterns and the various operating modes of the radar are selected from controls mounted on a radar control stick. This carries push buttons for adjusting aerial tilt, receiver gain control, lateral displacement of the reduced sector scan datum, ranging marker displacement control, and radar lock-on and unlock facilities.
Other operating modes provided include ground mapping (presumably with a 'beam-spoiler' to produce a cosecant-squared radiation pattern); terrain warning and clearance, using


Cyrano II installed in Mirage IIIE. The Head-up Display attack sight and radar CRT display unit can be seen

contour mapping and clearance plane techniques; ground ranging and navigational modes. The last of these modes incorporates a 'freeze' facility which enables the terrain picture at any instant to be retained on the radar screen.

DEVELOPMENT:

Development of Cyrano II was started by CSF (now part of the Thomson-CSF group) under French Government contract in 1960. The first prototype was completed in 1962 and the radar entered service in 1963.

STATUS:

Cyrano II is still in production and 1000 sets had been delivered by March 1974. It is fitted to Mirage III aircraft of the French Forces and those of a number of other nations.

MANUFACTURER:

Thomson-CSF, Division Equipements Avioniques et Spatiaux, 178, Bd Gabriel Péri, 92 240 Malakoff, France.

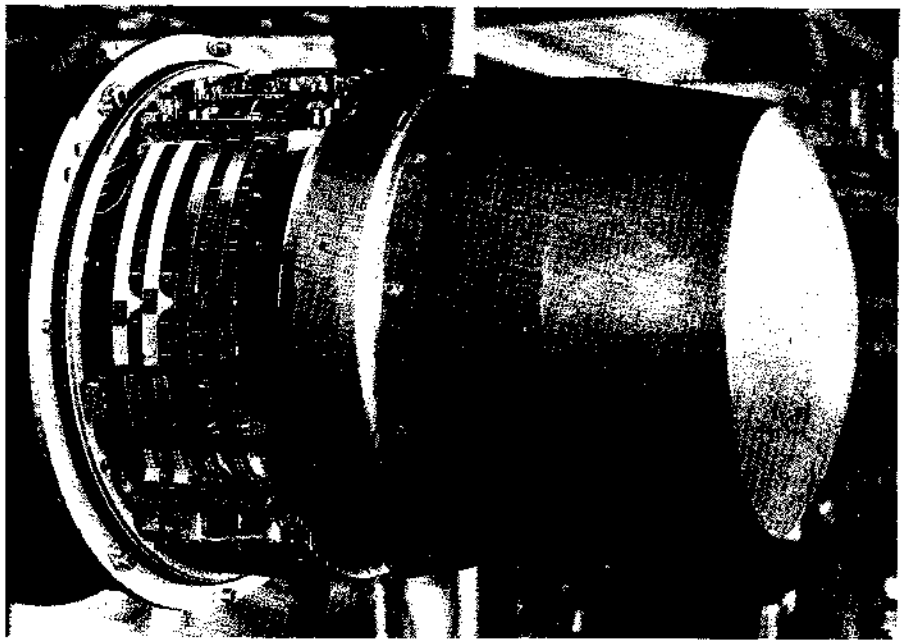
1052.353
CYRANO III FORWARD LOOKING RADAR (RA 538)

DESCRIPTION:

The Cyrano III designation embraces a range of nose radars which is also referred to by the manufacturers as the Cyrano 30 Series. Unlike the Cyrano I & II equipment, which was essentially designed for specific aircraft types (Mirage III), the 30 Series is intended to cater for numerous types of aircraft and a variety of operational roles.

This functional flexibility is achieved by the use of modular design, with a high degree of commonality and compatibility between units, and the availability of additional elements which can be incorporated either in the main radar pack or elsewhere in the aircraft to provide extra operational facilities.

Like Cyrano I and II, the RA 538 set is magnetron powered, but performance has been improved in a number of ways. Range has been increased, more sophisticated signal processing techniques are employed, such as doppler filtering to provide MTI facilities and improved performance in air-ground modes. Circuitry is now solid-state, and self-test facilities are provided. Operational frequency is in the X-band and peak transmitter power is 200 kW. A Cassegrain scanner system is used.



Cyrano III airborne radar

DEVELOPMENT:

Development was initiated by CSF (now a member of the Thomson-CSF group) as a private venture in 1967 and the first prototype was completed in 1968. Entry into service was in 1970.

Considerable use was made in the development of Cyrano III, of the experience in terrain following and obstacle avoidance radar techniques gained in the Cobra radar programme. This was conducted with French Government support and was largely an experimental project. There are no known production plans for Cobra.

STATUS:

The Cyrano III has been designed for modernisation of the fire control system of the Mirage IIIE. (Performance is believed to be very close to that of the Cyrano IV.)

MANUFACTURER:

Thomson-CSF, Division Equipements, Avioniques et Spatiaux, 178, Bd Gabriel Péri, 92 240 Malakoff, France.

1396.353
CYRANO IV ATTACK RADAR

DESCRIPTION:

The Cyrano IV is the latest development of the Cyrano series of airborne radars and is a multi-role equipment. In general appearance it is similar to the Cyrano III above, and has a similar wide range of functional options. It forms part of the Murol nav/attack system, the other elements of which are: Type 196E gunsight, air-to-ground attack computer Type 32D, laser range-finder Type TAV-38, navigation indicator Type LC 102. Other inputs to the system can include, doppler or inertial navigational data, altitude, and Air Data Computer.

Operational roles specified are: all-weather air interception and attack, with guns or missiles; air to ground attack, with guns, rockets or missiles; dive and pull-out bombing or low-level retarded bomb attacks; blind bombing.

STATUS:

Series production of one version is in progress for French l'Armée de l'Air F1 aircraft, and several versions for export for air-to-air and air-to-ground applications are in progress.

MANUFACTURER:

Thomson-CSF, Division Equipements Avioniques et Spatiaux, 178, Boulevard Gabriel Péri, 92 Malakoff, France.

CYRANO IV – 100 SERIES:

Thomson-CSF is understood to have in development a new family of modular digital radars under the above designation, for installation in export versions of the F1 M53 aircraft. Starting from a basic fire control radar, a multi-role capability (including terrain following) can be attained progressively by the incorporation of optional additional facilities.

1351.353
ORYX ATTACK RADAR

DESCRIPTION:

The EMD Oryx is a nose-mounted Ku-band attack radar providing facilities for air-to-air and air-to-surface attack, terrain mapping, and terrain following. Peak power is 100 kW and weight of the nose unit, including radome and structure is 90 kg. The receiver has a quoted overall noise factor of less than 10 dB and total gain of over 80 dB. AFC (Automatic Frequency Control) is provided over a range in excess of 60 MHz, and STC (Sensitivity Time Control) between 0.5 and 10 km.

The antenna is flat, slotted waveguide array, stabilised in pitch and roll, and with a maximum deflection of +60 degrees with respect to the aircraft axis. Antenna characteristics include a beamwidth of 12 degrees in azimuth and 2.8 degrees in elevation. Linear polarisation is employed, and average gain on the antenna axis is 28 dB. Monopulse facilities in azimuth and elevation are available in ranging modes of operation.

Inputs to the radar from other aircraft systems are roll and pitch data, angle of incidence, radio altimeter height, barometric height, vertical acceleration and ground or air speed.

OPERATION:

Operational modes listed by the manufacturer are: terrain following; ground mapping and navigational up-dating; air-superiority with guns and infra-red homing missiles (most semi-active radar homing missiles use X-band frequencies, and therefore are unsuitable for use with the Ku-band Oryx); bomb missions; and anti-shipping strikes.

In the terrain following mode, the beam is scanned in the vertical plane only, thus covering a volume ahead of the aircraft axis of 6 degrees left and right of the axis and plus 10 degrees and minus 30 degrees in elevation. Azimuth beamwidth (i.e. 12 degrees) is stated to be sufficient to enable crosswind effects to be neglected at operational flight speeds. It is not known what, if any, arrangements are made for turning flight at low levels, but EMD states that "in all cases, the clearance with respect to side obstacles remains sufficient".

Climb and descend demands for presentation to the pilot are based upon a computed 'protection profile', similar to that used in the Ferranti terrain following radar (Entry No. 1034.353, Janes Weapon Systems 1969-70). Any obstacles detected by the radar which penetrate this curve require an avoiding manoeuvre, and a computed demand signal is generated depending on the rate of obstacle penetration within the protection profile and a predetermined clearance value. The clearance value is dependent upon the selected clearance height, flight conditions, dive angle, load factor, and range and height of the obstacle with respect to the aircraft.

Both head-up and head-down CRT displays are employed in the terrain following mode. On the former, symbols are used to indicate pitch demands necessary to obtain the selected terrain clearance. This is repeated (in a different form) on the CRT which has a total of three separate but simultaneous displays, one above the other. Below the demand signals are an elevation/range presentation showing the radar profile ahead of the aircraft in comparison with the protection profile, and below that a lateral artificial horizon presentation.

In the ground mapping mode of operation, a 'one-beamwidth' (i.e. 2.8 degrees in azimuth and 12 degrees in elevation) scan pattern extending 60 degrees on each of the aircraft axis is used. This is presumably achieved by rotating the scanner sub-assembly in roll through 90 degrees from the terrain-following position, see photograph. There appear to be no provisions for depressing the boresight of the radar, which implies that in level flight at 1,000 metres the nearest ground ahead illuminated by the radar will be slightly less than 10 km from the aircraft's position.

A storage tube indicator is provided, and in the case of two-seat aircraft, the navigator is equipped with a high-definition remanent indicator CRT. Data presented in addition to the radar map includes a speed marker and updating reference marker. This mode cannot be used at the same time as the terrain following mode.

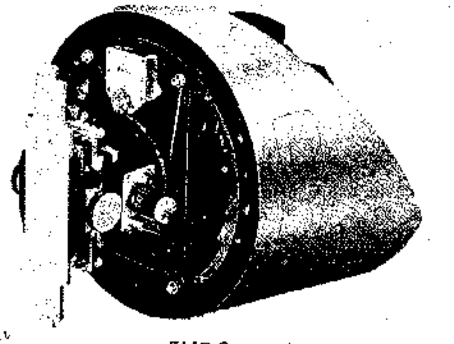
In the search phase of the air superiority mode, the pilot can select either wide or limited search scanner patterns. In the former, the scan pattern covers a zone of 12 degrees in elevation and ± 60 degrees in azimuth. These figures suggest that the scanner assembly is rotated so that the 12 degree dimension of the beamwidth is aligned with the vertical axis, with scanning taking place in azimuth. The head-down CRT display is used for target acquisition.

For the limited search pattern, the scanner is rotated through 90 degrees so that the 12 degree axis of the beam is aligned with the (lateral) horizontal and vertical scanning is used to produce a scanned zone 12 × 12 degrees. Display is by means of the head-up presentation, and target acquisition is automatic. A radio altimeter input is used to provide an altitude gate to prevent locking on to ground echoes.

In the tracking phase of the air superiority role, the scanner in elevation, echo position, compared with a tracking pulse, provides a lock-on pulse which stops the range search, and an error signal from the time discriminator which facilitates range slaving. A speed memory allows for tracking targets in the face of fluctuating or interrupted reception. Target range and angular deviations are presented on the head-up display.

DEVELOPMENT:

The Oryx is the latest in a line of development started in the mid-1960s with the Antilope. This was a private venture by EMD and was unsuccessfully proposed for a number of aircraft projects. This had a segment Cassegrain type scanner. At the 1969 Paris Air Show the Antilope II was shown, this having a flat slotted waveguide antenna in place of the Antilope I's Cassegrain system. The Oryx, revealed at the Paris Air Show in May 1971 is a further development of the Antilope II. Weights of the three models (nose unit only) are Antilope I – 160 kg, Antilope II – 70 kg, Oryx – 90 kg.



EMD Oryx radar

STATUS:

No production plans for this radar have ever been announced and the programme may now be moribund.

MANUFACTURER:

Electronique Marcel Dassault, 55, Quai Carnot, 92 St Cloud, France.

1672.353

AGAVE AIRBORNE RADAR

DESCRIPTION:

AGAVE is the definitive version of an airborne radar developed for use on naval aircraft, and which has evolved from the RH 370 helicopter radar (Entry No. **1395.353**, JANE'S WEAPON SYSTEMS 1972-73).

Basic functions of Vigie series radars are:

(1) Air-to-surface vessel search
(2) Target designation for the homing head of an active missile or to a sighting system
(3) Ground mapping
(4) Air-to-air search
(5) Automatic tracking of air or sea targets
(6) Ranging of air or surface targets

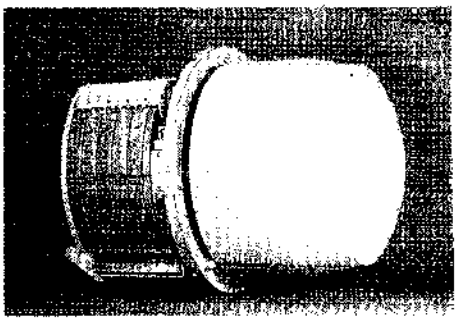
Additional optional functions are:

(7) Contour mapping
(8) Blind penetration
(9) X-band beacon reception
(10) Navigation up-dating and target designation to a bombing computer

The basic characteristics of the radar are: monopulse operation, X-band frequency, solid-state electronics using thick-film ICs, and built-in test facilities. In the ASV role a detection range of 22 to 35 nautical miles against a patrol boat target is claimed, and in the air target mode a fighter aircraft can be detected at ranges between 13 and 22 nautical miles. In both instances the exact range performance will depend upon the scanner size employed. To suit the more confined installation space in the nose of fighter aircraft, inverse Cassegrain scanners of several diameters are available. They are pitch and roll stabilised and have a scanning sector of 140 degrees.

STATUS:

The definitive AGAVE version has been ordered into production for installation in French Fleet Air Arm Super-Etendard aircraft. The programme is being conducted in collaboration with Electronique Marcel Dassault.



AGAVE airborne radar

MANUFACTURER:

Thomson-CSF, Division Equipements Avioniques et Spatiaux, 178 Bd Gabriel Péri, 92 240 Malakoff, France.

1352.353

SAIGA HELICOPTER RADAR

DESCRIPTION:

The EMD Saiga is a Ka-band radar designed to provide obstacle warning and avoidance facilities for helicopters flying at low levels. Peak output power at a frequency in the 35 GHz band is about 7 kW, and a pulse length of 0.2 microseconds is used. Overall noise figure for the system is quoted as being less than 13 dB. Weight of the radar with radome is 53 kg, and of the display unit 12 kg.

The antenna array consists of a pair of 44 cm diameter parabolic dishes with through feeds and sub-reflectors. These are mounted back-to-back within a gimbal ring which rotates about a vertical axis. This assembly is rotated at 660 rpm to provide azimuth scanning. The twin dish is supported within the gimbal ring with freedom to rotate about the horizontal axis. Rotation about this axis is controlled to provide pitch and roll stabilisation. Beamwidth of the scanner is 1.3 degrees and the limits of scan are greater than ±80 degrees in azimuth in respect of the fore-and-aft axis, and greater than ±10 degrees in elevation with respect to the velocity vector. The system can operate at speeds between 0 and 270 knots, and can provide a minimum clearance altitude of 30 metres.

OPERATIONS:

The principle function of the Saiga radar is obstacle avoidance to permit all-weather and night operations at low level, but it may also be used for navigational purposes and homing onto transponder beacons for tactical applications.

Saiga helicopter radar installation

In the obstacle avoidance mode, it will indicate pylons, overhead cables, etc in addition to high terrain. Avoidance manoeuvres are performed manually, using either of two display presentations available with Saiga. Both are CRT displays.

Type B (azimuth/distance) is a scan converted display with a maximum range of three nautical miles. This shows only dangerous obstacles to permit either lateral avoiding changes of course or braking manoeuvres. Solid lines on the display denote range and the braking distance is represented by a dotted horizontal line. Attitude information is given at the top of the display.

Type C (azimuth/elevation) presentation provides for either lateral or vertical avoiding action. Range scales of either one or three nautical miles can be selected. The desired clearance altitude is selected by the pilot. Dangerous obstacles are then displayed above a solid horizontal centre line on the display which represents the clearance attitude. Attitude information is displayed as in the Type B presentation.

DEVELOPMENT:

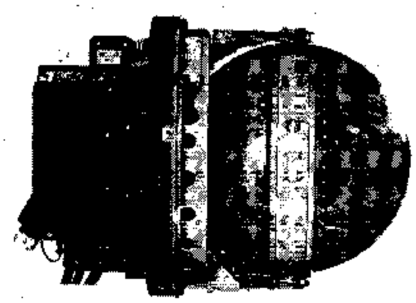
Development of the Saiga was started in the late 1960s.

STATUS:

Flight evaluations have been carried out by the French and US Services, but no production contracts are known to have been awarded.

MANUFACTURER:

Electronique Marcel Dassault, 55, Quai Carnot, 92-St Cloud, France.



Saiga helicopter radar

1674.353
NR-AI-3-A AIRBORNE IFF INTERROGATOR

DESCRIPTION:

The NR-AI-3-A system is based on the LMT ER-115-A transmitter/receiver unit. This incorporates a coder, one transmitter and one or two receivers. The respective operating frequencies are 1030 MHz and 1090 MHz. The equipment is designed to provide certain types of aircraft with secondary surveillance radar and IFF interrogation capabilities, and the possible Modes are 1, 2, 3/A and C, with Mode 4 if the system is equipped with a suitable coder and decoder. Up to four modes may be interlaced. Transmitter power can be selected at any one of three levels, 0.5 1, or 2 kW. Apart from the one transmitter tube, the equipment is all solid-state, and weighs 8 kg.

MANUFACTURER:

Le Matériel Téléphonique, 46/47, Quai Alphonse Le Gallo, 92103 Boulogne-Billancourt, France.

INTERNATIONAL

1784.353
AN/APS-503 AIRBORNE RADAR

DESCRIPTION:

The Canadian Department of Supply and Services has awarded a \$2.2 million contract for helicopter surveillance radars to a team made up of Litton Systems (Canada) Limited of Rexdale, Ontario, and AIL, a division of Cutler-Hammer, Deer Park, New York. The radars will be installed in CHSS-2 Sea King helicopters that are used for surveillance, and search and rescue missions. Under the terms of the contract AIL will design and deliver three preproduction prototypes and Litton Canada will manufacture the required 51 production radars in Canada.

The surveillance radars designed to search for surface targets will also display prominent terrain features as an aid to navigation. The combined system weight, including antenna, transmitter/receiver, a PPI display and the radar control units will be approximately 45 kg. The radar primarily designed to meet standards established by MIL-E-5400 will be modified to reflect the severe vibration environment in the helicopter.

Design plans for the helicopter search radar call for the antenna to be mounted on the top surface of the helicopter, to the aft of the main rotor drive assembly. It will provide 360 degrees of azimuth coverage by scanning its 61 cm antenna reflector at 30 rpm. A tilt adjustment up to 8 degrees will be provided to accommodate different beam depression angles. The antenna will be roll and pitch stabilised to take out attitude changes of the helicopter of up to 20 degrees from straight and level flight. The entire antenna assembly will be housed within a top-mounted radome.

The PPI will be an 18 cm diameter display and will weigh about 11 kg. The range scale of the PPI is adjustable from 1 up to 100 miles full scale. Radar returns will be presented with north or aircraft heading at the top of the display, and a heading strobe superimposed on the video return displaying the pointing direction of the helicopter. Adjustable range and bearing markets, coupled to digital readout indicators, will be provided to give an accurate location of selected targets.

The first pre-production prototype was scheduled for flight tests late in 1973 and delivery of production units is due to start in the Autumn of 1974.

The operating frequency (fixed) will be in the X-band, between 9.2 and 9.4 GHz, and the transmitter will have a peak output power of 50 kW. Pulse length and PRF will be 0.5 microsec and 400 Hz, respectively. The scanner will be stabilised in roll and pitch within limits of ±20 degrees and the Tilt control will provide a range of ±8 degrees. The rotation rate will be 30 rpm.

MANUFACTURERS:

AIL Division, Cutler-Hammer, Deer Park, New York, USA.

Litton Systems (Canada) Ltd, Rexdale, Ontario, Canada.

SWEDEN

1208.353
UAP 12 SERIES AIRBORNE ATTACK RADARS

DESCRIPTION.

Range of nose-mounted, forward-looking radars for search and fire control applications in interceptor aircraft. The radars in this series are pulse radar equipments operating in the X-band of the spectrum. There are four main units in each installation: aerial scanner; main electronics unit containing transmitter/receiver, power supplies etc; indicator; and control panel. All versions use a Cassegrain aerial with conical scan feed, although it is believed that a conventional dish aerial was employed at one stage of development of this range.

There are three variants of the UAP 12 Series, of which the UAP 12102 can be regarded as the basic version. This is also known as the PS-03/A and is widely fitted in Saab Draken B and D aircraft. The UAP 12201 version is a variant of the basic model, but intended for use in interceptors without a fire control computer. The UAP 12301 is a ground attack version with similar mechanical design to the UAP 12102, and operating in the monopulse mode.

OPERATION:

UAP 12102: The following operation modes are provided – search, acquisition, lock-on, and tracking. A space-stabilised search pattern is used for air target search with pilot option of narrow or broad scan in azimuth and two-or four-bar in elevation. The pilot also selects appropriate range limits. A B-scope presentation is used on the pilot's display during the search and acquisition phases.

During the tracking phase, conical scanning is used to track the target, and for this purpose the aerial has a feed which produces a conically rotating lobe in space. The covered volume is displayed for tactical information in the form of a jizzle band. The pilot locks the radar onto the target by placing a marker over the target echo on the indicator. This action stops the search pattern and initiates the automatic range and angle tracking phases. When automatic lock-on has been established, tactical information is displayed on the indicator.

UAP 12301: The following modes are provided – surface search (sea or ground), navigation, air target search, low level search (ground obstacles and aircraft flying at low level).

A monopulse, four lobe, aerial feed is used in this version, angular displacement of the target from the radar boresight being derived by signal processing of the four received signals, one from each lobe of the aerial pattern. Lobe-shaping is also applied, to further improve performance, in the horizontal plane during surface search, navigation and air target search modes. Lobe-shaping in the vertical plane is applied in the low level search mode.

For search operations against surface targets, the aerial performs a space-stabilised search pattern in azimuth with an angle of elevation determined by aircraft altitude. A sector-PPI presentation is used for all modes of operation and swept gain is employed during ground search for presentation of echoes at various ranges with the same intensity. A mapping mode is also available.

DEVELOPMENT:

This series of airborne radars represents the second generation of L M Ericsson equipments of this type, the first being those built for the Saab Lansen aircraft. Development was started in 1954 as a part of the Saab Draken programme.

STATUS:

The UAP 12102 (PS-03/A) version is fitted to J35B and D Draken aircraft of the Swedish Air Force.

MANUFACTURER:

Telefonaktiebolaget L M Ericsson, M I Division, S-43120, Möndial, Sweden.

1209.353
UAP 13 SERIES AIRBORNE ATTACK RADARS

DESCRIPTION:

This is a range of forward-looking airborne radars for air and ground attack roles, and there are five known variants. All are pulse radars operating in the X-band of the spectrum. The range is based upon an improved version of the UAP 12 Series described in Entry **No. 1208.353**. Improvements include increased power and additional facilities.

The basic model of the range is the UAP 13102, which is also designated PS-01/A. It is fitted to the Saab Draken J35F. The UAP 13103 (PS-011/A) is similar to the UAP 13102 but is designed to be used with the S71N infra-red search and track set. Both these models are intended for use in aircraft having a fire control computer. The two corresponding versions for aircraft without such computers are the UAP 13202 and UAP 13203, respectively. The fifth variant of this series is the UAP 13301 which is a search radar for ground attack aircraft. Mechanical design of this set is as the UAP 13102 but with fewer sub-units, and other features and functions are as the UAP 12301 (See entry No **1208.535**).

OPERATION:

The most important additional feature of the UAP 13102 compared with the UAP 12102 is the provision for slaving of missile radar and infra-red guidance systems to the aircraft radar. The operational modes (search, acquisition, lock-on, and tracking) and the display facilities are broadly similar. A 2-bar scanner search pattern is used in the elevation plane for the UAP 13102, and a choice of 2- or 4-bar in the UAP 13103.

DEVELOPMENT:

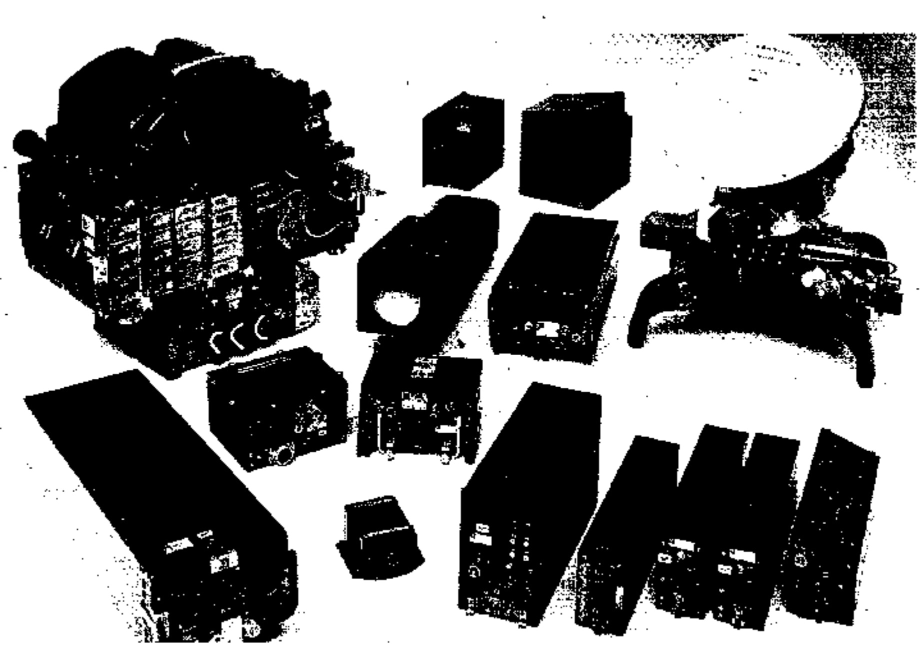
The UAP 13 Series is the outcome of continued development of the UAP 12 Series, and largely associated with the requirements of the J35F version of the Draken. The project started in 1959.

STATUS:

UAP 13102 and 13103 models are fitted to Swedish Air Force Draken aircraft, the latter variant of radar being the one used with the S71N infra-red search and track set.

MANUFACTURERS:

Telefonaktiebolaget L M Ericsson, M I Division, S-43120, Mölndal, Sweden.



The UAP 13104 radar installation for Finnish 35S Drakens

1210.353

UAP 1011 (PS-37/A) -AIRBORNE ATTACK RADAR

DESCRIPTION:

This is a multi-mode airborne attack radar, operating in the X-band, and using the monopulse technique. High output power is employed to provide long range performance. Cassegrain or parabolic dish scanners with fixed feed have been developed for this radar, but the latter is the preferred aerial system.

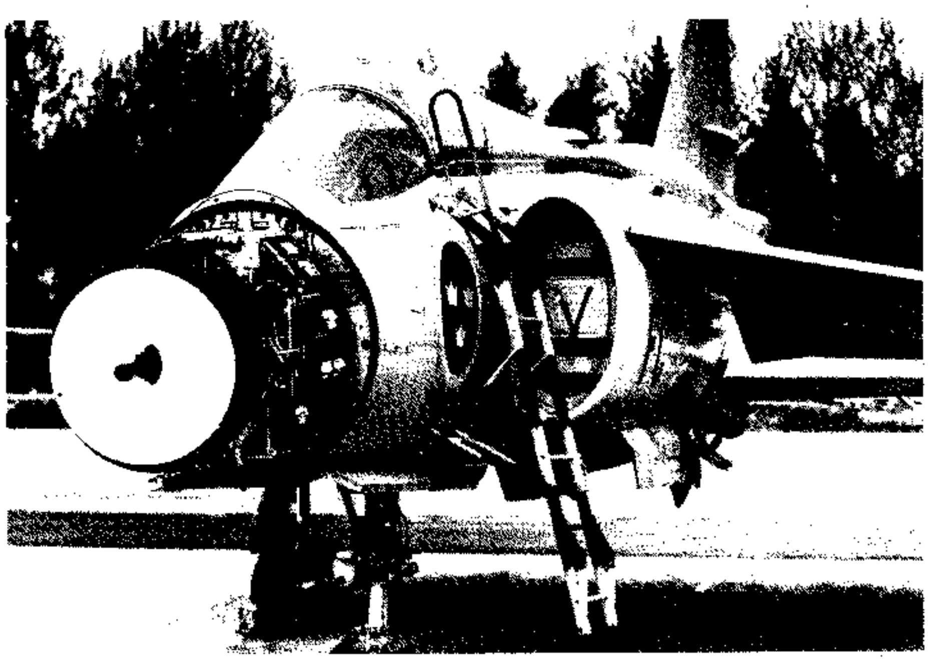
The UAP 1011 is an important element in the attack system of the Saab Viggen aircraft, and its design provides for considerable integration with the navigation, display, and the digital computer-based data processing sub-systems.
computer-based data processing sub-systems.

The radar is comprised of two main units, the electronics package and the scanner assembly. The former is made up of 13 replaceable units housed in a main assembly which carries the interconnecting cable looms. The division of electronic functions between the individual replaceable units has been arranged so that, as far as possible, related functions are housed within one unit, enabling the replacement of units to be effected without the need for subsequent trimming or adjustment. Each of the replaceable units contains between three and eight sub-units, which provide further facility for servicing.

With the exception of certain high-frequency devices, the UAP 1011 is a completely solid-state equipment. The mechanical design incorporates an hydraulic drive for the aerial scanning and stabilisation system, providing accurate and rapid movement over wide angles.

In the interest of high performance and optimum operational flexibility, including conditions of high interference (natural or ECM), elaborate signal processing facilities at both the radio-frequency and video levels are provided in the UAP 1011. Another technique employed to increase accuracy and resolution is lobe-shaping, which synthetically produces the effect of increased aerial aperture and reduced side-lobes.

In the Viggen installation both head-up and head-down display of radar information is provided, the data presented varying in accordance with the operational mode employed.



UAP 1011 radar in the 37 Viggen aircraft

OPERATION:

To comply with the requirements of operation of the Viggen by a single crew member (pilot), the UAP 1011 is designed for semi-automatic operation to reduce cockpit work-load. Facilities provided include: search, target acquisition, air target ranging, surface target ranging, obstacle warning fixed-point radar navigation, and terrain mapping. The system is designed to allow for terrain following by the addition of one unit.

Radar information is shown on the head-down display in the form of sector-PPI or B-scope presentation. This unit features a dual persistence CRT in which rapidly changing data (such as a radar map) is presented with a shorter persistence than alpha/numeric characters or other symbols. The latter can be used for the display of flight information or target designation, and are derived from a wave-form generator driven by the aircraft central digital computer.

DEVELOPMENT:

The UAP 1011 is the third generation of airborne radar equipment developed by L M Ericsson. Theoretical studies for a radar to meet the requirements of the Viggen were started in 1958, and ground tests on the first prototype took place in 1961. The first system-engineered model was built in 1965 and air tests began in 1966, with the radar fitted in a Lansen test-bed aircraft equipped with Viggen electronics. Verification tests in a Viggen took place in 1968, and production was ordered, starting in 1970. A new version for the Swedish fighter version of the Viggen (JA37) entered development in late 1971.

MANUFACTURER:

Telefonaktiebolaget L M Ericsson, M I Division S-43120, Mölndal, Sweden.

1741.353

DAX-100/200 SERIES AIRBORNE RADAR

DESCRIPTION:

The new radars being developed for the JA37 interceptor version of the Saab-Scania Viggen carry designations in the DAX series, the suffix number differing according to which prototype or test model is denoted. The eventual production version will have an entirely different designation. The advanced target search, acquisition and tracking system for the JA37 is based on the new radar, which is an X-band, all-weather search and fire control pulse-doppler equipment. Its specification calls for operation at all altitudes and attack angles, operation against all forms of background clutter (chaff, weather, etc) and incorporates high ECM resistance. The JA37 for which the radar is being developed will be armed with radar or infra-red guided missiles and guns.

The radar has a coherent high output power transmitter using a TWT and a newly developed Cassegrain antenna, with a two-gimbal motion system, giving extremely low side-lobe levels. Extensive use is made of digital techniques for signal and data processing, and the signal processor contains the doppler filtering and target tracking functions. Target data are extracted by software Kalman filtering in the processor, which by reprogramming can be adapted to changing ECM conditions. Moving ground targets are eliminated by appropriate waveform design, and the display has motion compensation to identify high- and low-speed targets. Built-in test facilities are provided.

The electronic display sub-system is the responsibility of the LMF subsidiary company SRA, and the type selected is an all-electronic arrangement comprising a digital processor and scan conversion driving CRT displays. The processor performs such data reduction tasks as correlation scan to scan, correlation between different sensor outputs, motion compensation, trail generation, and ECM processing. Depending upon circumstances, three presentation channels are available for use: head-up display for low level flight and close-in combat; head-down display for all-weather interception; and a tactical display electronic map for display of the combat situation and navigation.

DEVELOPMENT:

The DAX-100/200 radar is being developed by LME and SRA under contract on behalf of the Royal Swedish Air Force.

STATUS:

The first prototype began flight testing in a Saab Lansen testbed aircraft in April 1972 and by the end of that year 72 one-hour flights had been completed successfully. The same prototype has been used for ground tests also. In the course of 1973 further prototype models were brought into the programme.

MANUFACTURERS:

Telefonaktiebolaget L. M. Ericsson, MI Division, S-431 20 Mölndal, Sweden.

Svenska Radio AB, Alströmerg 14, Fack, Stockholm, Sweden.

THE UNITED KINGDOM

1785.353
UK AIRBORNE INTERCEPTION RADAR

DESCRIPTION:

In early 1974 it was announced that Marconi-Elliott Avionic Systems Ltd had been awarded a major contract for the initial phase of development of an advanced Airborne Interception Radar system for the RAF air defence version of the MRCA. The Electronic Systems Department of Ferranti Ltd will be major sub-contractor. The design of the new AI radar will draw on the latest technologies to provide a multi-mode system compatible with the size and weight limits of RAF air defence variants of MRCA and the operational requirements of the 1980s and beyond. A substantial part of the signal processing will be performed digitally, in addition to digital radar data handling. The new equipment will anticipate trends in offensive tactics, such as low-level penetration, use of ECM, etc, and will have the flexibility to operate as part of ground- or AEW-based control environments while retaining the capability for autonomous operation if these facilities are absent or degraded by enemy act on.

MANUFACTURERS:

Marconi-Elliott Avionic Systems Ltd, Airport Works, Rochester, Kent, England.

Ferranti Ltd, Electronic Systems Dept, Ferry Road, Edinburgh EH5 2XS, Scotland.

1740.353
EMI SEARCHWATER AIRBORNE RADAR

DESCRIPTION:

Searchwater is the commercial name of the airborne maritime search radar being developed by EMI Electronics for use by the RAF. The military designation and all but general technical details of the equipment remain classified information.

The operational requirements against which this radar is designed are the ability to detect small objects such as submarine 'snorts' and periscopes in high sea states; good long-radar and navigation facilities. The specification calls for performance which is generally well in advance of most contemporary equipment according to the designers. Detection of small targets in clutter at ranges in excess of present standards will be aided by the use of frequency agility, and a digital computer for signal processing. It has been stated that Searchwater will incorporate a unique system that will enable radar returns to be examined in detail. The result of each detection will be fed into the computer, and a history built up. The computer will also allow a large number of targets to be tracked simultaneously, thereby easing the operator's task.

Targets are displayed on a single, scan-converted, TV-type display giving a bright flicker-free presentation. A number of display modes are provided and can be selected by the operator to suit the operational situation. In the search mode a PPI display is used, or the target area can be examined by selecting another form of presentation giving a magnified display. Ranges, bearings, and other data are displayed in alpha-numeric form.

The control equipment can be arranged to suit varying installation and operational conditions, but in general the control and operation of the radar is shared between the operator and the computer. Three ranges and automatic sector scan of the antenna are provided. IFF is integrated into the radar display and control console, with active and passive code/decode facilities. Comprehensive ECCM are incorporated.

DEVELOPMENT:

Searchwater is under development by EMI Electronics Ltd in response to a UK MoD contract.

STATUS:

At prototype stage.

MANUFACTURER:

EMI Electronics Ltd, Radar and Equipment Division, Hayes, Middlesex, England.

1023.353
EMI SIDEWAYS LOOKING RECONNAISSANCE RADAR TYPE P391

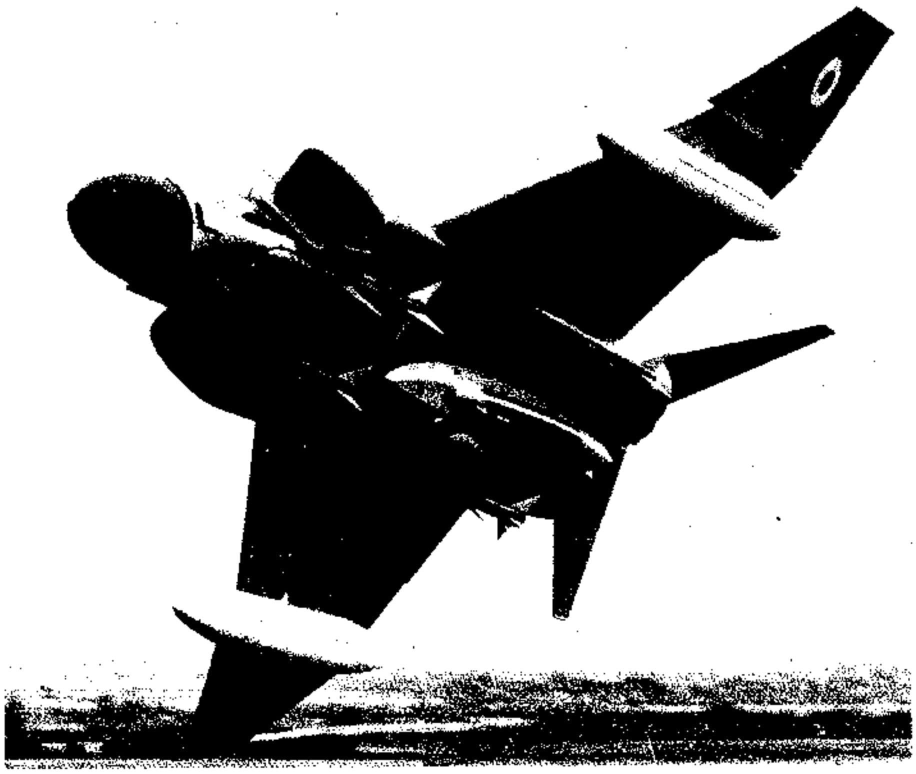
DESCRIPTION:

The Type P391 radar is a high definition equipment working in the Q(Ka) band. Two aerials are used for transmission and reception, one on each side. The resultant returns are recorded on 12.7 cm photographic film which is developed on return to base to provide a radar map of the terrain on each side of the path flown by the aircraft. The equipment is suitable for installation either in the aircraft itself or in a separate reconnaissance pack or pod.

The main units of the equipment are the transmitter/receiver, modulator, recorder, power units – one each for T/R and recorder, port and starboard aerials, and the control unit.

Aerials. Each aerial consists of an array of 12 slotted waveguides stacked vertically, the angle of fire in the horizontal plane being 4° away from the feed end. These are fed via a turret containing four microwave lenses, only one of which is in use at any time. These lenses control the phase and amplitude of the energy reaching the individual arrays in such a way as to give the required depression angles, together with some shaping of the nearside polar pattern to make it approximate to a cosecant squared law. Further correction and control of the overall sensitivity at each depression angle is applied by a swept gain system in the IF amplifiers.

Transmitter/Receiver Unit: This unit is housed in a cylindrical pressurised container and contains



Reconnaissance pod designed for RAF Phantom aircraft. It contains P391 radar, infra red linescan and cameras the magnetron, the RF output of which is fed via a duplexer to the RF switch. The RF switch, which is attached to the front of the T/R unit, connects the equipment alternatively to the port or starboard aerial at a rate of 237.5 Hz to give groups of 4 or 8 pulses on each side so that both sides may be recorded. Switching is achieved by the use of two ferrite rod Faraday rotators, the coils of which are driven by transistors in the unit. The switching is carried out just before the transmitter pulse so that no returns are lost.

Modulator: This is housed in a rectangular pressurised box and generates a 4 kV pulse of 230 kW peak power, duration 140 nanoseconds for driving the magnetron in the T/R unit. Power supplies are generated from the aircraft 3 phase 400 Hz supply.

Recorder: This is housed in a pressurised container, the major dimensions of which are dictated by the recording CRTs and optics. The CRTs used, type VX1711, have been specially developed to give the maximum overall resolution and to operate satisfactorily under vibration. Two such tubes are employed, each giving a 70 mm trace, images of which are focussed by high quality copying lenses on the film.

DEVELOPMENT:

Two types of linescan sideways looking radar were originally developed in collaboration by EMI and the Royal Radar Establishment for the TSR-2. One was an X-band equipment intended to fulfil a navigational role in addition to reconnaissance, and the other was the Q-band, high definition equipment, now designated P391. The P391 was incorporated in the reconnaissance pod developed for use with UK Phantoms.

STATUS:

In operational service with the RAF since 1970 at home and overseas.

MANUFACTURER:

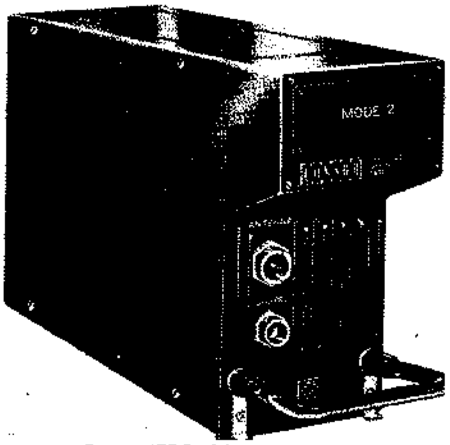
EMI Electronics Ltd, Hayes, Middlesex, England.

1572.353
COSSOR AIRBORNE IFF TRANSPONDERS

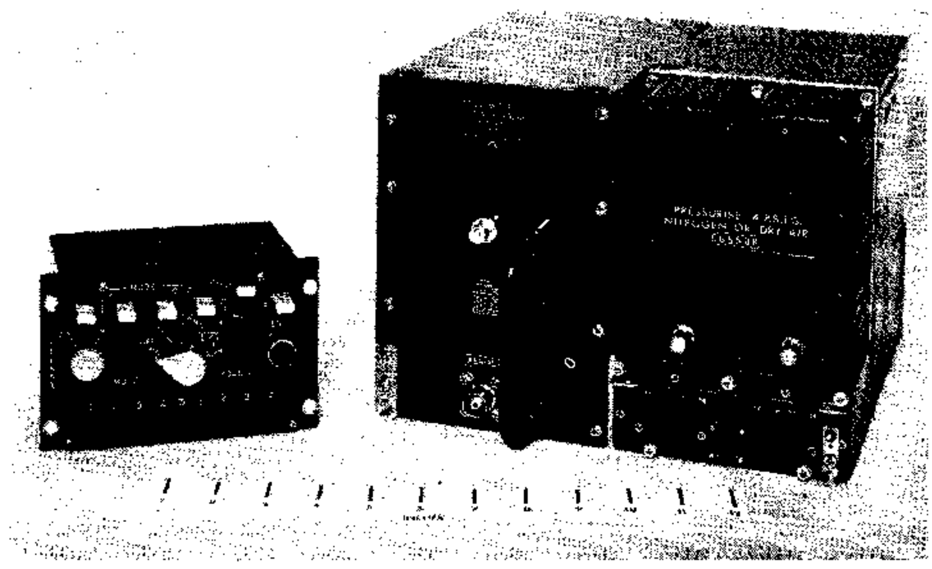
Cossor Electronics Limited are the prime suppliers of airborne IFF Transponders to the UK Government. Active in this field for many years, their current range of equipment includes microminiature IFF Mk.10(SIF) and SSR transponders conforming to the requirements of ICAO Annex 10 and STANAG 5017.

IFF1520

This transponder is designed for use in high performance military aircraft and is fitted to all first-line aircraft of the Royal Air Force and Royal Navy. Modes 1, 2, 3/A, B, C, and D, 4096 codes.



Cossor IFF 2720 transponder



Cossor SSR 1520 transponder with control unit

IFF 2720

Newly developed unit for military aircraft including strike-trainers and helicopters. Operating in modes 1, 2, 3/A, B and C and providing 4096 codes with provision for system expansion.

IFF 3000

Jointly developed with E.M.D. of France, this microminiature equipment is fitted to Belgian Mirage aircraft. Modes, 1, 2, 3/A, B and C, 4096 codes with provision for system expansion.

IFF 3100

Currently under development for high performance multi-role aircraft. Single package, microminiature equipment operating in modes 1, 2, 3/A and C with provision for system expansion.

MANUFACTURER:

Cossor Electronics Limited, The Pinnacles, Harlow, Essex, England.

1027.353
ARI 5955/ARI 5954 HELICOPTER TACTICAL RADAR

DESCRIPTION:

Airborne radar for ASV, ASW, MCM and SAR roles, designed specifically for helicopter installations. The ARI 5955 is the main radar set, capable of primary radar operation for the detection and location of air and surface targets. The ARI 5954 is a complementary transponder for use with the ARI 5955, and installation in friendly aircraft and surface craft to provide identification and increased range performance.

Operating frequency is in the X-band and a stabilised dish scanner is housed in a radome located on the upper surface of the fuselage, aft of the rotor pylon. Aerial tilt is adjustable from the radar operator's position, both above and below a horizontal datum. Receiver gain is adjustable, and variable swept gain facilities are provided. FTC (fixed time constant) operation can be switched in or out. A selection of range presentations, up to 50 nautical miles, is available.

The display unit employs a projection CRT in conjunction with a Schmidt optical system and field lens. This gives unusually high brightness over the 43 cm square plotting surface. An illuminated parallel-line protractor is incorporated.

The ARI 5955 transmitter/receiver unit has the following characteristics: X-band; transmitter peak power – 15 kW; pulse length – 0.5 microsecs; PRF – 400 Hz; IF frequency – 30 MHz; receiver noise factor – 10.5 dB max. The receiver includes a two-channel reception facility capable of being switched to receive either primary radar

ARI 5955/ARI 5954 tactical radar installation in Sea King helicopter, showing combined display/plotting console on left

returns or transponder responses.

The transponder has the following main features: interrogation frequency coverage – X-band; reply frequency – switched frequency X-band; IF pass-band 35-135 MHz; transmitter peak power – 100 watts; code pulse width 0.5 microsecs; dead time after interrogation and reply – 35 microsecs for single-pulse reply, 130 microsecs for coded reply; aerial beamwidth, azimuth – omni-directional, vertical – 30 deg; aerial gain 4 dB.

OPERATION:

Information displayed includes primary radar echoes from other aircraft, vessels and terrain up to a range of 50 n miles. Coded secondary radar responses from aircraft, helicopters or surface vessels equipped with the associated transponder units are also displayed. This secondary radar facility provides positive information and permits low-altitude helicopters to be plotted at much increased ranges in the presence of sea clutter. Both primary and secondary radar can be displayed separately or together. The range and bearing of sonar contacts are also indicated. The operator has the choice of three modes of presentation: conventional PPI, ground stabilised, ground stabilised with offset.

DEVELOPMENT:

Initial development was in response to a UK Government contract, and was conducted in collaboration with the Ministry of Technology.

STATUS:

The ARI 5955 entered RN service in 1968; it is known to form part of the Sea King ASW system (of which 82 have been ordered) and is assumed to be installed in all RN Wessex HAS 3 helicopters Production is continuing. Users, in addition to the RN, include the Australian, W. German, Norwegian, Indian and Italian Navies. Versions with two sizes of larger antenna are available. One such is being used for ice reconnaissance in Canada, the other being evaluated for an ASW helicopter with updated performance. Variants for use with missiles are under development.

MANUFACTURERS:

The MEL Equipment Company Ltd. Defence Systems and Avionics Division, Manor Royal, Crawley, Sussex, England.

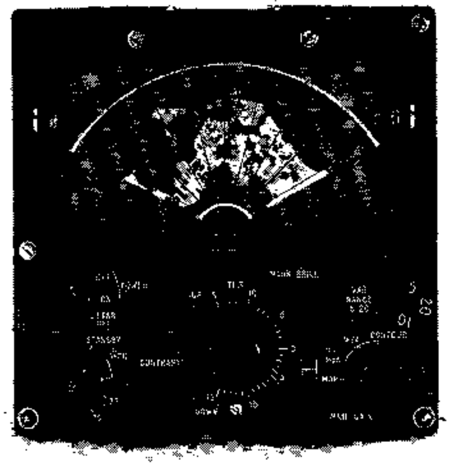
1028.353
E290M COMBINED TACTICAL AND WEATHER RADAR

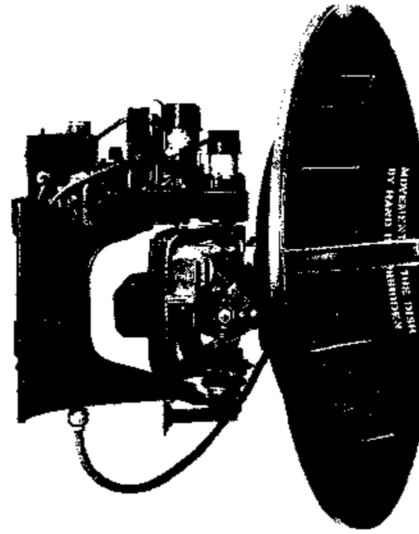
DESCRIPTION:

This is a military version of the widely used 'Ekco' E290 airborne weather radar with the addition of special features and facilities to suit it for a number of military roles. These include high definition terrain mapping and ASV (Air-to-Surface Vessel) functions.

The E290M systems are designed to provide not only long range weather and terrain mapping facilities, but also a special short range high resolution display, giving a capability in airborne approach and other roles, such as surface target detection. The duplicate type system is based on the E190/E290 duplicate system; it uses two Trans/Receivers, M3051B a 4 microsec 30 kW unit for long range weather and terrain mapping, and M3066A a ½ microsec 12 kW unit, which is especially intended for short range high resolution mapping.

The two Trans/Receivers are mounted side by side in a common tray with the Junction Box, which provides the unit changeover and cross switching facilities, at the rear. Either Trans/Receiver can be in operation with the other at warm standby or fully off. Thus long range surveillance is provided with the high power unit activated, and with rapid transfer facility the short pulse unit is available for the shorter range high resolution role. Should either Trans/Receiver unit fail each has a good performance in the other role, thus providing the in-flight reliability increase of a duplicate system, together with optimum long and short range characteristics.





Indicator and Scanner assembly for the Ekco E290M combined weather/tactical radar

The two Indicators M6300A, which can be operated simultaneously or alone, with either Trans/Receiver. Variants of E290M system are available employing one indicator and one Trans/Receiver, with Scanner type M2210 or M2267.

DEVELOPMENT:

Development was started as a private venture in 1966 and the first prototype was completed the same year. Entry into service followed in 1967.

STATUS:

The E290M system is now in service with the Canadian Defence Force. Over 100 systems have been delivered and are in service with the Canadian Defence Force and other Air Forces in fixed wing aircraft and helicopters. Variants for use with missiles under development.

MANUFACTURER:

The MEL Equipment Company Ltd., Defence Systems and Avionic Division, Manor Royal, Crawley, Sussex, England.

1031.353
AIRPASS I

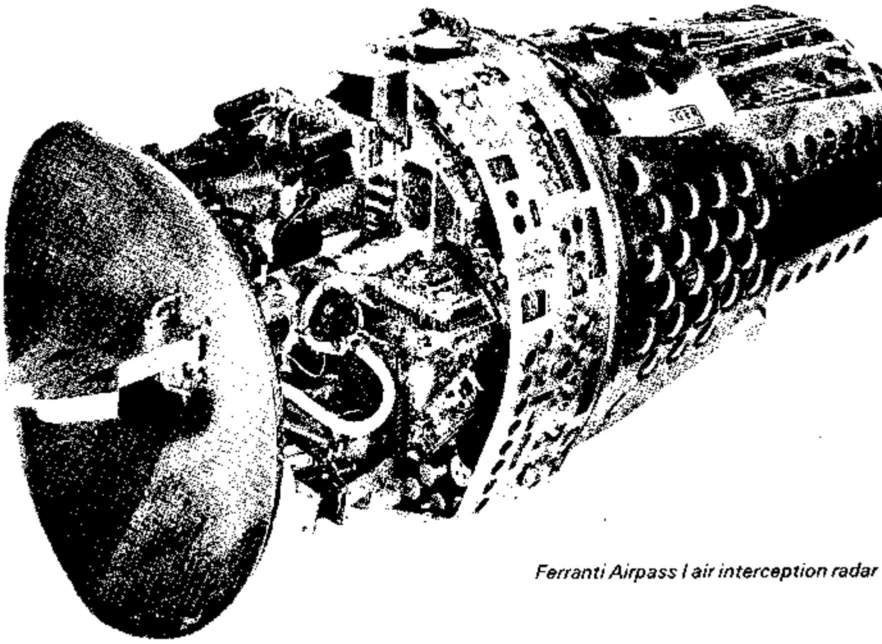
DESCRIPTION:

Forward-looking AI radar providing search tracking and ranging facilities. This equipment represents the later stage of development of AI radar using valved circuitry, now superseded by solid-state technology.

OPERATION:

Mechanical scanning of a twin-profile dish reflector with dual feeds is used to provide monopulse operation in the X-band sector of the radar spectrum. Constructional layout is designed to suit pod mounting of the radar within the nose air intake of interceptor aircraft. It is fully roll-stabilised.

Target search is carried out with the aid of a head-down display unit in the cockpit, with lock-on occurring once target identification has been achieved. The interceptor's approach course is calculated by a computer, which also determines launch point for the air-to-air missile selected by the pilot. Information from the computer is displayed to the pilot on a head-up display during the attack phase, permitting completely blind intercepts to be performed, if necessary. For targets of opportunity, where contact is made visually and little time is available, a radar ranging mode of operation can be employed. In this case, a search is carried out directly ahead of the aircraft, and lock-on is achieved on the first target detected. The range data may be used for either gun or missile attack. System weight is in the region of 113 kg.



Ferranti Airpass I air interception radar

The Airpass I has appeared in four versions: I, IB, IB(S) and I(SP). The IB is a developed version of the Airpass I providing increased countermeasure facilities and in which all attack information is displayed head-down. The export version of this equipment Airpass IB(S) also incorporates an air-to-surface capability for ground attack roles. Airpass I has been produced in a repackaged, short pack, version for export and is designated I(SP).

DEVELOPMENT:

Development of Airpass I by Ferranti under UK Government contract began in April 1954 and the first prototype was completed in March 1955. Entry into service with the RAF, installed in BAC Lightning aircraft took place early in1959, when it was claimed to be the first high-power monopulse AI radar to go into squadron service anywhere in the world. Work on the IB version started in November 1958, with first prototype completion in October 1960 and entry into service in December 1962. Production of Airpass I ceased October 1962, and of the IB in March 1969. A total of over 600 of all versions have been produced.

STATUS:

All known service installations have been in BAC Lightning interceptor aircraft of the following marks: F 1, F 2, F 3, F 6, F 1A, F 2A, F 53, T 4, T 5, T 55. Users include – Indian Air Force, Kuwait Air Force, RAF, Saudi Arabian Air Forces.

MANUFACTURERS:

Ferranti Ltd, Electronic Systems Dept, Ferry Road, Edinburgh EH5 2XS, Scotland.

1032.353
AIRPASS III

DESCRIPTION:

Forward-looking attack radar providing long-range air-to-surface search, ground mapping, radar ranging and tracking, terrain warning and conventional weapon aiming.

This radar is the latest in the Airpass series of equipments now in service. Mechanical design is similar in many respects to Airpass I and the operating frequency is within the same part of the radar spectrum (X-band). A monopulse radiation pattern is employed for tracking modes of operation, and it can be assumed that for ground mapping and ranging modes of operation, cosecant-squared and pencil beams, respectively, can be employed. The dish scanner reflector and feed arrangements of the Airpass III differ from those of Airpass I. A Cassegrain System being used in the former. Manufacturer's weight is 104 kg.

OPERATION:

Operational functions also differ as a result of this radar having been designed specifically for use in RN Buccaneer strike aircraft. Ground mapping, long-range air-to-surface search and ranging, terrain warning, and the ability to cater for a wide variety of weapons and stores, and a range of missions profile illustrates this. A head-down display is provided for the second crew member, and attack and guidance information is presented to the pilot via an Elliott head-up display. A version of Airpass III for use in SAAF Buccaneers incorporates a monopulse resolution enhancement facility.

DEVELOPMENT:

Development of Airpass III by Ferranti under UK Govt. contract began in September 1957 and the first prototype was completed in early 1959. Entry into service was in January 1962. Over 250 sets have been ordered and production is continuing.

STATUS:

All installations are in either the S Mk 1, S Mk 2 or S 50 versions of the Buccaneer. Further research into possible improvements is in progress in connection with the future operation of Buccaneer aircraft by the RAF, and the intention to carry Martel missiles on this aircraft. Users of Airpass III – Royal Navy, Royal Air Force, and the South African Air Force.

MANUFACTURER:

Ferranti Ltd, Electronic Systems Dept, Ferry Road, Edinburgh EH5 2XS, Scotland.

1033.353
AIRPASS II

DESCRIPTION:

Forward looking AI radar, based on Airpass I and providing similar operational modes, but with the addition of air-to-ground fire control and bomb aiming functions. Development was for use in dual-purpose interceptor/strike aircraft. Provision is also made for ground mapping, terrain clearance and avoidance and certain other modes of operation. It is reported to be somewhat smaller and lighter than Airpass I.

DEVELOPMENT:

Development of Airpass II from Airpass I was undertaken by Ferranti as a private venture.

STATUS:

Among aircraft types for which this equipment was proposed were the Mirage IIIs and Draken. No production contracts have been announced.

MANUFACTURERS:

Ferranti Ltd, Electronic Systems Dept, Ferry Road, Edinburgh EH5 2XS, Scotland.

1216.353
FERRANTI STRIKE & TERRAIN FOLLOWING RADAR

DESCRIPTION:

This radar is the developed version of the Ferranti Forward-Looking Radar, described in JANE'S WEAPON SYSTEMS, 1969-70 in Entry No. **1034.353** (p.477), and details of its operation, particularly in the terrain following mode appear there.

Principal characteristics include X-band transmitting frequency and a peak power of 70 kW. Two pulse lengths are employed: 2.3 microseconds at 400 pulse/sec for long-range mapping and 0.3 microseconds at 1500 pulse/sec for medium-range mapping and 0.5 microseconds at 3,000 pulse/sec for short-range mapping, terrain following, and radar ranging.

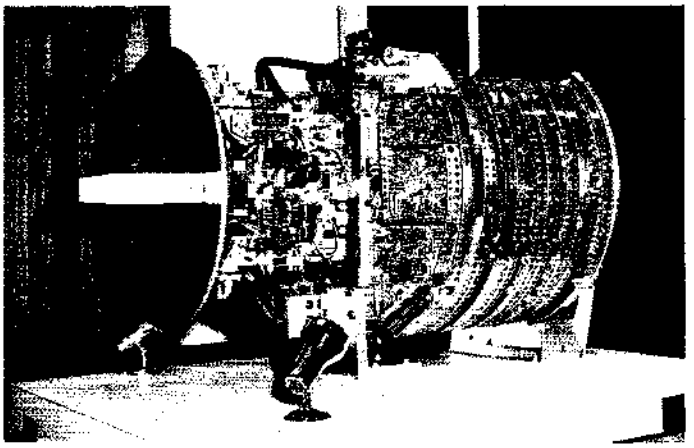
The aerial is a single plane monopulse unit with a 50.8 cm diameter dish and 4.6 degree beamwidth, or as required to suit the installation. Scan angles for mapping and beacon homing are ±55 degrees in azimuth and ±20 degrees in elevation, and vice versa for the other modes. Weight of the radar head is 91 kg and of the indicator 13.6 kg. Overall length is 103.25 cm, and maximum diameter 61 cm.

OPERATION:

The Ferranti SATF radar has the following principal modes of operation:

Terrain Following:

This provides facilities for: selection of any clearance height over all terrain between 60 and 300 metres; extension of minimum selectable clearance height down to 30 metres over water and flat ground; space stabilised steering outputs for manual control; duplicated pitch rate demand for autopilot coupling; speed range of 350 knots to Mach 1.0 without need for adjustment of parameters; full performance in turns of 45 degrees of bank at Mach 0.9; continuous automatic in-flight system test; and a manoeuvre monitor that ensures that terrain following demands are obeyed.



The Ferranti Forward Looking Radar. Originally developed for the TSR-2 strike aircraft

Radar Ranging:

The design caters for accurate ranging with particular emphasis on accuracy at low grazing angles consistent with the delivery of retarded stores from very low level. Successful ranging against airfield runway intersections has been achieved and the SATF has demonstrated its ability to lock-on at ranges in excess of 12 km. Lock-on has been accomplished and held during attacks on grazing angles as low as 3 degrees.

Ground Mapping:

Facilities in this mode include five range scales covering 0.36 km at 1 : 500,000 scale (with expansion to 1 : 15,000) if desired to 0.180 km at 1 : 2,000,000 scale; fan beam for short ranges by means of automatic spoiling; electronic marker for position fixing; track and ground stabilisation of display; monopulse resolution enhancement for improved azimuth discrimination.

Beacon Homing:

This facility gives assistance in identifying landing grounds or datum positions, in addition to rendezvous for flight refuelling or other exercises. Long pulse length is available for selective beacon interrogation. Ranges out to 180 km.

DEVELOPMENT:

Details of the early history of this radar were given in Entry **1034.353**. Five models have been flown on a Ferranti test programme using Buccaneer and Canberra aircraft. Several hundred sorties were flown over varied terrain and over 8,000 km were covered at a specified height of 60 metres. On one sortie, 320 km were flown in safety at 30 metres.

Continuing development is related to the use of frequency agility, which will (a) reduce ground and target glint, leading to better terrain definition and higher air-to-surface ranging accuracies, (b) reduction of sea clutter for improved target detection, (c) wide-band transmission to provide additional ECM protection.

MANUFACTURERS:

Ferranti Ltd, Electronic Systems Dept, Ferry Road, Edinburgh EH5 2XS, Scotland.

1224.353
PTR 820 AIRBORNE IFF

DESCRIPTION:

Lightweight L-band transmitter/receiver unit, together with an associated encoder-decoder and control unit, designed to provide certain aircraft with IFF interrogation facilities in Modes 1, 2, 3/A, B, C and D. Interlaced mode operation using any three modes is available. Mode selection is from the control unit, or the modulator can be triggered by an external pulse train. Passive decoding is to customer requirements.

Digital shift registers, using silicon integrated circuits are employed in the encode and decode sections, eliminating bulky and temperature-dependent delay lines. Solid-state digital defruiters use pulse-to-pulse validation techniques to ensure reliable operation in the presence of PRF jitter. A modular range store is used which can be matched to SSR range and mode requirements. The PTR 820 includes self-test facilities.

DEVELOPMENT:

Development was carried out by Plessey under UK Government contract, and was started in 1967. The first prototype was completed in mid-1969.

STATUS:

HS 801 Nimrod maritime aircraft of RAF Strike Command are equipped with the PTR 820, which was due to enter service in December 1970. 75 units had been ordered and five delivered at May, 1970. Foreign sales are pending.

MANUFACTURER:

The Plessey Co. Ltd., Vicarage Lane, Ilford, Essex, England.

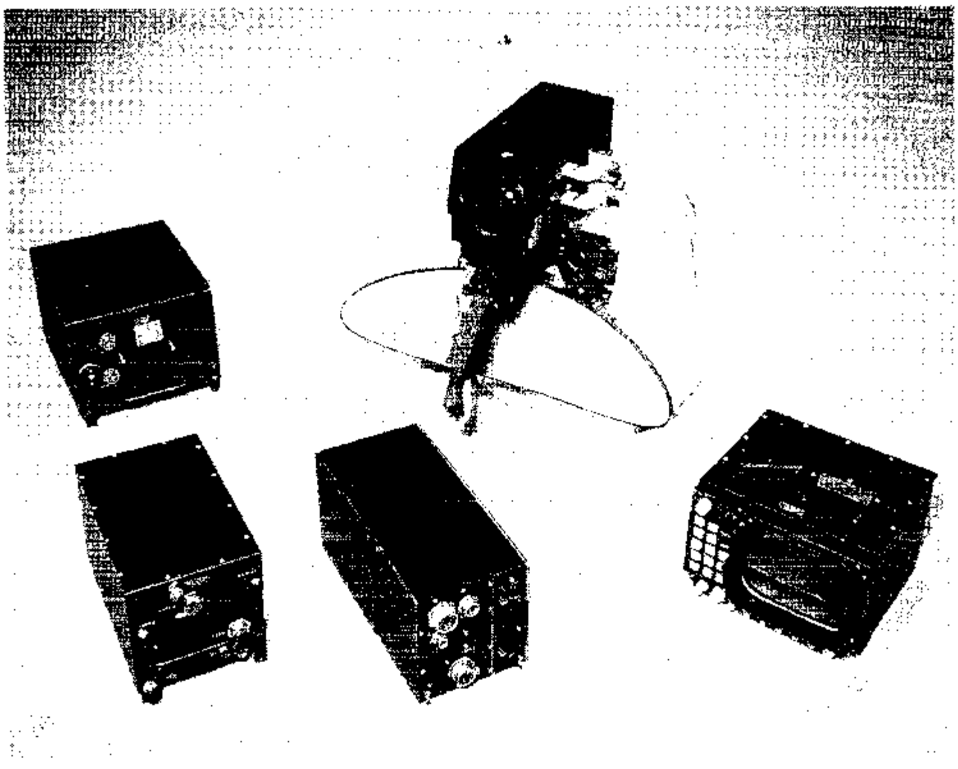
1342.353
FERRANTI SEASPRAY HELICOPTER ASV RADAR

DESCRIPTION:

Seaspray was specifically developed, and has been ordered, for the Royal Navy's Westland Lynx helicopter, in which application it carries the designation ARI 5979. The equipment has been designed to detect the track small high-speed surface craft of the type increasingly used as platforms for anti-shipping missiles. Other possible applications include general maritime surveillance.

The system comprises a scanner assembly, a display and control unit, transmitter, receiver, processor, and cooling matrix. System weight is less than 66 kg. The system operates at X-band frequencies with a transmitter power in excess of 90 kW, and employs frequency agility operation. This is employed for reasons of improved detection of targets in sea and weather clutter and ECM conditions, and also improves bearing resolution by reducing the effect of target 'glint'. Built-in test facilities are incorporated.

The scanner assembly is designed for housing in a nose radome in the aircraft, and is capable of providing for either wide-angle (90 deg left and right of the aircraft datum) or limited scans. The Observer is provided with a scan-converted, bright TV type display unit, on which target range and bearing information is displayed in alphanumeric form in addition to plan position indication of radar returns. In addition to the display controls, this unit also carries push-buttons for radar operational mode selection and other functions.



Seaspray naval helicopter radar system

OPERATION:

Two principal operational modes are provided: Search and Track, and Transponder Beacon. In the former mode either wide-angle or limited sector scans may be employed, depending on the phases of the various operations. Either scan might be used for the detection of surface targets while the sector scan would be used for extra performance and to provide a higher data rate prior to target tracking. Three range scales can be selected with automatic switching of the pulse-length.

In the tracking phase, the monopulse technique is used in azimuth to provide high angular accuracy.

In the Transponder/Beacon mode the display of friendly transponder beacons is provided, for tactical purposes and for operations such as station keeping and homing.

No official information has been obtained, but the Seaspray system also includes provisions for the control of the CL834 helicopter anti-shipping weapon under development for the Royal Navy. (Entry No. **1530.321**).

DEVELOPMENT:

Development was carried out under British Government contract to meet a RN requirement. A simpler variant of Seaspray, named Stalker, for users who do not have a requirement for all the sophisticated facilities of the former, is known to be under development. It will be cheaper and simpler, but will incorporate modes which make it attractive for use on general purpose helicopters.

STATUS:

First official announcement of the Seaspray was made at the Paris Air Show in May 1971, and flight trials have now been successfully completed. Production for the RN has started.

MANUFACTURER:

Ferranti Ltd, Electronic Systems Dept, Ferry Road, Edinburgh EH5 2XS, Scotland.

THE UNITED STATES OF AMERICA

1765.353
APG-63 AIRBORNE RADAR

DESCRIPTION:

The APG-63 is an advanced multi-mode nose radar installed in the USAF F-15 supersonic fighter aircraft (**1669.302**). It is a pulse doppler system thought to operate on a number of (selectable) frequencies in the X band. Little in the way of technical or mechanical information has been revealed, but some details of the APG-63's operational features have been published.

Radar information is digitally processed and there are two types of display employed: one is a small CRT located at the upper left-hand corner of the instrument panel and called the VSD (Vertical Situation Display); the other is the Head-Up Display (HUD). In general, the VSD is employed for the longer-range, initial stages of an interception, while the HUD is for use during actual engagements or close-in encounters.

The VDU presents the pilot with a 'cleaned' synthetic display of computer processed radar video data, together with alpha-numerics and symbols.

Controls for the APG-63 are located at three positions in the cockpit. The main control panel is on the console on the left side of the pilot. This console also carries the two throttles and key radar operating controls are located on them. The third location for radar controls is the aircraft control stick.

Mounted on the main control panel are switches for power, frequency channel selection, selection of various antenna scan patterns in azimuth and elevation, range, display control, and mode selector switches. The main mode selector has positions for four air-to-air modes, three air-to-ground modes, and 'Beacon' for homing and rendezvous use of the radar. A separate selector switch for the SPL Mode has OFF, MAN TRK (Manual Track), SNIFF (passive, open receiver operation), and FLOOD (probably a target illumination mode). A two-position switch provides for manual or automatic mode control. The latter mode is mostly applicable to the air-to-air roles of the APG 63, and this function enables the pilot to operate the radar according to the changing circumstances of an engagement whilst keeping his hands on the control stick and throttles. Controls on the latter are the antenna elevation adjuster, target designator button IFF interrogate button, and the weapon selector. The last of these is a three-position switch that enables the pilot to select either medium or short-range air-to-air missiles

(Sparrow or Sidewinder) or guns. Having made his selection, the information displayed on the VSD and HUD is programmed to the appropriate format automatically and radar scan patterns are similarly adjusted automatically to suit the weapon chosen.

Typical alpha-numeric information that can be presented on the VSD are target altitude, ground-speed, heading, range, aspect angle, closure rate, and g-force. Ground-speed and g-force data give valuable indications of the kind of target being tracked. A satisfactory response to an IFF interrogation is indicated by a symbol displayed on the VSD.

An automatic acquisition switch on the aircraft control stick enables the pilot to lock the radar onto targets within the 10 nautical mile range. There are two modes: in the boresight mode, the radar locks onto the first target that enters the aircraft boresight, as designated by the gun reticle on the HUD; the second, called super-search, locks the radar onto the first target that comes within the HUD field of view.

MANUFACTURER:

Hughes Aircraft Company, Los Angeles, California 90009, USA.

1585.353
AWACS RADAR

DESCRIPTION:

The Airborne Warning And Control System is intended to provide for early detection of airborne targets and control of interceptor aircraft, from an airborne platform (see Entry No. **1304.302** Section Two, F3). Aircraft of this type will be used in both tactical theatres and for continental defence. Major requirements are long range and the ability to detect and track low-level targets against a background of sea or ground clutter.

The radome contains, in a back-to-back configuration, a primary radar antenna and a separate secondary (IFF) array. Normal search rotation rate is 6 rpm, but during en route and standby flight the array can be rotated at ¼ rpm, in a so-called 'exercise' mode. This is for such purposes as slip-ring cleaning etc. Hydraulic drive is used.

The principal techniques adopted to achieve good target discrimination in the presence of severe surface clutter are those of MTI and maximum reduction of antenna side-lobes. The target signal is further enhanced by narrow-band doppler filtering to obtain high detection probability.

The high-PRF pulse doppler technique developed by Westinghouse has been used in production radars for aircraft and missile system applications.

In many of these systems, the high relative speeds between radar and target provide enough doppler shift to completely separate target return from background clutter. Therefore, in these applications there is no need to minimize background clutter with low-sidelobe antennas because target returns are well separated from the clutter spectrum. Large doppler separation of targets and clutter also permits relaxation of signal generation and processing requirements.

However, in the AWACS application, both high and low relative-speed target detection is required. Since low-speed target returns are not separated from the sidelobe ground clutter, techniques to minimize this clutter and maintain high sensitivity in the small residual clutter are necessary.

The transmitted radar signal is a train of coherent RF pulses at the high PRF and the frequency spectrum for that signal consists of a series of lines separated by the PRF and centered at the RF carrier frequency. The envelope of the lines of the spectrum is determined by the shape of the transmitted pulses. If the envelope of the pulses is rectangular the lines are weighted by the $(\sin x)/x$ function.

The frequency spectrum of the return signal from each target or ground scatterer also consists of a series of lines separated by the PRF, but the spectrum is centered at the RF carrier frequency plus a doppler shift. The composite signal return consists of signals from both targets and ground.

The ground returns, or clutter, appear at a variety of frequencies depending upon the radial velocity of the point on the ground relative to the radar platform. Thus, clutter frequency is proportional to the cosine of the angle between the line of sight to the point on the ground and the platform flight vector. The clutter return from ground at the horizon directly along the radar platform flight vector, with a relative velocity equal to plus the radar platform velocity, and the return from the horizon directly opposite the flight vector with a relative velocity equal to minus the radar platform velocity, define the maximum extent of the clutter spectrum.

Main beam clutter, which results from the antenna's main-lobe ground illumination, is the largest clutter return. The frequency of main-beam clutter varies as the cosine of the antenna azimuth angle relative to the velocity vector of the aircraft; thus, main-beam cutter frequency moves through the entire clutter spectrum as a 360-degree scan is performed. The main-beam clutter return is rejected in the receiver by means of recursive delay line cancellation techniques. Briefly, this is done by passing the received RF signal return through a first mixer whose local oscillator frequency is varied to maintain a constant difference from the frequency of main-beam clutter. The mixing action that results translates the main-beam clutter signal to a constant intermediate frequency (IF), which is then translated to zero frequency by a second mixing operation. That signal is converted to digital form and processed by a cancellation network that severely attenuates signal at zero frequency (and multiples of the PRF) and passes all other signals.

The other much smaller clutter returns, termed sidelobe clutter, result from ground illumination by sidelobes of the antenna. The clutter return from ground directly below the radar (altitude line) has zero relative velocity with respect to the radar platform and therefore has no doppler shift and appears at carrier frequency.

Moving Target Detection. The doppler shift of a target reflection is determined by the radial speed of the target relative to the radar platform. An approaching target provides a positive doppler shift equivalent to the vector sum of its velocity and the radar platform's velocity; a target being overtaken has a positive doppler shift proportional to the difference between target and platform velocity. The PRF is selected to be high enough so that the separation between spectrum lines is greater than the extent of sidelobe clutter. The

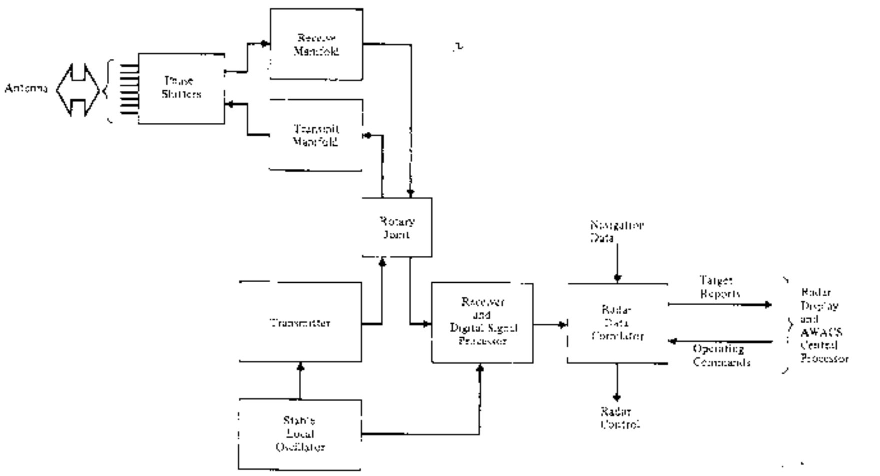
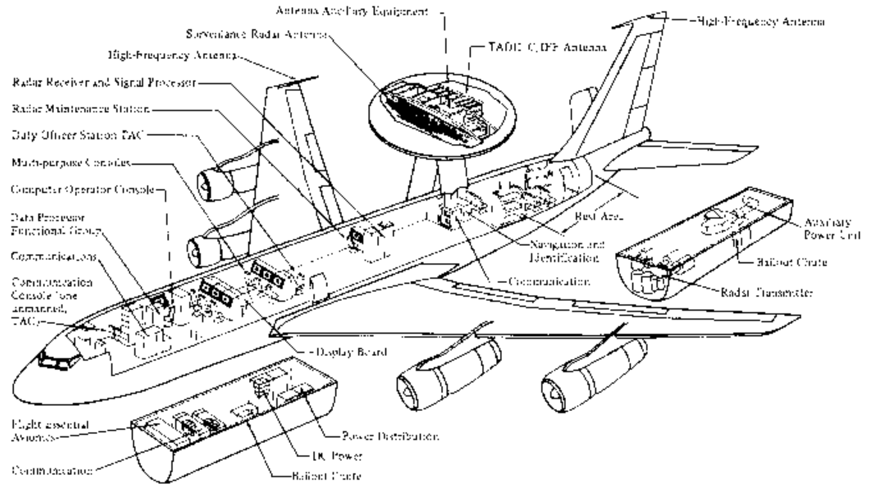
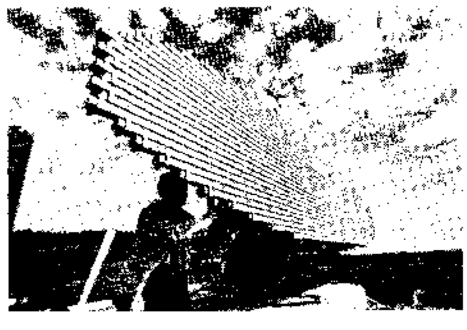


Figure 1



General arrangement of equipment as planned for production AWACS



AWACS antenna array

selection of a PRF based on this criterion produces unambiguous sidelobe clutter returns because the clutter associated with each PRF line never overlaps the returns from other lines. This has advantages in maintaining a low false alarm rate because clutter breakthroughs can produce false alarms only at the true velocity rather than at other ambiguous velocities.

Two basic requirements of the AWACS radar can be described in terms of the return signal spectrum. First, extremely stable signal generation and processing are necessary to permit cancellation of the main-beam clutter signal in frequency and degrade target detection capability at other frequencies. The improvements in signal generation capability necessary for AWACS have been made through advances in circuit components including oscillator crystals and transmitter tubes. The signal processing advances were made possible by the application of digital signal processing and A/D converter development to the AWACS problem.

Second, low antenna sidelobes are necessary to minimise sidelobe clutter return and avoid reduction in detection performance for target returns that fall within the sidelobe clutter region. To prevent this masking of target returns, the antenna and radome are designed for extremely low sidelobe radiation. In addition to minimising sidelobe clutter, the low side-lobes also help maintain radar performance in the presence of external electromagnetic interference.

Range Measurement. Because of the high PRF of the pulse doppler waveform, the time between successive pulses corresponds to only a few miles of range. Therefore, unambiguous range must be developed by the use of multiple PRF s. Two (or more) PRF s are transmitted sequentially in groups called bursts as the antenna beam is scanned over a target. The PRF s are chosen to have some common submultiple frequency which is much lower than either PRF. (This occurs if the PRF s are obtained by dividing a common clock frequency by relatively prime numbers.) The transmitted pulse trains are compared in a coincidence detector to obtain the common submultiple frequency. Similarly, comparison of the return pulses in a coincidence detector produces the same submultiple frequency delayed in time by the target range delay. In the AWACS radar, range delay is calculated digitally from the ambiguous range measurements made in each of three PRF s.

Range Rate Measurement. Range rate, or velocity, is measured in the AWACS radar by measuring the doppler shift of a target return. The return signals, after being converted to digital form and passed through the main-beam clutter canceller, are analysed by Fourier analysis. This transform divides the signal into frequency components that relate directly to target velocity. Since the doppler shift for higher velocity targets is sufficient to produce an ambiguity (with signals from adjacent PRF lines), unambiguous velocity is developed by using the multiple PRF s in a manner analogous to that used for range.

Elevation Angle. The pulse doppler operation of the radar also permits the measurement of elevation angle, which is used in the AWACS central processor to determine target height. That measurement is made by rapid electronic scanning of the antenna beam in elevation as the antenna scans mechanically in azimuth by means of rotation of the entire rotodome. The amplitude modulation that results from electronic scanning is processed in the receiver to determine time of peak signal return, which is then used to calculate target elevation angle.

The low-PRF pulse operation of radar, which provides sufficient time interval between pulse transmissions to prevent ambiguities in range, is more conventional in nature than the high-PRF mode. The AWACS radar design permits simultaneous operation of low- and high-PRF modes. The transmit waveform for pulse operation consists of a long linear FM-modulated pulse at low PRF, which is tailored to efficiently use the average power capability of the transmitter and antenna. The long pulse transmission is at a different RF frequency than the pulse doppler transmission and is spaced between the high-PRF bursts. The long pulse is compressed on receive by a separate receiver, which uses a dispersive delay line to form a narrow pulse that is processed to provide range accuracy and resolution.

The Radar Equipment

A block diagram of the Brassboard radar, which is the basic configuration now being further developed in the Full Scale Development phase, is shown in Fig. 1. The transmitter, located in the airplane fuselage, includes a stable local oscillator that provides the high degree of phase stability required for main-beam clutter rejection. Two amplifier stages raise the stable local oscillator signal to a level sufficient to drive the power amplifier, which is a wideband klystron.

The transmitter signal is fed up the rotodome strut to the antenna via a highpower rotary joint that provides signal continuity across the rotating-stationary interface.

The signal is passed through the transmit manifold, which divides it into 28 signals that have the proper amplitude weighting for low sidelobes. Those signals are passed through electronic phase shifters (which provide electronic scanning) and are radiated from the antenna. The antenna face is a planar array of slotted waveguides. The slot design provides the proper signal distribution across the array face for low sidelobes. A non-resonant antenna design is used to achieve low sidelobes simultaneously with broad operating bandwidth, an important feature for minimising the effects of external interference. The antenna provides both the height-finding function and space stabilisation, which is the positioning of the antenna beam to compensate for aircraft roll and pitch.

Target reflections received by the antenna pass through electronic phase shifters, are collected in the receive manifold, and are fed through the rotary joint to the pulse and pulse doppler receivers. Receiver processing includes analogue-to-digital signal conversion, recursive clutter cancellation, and frequency analysis of the signal returns by a fast Fourier transform filter bank. A constant false alarm rate (CFAR) is obtained at the output of the filter bank by adaptive circuits that provide detection thresholds which adjust automatically to changing receiver noise levels or sidelobe clutter amplitudes.

The radar data correlator is a high-speed programmable computer that performs overall radar management as well as processing detection data to form digitally formatted target reports. The reports, which include range, range rate, azimuth, elevation, and signal-to-noise ratio, are passed to radar displays and to the AWACS central processor. The central processor correlates the reports over successive scans to form target tracks. Radar control is accomplished by operating commands from the central computer or by commands from the radar operator console.

AWACS EC-137D radar test-bed aircraft

The radar design incorporates extensive ECCM (Electronic counter-countermeasures) to minimise the efforts of enemy ECM. Also, an inherent feature of the radar design is its flexibility to accommodate future growth through software control. With software control, processing is accomplished with programmed instructions rather than specific hardwired arrangements of circuitry. Thus, a function or process can be changed merely by altering the programmeof instructions rather than changing hardware. Characteristics under software control include target correlation algorithms, antenna beam positioning, system timing, CFAR processing, target report characteristics, and radar performance monitoring.

STATUS:

The US Secretary of Defence reported in March 1974 that flight demonstrations of 'brass-board' AWACS in the USA and Europe in 1973 had confirmed the high potential of the system to meet the requirement for long-range airborne surveillance and warning, and positive and precise control of tactical air forces. It was therefore proposed in the Fiscal Year 1975 Defence Budget that AWACS engineering and development be continued and the first 12 aircraft procured in FY 1975. A final production decision was planned for December 1974, and a total of about $770 million for the R&D and procurement was sought. The tentative plan is for a total of 34 E-3A aircraft to be bought, 12 more in FY 1976 and the last seven in FY 1977. The second batch of 12 would be fully configured for the tactical mission, whereas the first 12 would not.

MANUFACTURER:

Westinghouse Defence and Electronic Systems Centre, Baltimore, Maryland, USA.

1037.353
AN/APN-170 TERRAIN FOLLOWING RADAR

DESCRIPTION:

Small, lightweight airborne radar designed to provide terrain avoidance/following facilities for aircraft, missiles or drones.

Construction is modular, and the overall configuration is cylindrical to permit installation either within the vehicle or as an attached pod. Solid-state circuitry is employed, and computation is analogue. There are no moving parts, the aerial being fixed, and the radar beam has a fixed boresight aligned with the aircraft datum. No CRT display is provided, a simple cockpit-mounted indicator being used to give warning of terrain in the flight path, or a 'fly-up' demand signal. Operating frequency is in the Ku-band.

OPERATION:

Terrain range information from the aerial is fed to the analogue computer where it is correlated with flight characteristics and altimeter input. Continuous flight instructions are presented to the pilot through the cockpit display meter, or to the autopilot.

Using the APN-170, a pilot may fly manually, rely on an autopilot, or use an autopilot/manual override system. For pilot-controlled flight, the computer feeds data into the cockpit meter display, which instructs the pilot to climb or let down to maintain a fixed altitude above the ground, yet avoid all obstacles.

In the automatic mode, the altimeter and forward-looking radar feed information to the computer, which in turn issues commands for the automatic control of the aircraft.

A special warning feature provides complete and continuous system check by sending an RF signal into the wave-guide feed and then through the system. If a failure occurs, a warning light alerts the pilot. Failure during automatic flight results in an automatic climb command to the autopilot.

DEVELOPMENT:

Origin of the system lies in a USAF contract dating back to 1958 for a feasibility study of the low altitude control of a supersonic missile. Subsequent development, involving test flying in B-25 and B-58 aircraft turned to aircraft applications production engineering design started in 1962.

STATUS:

No firm details of deployment of the APN-170 are available, but it is believed that a number were purchased by the RAF a few years ago, when aircraft of the V-bomber force were given a limited low-level capability.

AN/APN-170 Characteristics:
Frequency: Ku-band
Peak power: 10 kW
Aerial diameter: 20.3 cm
Mode: Monopulse
Length: 84 cm
Diameter: 20.3 cm
Weight: 13.6 kg

MANUFACTURER:

General Dynamics Corporation, Electronics Division, 3302, Pacific Highway, PO Box 127, San Diego, California 92112, USA.

1568.353
NASARR AIRBORNE RADAR

DESCRIPTION.

The NASARR (North American Search And Ranging Radar) is the nose radar installation for the F-104 Starfighter aircraft used by five NATO and other nations. It has been produced in two main versions designated F-15 and R-21G. The system provides target search, acquisition, and attack facilities, and supplies range, range rate, azimuth and elevation angles, and line-of-sight rates to the armament control and missile launch computer. Operating frequency is in the X-band, and monopulse techniques are used. Later versions include terrain avoidance and mapping functions, and the system may also be used for ground attack.

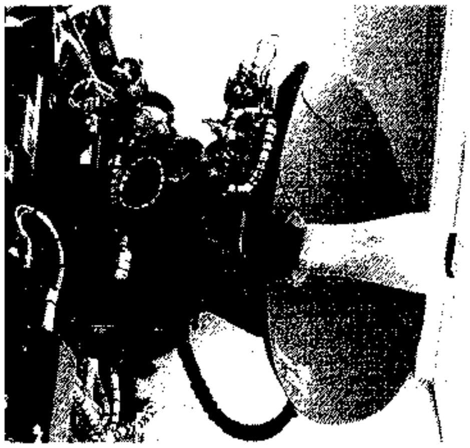
The basic NASARR carries the designation F-15A, and this was the subject of a very large collaborative international production programme, parallel to the joint production of the Starfighter for five NATO nations – Belgium, Canada, West Germany, Italy, and the Netherlands. The F-15J is fitted to Japanese F-104, and this version of the radar is produced in Japan under licence. The R21-G is a solid-state version of the F-15 developed for the Italian Air Force, and produced in Italy.

DEVELOPMENT:

Initial development was undertaken in the late 1950s by the Autonetics Division of North American Aviation (now North American Rockwell). In the mid-1960s, the R-21G version, and a new solid-state processor for retrofit to existing F-15A radars were developed by Autonetics.

STATUS:

Between 1000 and 2000 sets of all versions have been produced, and production is still continuing, although probably at a reduced rate.



F-15 NASARR radar for F-104 aircraft

1489.353
APQ-92 AIRBORNE RADAR

DESCRIPTION:

The AN/APQ-92 is the search radar carried by the A-6A all-weather attack aircraft of the US Navy. It is a 'shared aperture' system, being used in conjunction with APQ-112 target tracking radar (Entry No. **1490.353**), facilities on Modes 1, 2, 3/A, B, C, and D. Interlaced mode operation using any three modes is available. Mode selection is from the control unit, or the modulator can be ranging.

A far higher data rate than is usually associated with mechanically scanned air borne radars is achieved by means of a phased interferometer which eliminates the need for mechanical scanning in the elevation plane. The interferometer produces a vertical fan pattern of between 35 and 50 degrees, which, when swept in azimuth, covers the solid angle that would have to be swept by a raster scan if a pencil beam were used.

Selected targets are designated to the APQ-112 radar which is housed in the same radome, below the APQ-92

DEVELOPMENT:

Since introduction in the early 1960s, the APQ-92 has been the subject of a number of modification and improvement programmes. These include the substitution of solid-state circuitry for some part of the systems, changes in the display arrangements, and improvements to the MTI. At a later stage some of the APQ-112 subsystems were integrated in the APQ-92, enabling the latter to perform a three-axis tracking function. A new multi-mode radar (APQ-148) has been developed which combines the functions of the APQ-92 and APQ-112. This is described in Entry No. **1567.353**.

MANUFACTURER:

Norden Division, United Aircraft Corporation, Helen Street, Norwalk, Connecticut 06852, USA.

7014.353
AN/APQ-97 MAPPING RADAR

DESCRIPTION:

Side-looking radar was developed for high resolution mapping of military targets.

OPERATION:

The system operates in the Ka frequency band, 33-36 GHz. Normal slant range is of the order of 16-20 km. The mapping system includes the radar and its control console, a gyro-stabilised aerial sub-system, a recording sub-system, an onboard photographic darkroom and a light table for viewing the photographic record. The aircraft is also equipped for on site radar maintenance and equipment alignment.

The aerial of the side-looking radar is mounted on the side or base of the aircraft's fuselage, where it is freed from the restraints of the nose dimensions. The aerial is aligned with the longitudinal axis of the aircraft, so that the downward pointing radar beam is directed outward from the line of flight at an angle of 90 degrees. With this orientation, the aperture can be increased considerably, and the resolution improved accordingly. Azimuth scan consists of the aircraft carrying the fixed aerial past the strip of terrain being mapped.

The radar echoes from each azimuth increment are amplified in the receiver and used as the intensity modulation input to the cathode ray tube. A 15 m long, 23 cm wide strip of photographic film passing in front of the tube records the light signal on the tube face and stores it until a scan has been completed. The speed of the film is synchronised to the ground speed of the aircraft to record line-by-line the image of the ground displayed on the tube face.

As an aid to the interpretation of various terrain features, which may depolarise the transmitted signal in a non-uniform manner, the mapping system comprises two aerials and two radar receivers. One aerial is used for transmission and for the reception of echoes having the same polarisation as the transmitted signal. The second aerial is used for the reception of signals that have become cross-polarised.

Each aerial feeds one of the receivers, and each receiver provides the imagery on one-half of the film strip. Because of the non-uniform effects on signal polarisation, the imagery may stand out more clearly on one half of the film display than on the other. The dual receiver technique permits side-by-side examination of the two records.

DEVELOPMENT:

The AN/APQ-97 mapping radar was developed for the US Department of Defence by the Westinghouse Electric Corporation.

MANUFACTURER:

Westinghouse Defence and Electronic Systems Centre, Baltimore, Maryland, USA.

1490.353
APQ-112 AIRBORNE RADAR

DESCRIPTION:

The AN/APQ-112 is an airborne target radar associated with the APQ-92 (Entry No. **1489.353**) in the US Navy A-6A all-weather attack aircraft. It operates with that radar on a 'shared aperture' basis and is housed in the same radome, below the APQ-92. It provides facilities for tracking both surface and air targets which are detected and designated by the APQ-92. It also provides, as a back-up, certain facilities such as terrain avoidance, mapping, air-to-air and air-to-ground ranging, and weapon guidance. MTI facilities are incorporated.

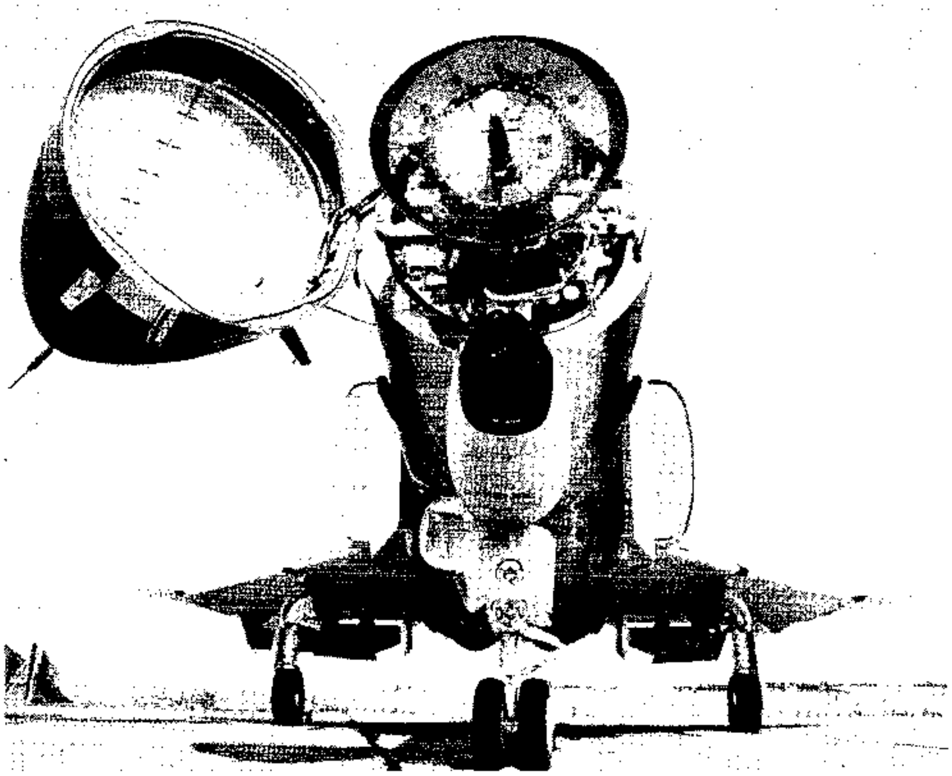
DEVELOPMENT:

The APQ-112 was introduced in the early 1960s. Subsequent development work has been directed towards integrating APQ-112 elements and function into the companion APQ-92 with the object of eliminating the APQ-112 as a discrete equipment. A new multi-mode radar (APQ-148) has been developed which combines the functions of the APQ-92 and APQ-112. This is described in Entry No. **1567.353**.

MANUFACTURER:

Norden Division, United Aircraft Corporation, Helen Street, Norwalk, Connecticut 06852, USA.

1310.353
AN/APQ-120 FIRE CONTROL RADAR
DESCRIPTION:
This is the latest in the APQ series of aircraft fire control radars produced by Westinghouse for the various versions of the F-4 Phantom. In 1959/60 the first of this series, the APQ-72, was delivered to the US Navy in the F-4B which remains a fundamental item in the US Fleet's interceptor and tactical aircraft inventory. Participation by the USAF in the Phantom aircraft programme from 1962 onwards resulted in three versions of the initial weapons control radar – the APQ-100 in the F-4C, APQ-109 in the F-4D, and now the APQ-120. The various versions which followed the APQ-72 were all the result of advancing performance and air-to-ground operational mode requirements additional to the original air interception functions.
The APQ-120, now in full production for the F-4E, also offers considerable improvements in weight (290 kg), volume, performance, and reliability through the use of solid-state circuitry. It is also designed to operate reliably in close proximity to the nose-gun installation of the F-4E.
MANUFACTURER:
Westinghouse Defence and Electronic Systems Centre, Baltimore, Maryland, USA.



Westinghouse APQ-120 installation in F-4 aircraft

1487.353
APQ-122 AIRBORNE RADAR
DESCRIPTION:
The AN/APQ-122 is a dual-frequency nose radar developed by Texas Instruments for use in the USAF AWADS (Adverse Weather Aerial Delivery System) programme for installation in C-130E transport aircraft. The radar is used for terrain avoidance/following and for navigational use in supply dropping missions.
Operation in the X-band is employed for long-range navigation and weather avoidance/penetration, and Ka-band frequencies are used for short-range high resolution performance for terrain avoidance and dropping zone location.
DEVELOPMENT:
Development was undertaken by Texas Instruments under USAF contract.
MANUFACTURER:
Texas Instruments Inc. PO Box 6015, MS240, Dallas, Texas 75222, USA.

APQ-122 radar installed in nose of C-130E of AWADS programme

1401.353
APQ-137 Airborne radar
DESCRIPTION:
The APQ-137 is a lightweight Ka-band high definition radar designed to provide for the detection of ground targets from the air. It has MTI facilities for locating moving targets against background clutter, and the MTI threshold and other parameters can be adjusted during operation.
The APQ-137B is used in pod-mounted form in the US Army SMASH programme (Entry No. **1400.302**) in which it is used in conjunction with a forward looking Infra-Red Sensor on board a number of modified AH-1G Hueycobra helicopters for night operations.
Operating frequency is 34.5 GHz and peak power is 25 kW, giving a maximum range of about 18 km. Pulse-length is 0.25 microsec and the PRF is 4,000 pps. It is reported to employ an externally coherent doppler technique of signal processing. Detection speed range of the MTI system is 3 to 30 kph.

Search and target ranging modes of operation are possible, with a cosecant-squared beam pattern for the former and a pencil beam for the latter. A 40 degree sector is canned during search.
A 13 cm diameter CRT display is provided, with B-scan presentation of data. Three range scale settings are provided.
DEVELOPMENT:
Development of the APQ-137 began as a private venture by Emerson Electric, under the designation Motardes which derives from "Moving Target Detection System", but was later supported by the US Army.

STATUS:
Three prototype SMASH Hueycobras equipped with the APQ-137B were delivered to the Army for acceptance trials in early 1971.
MANUFACTURER:
Emerson Electric Company, Electronics and Space Division, 8100 Florissant Avenue, St. Louis, Missouri 63136, USA.

1486.353
APQ-139 AIRBORNE RADAR
DESCRIPTION:
The AN/APQ 139 is a forward-Looking radar developed by Texas Instruments for use in 12 specially-equipped B 57G aircraft employed in the USAF Tropic Moon 3 Programme in Vietnam. This programme had as its principal objective improved night interdiction capabilities.
Operating frequency of the APQ-139 is in the Ku-band, and functions include terrain mapping and terrain avoidance in addition to the main offensive role of detecting slow-moving targets on the ground. For this last function, which is reported to be capable of detecting targets with speeds down to 4.8 km/h, a digital MTI system is used. The processor for this contains 2.54 cm diameter silicon ships, each carrying between 200 and 250 gates. These circuits act as shift registers to perform the storage function of the MTI system.
The airborne MTI accepts radar video and discriminates between fixed and moving ground targets, the latter being presented on the PPI at a higher intensity than the radar map produced. Range of the equipment in this mode is about 16 km.
In Tropic Moon 3 B-57G aircraft, the APQ-139 is associated with forward-looking infra red, low light-level TV, and a laser range-finder.

DEVELOPMENT.
Development was undertaken by Texas Instruments from 1967 to 1969 and acceptance tests of the B-57G Tropic Moon aircraft took place in 1970. The overall programme cost over $50-million. In December 1970 one of the twelve aircraft converted for Tropic Moon 3 was shot down by ground fire in Laos.

MANUFACTURER:
Texas Instruments Inc, PO Box 5474, MS240, Dallas, Texas 75222, USA.

1488.353
APQ-140 AIRBORNE RADAR
DESCRIPTION:
The AN/APQ-140 is a multi-mode phased array forward looking radar. In place of a mechanically steered reflector, beam steering and formation is accomplished by electronic scanning. This technique offers the possibility of mechanical simplicity allied to greater flexibility and increased capabilities.

Of the two generic types of airborne phased arrays, the APQ-140 is of the reflective variety in which a matrix of individual elements (3,800) which are capable of controlled variation of phase are illuminated from the front. The beam formation and steering functions are effected by computer control of the individual elements so that the combined effect on the energy they reflect is the generation of a beam which is capable of being steered at rates impossible by mechanical means.

The phase shifting elements are ferrite rod devices located within control coils, the driver amplifiers for which are also located within each individual element. The amplifiers are solid-state units and a single phase-shift element measures about 12 cm × 16 mm diameter. The complete array of 3,800 elements measures approximately 72 cm diameter. The computer used for phase-shift/beam steering is believed to be the Honeywell Alert (Entry No. **1451.063**).

Illumination of the array is by means of a circular ridged horn supported about 75 cm ahead of the phase-shifter mounting. The horn is fed by six waveguides. Linear or circular polarisation of signals can be employed. Operating frequency is in the Ku-band and it is believed that there are facilities for frequency-agile operation.

DEVELOPMENT:
Development of the APQ-140, and other electronically scanned radars, began under the sponsorship of the USAF Avionics Laboratory, Wright-Patterson AFB, Ohio, in 1965. Raytheon first produced an X-band experimental model. Flight evaluation of the Ku-band APQ-140 began in the first half of 1971 in a USAF KC-135 aircraft at Wright-Patterson AFB.

STATUS:
A possible platform for the APQ-140 is the B-1 bomber in its later versions.


APQ-140 Multi-mode phased array radar test installation on Boeing KC-135 aircraft

MANUFACTURER:
Raytheon Company, Missile Systems Division, Hartwell Road, Bedford, Mass. 01730, USA.

1567.353
APQ-148 MULTI-MODE RADAR
DESCRIPTION:
The AN/APQ-148 is a Ku-band airborne multi-mode radar specially developed to combine the functions of two radars previously required by US Navy A-6E all-weather attack aircraft, in a single radar. These two radars are the APQ-92 (search, and terrain avoidance/following) and the APQ-112 (target tracking and ranging). Functions performed by the APQ-148 include:
Search,
Ground mapping,
Tracking and ranging of fixed or moving targets,
Terrain avoidance or terrain following, and
Beacon detection and tracking.

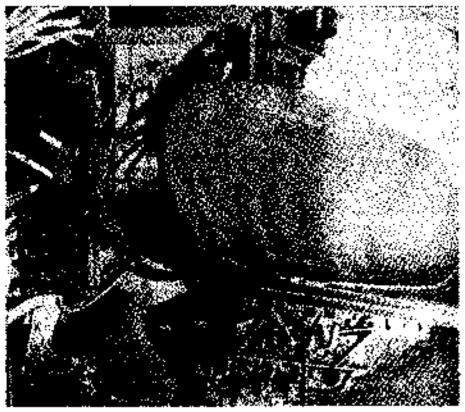
The 'track-while-scan' capability provides simultaneous range, azimuth, and evaluation data for weapon delivery. As in other systems, range and azimuth markers must be placed on the target, but elevation data is available on a continuous basis and is derived from a separate phase interferometer array carried below the main scanner dish. The latter has a width of about 1 metre and is illuminated by a conventional horn feed, to produce monopulse beams in azimuth.

The beams have a cosecant-squared profile in evaluation, and this with the interferometer elevation data provided, eliminates the need for mechanical scanning in the elevation plane. The interferometer array consists of two adjacent rows of 32 horns and moves with the main dish. Energy reflected from ground targets arrives at the upper and lower rows with a time difference which is measured by phase comparison techniques and translated into angular information.

There are two cockpit displays in the A-6E installation, a 5-inch (127 mm) storage tube unit for the pilot, and a 7-inch (178 mm) direct view radar indicator for the navigator/bomb aimer. Terrain data from the radar system also is presented on a vertical display for the pilot. The system is started to incorporate comprehensive built-in test facilities. System weight is about 230 kg.

DEVELOPMENT:
Norden was awarded a $18-million development contract in August 1969 after proposing the addition of track-while-scan facilities to the APQ-92. This called for five pre-production prototypes. The first was delivered in 1970-71.

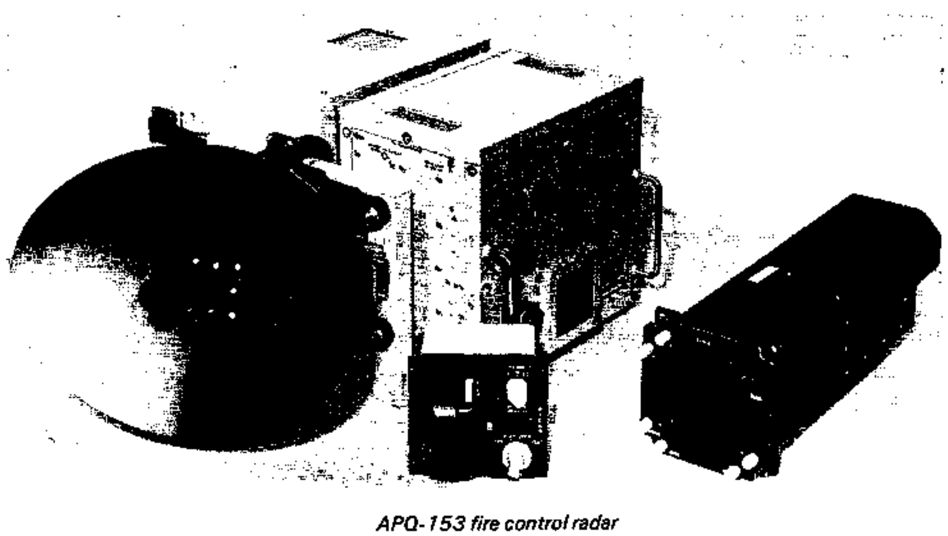
STATUS:
In the summer of 1971 Norden received a $5,946,000 contract for the delivery of 13 systems, and the first production equipment was handed over in Augut 1971. Two other production contracts, the latest in February, 1972, brought the total number ordered to 84 sets. Some will be used as retrofit equipment in A-6A aircraft.


APQ-148 multi-mode radar for A-6E aircraft. Note interforometer array beneath main dish. The horn feed for the latter is not shown in this picture; it projects forward from the assembly above the upper edge of the dish

MANUFACTURER:
Norden Division, United Aircraft Corporation, Norwalk, Connecticut, USA.

1675.353
AN/APQ-153 FIRE CONTROL RADAR
DESCRIPTION:
The AN/APQ-153 is a lightweight search and range tracking radar used aboard F-5E aircraft. This system operates in the X-band frequency range and provides stabilised search, automatic acquisition and target illumination, and automatic target ranging with boresight steering in the missile mode for heads-down launch of the Sidewinder AIM-9 series missiles. In the gunnery modes, the radar automatically provides range and range-rate outputs for targets within the sight lead angle computation envelope.

The system comprises five main units: scanner assembly, receiver-transmitter, radar processor, indicator and set control. Combined weight is 50 kg (110 pounds). The scanner is a parabolic 30 × 40 cm (12 × 16 inch) dish with horizontal polarisation. The indicator uses a 5-inch (127 mm) direct view storage tube and provides a "B" type


APQ-153 fire control radar

search display and a lock-on missile mode display.

OPERATION:

The APQ-153 has the following principal modes of operation:

Search Mode:

In search operation, a 7 degree elevation beamwidth is stepped up 3 degrees at the right azimuth limit and down 3 degrees at the left azimuth limit, providing a two bar scan coverage of 10 degrees in elevation. This two bar 10 degree coverage can be adjusted ± 45 degrees in elevation by the pilot. Azimuth search coverage i±+45 degrees. The search pattern is space stabilised for aircraft pitch and roll motion to allow searching a given volume of space and to prevent loss of the target and/or smearing of the display. Range of search coverage extends to 20 nautical miles (37 km).

Boresight Missile Mode:

The missile mode enables the pilot to lock-on to targets out to 10 nautical miles (19 km) and provides aircraft steering information to align the acquisition envelope of the AIM-9 missile with the target. Once a target has been acquired and lock-on occurs, azimuth and elevation steering data is provided on the indicator display in the form of a target steering bar. The aircraft is flown toward the bar to align it within the allowable AIM error circle scribed on the overlay. Missile acquisition occurs when the steering bar is within the allowable AIM error circle and the IN-RANGE indicator is illuminated.

Air-to-Air Gunnery Modes:

There are two air-to-air gunnery modes in the APQ-153, Dogfight and AA1/AA2. Both are external commands to the radar. The gunnery modes are heads-up and the radar automatically provides range and range rate information to the sight. Activation of a gunnery mode causes the scanner to align to a boresight in azimuth and 4.7 degrees down in elevation. The range gate will automatically slew from 500 feet to 6,000 feet at 30,000 feet per second (152 to 1,830 metres at 9,100 m/sec). Acquisition is automatic for the first target encountered.

STATUS:

Currently in production for use abroad Northrop F-5E aircraft.

MANUFACTURER:

Emerson Electric Co, Electronics and Space Division, St Louis, Missouri, USA.

1484.353
APS-94D SIDEWAYS LOOKING RADAR

DESCRIPTION:

The AN/APS-94D is an X-band sideways-looking airborne radar (SLAR) carried by US Army OV-1 Mohawk aircraft used for battlefield and forward area reconnsissance and surveillance. The radar also has survey and mapping applications.

The aircraft installation comprises five main sub-assemblies:

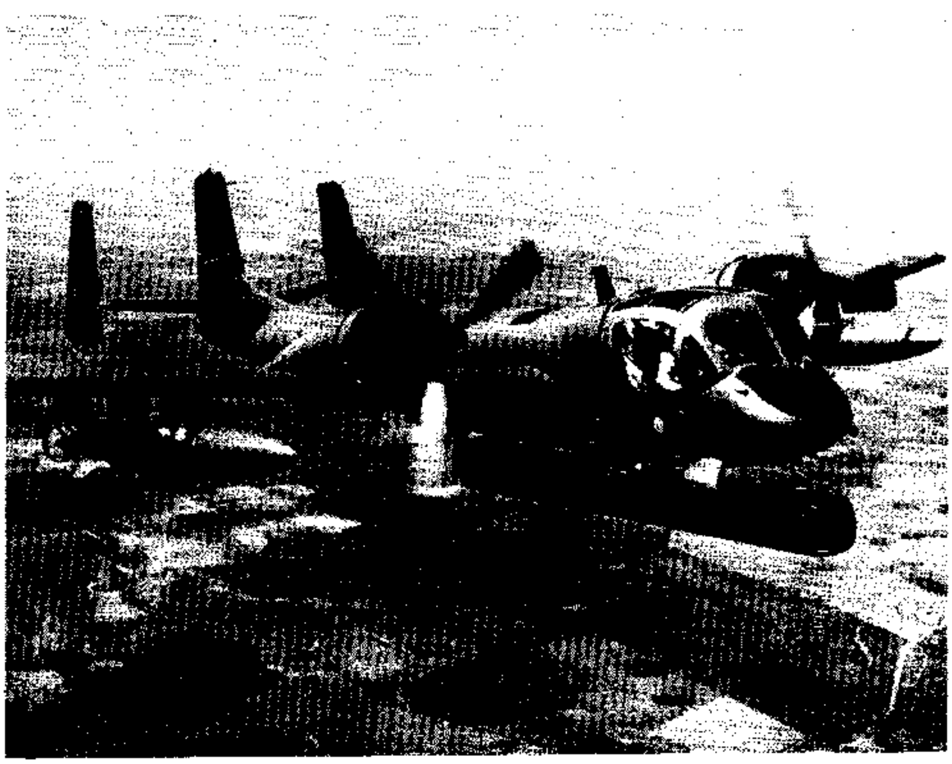
Antenna
Receiver/transmitter
Signal Processor
Interconnecting box
Cockpit Complex

The antenna unit consists of a pod (in the case of the Mohawk; other configurations are possible) containing two slotted waveguide arrays mounted back-to-back on a gyro-stabilised assembly that pivots at the centre. In flight, the antenna arrays are yaw stabilised to preserve the quality of the radar picture.

The receiver/transmitter is tunable within a portion of the radar X-band. It is located in the Mohawk equipment bay, with the signal processor and the interconnecting box. The antenna and other units can be simply removed and replaced on the aircraft to permit its use for alternative duties at short notice. Apart from high-power microwave devices, and certain display components, the APS-94D is of solid-state design.

The cockpit complex consists of the units necessary for operator control of the radar, recording and presentation of the data gathered. Two radar area maps are available to the operator. One depicts the entire sensed area, including all detected ground targets as though they are stationary; this is called the fixed target map. The other radar map shows detected moving targets and displays them against a suppressed background map of the area, this being the moving target map.

An area of up to 100 km on each side of the aircraft can be mapped when both of the antenna arrays are in use. Either one can be selected if it is desired to map only one side. A range control determines the width of the target area to be mapped and presented on the photo-radar map. This control has three settings corresponding to 25, 50 and 100 km wide scans by each antenna, and when used in conjunction with the antenna switch to select either left, right, or both arrays, maps corresponding to four standard scales can be presented on the display, 1:250,000, 1:500,000, 1:1 million, and 1:2 million. Provisions are made for the insertion of fiducial markers and other data.



AN/APS-94D Sideways looking radar mounted on a US Army OV-1 Mohawk

DEVELOPMENT:

The AN/APS-94D was developed under contract to the US Army Electronics Command.

STATUS:

In service on US Army OV-1 Mohawk reconnaissance aircraft. The APS-94D has also been fitted in an Argus of the Canadian Forces and installations have been made in B-26 and P-3 aircraft and the UH-1 helicopter.

MANUFACTURER:

Motorola Inc, Government Electronics Division, 8201 East McDowell Road, Scottsdale, Arizona 85252, USA.

1781.353
AN/APS-96 RADAR

DESCRIPTION:

The APS-96 radar is the search radar carried by the E-2A and E-2B AEW aircraft. It is a high-power radar which operates in conjunction with the APS-143 antenna group and the CP-413/ASA-27 computer detector to detect fighter type aircraft at long ranges from altitudes of 20,000 to 30,000 feet in the presence of strong sea clutter.

The radar incorporates the TACCAR technique for clutter rejection and coherent matched filter pulse compression which makes possible the transmission of high average power while retaining the resolution capability and reduced clutter effects of a short pulse system.

The CP-413/ASA-27 computer detector performs automatic detection and height finding computations for the radar. Other functions include beam-splitting, co-ordinate conversion, active and passive IFF decoding and formation of digital target reports for use of the tracking and intercept computer.

STATUS:

Operational.

MANUFACTURER:

General Electric Company, Aircraft Equipment Division, French Road, Utica, New York 13503, USA.

1782.353
AN/APS-111 (XN-1) RADAR

DESCRIPTION:

A study and breadboard hardware programme for modifying the APS-96 radar to provide overland detection capability resulted in two models of the APS-111 (XN-1) radar. This radar was flight tested by the Grumann Aerospace Corporation in an E-2 aircraft from 1964 to 1968. Some of the features incorporated were as follows:

1. An improved IF vector canceller (double delay line) to further reduce the high clutter level from ground returns.
2. An improved TACCAR circuit to better resolve the frequency shift of clutter due to

platform motion.
3. A displaced phase centre antenna (DPCA) and addition of a monoplexer to resolve variation in frequency shift across the beam width.
4. A stable local oscillator to improve internal stability.
5. New techniques in sidelobe suppression.

STATUS:
Not known.

MANUFACTURER:
General Electric Company, Aircraft Equipment Division, French Road, Utica, New York 13503, USA.

1485.353
APS-116 AIRBORNE RADAR

DESCRIPTION:
The AN/APS-116 is the ASV (air to Surface Vessel) search radar which is being developed for the new S-3A USN carrier borne ASW aircraft (Entry No. **1403.302**). At this stage, few details of the equipment have been made available beyond the fact that it will operate in the X-band and will be housed in a nose radome. The transmitter uses a high-power travelling wave tube, but otherwise the radar is essentially all solid-state. Other general features are high power, broad band-width and high scanning rate. It will be integrated with the aircraft's ASW data processing and display system, and can be expected to provide for mapping, schnorkel detection, cloud and collision warning, in addition to the ASV mode. The location and scanner arrangements shown by Lockheed, prime contractors for the S-3A, indicate an azimuth coverage of about 200 degrees ahead of the aircraft.

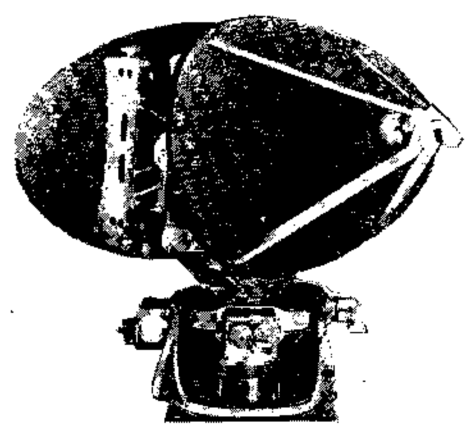
DEVELOPMENT:
The APS-116 is being developed by Texas Instruments under contract to the US Naval Air Development Centre. Development models began laboratory and airborne tests in 1969.

MANUFACTURER:
Texas Instruments Inc. PO Box 5474, MS240, Dallas, Texas 75222, USA.

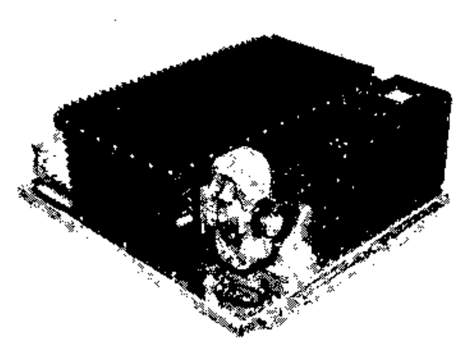
1311.353
AN/APS-119(XN-1) AIRBORNE SURFACE SEARCH RADAR

DESCRIPTION:
The APS-119 is a forward-looking radar for use in maritime aircraft for the detection and location of very small targets on the surface of the sea. It may also be used for navigation and weather avoidance purposes. Its principal characteristics are:

Frequency: 8.5 to 9.0 GHz
Transmitter output: 250 kW peak
PRF: 7.0, 3.5, 1.75, 0.875 and 0.44 KHz
Pulse widths: 0.1, 0.2, 0.4, 0.8 microsec
Aerial gain: 34 dB
Azimuth beamwidth: 2.4 deg
Elevation beamwidth: 4.0 deg
Rotation rate: 30, 60, 120, 240 and 300 rpm
Polarisation: Horizontal, vertical or circular
Receiver noise figure: 8 dB



AN/APS-119 Scanner assembly



AN/APS-119 Transmitter/receiver

The pedestal assembly located in the radome contains the scanner, pedestal, vertical reference, servo-amplifiers and receiver; the transmitter assembly contains the modulator-transmitter and its power supplies; the synchroniser contains the system and display timing generators and the video processor; the scan-converter contains the display generating equipment; the radar operator's and navigator's console have displays and controls; and there is a pilot's display.

The antenna consists of back-to-back 103 cm by 61 cm paraboloidal reflectors illuminated by centre-fed, Cutler-type feeds. The azimuth beam width is 2.4 degrees while the elevation beam width is 4 degrees. The antenna pedestal assembly is a light-weight four-axis unit derived from a design used in a number of AIL tracking and surveillance radars.

The radar console control panel and the navigator control panel determine the operating modes of the radar and the associated video processing, as well as the positioning of the track designators on the displays. The radar, navigator, and pilot displays provide the monitoring function of the received video.

The radar operator's console is equpped with a main display consisting of a 25 cm diameter CRT providing a TV-raster presentation. The display can be orientated with aircraft heading or ground stabilised relative to either aircraft track or magnetic North. The display is corrected for aircraft altitude. Ranges of 10, 20, 40, 80 and 160 miles can be selected. There is a 12.7 cm diameter auxiliary display at this position and this is a DVST unit offering a choice of either PPI presentation or B-scope (azimuth/range) of a 60 degree sector of the main display. The centre of the sector is controlled by one of two target designators. Range is 20 per cent of that displayed on the main display. Controls are provided for varying all antenna, receiver, transmitter, scan-converter and display parameters for which there are optional values. There is also provision for the control of the positions of two target designators and readout of these positions in either polar or cartesian coordinates.

The navigator's console has the same functions as that of the radar operator with the exceptions that a 12.7 cm diameter CRT is provided; only one target designator is available: scanner rate, PRF and pulse-width are automatically set to preset values for each range-scale setting selected.

The pilot's display is identical to the navigator's display and is mainly for monitoring purposes.

A more detailed description of the APS-119 appeared in the 1971-72 edition of JANE'S WEAPON SYSTEMS.

DEVELOPMENT:
A $1.46 million contract was awarded to the AIL division of Cutler-Hammer for the development of the APS-119 in July 1970. This calls for two prototypes. The first APS-119 (XN-1) has been extensively shore tested at the US Coast Guard's Electronics Engineering Centre in Wildwood, New Jersey during 1972, and it began flight tests in early 1973. Development was undertaken on behalf of the US Coast Guard but the equipment has obvious application to other US Forces.

MANUFACTURER:
AIL Division of Cutler-Hammer, Deer Park, Long Island, New York 11729, USA.

1783.353
AN/APS-120 RADAR

DESCRIPTION:
The APS-120 radar is currently in production for the E-2C aircraft. It operates in conjunction with the OL-93/AP radar detector processor (RDP) and APS-171 antenna group incorporating many of the techniques proven in the APS-111 (XN-1) flight test programme to detect targets at even longer ranges and in more severe clutter environments than the APS-96.

It also incorporates a new, more stable and reliable co-axitron transmitter to enhance its operation. Advance design efficiencies allow all these features to be incorporated into a more reliable and maintainable system that takes no more weight or space than the APS-96 Radar and Computer Detector installation.

The RDP links the radar to the tracking and intercept computer performing automatic detection and providing digital target reports. It integrates the signal, provides an adaptive threshold to maintain a constant false alarm rate (CFAR), performs azimuth beam-splitting and a preliminary sorting for target reports to the computer.

ADVANCED RADAR PROCESSING SUBSYSTEM (ARPS)

ARPS is an APS-120 improvement which combines increased sensitivity in noise and clutter with sophisticated false alarm control and major ECCM advances to provide the E-2 system with a truly automatic overland capability. Two sets of ARPS hardware exist and are presently in flight test at Grumman. After successful flight test, ARPS is expected to be incorporated into new E-2 production aircraft and is capable of being retrofit into existing E-2C aircraft.

MANUFACTURER:
General Electric Company, Aircraft Equipment Division, French Road, Utica, New York 13503, USA.

1569.353
APX-83 AIRBORNE IFF INTERROGATOR

DESCRIPTION:

The AN/APX-83 is an airborne IFF interrogator which is being installed in EC-121 Airborne Early Warning aircraft to upgrade their surveillance capability. Each aircraft will be equipped with an interrogator system and control/indicator equipment groups for each operator position in the aircraft. Each group will semi-automatically process and display IFF responses from aircraft, ships, and ground transponders within the EC-121 interrogation range. There are provisions for expansion to a fully automated processing and display system.

A complete equipment set consists of: either a Synchroniser/Coder or Coder, Decoder, Decoder Controls, Decode Displays, Interrogator Control, Receiver/Transmitter and RF Switch.

The Coder interfaces with the associated radar, R-T unit, RF Switch, Decoder, Decoder Control, and the aircraft's APX-72 transponder. It accepts an external pre-trigger from the associated radar set and generates synchronous pulse-pairs and SLS pulses. These pulses are sent to the R-T Unit for modulation of the RF signals. A sync-trigger is sent to the Decoder for range correlation of replies. Mode Coding on a per Sweep basis is done on two data lines which are also connected to the Decoder. Video is steered through the Coder to the Decoder.

The Decoder accepts raw video and mode triggers from the Coder and generates bracket decodes, delayed raw video and identity or altitude data for processing by the Decoder Control.

The following functions are performed:

(1) Reply detection
(2) Garble sensing
(3) Altitude conversion
(4) Emergency detection and alarm
(5) Identification of position (I/P or SPI)

The Decoder Control receives the digital data and sync triggers, bracket video, and raw video from the Decoder. It performs two different types of filtering: Passive decoding and Active decoding. The former is accomplished by six sets of thumbwheel switches. A target whose mode and code combination is dialled into any one of the thumbwheel sets causes its bracket decode video to be stretched on the PPI. Two degrees of stretching (narrow and wide) are available in order to sort out the six sets.

Active decoding is accomplished by generating an area gate around an unknown IFF target by means of a range "marker" on the PPI and a hand held switch which is activated just prior to the radar sweep passing through the target of interest. When the target is thus acquired, its code replies to the interrogation modes are transferred for display by the Decode Indicator.

The Indicator accepts the Active decode target code and/or altitude data from the Decoder Control, and displays it for approximately one scan period (8 to 15 seconds) on a set of numeric readouts. It also displays the current interrogation modes. A military or civil emergency or communication failure causes one of three alarm lights to flash.

The Interrogator Control is a small box which performs the control functions for the IFF Interrogator Receiver.

STATUS:

A Department of Defense contract worth $3.3 million was awarded in January 1971 for an undisclosed number of APX-83 equipments for installation in EC-121 early warning aircraft.

MANUFACTURER:

AIL Division, Cutler-Hammer, Deer Park, Long Island, New York 11729, USA.

1100.353
AN/AWG-9 AIRBORNE MISSILE CONTROL SYSTEM

DESCRIPTION:

This is the aircraft-fitted element of the Phoenix (AIM-54A) missile system (which see) developed for the US Navy F-14 aircraft. It comprises a fire control and target illuminating radar, infra-red tracker, digital computers and displays. Provision is also made for the acceptance of data link information from NTDS (Naval Tactical Data System) and ATDS (Airborne Tactical Data System) for target designation and other functions.

For on-board target acquisition, the AMCS includes a long range, high-power pulse doppler radar. This system has a "look down" capability that enables it to pick moving targets out of the ground clutter that normally obscures targets in a conventional radar.

In addition to its long range, the AMCS was intended to introduce into the fleet for the first time in an aircraft, the ability to track many targets at once, with computer-aided selection of target priority. The system is designed for virtually simultaneous launch and for simultaneous guidance of up to six missiles against separate targets.

The radar aerial is a planar, slotted-plate array, and represents a significant step forward in design. It is claimed to be the largest circular aerial ever built for airborne operations, with a high aperture efficiency for increased radar range.

The principal weapon is the long range Phoenix, AIM-54A (Entry No. **1099.331**) air-to-air missile, but the AWG-9 system can be used also for launching AIM-7E/F Sparrow missiles (Entry No. **1106.331**), AIM-9G Sidewinder (Entry No. **1308.331**), and control of an M-61 Vulcan gun.

OPERATION:

The AMCS uses the pulse doppler radar as its primary target sensor, a parallel infra-red (IR) target sensor, a multi-purpose digital computer, and associated control and display subsystems. The pulse doppler radar system represents several years of development in transmitter tubes, crystal filters and planar array aerial techniques to enable the long range requirements of Phoenix to be met. A low noise parametric amplifier in the receiver section contributes to this long range capability. Advanced doppler techniques make look-down target acquisition possible. A flexible, high capacity computer permits simultaneous track of a large number of targets and aids the missile control officer (MCO) in the assignment of kill priorities and in missile firing.

The IR target detector system complements the AI radar's operation. In conjunction with the radar, and slaved to it, the IR subsystem has the angular resolution to count the individual elements of a raid that to the radar might appear as a single blip. Alternately, the IR subsystem can contribute high-altitude surveillance when the radar is occupied with attacks at low level. The sensor is especially effective against small, high-speed targets that present a very small cross section to the radar.

Target detection, tracking and ranging functions for all F-14 air-to-air weapon configurations (6 × Phoenix; 6 × Sparrow; a mixture of these; plus 4 × Sidewinder: and the 20 mm Vulcan cannon) are handled by the AWG-9 radar. It can operate in either pulse-doppler or conventional pulse modes. A separate TWT provides CW illuminating energy for the semi-active homing Sparrow (AIM-7E). Time-sharing techniques allow up to six Phoenix missiles to be given pulse-doppler mid-course guidance simultaneously. The passive IR search and acquisition set is capable of independent operation.

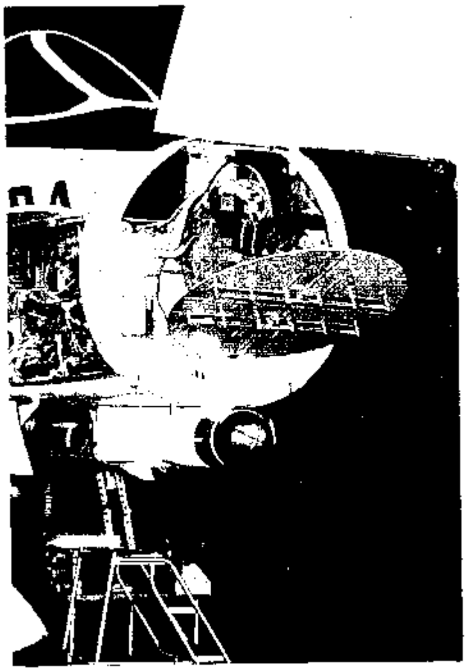
Data processing in the AWG-9 AMCS is performed by a general purpose digital computer that features high speed operation and a large memory capacity in an extremely compact package. The Control Data Corporation computer keeps track of targets detected by the radar while the radar continues to search. Based on pre programmed logic the computer evaluates threats, generates steering information for the pilot, and paints a complete tactical situation for the MCO by designating friendly and hostile targets in standard NTDS symbology, all based on data generated either internally or obtained through external data links.

For control of the Phoenix weapon system, the aircraft's Missile Control Officer is provided with two CRT display units. One, a 12.7 cm diameter unit, is used as a multi-mode display for the presentation of raw radar and I/R derived target information, while a larger (25.4 cm dia) unit is used for the display of processed data.

The latter includes target track information alpha-numeric and symbolic data obtained via data link from other units of a naval force, and IFF returns. The display is also used as a computer read-out device for the presentation of computer-recommended missile/target assignments.

DEVELOPMENT:

The AWG-9 AMCS is related to the AN/ASG-18 developed by Hughes for the YF-12A Mach 3 interceptor, and it is believed that considerable similarity in concept and technology exists between the two systems.



Phoenix missile and AWG-9 weapon control system installed in F-14 aircraft

After cancellation of the USN F-111B, the AWG-9 system was selected for development for the F-14A aircraft. Among changes made were provision for controlling weapons additional to Phoenix (Sparrow) Sidewinder, and Vulcan 20 mm cannon), additional operational modes for 'dog-fight' missions, and a reduction in overall weight. The first test model was delivered to the US Navy in February 1970.

Sea trials of the AWG-9 were carried out by the US Navy in the latter part of 1972 to assess the feasibility of its use in a multiple target ship's air defence system.

STATUS:

Extensive trials of the AWG 9 system with the Phoenix weapon system were run in 1972 and continued into 1973, achieving a success rate of 70 per cent or better. This included multiple target engagements. In Spring 1973, 160 sets had been ordered for the USN of which 63 had been completed by March 1973.

MANUFACTURER:

Hughes Aircraft Company, Culver City, California 90230, USA.

1673.353
WESTINGHOUSE WX SERIES FIRE CONTROL RADARS

DESCRIPTION:

The Westinghouse WX Series is a private venture project for the development of a range of forward radars for fighter and attack aircraft, based on the use of modular design. The latter feature is intended to enable radars appropriate to varying roles and with differing degrees of sophistication to be constructed from mostly standard units, with consequent cost benefits.

The 'base' model of the range is the WX-200 and this is a pulse-doppler equipment intended for air-to-air combat purposes. Beyond a provisional system weight of about 350 lb (160 kg), without cockpit display, few specific details have been revealed, but the following general design characteristics are known. A travelling wave tube will be used in the transmitter to provide wide bandwidth, a high peak-to-average power ratio, and to permit the adoption of frequency agility techniques of ECM.

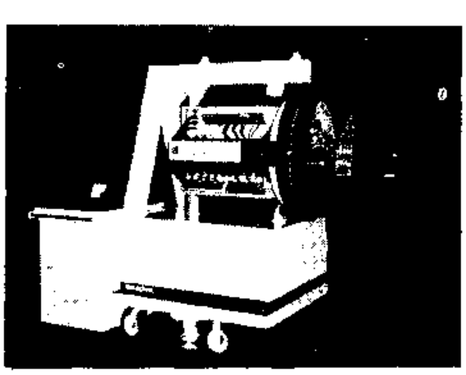
Wherever possible digital circuitry is used, with incoming returns being converted to digital format as near the receiver front end as convenient. The receiver employs a parametric amplifier. A Cassegrain scanner is employed to eliminate the cost, weight and reliability considerations of a rotary joint. The scanner itself is not stabilised, this function being performed electronically to provide a stabilised cockpit display, the data presumably being derived from the aircraft's own attitude sensors.

The Westinghouse development plan is to evolve other radars from the WX-200 which are both simpler and more sophisticated than the base model, which has been decided on for engineering development. The other models would be achieved either by the addition of modules to provide extra desired operational features, or simplification of the basic WX-200 to satisfy less elaborate requirements. The company has given a number of provisional designations to other models which could be developed in the WX series.

The WX-150 is a reduced power version of the WX-200. By adding data processing capacity to provide beam sharpening for high resolution ground mapping, the WX-200 would become the WX-300 for air-to-air and air-to-ground roles. The WX-400 would be a higher power version, without air-to-ground facilities but capable of long-range AI missions. A lightweight, lower cost, non-coherent pulse version would carry the designation WX-60 and a simple, lightweight pulse mapping radar would be the WX-50.

STATUS:

Construction of two WX-200 prototypes was started in 1972, the first of which began engineering tests in August of that year. The US Air Force Avionics Laboratory has announced that it will flight test the WX-200 in conjunction with Air Force Aeronautical Systems Division and the Naval Air Systems Command. These tests will start in Autumn 1974.



Westinghouse WX-200 radar

MANUFACTURER:

Westinghouse Defence and Electronic Systems Centre, Baltimore, Maryland, USA.

1676.353
AN/UPD-4 SIDE LOOKING RADAR SYSTEM

DESCRIPTION:

The AN/UPD-4 side-looking Radar System consists of an airborne, synthetic aperture, side-looking radar set, officially designated AN/APD-10 Radar Mapping Set, and a ground-based ES-83A Correlator-Processor Set, and AN/APM-321 test bench set. The complete system forms an advanced design, all-weather, tactical and strategic reconnaissance sensor that records, line-by-line, on 241 mm-wide photographic film, the doppler phase histories of signal returns from terrain features and targets, both moving and stationary, illuminated by the transmitted X-band radar energy. This data film later is automatically processed and correlated in the ground-based ES-83A to produce a high-resolution image film for viewing.

This reconnaissance sensor provides:

(1) High-resolution data collection, both in azimuth and range, of terrain features and moving and stationary targets from very high and very low altitudes, over a wide range of ground speeds, from either side of the aircraft and without flying directly over the areas of interest.

(2) A variety of operating modes, allowing specific missions to be carefully planned for optimum.results and executed and a minimum possibility of detection and interspecific missions to be carefully planned for optimum results and executed with a minimum possibility of detection and interception.

(3) Moving target indication (MTI) modes that enable detection and separate display of moving objects within the area under surveillance.

(4) A sea search mode for detecting maritime traffic with a resolution sufficient to tentatively determine the size and type of ships.

(5) Built-in test equipment for in-flight performance checks of the airborne radar and associated systems identifies and isolates malfunctions, allowing modification of mission plans so the flight often can be continued.

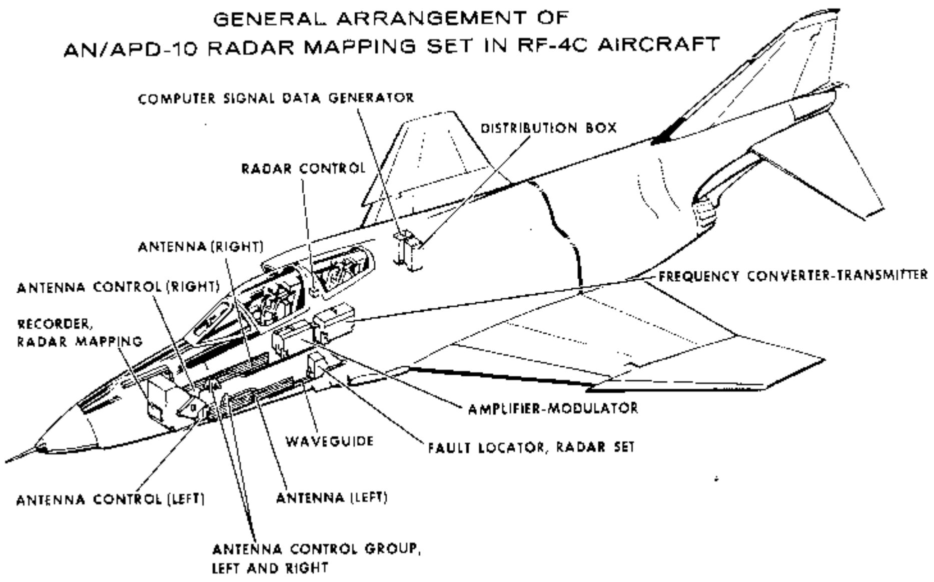
The AN/UPD-4 was specifically designed to be compatible with other sophisticated equipment to provide the near real-time, all-weather total reconnaissance capabilities essential in dynamic operational situations. When coupled to an air-to-ground data link, the radar mapping video information and associated coded data can be transmitted directly to a mapping recorder mounted on the ground-based ES-83A Correlator-Processor. The duplicate data film thus produced is processed and correlated immediately, providing an image film for viewing shortly after the aircraft time-over-target. A light table mounted on the correlator-processor and a high-power microscope supplied with the operator's kit allows the image film to be viewed and areas of special interest carefully scrutinised as the final film emerges from the machine.

The airborne AN/APD-10 Radar Mapping Set was originally designed for installation in the RF-4C aircraft as shown in the accompanying diagram. However, with minor modifications, the modules can be installed internally, or partially pod mounted, in other types of aircraft. Each unit is described briefly in the following paragraphs.

The left and right antennas are multi-element, phased, linear waveguide arrays designed to radiate a vertical pattern with a narrow azimuthal beam width. Except for mounting provisions, the antennas are identical, RF energy is carried to and from the antennas by a length of waveguide that bisects the elements and forms a power divider. The antennas are mounted on servo-actuated gimbals, allowing a limited movement in four axes: tilt, azimuth, roll and pitch. Signals supplied by the computer-signal data generator determine the initial look angle of the antennas. This look angle is maintained constant during flight by an electronic control system that receives error signals from the aircraft inertial navigation system and gimbal-mounted gyroscopes and accelerometers. These signals are amplified and applied to solenoid values that control the flow of hydraulic fluid to the gimbal-positioning servos.

The frequency converter-transmitter contains the circuits that generate the stable radio frequency used for phase looking and producing the X-band radar signals. The module also contains the transmit-receive and antenna switching components, supplies the swept frequency for modulating the transmitted pulses, amplifies the reflected X-band signals, and converts the received radio frequency to intermediate frequency. The amplifier-modulator is a high-power, RF pulse amplifier. After amplification, the RF pulses are returned to the frequency converter-transmitter and routed to the left or right antenna for transmission.

The computer-signal data generator receives



APD-10 side-looking radar installation information relative to the aircraft velocity and mode, and uses these data to establish the radar pulse repetition frequency (PRF). The unit generates the basic timing reference signals required throughout the system, and demodulates incoming IF signals against offset reference signals to obtain the MTI (moving target indication) and FTI (fixed target indication) video. The computer-signal data generator also contains the circuits that develop the motion compensation and clutterlock signals used for correcting, respectively short term and long term motions of the aircraft.

The radar mapping recorder contains the optical, electronic and electromechanical assemblies required to record the radar video data and associated coded data on 241 mm-wide photographic film. These data are displayed on two five-inch cathode ray tubes as four intensity modulated traces, one for each of the radar operating channels. The light energy from the CRT traces is transferred by two mirror assemblies and four recording lenses which focus the images on the film. Also recorded at the centre of the data film are mode strips that convey essential operational information such as the reconnaissance mode used during the mission. These mode stripes are interrupted at intervals corresponding to approximately five miles (8 km) of ground travel to display a multi-element data block containing coded information pertinent to the mission, such as aircraft number, flight location and date. The photographic film is contained in a two section, light-tight magazine that fits securely into the mapping recorder. During operation, the film passes over two recording drums, one for each pair of traces. To ensure the azimuth accuracy of the recorded terrain features and targets, the film speed-of-travel is carefully controlled to maintain a fixed relationship to the aircraft ground speed.

The radar set control mounts the switches required to turn the airborne radar system on and off and select the desired mode of operation. It also mounts the BITE SEL switch and indicator that enable the operator to check the performance of the radar set line replaceable units and other aircraft systems that supply inputs to the radar mapping central.

The ground-based ES-83A Correlator Processor contains the electro-mechanical optical and chemical components required to process automatically the data film exposed in the radar mapping recorder, optically correlate the resultant imagery and expose it onto the image film, then process and dry the image film. Three basic operating configurations are available.

The RCP configuration is used when a mapping recorder mounted on the correlator-processor receives the radar data from the aircraft via a data link system. The exposed, but unprocessed data film is fed directly into the correlator-processor at a synchronised speed, chemically developed in the data film processing tanks, and dried. The film then enters the optical correlating section, which utili es a laser light source and sophisticated lens system to focus the recorded doppler phase histories and coded data onto a second strip film, travelling through the correlating area. This film also is automatically processed and dried, and emerges from the correlator-processor as the final image film.

When operated in CP configuration, the light-tight magazine containing the exposed but undeveloped data film is removed from the airborne mapping recorder and loaded into the correlator-processor. The data film is then processed and used to produce the final image film in the same manner as in the RCP configuration.

In the TBP configuration, previously processed data film is loaded into the correlator-processor for correlation only. The data film processing and drying operations of the machine are bypassed, the pre-processed film proceeding directly to the optical correlating section where it is used for producing the final image film.

Operation:

The information recorded on the flight data film is a history of the velocity relationship between the aircraft and the ground target. This velocity relationship is represented by the doppler frequency which is generated as the relative velocity between the aircraft and the ground target changes. This doppler frequency recording provides an unambiguous representation of frequency change only if the aircraft maintains a relatively fixed flight path while illuminating the target. Translational motions due to wind gusts or steering transients cause velocity changes, which must be cancelled if target ambiguities are to be avoided. To provide this cancellation, the radar system is equipped with motion compensation circuitry that senses translational motion, and generates electronic correction to the doppler frequency before it is recorded. Two sensing devices are used:

(1) Linear accelerometers mounted on the antenna gimbaling system sense motion in both the vertical and lateral directions. The accelerometer outputs are fed to a vector computer which calculates the slant range or radial velocity change.
(2) A clutterlock circuitry compares the doppler phase of the actual radar energy received from one transmission with the phase of the energy received from the previous transmission. A phase difference will exist if translational motion has occurred.

For most effective operation, the AN/UPD-4 side-looking Radar System requires inputs from the aircraft inertial navigation system (INS), the high altitude radar altimeter (HARA) and the aircraft camera parameter control (APC). For high-altitude operation or during weather conditions that prevent visual observations of the initial points, other navigational aids, such as the forward looking radar (FLR) in conjunction with the Tactical Air Navigation (TACAN), must be used. In addition, when the mission plan allows straight and level flight, the autopilot system, properly adjusted to eliminate over-correction and oscillation, will be engaged.

The inertial navigation system provides the radar antenna gimbaling system with stabilisation signals in the pitch, roll and yaw axes as necessary to maintain the antenna array parallel with the line of flight. The INS also supplies ground speed signals which are the basis for nearly all system timing and film drive control. The high altitude radar altimeter provides signals indicating the position of the aircraft above the terrain. The radar system uses this information to position the antenna array, and to scale the accelerometer outputs used in the motion compensation network. The aircraft camera parameter control provides the fiducial pulse which starts the generation of the range marks that are applied to the data film every five miles. This fiducial pulse is also used to trigger the Auxiliary Data Annotation Set (ADAS), causing the ADAS information to be displayed on the data film. During correlation, the range marks and ADAS information are transferred to the final image film. The range marks occur at intervals corresponding to five nautical miles along track, appearing as a series of reference marks spaced across the image film at slant range increments of 0.5 nautical miles. These marks are used during interpretation to relate imagery details to actual map or ground distances. The data block, which follows the corresponding range marks by approximately five nautical miles (8 km) and is printed at the edge of the image film, indicates the direction of flight and the look direction (left or right). The block also provides important auxiliary information such as the radar mode of operation, the location and time of the flight, and the aircraft altitude, heading and altitude.

The AN/UPD-4 has several modes of operation, providing a variety of standoff distances, altitudes, ground speeds, and the option of recording only fixed target imagery (FTI) or both FTI and moving target imagery (MTI). In addition, imaging of the terrain at either side of the flight path can be obtained at the discretion of the system operator.

The final imagery is recorded on the 241 mm-wide film in four channels at a scale of 1:100,000 for all modes. In the azimuth (along track) direction, targets and terrain features are imaged in terms of distance travelled by the aircraft, and so represent true ground separations. In the range (across track) direction, the imagery is recorded in slant range or the distance from the aircraft to the target. Through simple geometry, slant ranges can be converted to ground ranges. The system operator can indicate areas of special interest during the flight by pressing a switch, thus placing an arrow in the margin of the film adjacent to the imaged area.

Status:

This system is in operation with some USAF RF-4C aircraft. Deliveries of UPD-4 radars for all 24 RF-4Es for the Japanese Air Self Defence Forces began in November 1974.

Manufacturer:

Goodyear Aerospace Corporation, Arizona Division, Litchfield Park, Arizona 85340, USA.

1706.353
HUGHES COBRA RADAR

Description:

The Cobra radar is a pulse doppler system configured for air-to-air combat in an air superiority role, while also providing capability for highly effective air-to-ground weapon delivery, air patrol, and airborne intercept missions.

It is designed to be effective in these missions independent of ground clutter at any altitude, target aspect angle-target attitude and radar look angles. Air-to-ground ranging is provided for weapon delivery, as well as all-weather capability and mission effectiveness in normal ECM environments.

A high resolution ground mapping capability is provided to aid in ground target identification and navigational up-grading. The radar has heads-up auto-acquisition modes for dogfight encounters, a look-down and look-up capability, and digital scan converter-CRT display equipment for bright, fade-free target data presentation. It is capable of directing the firing of all current armament, including guns, missiles and guided bombs.

An integral part of the system is a programmable radar processor which is a small, general purpose digital computer that provides complete radar configuration control for the various operational modes, management of the built-in test functions and antenna servo control.

The COBRA system is a coherent radar utilising programmable digital processing and featuring a clean-scope presentation. The transmitter is an X-band, low peak power, high duty cycle design that permits air-cooling, with commensurate weight and maintenance advantages. In the radar processor, doppler filtering provides for rejection of clutter and of unwanted ground moving targets and for detection of desired airborne targets.

After a thorough study and analysis of both array and reflector antenna designs, Hughes selected a flat-plate, or planar array, electrically driven antenna for the P-530 Cobra radar. Of all antenna candidates, the planar array provides for maximum radar system range because it makes the most efficient use of the available space within the aircraft nose radome.

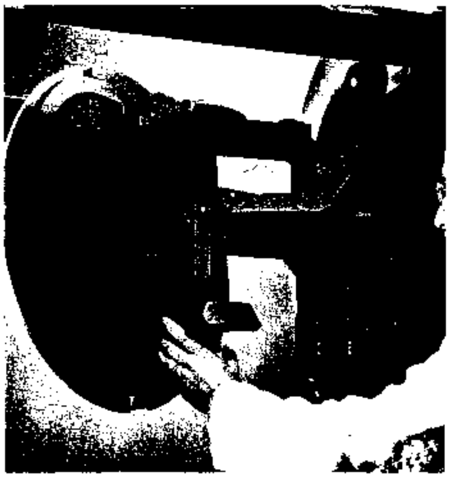
Among the many considerations that led to the design choice is the fact that the centre of gravity of a planar array is very close to the centre of gimbal rotation. This feature minimises the antenna moment of inertia and also allows the maximum radiating aperture area for a given gimbal and radome combination. As a consequence, the useful aperture area of a planar array for the Cobra radar is nearly 10% larger than that of, for example, a reflector antenna of the polarisation-twisting Cassegrain type, and a significant radar range advantage results.

In addition, the aperture distribution of a planar array is extremely controllable, and this allows the realisation of the ideal aperture excitation for a given sidelobe requirement. Such precise aperture distribution control is difficult to achieve in an optically-fed reflector antenna because of the inherent inflexibility of the primary feed pattern.

Both lightweight and high reliability result from a unique thermal design for printed circuit board modules developed for modern radars and incorporated in the COBRA radar. Modules are formed by sandwiching a lightweight aluminium heat exchanger core between two printed wiring boards. Cooling air passes directly through the core and has a very short thermal path to the components mounted on the wiring boards. The resulting high efficiency heat dissipation permits either exceptionally high component packaging densities or the use of more modern packaging techniques which, in turn, results in reduced weight. Moreover, efficient cooling to reduce the operation junction temperatures is the single most effective means of lowering semiconductor device failure rates.

DEVELOPMENT:

Development of the Cobra radar was initiated as a company-funded venture by Hughes to meet the attack radar requirements of new generation tactical fighter aircraft such as the Northrop P-530 Cobra.



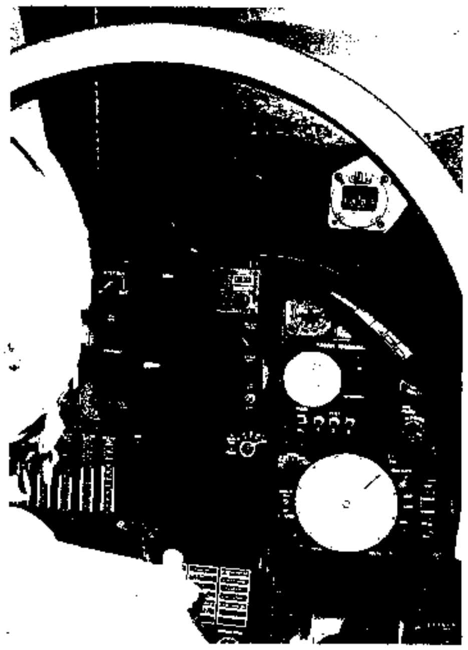
Hughes Cobra radar antenna and waveguide layout

STATUS:

Flight test and demonstration programmes began in mid-1973.

MANUFACTURER:

Hughes Aircraft Company, Aerospace Group, Culver City, California 90230, USA.



Cobra radar cockpit layout

THE UNION OF SOVIET SOCIALIST REPUBLICS

1475.353

LOOK TWO AIRBORNE RADAR

DESCRIPTION:

Look Two is the NATO designation for an X-band Soviet bombing and navigation radar system. No mechanical or technical details are available beyond the signal characteristics which have been obtained by 'Western' Elint (Electronic Intelligence) operations. These include operating frequencies in the band 9245 to 9508 MHz, with frequency agility capability and four PRFs: 320-360, 619-632, 1247-1253, and 1871-1879 pps. Presumably, pulse-length is also varied, changes being made according to operating mode and height.

1476.353

PUFF BALL AIRBORNE RADAR

DESCRIPTION:

PuffBall is the NATO designation given to an X-band Soviet search radar which has been stated to equip the Bison long-range, four-jet reconnaissance/bomber. It is also probably fitted in certain versions of the Badger and Bear. Its principal function is long-range surface mapping, and among its uses may be the direction of air-launched missiles such as Kangaroo, Kennel, Kelt and Kipper.

American reports state that Puff Ball has facilities for providing friendly surface-to-surface missile batteries with target designation services, and that this is accomplished by transmitting via a data link the relative positions of target and missile battery as presented on the radar PPI display.

Puff Ball PRFs are 414-418 and 621-628 pps.

1477.353

SCAN FIX AIRBORNE RADAR

DESCRIPTION:

Scan Fix is the NATO designation given to the AI (Airborne Intercept) radar fitted to MiG-17 and MiG-19 interceptors. Like those aircraft, the Scan Fix must be considered obsolescent. Both X-band and S-band versions are believed to have been produced. The latter equipped the Frescoe series of MiG-17s, while the MiG-19 Farmer A, C and D version were given X-band models. American reports confusingly state that both versions employ fixed scans. This may mean that there is no antenna stabilisation, or that the radars may provide only target ranging and illumination facilities.

1478.353

SHORT HORN AIRBORNE RADAR

DESCRIPTION:

Short Horn is the NATO designation given to an airborne bombing and navigation radar, which, from the Elint (Electronic Intelligence) data available, appears to be an example of some of the latest Soviet radar technology. The operating frequency is in the Ku-band, between 14 and 15 GHz, and there are frequency agility and frequency diversity facilities. There are four PRF/pulse-width combinations for various operational modes: 313-316/1.0-1.8, 496-504/0.5-1.4, 624-626/0.4-1.3, and 1249-1253/0.01-0.9 pps/microsecs. Both circular and sector scans have been recorded.

No information is available on the physical configuration or of the aircraft equipped with Short Horn but the parameters above suggest that its uses include ASV (air-to-Service Vessel) and maritime applications. One possible platform for this radar is the Hormone ASW helicopter carried aboard Moskva and Leningrad.

1479.353

SCAN ODD AIRBORNE RADAR

DESCRIPTION:

Scan Odd is the NATO designation for the AI radar fitted in MiG-19, Farmer B, Soviet interceptors. It is an X-band set, operating at frequencies between 9,300 and 9,400 MHz. This is apparently a later equipment than the Scan Fix AI radar, and is reputed to have an unusually complex scan pattern. There are differing PRFs for search and tracking modes of operation.

1480.353

SCAN THREE AIRBORNE RADAR

DESCRIPTION:

Scan Three is the NATO designation for the AI radar fitted in the Yak-25, Flashlight, Soviet interceptor aircraft. It operates in the same frequency band, X-band between 9,300 and 9,400 MHz as the Scan Odd radar (Entry No. **1479.353**). Three scan patterns for different operational modes, have been detected and Scan Three is reported to employ a very high pulse repetition frequency. The Yak-25 was introduced in 1955 and this radar is now presumably obsolete.

1481.353

SKIP SPIN AIRBORNE RADAR

DESCRIPTION:

Skip Spin is the NATO designation for the AI radar installed in Su-11, Flagon-A, and Yak-28P, Firebar interceptors. Introduction took place in the mid-1960s. The operating frequency is in the X-band, and estimated transmitter power is in the region of 100 kW, giving a reported range of 40 km. The frequency has been quoted as being between 8690 and 8995 MHz, pulse width about 0.5 microsecond, and PRF 2700-3000 pps.

The Flagon-A and Firebar interceptors generally are armed with Anab air-to-air missiles (Entry No. **1144.331**), (though the infra-red homing Atoll (Entry No. **1146.331**) is also carried) and therefore Skip Spin can be assumed to provide search and tracking modes for both these weapons, and target illumination for the radar homing version of Anab.

1482.353

SPIN SCAN AIRBORNE RADAR

DESCRIPTION:

Spin Scan is the NATO designation given to a series of AI radars. They are believed to operate at X-band frequencies, and to have a transmitter power in the 100 kW region.

Soviet aircraft fitted with Spin Scan radars are the D and F models of the MiG-21, Fishbed interceptor, and the Su-9, Fishpot B. In all cases, the radar installation is of the type where it is housed in an aerodynamic pod in the nose air intake of the aircraft. These differ in size, that of the Fishbed D being larger than the Fishbed F version. Spin Scan A/B fitted in Fishbed D and Fishpot B, has two PRFs, 825-950 pps for search, and 1750-1850 pps for the intercept and tracking modes. A rotating scan pattern is employed.

ELECTRONIC WARFARE EQUIPMENT

CANADA

1714.353
MODEL 100 NAVAL DF SET
DESCRIPTION:
The Model 100 is a shipboard direction finding, intercept and surveillance system covering the frequency range 10 kHz to 180 MHz.

The Model 100 DF Set operates on the principle of resolving the electromagnetic field at the antenna location into a set of orthogonal vectors which are then amplified and applied to the plates of a cathode ray tube, so as to trace a bearing line indicating the azimuth of arrival of the signal.

Two antennas are used: one for the LF to HF ranges and one for VHF. The LF/HF antenna derives the DF vectors from a pair of multiturn, switched loops while the sense is obtained from a set of balanced dipoles. The VHF antenna comprises 16 separate monopole elements which can be arranged as crossed-Adcock and parallel dipole arrays in both the horizontal and the vertical plane of polarisation. The VHF antenna is constructed around a hollow column which permits the passage of cable to the LF/HF antenna and to an aircraft warning light, located uppermost.

The DF signal vectors are amplified by two identical receiver channels which are accurately matched in phase and gain under all conditions of tuning and signal strength. A third channel, matched in phase only and equipped with a separate AGC, serves to amplify the omnidirectional sense signal which is applied to the grid of the CRT to blank out the unwanted half of the bearing trace.

In addition to the instantaneous single-signal DF mode, the receiver can be operated in a panoramic mode (amplitude/frequency display), or in a wide-band sweep mode, allowing the operator to see simultaneously the bearings and frequencies of all the signals present within the search band. This "3-D" display is made possible by using colour modulation as the frequency parameter.

A phantom omnidirectional audio output is available at all times for intelligence interception purposes. This monitor channel can be tuned to any of the signals within the sweep band without disrupting the panoramic bearing display.

Digital, automatic tuning (local or remote), is derived from a phase-locked frequency synthesiser fitted with an oven stabilised frequency standard. The synthesizer is designed for fast access manual tuning, using the 3-DEK decade reed switches which are gear-interlocked to count up or down automatically. The tuning frequency is indicated directly by the decade knobs and in addition there is a projection-type luminous readout which can be duplicated in a remote location.

The Radio Direction Finder measures the velocity vector of the electromagnetic field as seen at the antenna site, hence successful radio DF on board a ship depends to a great extent on the location of the antenna. The instrumental accuracy of the Model 100 DF Set itself is ± 1 degree for ground-propagated waves. Additional bearing errors will be caused by re-radiation from the ship's superstructure. Most of these errors can be eliminated by calibration, the repeatability of reading the bearing being of the same order as the instrumental accuracy.

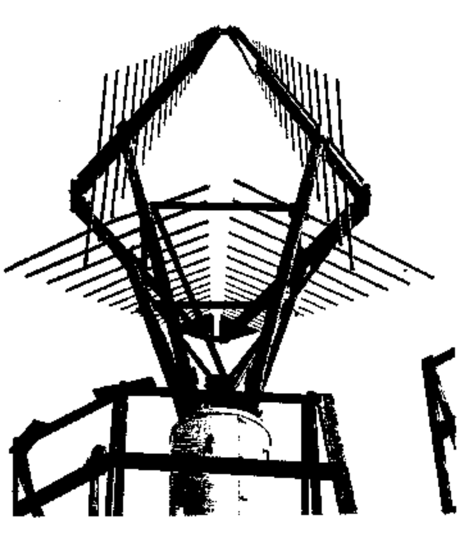
The VLF-VHF Direction Finder is intended to replace the older HF/DF sets and extend their operational range and usefulness. However, the new operational concept of combining DF, surveillance and monitoring, offers the possibility of equipping smaller vessels with DF, where the Model 100 DF Set can also perform the functions of communication and navigation. With a suitable mast and grounding installation, the Model 100 forms a basis of fixed land station where the bearing accuracy may approach that of the set alone.

The equipment is also produced in a land-mobile configuration, under the designation Model 109, to form a complete two-man vehicle-mounted DF and surveillance unit.
MANUFACTURER:
General Precision Industries Ltd, PO Box 88, Place Bonaventure, 32 Brome Street, Montreal, 114 P.Q., Canada.

GERMANY (FEDERAL REPUBLIC)

1718.053
ND210 and ND260 MONITORING EQUIPMENT
DESCRIPTION:
Monitoring Equipment, ND210 or ND260, by Rohde & Schwarz, instantaneously shows the occupation of the frequency range 170-470 MHz (ND210) or 450-1,000 MHz (ND260). The equipment consists of a panoramic receiver, fade-in unit and switch unit. The overall frequency range is displayed in five bands of 60 MHz (ND210) or 110 MHz (ND260) on the screen of the panoramic receiver. A signal occurring in the reception range appears on the signal scale as an intensity-modulated line. A crystal spectrum with 10-MHz spacing is displayed as a marker scale under the signal scale, permitting rapid course determination of the received signal frequency. When the tuning position of a connected receiver is superimposed on the marker scale and brought to coincidence with the received signal, the receiver can be used to identify the received signal (aural modulation monitoring, accurate frequency determination).

The standard version permits up to five monitoring receivers to be connected via the switch unit. A multicoupler for the operation of the five receivers from one antenna is built into the switch unit. In conjunction with other equipment from the Rohde & Schwarz range, such as frequency counter, Analyskop or lobe-scanning direction finder, versatile monitoring systems can be set up for a range of operational requirements.
MANUFACTURER:
Rohde & Schwarz, 8000 München 80, Mühldorfstrasse 15, West Germany.



Log-periodic antenna array of Rohde and Schwarz monitoring equipment

1901.053
ROHDE & SCHWARZ DIRECTION FINDING EQUIPMENT
DESCRIPTION:
Rohde & Schwarz produce a comprehensive range of radio and electronic direction finding equipment, embodying a variety of techniques and covering most of the spectrum. Some of this equipment is reviewed in the following paragraphs.

Directional information is supplied by DF antenna systems consisting of several elements. The phase differences between these elements are either evaluated direct, or represented in the form of radiation patterns by connecting several antenna elements into groups. Particularly good results are obtained with antenna systems whose dimensions are large in comparison with the wavelength, ie, wide-aperture systems, since they can considerably reduce the bearing errors in an interference field.

Direction finders operating on the Doppler principle are frequently used in the VHF and UHF ranges. In these cases, the DF antenna system consists of a large number of vertical dipoles (16 to 32) arranged in a circle with a diameter of a few wavelengths. To simulate the rotation of a single dipole about a circle, the individual elements are cyclically scanned, thereby resulting in a frequency modulation of the incoming signal which can be automatically evaluated. Triangulation systems with unattended direction finders can be realized by using accessory remote frequency-control or remote bearing-transmission equipment.

The Doppler-type Wide-Aperture Direction Finders NP 7 and NP 8 are available for the VHF range and the NP 9 for the UHF range. The DF antenna systems frequently used in the HF range (1.5 to 30 MHz) have four to eight equidistantly distributed elements with the opposite elements connected out of phase. With these Adcock configurations, the voltages obtained at the IF outputs of a two-channel receiver connected, if necessary, via a synchro resolver, are proportional to the sine or cosine of the bearing azimuth. This permits a simple bearing indication to be represented on a CRT screen as a radial beam. Rohde & Schwarz use the Adcock Direction Finder SFP 5000 in detection systems for the HF range.

Wideband radio detection in the higher frequency ranges is carried out by means of wideband direction finders, which often use log-periodic dipole antennas. Mobile systems in particular use active loop antennas, crossed-loop ferrite antennas, or antennas camouflaged as luggage racks in conjunction with the SFP 5000 direction finder.

The NP 12 Rotating Direction Finder covers the range 80 to 1,300 MHz (special model PA 003 with smaller mobile antenna: 25 to 1,300 MHz). Two pairs of log-periodic antennas, or, with the PA 003, active loop antennas, are used for vertical and horizontal polarization and are suitable for minimum-signal (differentiating circuit) and maximum-signal direction finding. The bearing diagram is represented on the screen of a cathode-ray tube, a manually adjustable bearing graticule being used for determining the exact azimuth. The DF antenna can be halted and adjusted for directional reception.

In the case of bearings on signals of short duration, where a complete antenna rotation or scanning cycle takes too long, fixed directional antenna configurations are used comprising, say, six log-periodic antennas each with an angular spacing of 60 degrees. In the simplest case, each of the antennas has a cardioid pattern.

By finding the difference between every two of the output voltages of the four-channel receiver into which these antennas are operating, the sine or cosine of the bearing azimuth is obtained in the form of a DC voltage. The azimuth indication is represented as a well-defined radial line on the screen of a cathode-ray tube by converting this voltage into a sawtooth waveform. Like the Doppler-type direction finder, both wideband DF systems can be operated with a programmable receiver in largely automated assemblies using digital transmission equipment.

It is also possible to use the DF Triangulation System NZ 181/6 for displaying the transmitter position in such triangulation systems. In this case, the triangulation display of up to four beams is recorded with a small TV camera placed before the screen of a cathode-ray tube and shown together with a map of the area concerned on a TV monitor.

A computer-controlled DF system designed by Rohde & Schwarz receives RF transmissions in the frequency range 10 KHz to 30 MHz and locates the respective transmitter, if necessary, by triangulation. The system is devised such that it can be assembled and extended in stages, particular importance being attached to the possibility of adding equipment without making other equipment redundant. The complete version contains the following main components: one or more radio monitoring stations with as many radio monitoring positions as required, a command and evaluation centre and DF stations depending in number on the size and nature of the area being monitored. The individual radio monitoring and DF stations are interconnected by an AF and data transmission system via the command and evaluation centre.

At the monitoring positions, the equipment is arranged for ease of operation in twin consoles. The Antenna HA 230/403, consisting of three single dipoles, is used. The most suitable dipole is connected to the input of the Communication Receiver EK 47 or EK 049 via the antenna selector. Using Telegraphy Demodulator NZ 47, all signals in the frequency range 10 kHz to 30 MHz with a field strength of 1 V/m can be amplified and demodulated. Tape recording equipment is provided for the storage of the modulation information. The assembly also contains an AF junction panel to which the telephone set can be connected, and a control unit for linking the monitoring position and central station or DF station. The received signals present at the monitoring position can moreover be transmitted from a command centre to the DF stations via this control unit, thereby ensuring that all stations used for the bearing determination take the bearings of the same transmitter.

On detection of an unknown signal by the monitoring position, the operator can depress a bearing request button for connection to the central station, where the frequency and type of modulation of the unknown signal are indicated on a data display unit. It is also possible to aurally monitor the AF signal. The operator at the monitoring position and his counterpart at the central station can speak to one other. If the line to the central station is occupied, it can be cleared by means of a priority button. The Data Terminal System NT 100 and VFT Equipment WT 402, for example, are used for transmission of the data and AF. The remote-transmission network consists of four-wire telephony channels (300 to 3,400 Hz according to CCITT). These telephony channels can be switched via carrier-frequency lines, radio links, or duplex shortwave links.

The central station includes evaluation desks, a control centre with interface, the AF distribution network and the data transmission equipment. The evaluation desks contain a data display unit for indication of the DF frequency, the direction finders in use, the bearings taken, and for monitoring the data input. The individual units include an alphanumeric keyboard for control command inputting, data stores, an alphanumeric printer for printing out the screen contents of the data display unit, a telephone set for monitoring the modulation of the connected monitoring position and for dealing with the radiotelephone traffic to the interception and DF operators, and a DF Triangulation System NZ 181, which projects the bearings onto a 50 cm × 70 cm transparent map. A process computer with peripherals centrally controls the data distribution and storage processes as well as the data display units, the DF Triangulation System and the AF switching network.

When a bearing is to be taken, three or four DF stations are connected via the communication system to the respective monitoring position from a given operator's position. The direction finders are automatically adjusted from the central station to the frequency and type of modulation. The DF operators merely have to adjust the cursor to the DF beam. After operation of a button, the bearing information is sent to the central station, where the results of up to four direction finders appear in analogue form on DF triangulation display units. These displays can be switched simultaneously to several observation posts by means of TV monitors or a TV close-up projector. The DF results can also be printed out at the operator's position; all data can be stored and made available when required by the computer. A possible application is the monitoring of maritime traffic, enabling the course of a ship to be tracked over a considerable length of time.

MANUFACTURER:
Rohde & Schwarz, D-8000 München 80, Mühldorfstrasse 15, Federal Republic of Germany.

1902.053

EZF/EZFU RADIO RECONNAISSANCE & MONITORING SYSTEM

DESCRIPTION:

The Frequency/Time-Domain Analyzer Analyskop EZF and the UHF Tuner EZFU are the main units of assemblies for radio monitoring and reconnaissance in the frequency range from 6 kHz to 2700 MHz. The assembly permits the display of frequency spectra as well as time-domain display of modulation. For radio monitoring, the EZF analyses the signals as to frequency, modulation spectrum, modulation depth and spurious emissions.

The combination Analyskop EZF + UHF Tuner EZFU can be used to perform the following monitoring tasks:

(1) Detection of unknown signals by sweeping the entire frequency range from 6 kHz to 2700 MHz. The sensitivity is approximately 0.5 µV with a resolution of 1 kHz.
(2) Monitoring of particular frequency subranges of selectable width between 1400 MHz and 6 kHz.
(3) Rapid determination of frequency and amplitude of an unknown signal by electronically superimposed, parallax-free, calibrated frequency markers and level line. The seven-digit counter reads out the frequency with a resolution of 10 Hz to 1 kHz.
(4) Investigation of modulation spectra of individual signals with seven selectable resolving bandwidths from 300 kHz to 50 Hz.
(5) The Analyskop can be used as a monitoring receiver with AM and FM demodulation and seven selectable IF bandwidths.
(6) It is possible to superimpose the tuning frequency of the receiver section as a bright-up marker on the spectral display. After switching over to time-domain display the signal may immediately be monitored aurally.
(7) The Analyskop contains a facility for automatic identification of spurious signals in the spectral display so that they are excluded from evaluation.
(8) A recorder adapter permits the spectrograms displayed on the screen with frequency markers and level lines to be recorded on an XY or YT recorder at sweep times of up to three minutes.

With a combination of two EZF's and one EZFU it is possible to observe the spectral display and at the same time aurally monitor the test result. After selection of a certain frequency band between 30 and 2700 MHz and switching over to synchronised operation, a signal to be selected from the upper EZF is brought to coincide with the centre marker. The sweep width and resolution can be chosen according to the requirements of the radio services and channel spacings. Aural monitoring is possible on the lower EZF which either operates as a receiver or as a narrowband analyzer. The band display on the upper EZF is preserved but may be varied without interrupting aural monitoring.

Other operating capabilities are provided by combining two EZF's, such as simultaneous monitoring of two frequency channels within a band analysis of two frequency channels. Moreover, it is possible to sweep the band of interest at a high sweep speed and at the same time record the entire band or a part of it on an XY recorder. If the lower EZF is also adjusted for band sweeping the signal to be monitored can be marked by intensity modulation. It is then not necessary to make it coincide with the centre marker of the upper EZF.

MANUFACTURER:
Rohde & Schwarz, D-8000, München 80, Mühldorfstrasse 15, Federal Republic of Germany.

CHARACTERISTICS:

Input frequency range	I	II	III	IV	V	VI
Input frequency:	6 kHz–1.3 MHz	60 kHz–13 MHz	100 kHz–130 MHz	150–170 MHz	30–1400 MHz	1300–2700 MHz
Amplitude error:	± 0.5 dB, max	± 0.5 dB, max	± 1 dB, max	± 0.5 dB, max	± 1 dB, max	up to 2500 MHz: + 2 dB, max. up to 2700 MHz: —3 dB, max.
Sensitivity: (S + N = 2N at 1 kHz resol.)	0.5 V	≦ 1 V	≦ 1.5 V	≦ 1 V	≦ 2 V	≦ 2 V
Maximum sweep width:	200 kHz	2 MHz	130 MHz	20 MHz	1400 MHz	1400 MHz
Input attenuator:			continuous ≧ 60 dB		50 dB in 10-dB steps	
Level measurement range:			(operating range 146 dB)		absolute: + 10 to —122 dBm	
IF attenuator:	continuous 100 dB, with level line tracking					
Tuning:	int. osc. in EZFU for ranges I, II, III, V, VI; 7-digit counter; ranges I-III also via plug-in crystals or ext. osc.					
Input impedance:	for all ranges 50 ohms, VSWR ≦ 1.5					

Frequency-domain measurements:								
Sweep width:	1400 / – / 20 MHz	20 MHz	6 MHz	2 MHz	600 kHz	200 kHz	60 kHz	6 kHz
Resolution:	fixed (300 kHz) or any other freq.	300 kHz	100 kHz	30 kHz	10 kHz	3 kHz	1 kHz	50 Hz
Frequency markers:	for sweep widths ≦ 20 Mhz: marker spectrum with centre marker; EZFU for sweep widths 20 MHz: shiftable marker							

1903.053

ND 210 & ND 260 RADIO MONITORING EQUIPMENTS

DESCRIPTION:

Rohde & Schwarz supply two types of monitoring systems, differing only in frequency range, for the detection of unknown signals during frequency-band monitoring and radio reconnaissance.

Type ND 210 including Panoramic Receiver
Type ED 210, frequency range 170 – 470 MHz; and
Type ND 260 including Panoramic Receiver
Type ED 260 frequency range 450 – 1000 MHz.

These systems provide a permanent and rapid monitor display over relatively wide frequency ranges. Used in conjunction with monitoring receivers, they permit frequency determination and analysis of discrete signals. They are composed of the following units:

Panoramic Receiver	ED 210 or ED 260
Fade-in Unit	NZ 211/3
Switch Unit	NZ 212
Multicoupler	NV 3301-1 or NV 3401-1
AC Adapter Unit	NZ 210/3

The heart of the system is the Panoramic Receiver, on whose screen the received signals are displayed as an intensity record over five ranges of 60 MHz or 110 MHz width. A crystal spectrum and/or an external frequency marker can be written into the marker scales displayed below the signal scales. By means of the Fade-in Unit the tuning position of a connected receiver (selected with the Switch Unit) can thus be indicated and the receiver tuned to the signal detected by the panoramic receiver.

The tuning position can also be transferred to further receivers, for example for monitoring purposes.

The Panoramic Receiver provides a clear picture of the frequency-band occupancy in five ranges of equal width. The ranges can be selected individually or in any combination. The frequency sweep through each range (displayed line) takes about 1.5 msec. The Monitoring Receiver Type ESUM with standby unit is suitable for operation in conjunction with the Panoramic Receiver. Any external receiver must have a local-oscillator output with adequately flat frequency response and low harmonic content. If several receivers with range-dependent first IF are used, range selection for the Fade-in Unit is possible from the receivers via remote-control lines. The range selectors of the receivers should preferably be provided with remote-control contacts.

CHARACTERISTICS:

Frequency range:

ND 210	170-470 MHz
ND 260	450-1000 MHz

Antenna connection:

Nominal impedance	50 ohms
VSWR:	≦ 2
Gain via Multicoupler:	1.5 ± 1 dB (ND 210) 1.5 ± 1.5 dB (ND 260)
Permissible oscillator reradiation of receivers:	≦ 25 V into 50 ohms
Power supply:	24 V DC ± 10% or 110/220 V AC ± 10%, 45 – 480 Hz, 220 W or 260 VA
Nominal temperature:	+ 10 to + 40°C
Operating temperature:	—20 to + 50°C
Shelf temperature:	—40 to + 70°C
Dimensions, weight:	484 mm × 488 mm × 453 mm, 80 kg

MANUFACTURER:

Rohde & Schwarz, D-8000 München 80, Mühldorfstrasse 15, Federal Republic of Germany.

ITALY

1715.253

MM/SPR-A NAVAL RADAR INTERCEPT SYSTEM

DESCRIPTION:

MM/SPR-A is a shipboard medium-sensitivity radar intercept equipment comprising three units: antenna assembly, receiver/display unit and power supply. Frequency coverage is continuous from 1.0 to 10.5 GHz. The system is designed for either autonomous use on smaller vessels or to provide 100 per cent detection probability as a complement to high-sensitivity intercept systems using rotating antenna systems on board larger ships.

Four fixed antennas are used on the MM/SPR-A, and the reception sectors of the four overlap to ensure that 360 degree azimuth cover is given. This omni-directional detection capability is associated with "wide-open" reception circuits (crystal-video channels). Thus the system is non-selective in respect of direction and frequency.

Bearing information is obtained by comparing the amplitude of a signal as received by adjacent antennas of the array. Each antenna element of the array is followed by a filter, a crystal protection device and detector, and a video channel which drives one of the deflection plates of the display unit CRT. Any received radar signal within the frequency coverage of the system automatically results in a bearing trace showing the direction of arrival on the CRT.

STATUS:

In production and installed on Italian Navy and other ships.

MANUFACTURER:

Elettronica SpA, Via Tiburtina KM 13,700, 00131 Roma, Italy.

NORWAY

1857.253
SR-1-A RADAR SEARCH RECEIVER

DESCRIPTION:

The SR-1-A is a radar intercept equipment of the "wide open" receiver type and is suitable for fitting in ships of frigate size and above. The equipment comprises two major units – the antenna assembly, and the display/control console – together with several other small electronics cabinets. The antenna unit consists of two separate units combined in a single assembly: a "spinner" type directional antenna with a protective radome, and a fixed omni-directional octagonal array of horns. The console has the necessary controls for operation of the system and the principal display elements are three CRTs which provide the requisite display functions for direction finding, pulse analysis, and frequency measurement functions, respectively. A separate warning indicator which provides for radar warning and coarse directional information is incorporated and this can be located remotely from the display console.

CHARACTERISTICS:

Frequency coverage: 2.5 to 18 GHz
Frequency measurement: to better than ± 1% with automatic and instantaneous indication
PRF measurement: 200 Hz to 10 kHz
Pulse-width range: 0.2 to 10 microsec
Polarisation:
Warning section: Any
Spinner antenna: Circular
Bearing accuracy:
Spinner antenna: ±3.5° relative or true
Omni-antenna: ± 22.5° relative

Assuming line of sight to a 50 kW radiator with a 36 dB antenna gain, the SR-1-A provides omni-directional warning to a range of 150 nm (280 km) and directional intercept up to 800 nm (1,480 km).

OPERATION:

Signals intercepted by the spinner antenna produce radius vectors on the D/F CRT, and when the antenna is rotating, a deflection pattern of multiple radial lines results on the face of the CRT. The length of these lines will have a pronounced maximum in the direction of the intercepted radar source. This can be read off as either a relative bearing or a true bearing. The spinner antenna can be operated at any speed up to 500 RPM. Whatever speed is selected is automatically varied about the mean to ensure that rotational synchronism between the SR-1-A antenna and that of transmitting antennas does not lead to loss of intercept probability. Provision is made for stopping the spinner antenna in any chosen bearing and for manual directional control from the console.

The SR-1-A can be fitted with a directional responder as a customer option. The purpose of this is to aid the operator in his task under heavy radar traffic conditions by excluding signals from within a sector, the direction and extent of which can be selected at will. The SR-1-A has been designed for one-man operation.

DEVELOPMENT:

The SR-1-A was developed by the Norwegian Defence Research Establishment in collaboration with NERA Bergen. Production and marketing responsibilities rest with the latter organisation.

MANUFACTURER:

NERA AS, Division Bergen, PO Box 53, N-5032 MINDE, Norway.

1860.253
VR-2 PORTABLE RADAR SEARCH RECEIVER

DESCRIPTION:

The VR-2 is a portable, handheld receiver with a frequency coverage of 2.5 GHz to 11 GHz. It has facilities for discriminating between X- and S-band, and there is a possibility of obtaining determination of bearing within + 2° in the X-band. The VR-2 has proved itself a very valuable piece of equipment on small, fast boats operating in coastal waters. It may also serve as a low cost supplement to the larger search receivers.

The receiver can be mounted on a special tripod fitted with a compass for land-based use, or with a special clamping arrangement for securing the receiver to a ship's railing. The receiver may be rotated in the clamping device which is fitted with a scale for determination of bearing.

As a companion to the VR-2, an accessory analysis unit (Type 3KT22) has been developed, providing the following facilities:

Determination of PRF to within ±6%
Approximate determination of radar antenna RPM
Test of the VR-2 battery
Test of the VR-2 proper
Intercom between the VR-2 operator and other relevant personnel

DEVELOPMENT:

Development of the VR-2 was undertaken jointly by the Norwegian Defence Research Establishment and NERA. Development of the Type 3KT22 analysis unit was by NERA in response to a Royal Norwegian Navy requirement.

MANUFACTURER:

NERA AS, Division Bergen, PO Box 53, N-5032 MINDE, Norway.

1858.253
VR-30 SERIES RADAR SEARCH RECEIVERS

DESCRIPTION:

The VR-30 Series of equipments forms a range radar search systems of modular design suitable for installation on board small, fast surface vessels where space and weight considerations are of prime importance. Submarine versions are produced also. The design is based on a building block principle which enables a user to progress from a very simple warning set giving acoustic and visual alarm, with an indication only of frequency band, to a system that will give instantaneous information on bearing to the transmitter, PRF and pulse width. In addition to frequency band warning lamps, the VR-30 acoustic warning device provides a special J-band intercept warning note, easily distinguishable from that denoting an X-, C-, or S-band intercept. As now available, the VR-30 Series comprises five versions, VR-30, VR-31, VR-32, VR-33, and VR-34. A suffix letter denotes the surface or submarine version of each model, C or B, respectively. The five models are formed by various combinations of three types of antenna and four display and data output arrangements, as shown in the following table:-

	VR-30	VR-31	VR-32	VR-33	VR34
Omni Antenna	•		•		
Horn Antenna		•	•	•	
Directional Antenna				•	•
Band Indicator	•		•	•	•
Warning Display		•	•	•	
CRT		•	•	•	
Bearing Indicator				•	•

The horn antenna unit consists of an octagonal array containing four horns (one each for the S, C, X and J-bands) in each of the eight sectors, and this unit also contains the appropriate detectors and video amplifiers. (A smaller version covering the S, C and X-bands only is also available.) This unit provides coarse bearing information. The directional antenna is a broadband, highly directional unit which is steered by remote control from the operator's console to establish the direction of arrival of intercepted radar signals. The display and indication facilities listed in the table above are not necessarily discrete items of equipment and dependent upon the SR-30 Series model concerned one or more of them will be combined within a single item of hardware. The following brief description of the SR-33 system, which incorporates them all, should make this clear.

TYPE VR-33:

This version employs the horn antenna array and the directional antenna. The former provides coarse bearing data, whilst the latter with its associated RF filters provides for accurate bearing determination and enables the frequency band to be established. The operator is free to choose either antenna system when analysing signals on the CRT of the indicator unit.

The indicator unit contains two displays, a double beam CRT for determination of PRF and pulse-width, and a warning display giving an approximate bearing of an intercept as well as an indication of the relevant frequency band. Optionally the warning display can be fitted with a gyro-stabilised azimuth scale. Any of the four frequency bands can be selected from the directional antenna for analysis, or any of the eight sectors of the octagonal array can be switched out. The warning display comprises a group of indicator lamps arranged radially to represent the eight sectors of the octagonal antenna array. The outermost lamps of each radial are the warning indicators, whilst the others are arranged to denote the frequency (S, C, X or J-band). The latter lamps light only when the directional antenna has been steered to the relevant bearing. When this is done, a separate numeric indicator gives a readout of the fine bearing measurement thus obtained. This procedure is further aided by arranging for the intensity of the bearing indicator readout display to vary with increasing or decreasing signal strength, which enables the operator to accurately aim the antenna at the required signal source.

VR-30 SERIES CHARACTERISTICS:

Frequency coverage: 2.5 to 18 GHz +
Polarisation of signals: Any
PRF measurement: 200 Hz to 10 kHz
Pulse-width range: 0.2 to 10 microsec
Bearing accuracy:
Directional antenna: ± 2°
Omni antenna: ±22.5°
Frequency band indication: S, C, X and J-band
Sensitivity: better than 0.3 mW/m²

MANUFACTURER:

NERA AS, Division Bergen, PO Box 53, N-5032 MINDE, Norway.

1859.253
VR-1-B/C RADAR SEARCH RECEIVERS
DESCRIPTION:

The VR-1 equipment is a passive radar search receiver for use on submarines (VR-1-B) or smaller surface vessels (VR-1-C). It is designed to provide radar warning facilities together with limited signal analysis capability. Pulsed radar transmissions of any polarisation within the frequency range 2.5 to 18 GHz are automatically identified with respect to direction and PRF or pulse-length and shape. As the receiver is "wide open" all the time, both in respect of frequency and direction, flash signals also are received. High sensitivity facilitates reception of transmissions originating from beyond the radar horizon. The VR-1 maintains full sensitivity during operation of own radars as provision is made for blanking out the amplifiers for the duration of the "main bang" from these systems. The VR-1-B is specially designed for submarine fitting and has a pressure-tight antenna for mounting at the top of a periscopic mast, and this is capable of withstanding pressures equivalent to a depth of 320 metres. The VR-1-C is intended for use aboard smaller surface vessels and is equipped with a lightweight antenna consisting of two identical halves for mounting around a mast. Apart from this difference, the VR-1-C and VR-1-B are identical.

VR-1-B/C CHARACTERISTICS:
Frequency coverage: 2.5 to 18 GHz
Polarisation of signals: Any
PRF measurement: 200 Hz to 10 kHz
Pulse-width range: 0.2 to 10 microsec
Bearing accuracy: + 22.5° or better
Typical sensitivity: 0.3 mW/m² or —46 dBm (B-band)

The antenna unit is an octagonal array of horns, each segment having a pair of horns for each frequency band, these being disposed for vertical and horizontal polarisation. Each horn has a crystal detector. Video signals are fed to an eight-channel solid-state video pre-amplifier before passing to the indicator unit for display and analysis. The amplified video from each channel is fed separately to the warning indicator display. The indicator unit has a 5-inch (127 mm) CRT on which alternative displays can be selected for both presentation of pulse-width and for PRF. Audio analysis facilities are provided also.

MANUFACTURER:
NERA AS, Division Bergen, PO Box 53, N-5032 MINDE, Norway.

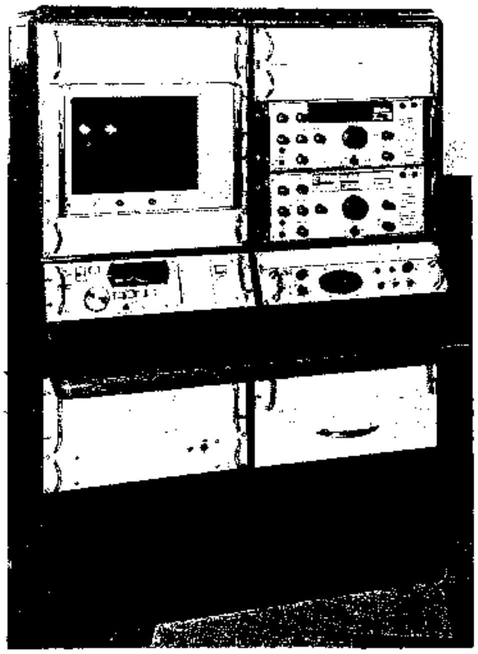
THE UNITED KINGDOM

1712.153
PLESSEY HF MONITORING AND DF SYSTEM
DESCRIPTION:

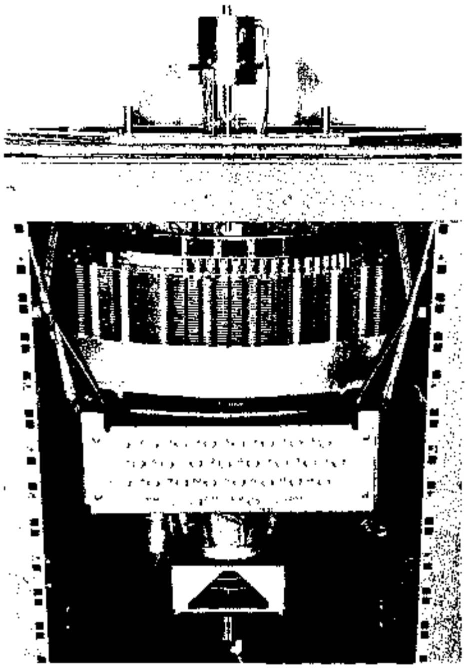
This system is produced in several configurations, appropriate to varying operational requirements, for the reception, monitoring, direction finding, and in some cases analysis of radio signals in the HF band 1.5 to 30 MHz. In those instances where the full frequency coverage is not required, some items of equipment such as part of the antenna array are omitted. The following description relates principally to the complete system.

The main elements of the system are the PVS1120A multiple beam HF receiving antenna system and the PVS 860 Series direction finding equipment. Additional equipment is used as required to provide those extra facilities such as analysis and recording to suit specific operational needs.

The PVS1120A antenna array consists of two sets of 24 monopoles equally spaced on 150 metre and 50 metre diameter circles respectively. The outer ring (PVS890A) covers the band 1.5-10 MHz and the inner (PVS880A) the band 8-30 MHz, and either may be employed on its own if the other frequency coverage is not required. Sets of electrically equal feeder cables carry antenna signals to beam-forming networks at the centre of the circle, and the net effect of the array is 360-degree cover in azimuth and 24 simultaneous 15-degree wide beams. Each of these beams can be fed to a number of monitor receivers.



Plessey PV871 Bearing and Display Console



Goniometer assembly of Plessey HF monitoring and direction finding system

The addition of the PVS 860 Series HF direction finding systems to the multi-beam antenna array provides accurate information on the azimuthal direction of arrival of any given signal. This facility is obtained independently of the 24 beams available from the antenna systems for normal receiver operation. The complete system functions by connecting the 24 outputs from the antenna system to the stater of a goniometer and scanning by a continuously revolving rotor, using capacitative coupling. At any particular instant, outputs from a group of eight adjacent antennas are coupled to the rotor and are phased and combined to give optimum response in a direction dependent upon the physical position of the eight antennas in the complete system. There are two DF outputs from the rotor, one being the sum of all eight antenna outputs and the other being the difference between two theoretically equal halves of the group. The result is the continuous scanning of the full 360 degree coverage, yielding at any instant, 'sum' and 'difference' outputs optimised for a directional normal to the sector formed by the coupled group of eight antennas.

The rotor outputs are connected to two receivers and the IF outputs relative to the required RF are displayed on the face of a CRT. This display also shows the amplitude of the sum and difference outputs, back-to-back, over the sector being scanned, the coincidence of maximum 'sum' signal and minimum 'difference' amplitudes indicating the bearing of the signal being examined.

As mentioned above, there are a number of equipment variations on the basic configuration just described, and to any of these certain additional items of equipment can be connected to provide whatever degree of sophistication in signal collection and analysis is required.

STATUS:
Systems of this type have been supplied to a number of unspecified users in Australia, Canada, Denmark, Sweden and the UK.

MANUFACTURER:
The Plessey Radio Company Ltd, West Leigh, Havant, Hants, England.

1707.253
SUSIE ECM RECEIVER SYSTEM
DESCRIPTION:

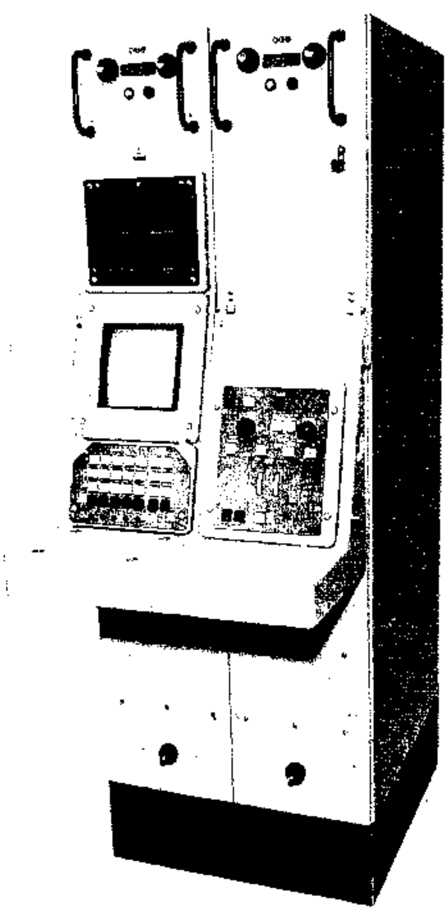
This passive intercept receiver is designed to detect all types of pulsed radar transmission and automatically present the received signals on a tactical situation display for assessment by the operator. The equipment may be left unattended and will give an alarm when signals of a preselected type or bearing are intercepted.

A situation display gives instantaneously a correlated pulse width/bearing indication together with frequency band simultaneously for all detectable signals. Thus the total radar environment is at all times shown without intervention by the operator. Signals may be selected by a strobe controlled by the operator for automatic readout of signal parameters or for automatic tracking, blanking or warning. The equipment is all solid state (except CRT and lamps), employs digital techniques, and is of modular construction. It has considerable stretch potential to provide for more sophisticated requirements.

The basic SUSIE equipment provides coverage from 2-18 GHz in four bands. Additional coverage in the range 1-40 GHz can be provided. The aerial system for SUSIE has no moving parts and can be supplied for mounting either on a platform or integrated into the mast structure.

STATUS:
In production and ordered for several navies.

MANUFACTURER:
The MEL Equipment Company Ltd, Manor Royal, Crawley, Sussex, England.



Operator console of SUSIE

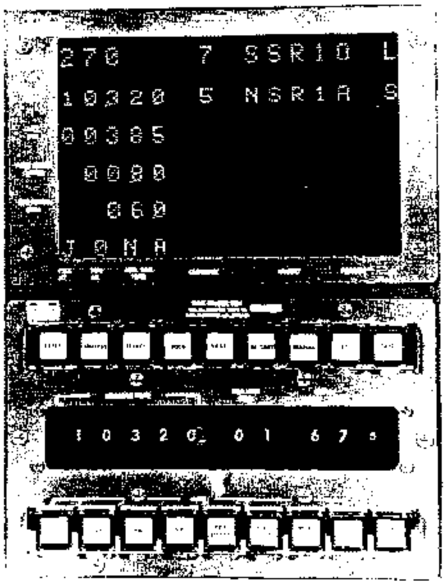
1743.263
SARIE – SEMI AUTOMATIC RADAR IDENTIFICATION EQUIPMENT

DESCRIPTION:
Because in the present environment the rate of radar intercepts can be high and the time that can be permitted to elapse between intercept and threat evaluation may be only a matter of seconds, speed and capacity are all-important in the modern identification system. Dependence upon operator reference to known radar parameters is thus unacceptably time-consuming and automatic identification is essential. It is to meet this type of operational requirement that the SARIE system has been produced. This system produces a solution to the problem by providing the results of automatic comparison of intercepted signal characteristics with a flexible dictionary of radar parameters in approximately 0.1 second. The equipment is also a useful tool in extending the existing library of data by analysing previously unrecorded transmissions.

The equipment consists of a display unit, control unit, and a data processing unit. The latter houses the dictionary, logic circuitry, punched tape reader and power supply. It can be remotely sited, as access is needed only for maintenance or to modify the dictionary contents. Dimensions are 785 × 710 × 230 mm and the weight 62 kg. The Display and Control Unit carries all the essential controls for operation of the system and the electronic display panel. Separate location of the control and display sections, to suit CIC or EW room requirements, can be accommodated if desired.

SARIE can be used with any EW receiver, accepting the video signal derived from the intercepted transmission. It automatically measures the PRF, pulse width and scan period with high accuracy, and detects the presence of PRF jitter. The equipment also accepts data on frequency, frequency agility modulation type and scan type for use in identification. This additional data, where available from the EW receiver, can be accepted automatically, or it may be entered manually by the operator from the control panel. The library is capable of storing parameter information on 475 radar types. The dictionary contents will be selected by the user to suit the anticipated operational requirements, and can be readily modified by means of the punched tape input.

The display presents data in alpha-numeric form, and typical information displayed includes the parameters of the intercepted signal, the results of the automatic comparison with the stored data to give possible identification(s) of the signal and the associated platform. Each comparative identification is given an automatic confidence level figure. The operator is able to select intercepts for identification.



SARIE Control Unit and Display Unit

MANUFACTURER:
EMI Electronics Ltd, Radar and Equipment Division, Hayes, Middlesex, England.

1877.253
EMI SIGNAL SELECTION AND PULSE ANALYSIS EQUIPMENT

DESCRIPTION:
The Signal Selection and Pulse Analysis Equipment has been designed to extend the capabilities of existing electronic warfare intercept receivers by providing an automatic analysis of the pulse width and pulse repetition frequency parameters of intercepted radar transmissions.

The inputs necessary are the demodulated pulse signals derived from the intercept receivers. A band selector switch is provided to allow for processing of four alternative signal inputs. The selected signals are fed to an octant selector stage and also to a threshold detector. The threshold detector stage includes a preset control (located on the front panel) to allow an operator to make a setting for optimum signal/noise conditions. The octant selector compares the selected input signal with the output from the threshold detector. When correlation occurs the signal from the selected octant is fed to the analysis circuits.

The first parameter to be analysed is the pulse repetition frequency. This is achieved by measuring the pulse interval. Several examinations of pulse intervals are made, each subsequent one is compared with the former. If these subsequent measurements are within a tolerance of ±2%, the pulse interval is directly converted into PRF. The PRF measurement is made in the range 100 Hz to 9999 Hz with the following accuracy.

± 1% at 100 Hz
± 0.2% at 1000 Hz
± 1% at 9999 Hz

These parameters are displayed on four numeric display tubes giving visible characters 13 mm high. A reset switch is provided for either automatic resetting (adjustable over the range 0.5 to 5 seconds) or manual reset, so that the read out may be retained.

The pulse width measurement is made on one of the pulses selected for PRF conversion and is effected in the range 0.1 to 9.9 μs with an accuracy of ±0.1 μs, but it is not displayed until the PRF measurement has been satisfactorily completed. The automatic and manual reset facilities provided for the PRF measuring circuits also operate on the pulse width measuring circuits. The measured result of pulse width is also displayed on two separate numeric tubes. In addition to the display tubes, facilities are incorporated for audio monitoring of the selected signal. Facilities are also provided for supplying the results of the analysis to a remote strip-line printer so that a permanent record may be obtained.

DEVELOPMENT:

The equipment has been developed by EMI Electronics Ltd., Hayes, Middlesex in conjunction with the Admiralty Surface Weapons Establishment for introduction into Royal Naval service.

MANUFACTURER:

Radar & Equipment Division, EMI Electronics Ltd., Hayes, Middlesex, England.

1341.253
DECCA RDL SERIES RADAR DETECTION EQUIPMENT

DESCRIPTION:

The purpose of this equipment is to detect radar transmissions and so provide warning of the approach of surface ships, submarines or other weapon platforms employing radar controlled weapon systems.

Although designed primarily for surface ships, versions of this equipment are now available for submarines, aircraft or vehicle use.

The RDL Series provides reception in the frequency bands 1 to 18 GHz dependent upon the particular version selected, and may be used in combinations to suit various tactical roles.

RDL-1BC:

A typical system for use on a fast patrol boat is the RDL-1BC, which provides instantaneous bearing, automatic pulse analysis and alarm, together with measurement of frequency band. Frequency coverage is from E to I band. The equipment comprises an antenna, a bearing display, a control unit, a power unit and a pre-pulse unit, all of which, apart from the display tubes, are solid state. The antenna is light and compact, and has been designed in two halves to wrap around a mast or other mounting and thus avoid the coveted mast head position.

The bearing measurement system employs a circular array of eight wide-band antennas spaced at 45° intervals in azimuth. For each antenna there is a radio frequency filter, a solid state crystal protection device, a crystal detector and integrated video pre-amplifier. The eight video signals are taken down the mast by way of sealed connectors and coaxial cables. This, and the absence of RF feeders, ensures easy installation to new or retrofitted vessels, The signals are fed to the bearing display when they are suitably amplified and pulse-lengthened before being applied to the deflection amplifiers of the display tube. A voltage controlled attenuate signals from the ship's own radars when pre-pulses are received from a pre-pulse unit. The pre-pulse unit accepts signals from the ships radars, transponders and IFF transmitters and combines them into a single blanking pulse which renders the RDL equipment inoperative during transmission. To enable the signals to be represented as a true bearing an input on the display from the ship's gyro compass is available for azimuth stabilisation.

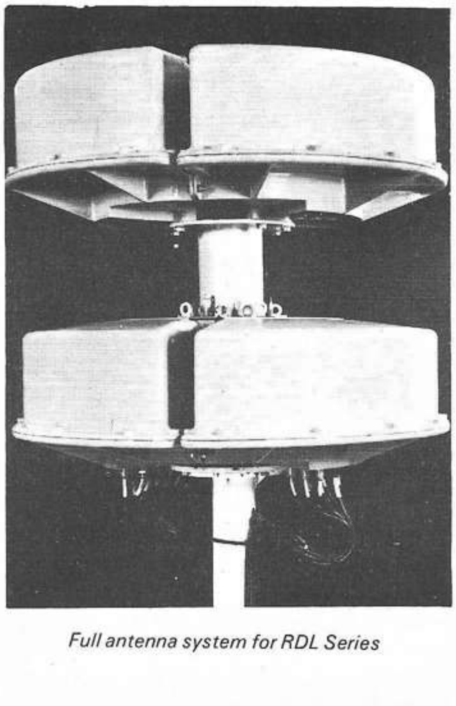
A second antenna array mounted below the bearing measurement array, consists of another set of eight antennas, also spaced at 45° in azimuth. Both the antenna arrays are located in a single radome and are supplied in all versions of the RDL series. In the more complex systems the lower array is used for frequency and pulse analysis purposes. In the case of this system it is used to provide frequency band identification in any one of eight switched azimuth sectors.

APC-1C:

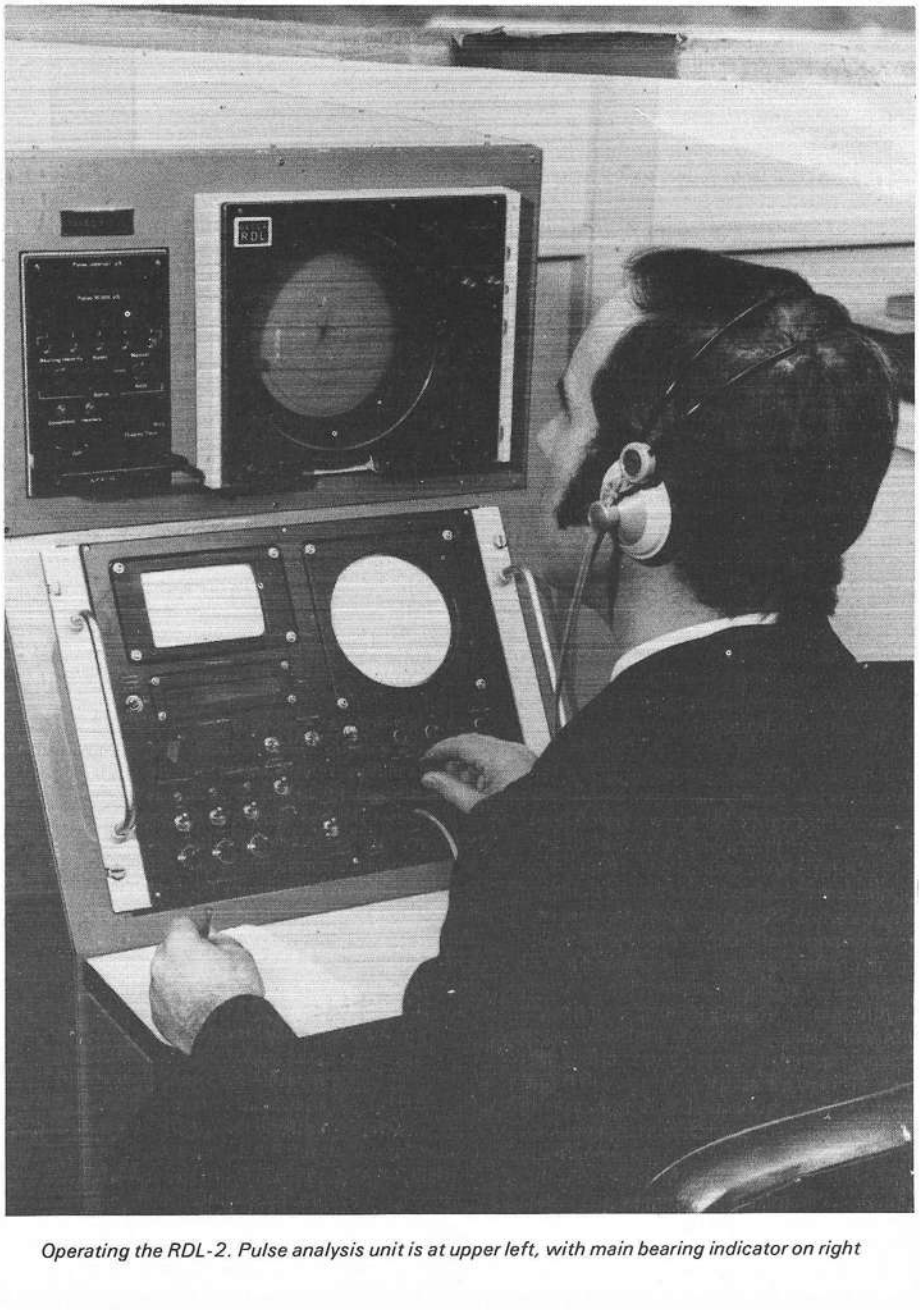
The Automatic Pulse Analyser APA-1C is a self-contained unit which may be used with any suitable EW receiving equipment. Used with the RDL-1BC, the unit provides an automatic digital readout of the pulse parameters of all signals or those selected from the switched lower antenna array. The unit is completely automatic and requires minimal operator skill or attention. For Elint purposes a line printer can be used to give a fast permanent record of the measured parameters of the intercepted radar transmissions.

There are also facilities available for the pulse parameters of up to five sets of independent radar transmissions to be set into the unit by plugging in printed circuit cards. When a signal is received which falls within these parameters, the operator is warned by the illumination of a solid state lamp or other remote triggered alarm, that a hostile transmission is present. The unit is completely solid state and employs LED numerical indicators.

The complete equipment is controlled by a master control unit, which enables the operator to display and analyse the intercepted signals in



Full antenna system for RDL Series



Operating the RDL-2. Pulse analysis unit is at upper left, with main bearing indicator on right various ways. He may, for example, display and analyse on the APA-1C *all* the signals intercepted and thereby obtain a complete picture of signal activity. Alternatively he can select and analyse only those signals on a particular bearing sector. A third and tactically important mode enables only alarm signals which appear on the APA-1C to be identified on the bearing display. An audio output enables radar signals to be recorded for off-line analysis or for subsequent use with operator training simulators.

APC-1C CHARACTERISTICS:

Pulse Interval Range: 10 μ S to 10 mS
Pulse Interval Accuracy: ± 1 u S
Pulse Width Range: 50 nS to 100 uS
Pulse Width Accuracy: ± 50 nS
Speed of Response: Readout on third pulse

RDL for Larger Ships:

Add-on units are available which convert the RDL-1BC equipment to meet the more exacting requirements of larger ships. The RDL-2ABC equipment has all the facilities of the RDL-1BC and in addition provides frequency measurement, visual pulse analysis and RF amplification in the analysis channel. The latter increases the range and permits better use of analysis facilities. The equipment consists of the units described previously and in addition contains an RF amplifier unit, a frequency and pulse analyser, and additional power supply units.

The antenna is identical to the RDL-1BC unit but contains additional components to upgrade the performance. The initial simple system can therefore be readily converted to the more comprehensive system.

The RF amplifier unit, RA-1 is fitted beneath the antenna. It contains components associated with the frequency measurement receiver and a broadband travelling wave tube which increases the sensitivity of the analysis channel. Again the intercepted signals are displayed on a standard bearing display unit and can be analysed automatically on the APA-1C.

The measurement of frequency and further pulse analysis is required for more sophisticated intelligence purposes or where active countermeasures are being considered. Several methods of frequency measurement are open to the designer, for instance IFM, (Instantaneous frequency measurement), superhetrodyne techniques and YIG (Yittrium Iron Garnet) filters. The YIG solution was adopted for RDL series equipment since it offered the best combination of performance and reliability related to cost.

In the RDL system, frequency is displayed panoramically with signals appearing as vertical deflections on the horizontal frequency scale. The operator must first select the azimuth sector containing the required signal and the band he requires to sweep. Then he may select one of two modes, auto-stop or auto-pause. In the auto-stop mode, the receiver stops sweeping automatically on signal reception and the radio frequency is indicated digitally.

In the auto-pause mode the system provides an overall picture of signal frequency activity on the selected band in the selected azimuth sector. Provision for selecting narrower frequency bands enables the system to have a high probability of intercept in that band although the whole frequency range can be swept if required.

Other facilities permit further expansion of the frequency bands, fine tuning of the received signal to obtain better frequency accuracy and the suppression, if required, of up to three specific frequencies. This enables the operator to prevent the receiver from stopping automatically on the friendly signals or those already analysed.

The RDL-2ABC system contains, in addition, a visual pulse analyser with a dual trace display. This enables two ranges of either pulse width of pulse repetition frequency to be measured visually against an illuminated graticule. This display also enables pulse peculiarities to be identified, including jittered PRF.

Elements of the RDL series, RDL-5 and RDL-6 provide for the addition of a D-band capability. All facilities available for the RDL-2 series are either useable or available as additions for signals in this frequency band. Similarly RDL-7 and RDL-8 equipment extend the system capability up to band J8.

The system RDL-2ABC 6AC 8AC covers the full 1 GHz to 18 GHz band with frequency measurement and automatic pulse analysis over the whole range. This equipment, with the addition of standard peripheral units such as computer injection panels, printers and recorders, represents a system comprehensive enough to fulfil the most stringent requirements, but is nevertheless only a few steps away from the simplest tactical system in the series.

DEVELOPMENT:

Design and development started in 1968, as a private venture.

STATUS:

Production. RDL Series in service or on order for 15 navies.

MANUFACTURERS:

Decca Radar Limited, Lyon Road, Hersham, Walton-on-Thames, Surrey, England.

1876.053
HWR-2 RADAR WARNING RECEIVER

DESCRIPTION:

This is a miniature warning receiver, designed specifically for use in environments such as helicopters and small patrol craft where space and weight are invariably at a premium and the installation of sophisticated Electronic Warfare equipment is uneconomical. In its basic form the receiver is handheld and operates completely independently of available supplies and mounting arrangements (although it may be hard-mounted in rotary wing aircraft and surface ships).

Held by a pistol-grip handle, it can be used to locate pulsed radar transmissions of any frequency in the range 2 GHz to 11 GHz. The presence of a radar transmission is indicated by listening to the audio note of the transmitted PRF on a headset. The electronic circuits are housed in a cast metal case designed to withstand rugged service conditions.

All controls are grouped on the rear face of the receiver with the single multiway connector for electrical interfaces. Using the Handheld Receiver, an operator may assess the following characteristics of a radar signal:

Bearing:

By scanning the receiver in azimuth and noting the direction of maximum signal volume in the headset, the bearing of a radar may be ascertained to an accuracy of approximately $\pm 10°$.

Polarisation:

By twisting the receiver for maximum signal volume, an assessment may be made of the radar polarisation. When the receiver is held normally with the handle pointing downwards the antenna polarisation is linear at 45°, and thus horizontal, vertical and circular polarisation may be received. The receiver polarisation is indicated by an arrow on the back of the case.

Frequency Band:

By operating the Band switch from the All position to the High position, an assessment may be made of the radar frequency band. If the signal is in X-band, then it will remain audible, if it is S-band, it will be suppressed.

Scan Pattern:

The audible sequence gives a very good indication of the type of radar scan e.g. continuously rotating, sector scanning etc.

PRF:

An experienced operator will be able to discern quite accurate information about the radar PRF from the audible note.

Range and Power:

The relative intensity of a received set of signals provides some indication of their range and power. The sensitivity of the receiver may be reduced by 15 dB by operation of the sensitivity control from High to Low.

STATUS:

In production and delivered to various users

Decca HWR-2 hand-held radar warning receiver in use

MANUFACTURER:

Decca Radar Ltd., Lyon Road, Walton-on-Thames, Surrey, England.

THE UNITED STATES

1904.393
ALE-37 CHAFF DISPENSER

DESCRIPTION:

The AN/ALE-37 is a high-capacity chaff dispenser for large area coverage, and although not officially confirmed, it is assumed to be internally carried by the seeding aircraft. It is capable of dispensing chaff or expendable jammers for anti-radar purposes, or flares. The probable use for this equipment is not so much self defence for the seeding aircraft as an element of full-scale EW support for a large-scale bomber attack or other large formation operation. Although it cannot be confirmed, it is probable that there are provisions in the equipment for programmed shot dispensing of the chaff or other stores, and that a range of radar frequency bands can be handled.

STATUS:

Believed to be in development during 1973.

1905.393
ALE-39 ECM DISPENSER

DESCRIPTION:

The ALE-39 ECM dispenser developed as a replacement for the ALE-29B equipment. The latter has been deployed on almost all types of US Navy tactical aircraft, and is capable of dispensing both chaff and flares. However, it has to be preprogrammed on the ground, before take-off: the ALE-39 allows the pilot to select from the cockpit, while airborne, whether a chaff cartridge or a flare for IR missile defence is dispensed. The system also will have the capability for selection and ejection of expendable jammers when these are operationally available. The ALE-39 is intended for self-protection of tactical aircraft such as the A-4, A-6, A-7 and F-4 types. Development was completed and the ALE 39 was released for production in October 1972.

MANUFACTURER:

Goodyear Aerospace Corporation, Lichfield Park, Arizona 85340, USA.

1906.393
ALE-40 CHAFF DISPENSER

DESCRIPTION:

The ALE-40 is a radar counter-measure chaff dispensing equipment that can be carried on aircraft external stores pylons without preventing the use of these pylons for their primary purpose of carrying missiles or other munitions. This is achieved by mounting honey-comb type container/dispensers on the vertical sides of the wing pylons. Each such container can house 30 cartridge ejected chaff packages which are expelled rearward from the container. The packages are rectangular in section to conform with the container, and they can be loaded with either RR 170A/AL aluminium-coated glass or RR-170B/AL aluminium foil chaff. Measurements of chaff packages are 23 × 23 mm square × approximately 16 cm long and each incorporates its own ejector cartridge. A complete equipment set consists of four launcher containers which, in the case of the F-4 aircraft, are located on the inboard wing pylons.

MANUFACTURER:

Tracor, Inc., 6500 Tracor Lane, Austin, Texas 78721, USA.

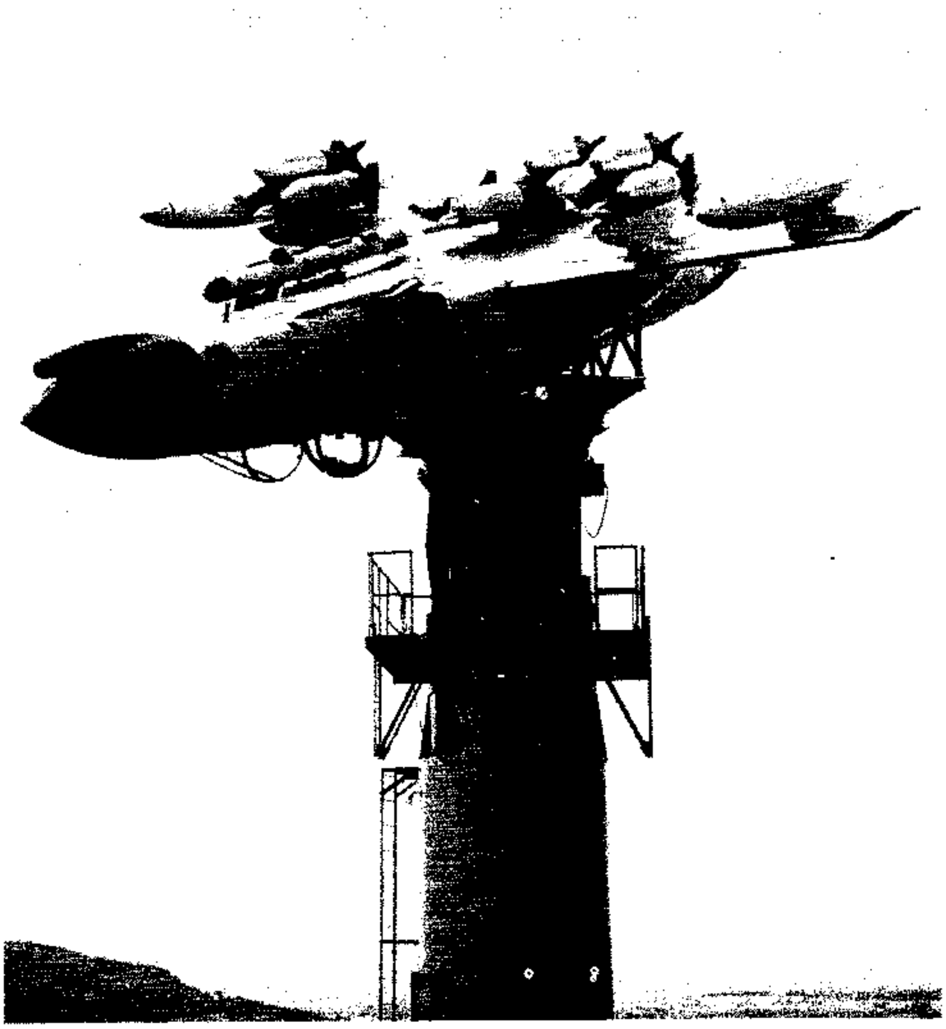
1907.393
ALQ-87 ECM POD

DESCRIPTION:

The AN/ALQ-87 is one of the later jamming pods to emerge from the long-running QRC-160 programme (c 1960-1965), and was the '-8' model of that series. (The '-1' became the ALQ-71 S-band noise jammer, and the '-2' was the X-band ALQ-72.) The broadening range of threats and frequencies employed, which were encountered by the USAF in SE Asia led to an examination of new countermeasures and the requisite technical means to extend jamming frequency coverage. Among the latter, the backward wave oscillator was adopted for the QRC-160-8 which had the ability to cover the C-band. This version was designated the ALQ-87. It later was given an X-band capability, in late 1968, followed in 1969 by another upward frequency increment into the Ku-band. This pod had barrage jamming capabilities against both land-based threats and interceptor AI radars.

MANUFACTURER:

General Electric Company, Aerospace Electronic Systems Department, French Road, Utica, New York 13503, USA.



A salvaged F-4B aircraft, installed on a test rig at Rome, NY, Air Development Centre is used for the evaluation of the ALQ-87 countermeasures pod on centre-line of fuselage

1908.393
ALQ-99 ECM EQUIPMENT

DESCRIPTION:

The AN/ALQ-99 is a large and sophisticated tactical noise jamming system forming the major portion of the US Navy EA-6B ECM aircraft's operational payload. It comprises five external pods, each capable of housing two very high powered jamming transmitters, a tracking receiver, the requisite aerials and a ram air turbine to provide electrical power. Other associated equipment is housed in the large fin-top blister of the EA-6B, and in the aircraft itself there is further ALQ-99 equipment which includes a digital computer and display and control facilities for two operating crew members.

The pods are detachable from the aircraft and are capable of housing various combinations of transmitters and receivers to cover any desired frequency bands. These can be arranged to provide an aircraft with any combination of duplicated and different operating bands, within the total capacity of the equipment and as required by operational necessities.

System Integration Receivers are responsible for monitoring the threat situation (ie opposing radar transmissions) and the outputs of the ALQ 99 transmitters, to ensure that the systems respond to valid threats and not to the aircraft's own transmissions. The SIR system receivers and antennas are housed in the fin blister. An IBM 4 Pi general purpose digital computer inside the aircraft carries out processing for the tactical jamming system as well as performing a navigational function. The latter facility enables the computer to perform a transmission beam steering (or transmission blanking) function so that jamming radiation can be restricted to a given 30-degree azimuth sector. The computer also interfaces with the SIR and display sub-systems.

Of three possible operating modes for the ALQ-99, in the automatic mode the computer performs the sorting of detected signals and directs the selection and activation of jamming against threats. In this mode, the two operators monitor system operation. In the semi-automatic mode, the computer identifies and indicates threats and the operators select and initiate ECM actions. In the manual mode the operators each search their apportioned parts of the spectrum, identify threats and assign jammers to them.

STATUS:

In service with USN EA-6B aircraft. An internally located version of the ALQ-99 is under consideration by the USAF for use in the projected EF-111A ECM aircraft. It is envisaged that this would incorporate a number of improvements, among them: (1) reduced search time for receivers to search the radar bands and identify enemy signals; (2) an increase in the number of radars that can be jammed by each ALQ-99 transmitter by increasing the jamming bandwidth and generating (modulated?) instead of (noise?) jamming signals; (3) increased operational flexibility by permitting several jammers with different frequency coverage to employ the same exciter, or signal source; and (4) further extra operational flexibility by adding omni-directional antennas to permit selection of either directional or omni-directional transmissions. Note. The words in brackets in the above passage have been substituted for the word 'Deleted' which appeared in the original document. It is believed, also, that the EF-111A version of the ALQ-99 would employ more transmitters than that used on the EA-6B.

MANUFACTURERS:

AIL – Surveillance antennas, receivers, displays and encoders

Raytheon – Transmitters and exciters

AEL – Transmitting antennas

Hughes and Teledyne – Travelling wave tubes

General Instrument Corp – SIR system

McDonnell Douglas – Pods

IBM – Computer

Garrett – Ram air turbines

ALQ-99 ECM system used in the US Navy EA-6B aircraft seen undergoing final test at the AIL Long Island plant

1909.393

ALQ-100 ECM EQUIPMENT

DESCRIPTION:

The AN/ALQ-100 is an internally-mounted Deception Electronic Counter-Measures (DECM) equipment fitted in US Navy A-4, EA-6B and A-7 aircraft. It is a multiple-band, repeater-type track breaking jammer and operates in conjunction with the aircraft's threat warning receiver. No official details have been revealed but it is thought that the ALQ-100 responds to detection of a radar signal associated with a known Soviet AA missile threat by high-power, broad-band noise jamming in the same radar band, or in the DECM mode by repeating the threat radar's signals after a delay to deceive the system and break track.

An advanced version of the ALQ-100 was procured by the US Navy under an updating programme called PRIDE, and a contract valued at over $38-million was awarded in August 1972.

MANUFACTURER:

Sanders Associates, Inc, Daniel Webster Highway, South, Nashua, New Hampshire 03060, USA.

1910.393

ALQ-101 ECM PODS

DESCRIPTION:

The AN/ALQ-101 designation embraces a large family of jamming pods with varying capabilities, and which have evolved over a period of about eight years. The USAF project Sesame Seed of 1966 called for proposals for a range of modular jamming pods, and this led first to a contract for five QRC-335A prototypes and eventually to production of 155 pods designated QRC-335A/101-1. Deliveries commenced in 1967 and were completed by Summer 1968. This version was a fore and aft-facing jammer covering the S-and C-bands, and during the production run the nomenclature was changed to ALQ-101A.

The ALQ-101(V)3 model which followed was a more powerful version covering the same frequency bands, and 71 were produced. An option for a further 60 was overtaken by rapid changes in the threats to be countered, which resulted in an updating programme to add X-band capabilities. This model became the ALQ-101(V)4 and a total of 324 pods were procured, of which 60 represented the option on (V)3 models.

The ALQ-101(V)6 model followed in the Fiscal Year 1970 funding, this version having a further extension of its frequency coverage. A total of 58 pods were delivered to the USAF.

All of the above versions of the ALQ-101 were of circular cross-section and were about 25 cm in diameter, the first QRC-335A model having been approximately 230 cm long and the three succeeding versions about 390 cm in length. The final model of the series, the ALQ-101(V)8, was the first of the so-called 'gondola' type in which the underside of the pod has throughout its length a trough-shaped compartment which considerably increases the available volume of the pod without serious increase in cross-sectional area. This model enlarged the frequency coverage once again and also incorporated other improvements to provide "full capability", or the ability to counter all known anti-aircraft threats. Earlier ALQ-101 pods were retrospectively updated to (V)8 standard and a total of more than 300 was procured. This final model of ALQ-101 is approximately equivalent to the ALQ-119 which followed after the USAF awarded a contract in 1970.

One other derivative of the original QRC-335 pod which should be mentioned. This is the ALQ-105 which consisted of a repackaged version that amounted to a longitudinal splitting of the pod, the two halves being grafted onto the sides of the F-105 fighter-bomber aircraft. About 90 were produced.

MANUFACTURER

Aerospace and Electronic Systems, Westinghouse Electric Corporation, Baltimore, Maryland 21203, USA.

1911.393

ALQ-119 ECM POD

DESCRIPTION:

The AN/ALQ-119 is a dual-mode jammer pod which was developed for the USAF to provide "full-capability" protection for strike aircraft. By full-capability is meant a complement of countermeasures against known AA threats. Various types of aircraft can be equipped with the ALQ-119 but the principal model is the F-4 Phantom. It is reported to be a three-band equipment, and qualifies for dual-mode status by virtue facilities for both noise jamming and repeater deception jamming.

When initiated as QRC-522 in 1970, the equipment was given extended frequency capabilities and enhanced modulation performance to become the USAF production version designated

ALQ-119. The three frequency bands covered by the equipment have not been disclosed but are probably X-, C-, and S-band.

DEVELOPMENT:

Development was initiated by QRC-522 and R & D was carried out by Westinghouse. In 1970 a contract for 20 prototype pods was awarded. It entered service in Vietnam in 1972.

STATUS:

Between 600 and 700 ALQ-119 pods have been produced and in July 1974 the rate of production was running at about 20 pods per month. This figure was expected to increase to around 45 per month as production of the older ALQ-101 pod tapered off and stopped. In March 1974, a total procurement of 122 ALQ-119s was funded for FY 1975. Reportedly, this equipment was among EW hardware supplied to Israel during the 1973 conflict.

Under the USAF Compass Matrix project, the ALQ-119 is to be provided with a computer-controlled energy management system, by means of which the power radiated by the pod, in terms of frequency, type of signal etc, will be automatically controlled in accordance with the threat situation encountered.

MANUFACTURER:

Aerospace and Electronic Systems, Westinghouse Electric Corporation, Baltimore, Maryland 21203, USA.

ALQ-119 ECM Pod produced by Westinghouse

1912.393
ALQ-123 INFRA-RED COUNTER-MEASURES

DESCRIPTION:

The AN/ALQ-123 is an airborne infra-red jamming equipment, developed to provide aircraft with protection from IR-homing missiles, particularly surface-to-air weapons such as the Soviet SA-7, Grail. It is a pod-mounted equipment and is powered by a ram-air turbine, and was designed for carriage on A-6 and A-7 type attack aircraft. Modification of the system for internal installation in the tail of fighter aircraft has been given some consideration by the US Navy.

The ALQ-123 is not an IRCM of the flare dispensing type (which is a known technique of decoying IR-homing missiles), and it is understood to comprise a method of generating a series of fuel-air aerosols behind the aircraft and causing them to ignite at appropriate intervals to confuse or break the lock-on of an IR seeking missile.

STATUS:

Development had been completed by March 1973 and operation evaluation followed with production examples two or three months later. The system is now in the US inventory.

MANUFACTURER:

Xerox Corporation, Electro-Optical Systems, 300 N. Halstead Street, Pasadena, California 91107, USA.

1913.393
ALQ-126 ECM EQUIPMENT

DESCRIPTION:

The AN/ALQ-126 is a Deception Electronic Counter-Measures (DECM) equipment developed under the US Navy's Charger Blue EW updating programme. It provides a wider coverage of radar frequency bands than the ALQ-100, upon which it is based, and was initiated in response to the new threats represented by recently introduced Soviet anti-aircraft missiles and gun systems.

The ALQ-126 is internally fitted in US Navy tactical aircraft such as the A-7, A-6 and RA-5, and is intended to progressively replace the ALQ-100 In addition to increased frequency coverage, the ALQ-126 incorporates improved deception techniques, more modern construction, packaging and cooling arrangements.

STATUS:

The USN Fiscal Year 1974 Budget sought funds amounting to over $53-million to provide ALQ-126 equipment for 219 aircraft. Production had commenced by June 1973. Later in 1973, it was announced that a total of almost 1300 sets were to be acquired by the USN at an estimated cost of $225-million. A small quantity for use on Royal Netherlands Air Force F-104 aircraft was ordered in 1974.

MANUFACTURER:

Sanders Associates, Inc., Daniel Webster Highway, South, Nashua, New Hampshire 03060, USA.

1914.393
ALQ-130 ECM EQUIPMENT

DESCRIPTION:

The AN/ALQ-130 is a tactical communications jamming equipment for use by US Navy fighter and attack aircraft, including A-4, A-6, A-7, and F-4 types. The principal function is probably the disruption of the communications links associated with enemy air defence networks and surface-to-air missile formations. The jamming may include broad-band electrical and/or acoustic noise or spot frequency jamming, but the former is probably more likely.

Development of the ALQ-130 was initiated as an updating programme for the ALQ-92 tactical communications jammer, which on the USN EA-6B is internally mounted, suggesting that the ALQ-130 also will be carried this way.

MANUFACTURER:

AIL Division, Cutler-Hammer, Deer Park, Long Island, New York 11729, USA.

1915.393
ALQ-131 ECM POD

DESCRIPTION:

The AN/ALQ-131 is an advanced ECM, jamming pod being developed under Programme Element 64739F which covers protective systems for the F-4 and F-105 aircraft types. Dimensions of the ALQ-131 are: length, 437 cm × 25 cm deep × 30 cm wide, and weight 377 kg. It is a modular equipment, described in US defence circles as a full-capability-plus system, and is based on the use of a digital computer contained within the pod. There are eight different modules for one version of the pod, providing for jamming of all known anti-aircraft missile system frequency bands. Another module is a radar warning receiver, which, in conjunction with the pod's self-contained digital processor, enables threat evaluation to be carried out autonomously without recourse to internal aircraft analysis equipment.

DEVELOPMENT:

Development was undertaken in response to a USAF RFP, (QRC-559) in the 1971-72 period, when proposals were put up by a number of US industry teams. That headed by Westinghouse was chosen to develop the ALQ-131. Other members of this team were Motorola and Dalmo Victor, the former handling the lower-band portion of the equipment, and the latter being responsible for the digital processor and warning receivers.

The programme was halted briefly in March 1973 when Westinghouse and the USAF embarked on a cost-cutting exercise, but it was re-started in the following May. Development continued in 1974.

STATUS:

Supplemental funds to increase the pace of ALQ-131 and its associated support equipment during FY 1975 to the extent of $5.4-million. Estimated cost per copy of production models is $400,000 and the first 25 pods of an anticipated initial purchase of 100 was reported in March 1974. First flight test were due in Summer, 1974.

MANUFACTURER:

Aerospace and Electronic Systems, Westinghouse Electric Corporation, Baltimore, Maryland 21203, USA.

1916.393
ALQ-133 ELINT EQUIPMENT

DESCRIPTION:

The AN/ALQ-133 is a tactical Elint system which is under development to be used by the US Army to convert a number of OV-1 reconnaissance aircraft for emitter detection and location missions. OV-1 Mohawk aircraft converted in this way will bear the new designation EV-1. The ALQ-133 has also been proposed for use in a number of A-10 tactical aircraft.

The EV-1 configuration of the ALQ-133 consists of two pods containing Elint receivers needed to cover a frequency range extending probably from VHF or UHF up to 18 GHz, and equipped with the appropriate broad-band antennas; and data processing equipment housed in the aircraft fuselage. The pod antennas will be phased interferometer elements, capable of providing direction-of-arrival measurements over a 90-degree sector abeam of the aircraft to a typical accuracy of 0.5 degree. If some degradation of bearing accuracy is acceptable, the coverage sector can be enlarged to 120 degrees.

The data processor is responsible for control of the search receivers, analysis of intercepted signals and comparison of these against a file of known hostile radar characteristics. Other data processing options include housing this part of the equipment in a third pod (this is proposed for the A-10), and locating it on the ground, the raw Elint being passed from the aircraft by data link.

STATUS:

In May 1974 funds amounting to $5.7-million were being sought by the Army for six ALQ-133 electronic surveillance radar target locator systems. At that time, two pre-production models were under construction, plus a third for military qualification testing, under a separate development contract worth about $8 million. Completion was due in late 1974.

MANUFACTURER:

United Technology Laboratories, 410 Kirby, Garland, Texas 75042, USA.

1917.353
ALR-45 ECM EQUIPMENT

DESCRIPTION:

The AN/ALR-45 is an aircraft radar warning and direction finding receiver which is fitted to most types of US Navy tactical aircraft. It is similar to the earlier APR-25 warning receiver but provides for high-speed, digital processing of threat data as well as having a wider frequency coverage. Few details of the ALR-45 have been released but it has been described as a wide-open, broad-band receiver covering a frequency range of 2 GHz to over 14 GHz.

Four cavity-backed planar spiral antennas are used, each with its own pre-amplifier and interface unit linking it to the central receiver and processor.

MANUFACTURER:

Itek Corporation, Applied Technology Division, 3410 Hillview Avenue, Stanford Industrial Park, Palo Alto, California, 94304, USA.

1862.353
ALR-47 RADAR HOMING AND WARNING SYSTEM

DESCRIPTION:

The AN/ALR-47 Counter-measures Receiving Set has been developed for the US Navy's newest ASW aircraft, the S-3A Viking (Entry No. **1403.302**) and is representative of the latest practice in RHAW equipment. In the Viking the ALR-47 obtains emitter signature and directional data which is fed into the aircraft's general-purpose digital computer for display on a multi-function display console. Among new features of the ALR-47 are automatic operation with variable control for frequency band limits, speed of tuning, and signal selection. Fixed antennas are used (4 in each wing-tip), superhet receivers, and a digital processor.

Twin narrow-band receivers are incorporated in each ALR-47, and these incorporate an IF discriminator, out-of-band rejection logic, and voltage controlled oscillators which are tuned directly by computer control. The receiver channels are designed for high sensitivity and there is logarithmic compression of video outputs.

The characteristics of video outputs from four monopulse receiver channels are derived in a signal comparator which converts the data to digital format. All subsequent signal processing is performed digitally under computer control.

The two antenna groups are each comprised of two pairs of cavity backed planar spiral broad-band antennas, arranged in a near orthogonal disposition for monopulse direction finding.

Control of the ALR-47 system is by means of computer programs which provide for receiver tuning, signal processing, and initiating warnings of significant contacts or known threats identified by stored signal characteristics. Provision is made for human intervention and manipulation of the software in the course of a mission to meet specific operational needs. Examples of this are facilities for filtering out unwanted signals of various types so that the overall processing and display load is reduced. Similarly parameters such as scan speed and frequency scanning limits, PRF, pulse-length or bearing limits may all be varied at the discretion of the operator.

STATUS:

In production for the USN S-3A Viking ASW aircraft.

MANUFACTURER:

IBM, Federal Systems Division, 10215 Fernwood Road, Bethesda, Maryland 20034, USA.

1918.353
ALR-50 ECM EQUIPMENT

DESCRIPTION:

The AN/ALR-50 is a surface-to-air missile alert and launch warning receiver set. Official details of its frequency coverage range have not been released but the ALR-50's coverage is believed to provide for warning of the radars associated with such Soviet surface-to-air missiles as the latest SA-6 Gainful as well as the earlier SA-2 and SA-3 weapons. It is possible, however, that whereas systems of this type (ALR-50) normally provide the aircrew with some indication of the status of the threat (Eg, search, tracking, lock-on etc), in the case of the SA-6 Gainful the use of as many as five bands for this missile's associated radars may prevent the ALR-50 from providing complete threat status information.

STATUS:

Development completed, in service with various US Navy aircraft types, including: A-4, RA-5, A-6, A-7, F-4 and F-8.

MANUFACTURER:

The Magnavox Company, 1700, Magnavox Way, Fort Wayne, Indiana 46804, USA.

1919.353
ALR-52 ECM RECEIVER

DESCRIPTION:

The AN/ALR-52 is a multi-band IFM (Instantaneous Frequency Measuring) receiver for airborne or land mobile applications. A naval variant is produced also under the nomenclature AW/WLR-11. Typical systems cover the microwave frequency band from 0.5 GHz to 18 GHz, using receiver modules that cover octave-bandwidths. Additional capabilities include provision for selection of a particular signal or frequency band, blanking of signals which are of no further interest, separation of interleaved pulse trains, measurement of radar parameters, analysis of CW as well as pulse signals, and direction-of-arrival (DF) measurement. The complete equipment provides for two operator positions, each equipped with a control unit and a display. The two IFM control units are capable of complete control over any band selected. If the same band is selected by both units, the video processing unit gives priority control to one position only. All intercepted signals, however, are presented on the displays at both positions.

A modified version of the ALR-52 has been developed and deployed, in which one of the operator positions has been replaced by an interface unit to link the IFM receiver with a digital computer. This system also employs a 1 to 18 GHz DF antenna system. The computer uses the data to 'tag' every received pulse with its frequency, pulse-width, time-of-arrival and azimuth. This information is stored and used to develop an emitter parameter.

STATUS:

The US Navy placed a contract for $2.1-million in March 1972 for ALR-52 equipments, and the shipborne version, WLR-11, also is in service.

MANUFACTURER:

ARGO Systems, 1069 East Meadow Circle, Palo Alto, California 94303, USA.

1863.363
DSA-20 DIGITAL SIGNAL ANALYSER

DESCRIPTION:

The DSA-20 is a digital signal analyser designed as a direct replacement for the analogue, hard-wired type of analyser used in Radar Homing and Warning Systems (RHAW) such as the ALR-45, APR-25, APR-36, and APR-107. The DSA-20 is interposed between the existing RHAW receiver(s) and threat display and bearing indicators, and no aircraft modifications are called for. A major benefit claimed for this equipment is the improved presentation of information on the RHAW azimuth indicator. In place of the conventional families of radial lines for each emitter detected, the DSA-20 provides alpha-numeric symbols for each class of contact, and the digital system permits priority allocation by push-button so that overlapping threats may be separated and unwanted signals cleared from the display. The use of digital processing offers another significant advantage in that changes in threat signatures that have been detected by Elint operations can be inserted rapidly into the RHAW, with far less delay than is possible with hard-wired, analogue analysers.

STATUS:

In production for the USAF.

MANUFACTURER:

Dalmo Victor, 1515 Industrial Way, Belmont, California 94002, USA.

1861.053
SYLVANIA EW ANTENNAS

DESCRIPTION:

The Electronic Systems Group of GTE Sylvania, Inc has developed and produces a wide range of special antennas for electronic warfare applications and in the following paragraphs the salient features of major examples of this range are listed.

AN-10B Broadband Horn:

This is a microwave horn antenna for which high, and near-constant, efficiency over an operating frequency spectrum of more than 10:1 is claimed. This is achieved by locating a dielectric phase-correcting lens in the flared section of a double-ridged horn. The frequency range is 1 – 11 GHz and linear, horizontal or vertical polarisation is acceptable. The nominal gain (over an isotropic source) is specified as 2 to 20 dB.

AN-10C Broadband Horn:

The AN-10C is a compact microwave horn with a frequency coverage of 2 – 11 GHz. The antenna is basically a double-ridged horn with a solid-dielectric, phase-correcting lens located in the horn aperture. Weight is less than 0.6 kg and the gain 6 to 17 dB.

AN-10E Broadband Horn:

This microwave horn provides high efficiency over a band of 0.5 to 4 GHz. A double-ridged horn, the AN-10E represents a compact UHF unit for ECM, tracking, and surveillance. Gain is 8 to 14.5 dB.

AN-10F Broadband Horn:

The AN-10F is another example of the double-ridged horn with a dielectric phase-correcting lens in the horn aperture. Its frequency range is 3 to 18 GHz, with gain specified as 6 to 20 dB. Applications are ECM, tracking, surveillance, etc. and it may be used either as the main radiating or receiving element or as the feed for a parabolic reflector.

AN-13 High-gain Omni-directional Antennas:

This range of omni-directional antennas has been developed for signal acquisition and side-lobe suppression applications. The basic construction is that of a biconical horn, with metal grids or meander lines in the aperture, yielding 45-degree slant linear or circular polarisation, respectively. The polariser grids also serve as a structural support and protective radome. A large biconical antenna aperture gives narrow elevation beamwidths and relatively high gain. The various frequency ranges of the series are denoted by suffix letters and numbers which follow the basic AN-13 model, as shown in the following table. All models from AN-13A to AN-13D have 45-degree slant polarisation, while those from AN-13E to AN-13GZ have circular polarisation.

Model No.	Frequency (GHz)	Beamwidth (Elev)
AN-13A	1-4	30
AN-13A2	0.25-0.5	20
AN-13A3	0.5-1	20
AN-13A4	1-2	20
AN-13B	4-12	15
AN-13B2	8-12	30
AN-13B3	3-18	100 to 25
AN-13C	12-18	60 to 29
AN-13D	17-26.5	55 to 22
AN-13E	12-18	40
AN-13E2	7.5-16.5	40
AN-13E3	8-12	20
AN-13E4	12-18	20
AN-13E5	10-18	40 to 20
AN-13F	7-17.5	−10 to +30
AN-13G	2-4	20
AN-13G2	4-8	20

AN-15 Conical Log Spiral Antennas:

These are produced by means of a three-dimensional printed-circuit technique for generating precision log spirals on dielectric cones. These conical log spirals maintain essentially constant radiation pattern performance with low polarisation axial ratio over several octaves of bandwidth. They have been designed for use as reflector feeds, primary radiation, and array elements. The tip diameter of the conical spirals is typically 0.1 wavelength of the highest operating frequency. The base diameter is normally about 0.3 wavelength of the bottom cut-off frequency, for small cone-angles. For large cone-angles the latter value becomes 0.4 wavelength.

Model	Cone-angle	Freq. (GHz)	Half Power Beamwidth
AN-15A	25	0.05-1.0	80
AN-15B	15	0.5-1.0	70
AN-15C	10	1.0-2.0	70
AN-15D	10	2.0-4.0	70
AN-15E	10	4.0-8.0	70
AN-15F	10	8.0-12.0	70
AN-15G	10	12.0-18.0	75
AN-15H	15	1.0-4.0	80
AN-15I	25	2.3-11.0	80
AN-15J	25	1.0-8.0	80
AN-15K	30	1.0-12.0	90
AN-15L	30	0.5-4.0	90
AN-15M	30	4.0-12.0	90
AN-15N	20	1.0-4.0	120
AN-15O	20	4.0-8.0	120
AN-15P	20	8.0-18.0	120

AN-16 Cavity-backed Spiral Antenna:

The AN-16 is a precision cavity-backed, planar-spiral antenna covering a frequency band of 2 to 18 GHz. Antennas of this type track one another extremely well when associated, in both amplitude and phase, this applying not only in the on-axis situation but up to ± 30 degrees off the antenna axis.

AN-18 Dual-polarised Horn Antennas:

A number of broadband, quadruple-ridged horn antennas have been developed covering frequencies in the range 50 MHz to 18 GHz. Horns of this type, covering frequency bands of up to 8:1, have two orthoganal probe feeds. Through a polarisation switching network, two orthogonal linear polarisations and left- and right-hand circular polarisations can be obtained. Isolation between probes is greater than 30 dB. Phase imbalance between probes is less than 10 degrees and the amplitude imbalance less than 1 dB across the frequency band of interest. This series of antennas was designed for use in reconnaissance and surveillance of signals of unknown polarity.

AN-23 Lindenblad Antennas:

GTE Sylvania has developed printed circuit board circularly polarised omni-directional Lindenblad antennas to cover octave frequency bands. Five different units are available in the 0.5 to 12 GHz range. They are produced as complete sealed units, with integral radome, and are suitable for airborne use in intercept/collection and other applications.

AN-34 Conical Spiral Array:

Under this designation a series of conical-spiral antenna arrays for broad-band, high-accuracy tracking and direction-finding is produced. Features of such arrays include circular polarisation, low polarisation axial ratio, frequency-independent performance, small bore-sight shift, and phase and amplitude tracking among antennas. An antenna array for two-channel monopulse operation consists of two conical-spiral antennas arranged in the frequency-independent manner and a magic-T which provides the sum and difference output. The one Sigma DF accuracy of such an array over an azimuth sector of 45 degrees (±15 degrees in elevation) is better than 1.5 degrees over an octave bandwidth.

MANUFACTURER:

GTE Sylvania Inc., Electronic Systems Group, Western Division, 100, Furguson Drive, Mountain View, California 94040, USA.

1887.153
FAIRS ELINT SYSTEM

DESCRIPTION:

The Fairchild Automatic Intercept and Response System (FAIRS) is a multi-site/multi-purpose electromagnetic data acquisition and processing system. The basic FAIRS concept is to acquire and process data from a number of remote sites or mobile units and provide pre-processed data to a central command centre or remote users for decision making. The collection system is extremely flexible and expandable. The entire system may consist of a single site or may be composed of a dozen or so fixed stations, land mobile units, or airborne platforms.

Features of the FAIRS concept which make it extremely flexible include:

The system utilizes off-the-shelf subsystem components.

Subsystem components are basic building blocks and can be easily configured or reconfigured.

The system can perform many tasks simultaneously.

Changes in system mission profiles are essentially software changes and do not require new hardware.

A wide frequency range, 5 kHz to 12.5 GHz, can be covered.

Site-to-site command and control require only telephone lines; traffic on data links is minimized by utilizing site computers to perform functions asynchronously.

Direction finding (DF) may be accomplished from a single site or from multiple sites for improved probability of location.

DF is possible at frequencies as low as 500 kHz.

Fairchild Space and Defence Systems Division's BRT/MXB Series Broadband Receiving System is capable of being remotely controlled, either by special circuitry or directly from a digital computer. All functions of the BRT/MXB, such as attenuator setting, frequency selection (by digitally controlled frequency synthesis), and bandwidth (continuously variable from 500 Hz to 20 MHz) are remotely controllable. Thus, the BRT/MXB can be the key element in receiving systems which completely adapt to the electromagnetic environment at the antenna terminals.

The state-of-the-art in direction-finding antenna now makes possible broadband electronically-steerable arrays which provide simultaneously good sensitivity, rapid response, and accurate direction finding.

The completely computer-controlled receiver, coupled with electronically-steerable surveillance and direction-finding antennas, makes possible high-speed systems for detection, identification of signals, and location of the source of the emitter. A system which uses a digital computer to directly control receivers, antennas (both surveillance and direction-finding), signal processing equipment, data transmission, and other necessary functions can be provided with presently available state-of-the-art components.

In addition, computer-controlled data communications make possible direct communications between computers at remote operational sites and a central command computer. Thus, a complete system of operational sites and a command and control centre all tied together by data links are readily attainable and can provide a high level of effectiveness in detection, identification, and location of radio frequency emitters.

The FAIRS system has been designed to provide a wide range of flexibility. One of the specific tasks which can conveniently be performed by the system is frequency management. With the appropriate input, output, and storage units, the computer can perform a number of tasks needed for proper frequency allocation and scheduling.

This portion of the FAIRS systems provides communication command and control functions which allow the system to perform automatic DF and surveillance. It also performs message switching and priority selection for the FAIRS system, and can perform analytical work on a time-shared basis. As part of the overall mission of FAIRS and the user agency, frequency management capability has been incorporated into the FAIRS system. Both software and hardware to accomplish the desired task are provided.

MANUFACTURER:

Fairchild Space and Defence Systems, 300, Robbins Lane, Syosset, Long Island,. New York 11791, USA.

1886.153
BRT/MXB SERIES BROADBAND RECEIVING EQUIPMENT

DESCRIPTION:

The Fairchild BRT/MXB Series Programmed Receiving System is a digitally controlled receiver and signal processor that operates over the frequency range of 5 kHz to 12.5 GHz. The system may be utilised under computer control for completely automatic data acquisition, or under manual control for field use and special applications.

The receiver features direct digital control of all receiver functions. Digital frequency control of the receiver is by BCD groups. Control of all functions, such as frequency, bandwidth, detector functions, and receiver overall sensitivity, may either be selected using BCD digital inputs or using manual controls on the front panel of the receiver. TTL logic is used for interfacing with the BRT/MXB Series Receiver.

The heart of the BRT/MXB Programmed Receiving System is a stable frequency synthesizer that provides local oscillator drive for the various frequency conversions. The use of a synthesised local oscillator provides for an extremely stable receiver, as well as convenient digital control of frequency. The BRT/MXB Series has an extremely broad tuning range, covering more than five decades. It also has a wide range of overall system bandwidths from 500 Hz to 20 MHz. The wide range of selectable bandwidths allows the system to be utilised as a narrowband receiving system or a broadband receiving system. A unique continuously variable bandwidth is a standard feature of the BRT/MXB Programmed Receiving System. A number of detectors are available for demodulation and analysis of the received signal.

In the computer mode, the BRT/MXB System is capable of extremely fast data acquisition and analysis. Both digital and analogue outputs are available at the rear of the receiving system. These include IF, video, and detected outputs. Standard detectors are peak, average, AM, and FM. An audio output is available for aural analysis and signal identification.

The system is designed to operate conveniently with a 16 bit mini-computer. A standard interface between a BRT-35 and a mini-computer requires four input/output channels for both control and data acquisition. Programming of the BRT/MXB System, utilizing a computer, is simple and straightforward. Computer languages, such as FORTRAN, BASIC, ASSEMBLER, AND ALGOL are all compatible with standard mini-computers and the BRT/MXB Series Receiver Systems.

MANUFACTURER:

Fairchild Space and Defence Systems, 300, Robbins Lane, Syosset, Long Island, New York 11791, USA.

1872.153
R-200 INSTANTANEOUS FREQUENCY MEASURING RECEIVER

DESCRIPTION:

The R-200 IFMR provides an automatic surveillance capability over the frequency spectrum from 0.5 to 18.0 GHz in six bands, while simultaneously indicating the presence of specific preset signals. The six bands may be operated simultaneously or singly, and displayed on instantaneous panoramic displays of conventional appearance. The system control function can be set to activate an alarm upon the receipt of a preset frequency, or upon the receipt of any signal whose amplitude exceeds the detection threshold.

The R-200 is composed of the following modules:

R-200P	Processor Unit
R-200D	Display Unit
R-200I	Intercept Alert Unit
R-200A1	RF Unit C Band (0.5 – 1 GHz)
R-200A2	RF Unit D Band (1 – 2 GHz)
R-200A3	RF Unit E & F Bands (2 – 4 GHz)
R-200A4	RF Unit G & H Bands (4 – 8 GHz)
R-200A5	RF Unit I & J Bands (8 – 12 GHz)
R-200A6	RF Unit J Band (12 – 18 GHz)

The RF Unit consists of the RF amplifier driving the phase comparator discriminator. Dual out-of-phase signals from the discriminator are used by the video circuits to produce two signal related functional outputs: (1) A-function, a voltage proportional to the input signal amplitude, and (2) F-function, a voltage proportional to the input signal frequency.

The A and F signals are then processed for display, signal intercept or alert alarm. The A and F signals may be coupled into the Intercept Alert Unit to extract frequency, PRF and scan data for each signal. The Intercept Alert Unit is programmable to detect specific signals matching preset parameters of frequency, PRF and scan type.

The R-200 can display RF, signal strength and PRF on intercepted signals contemporaneously for rapid operator assessment. Each intercepted pulse paints a signal strength strobe with a bright dot at its tip for strength analysis. In addition, a PRF circuit paints a strobe extension, again with a bright dot at its tip, to indicate the PRF of each intercepted signal. It is thus possible to identify tracking radars quickly on the basis of PRF and RF at a glance.

If a detailed analysis of a signal is desired, the cursor can be manually positioned over the signal of interest and the associated video modulation is made available at a front panel jack. The selected signal is also presented to a headphone jack for monitoring. The headphone circuit can be connected so as to monitor all signals present.

A built-in alarm system also enables the cursor to be preset to a specific RF channel of interest. If a signal should appear in that channel the alarm is activated. An alternative mode causes the alarm to sound when any signal is intercepted, regardless of frequency.

The rectilinear display is convenient for identifying frequency jumping emitters, FM modulations, PRF jitters, PRF inter-leaving, antenna scan characteristics, and many other signal parameters.

Specification

Frequency coverage: 0.5 to 18 GHz, in 6 bands
Sensitivity (20 dB S/N): −55 dBm to −15 dBm adjustable
Frequency accuracy: ±1% of indicated frequency
Frequency resolution: ±10 MHz
Single pulse intercept probability: 100%
Dynamic range (automatic): 60 dB
Minimum pulse width: 0.1 sec
Maximum pulse width: 100 sec
Maximum PRF: 50 kHz

MANUFACTURER:

Scope Electronics Inc., 1860 Michael Faraday Drive, Renton, Virginia 22070, USA.

1874.153
RD-280 RECEIVER AND DISPLAY

DESCRIPTION:

The RD-280 is a versatile HF/VHF receiver used for reception of AM, FM, SSB (USB and LSB), and CW in the frequency range 2 to 80 MHz. It is designed for either manual control or computer control of frequency, mode, bandwidth, AGC, AFC, and signal seeking. Various equipment options are offered.

A precision digital synthesiser provides 100 Hz channel spacing, and the tuned frequency is displayed in 100 Hz increments on a 6-digit front panel "nixie" tube display. The synthesizer can be controlled to any accuracy desired by an external standard, or the internal ovenless temperature-compensated crystal oscillator can be used to provide the necessary reference with a stability of 1 part in 10^6. A fail-safe feature automatically switches control from external to internal in event of failure of the external signal. Manual scanning, or frequency control, is accomplished by two toggle switches and a dual-concentric control. The toggle switches control the "tens" MHz and "units" MHz digits, and the dual-concentric knob provides a fast scan and slow scan control of the remaining four digits (the dual knob actually controls all 6 digits, but use of the toggle switches speeds up large frequency changes). The receiver has two audio outputs including a headphone jack, and an IF output for external use.

The optional additional facilities available in module form are listed below.

PANORAMIC DISPLAY

A front panel 25 × 76 mm waveform display is used to monitor the spectrum of either pre-IF or post-IF received signals. Resolution, sweep width and sweep rate are determined by front panel controls. In the automatic mode, display parameters are set in accordance with the mode, bandwidth, and frequency controls.

Resolution	*Sweep Rate*	*Sweep Width*
500 Hz	1 per sec	1, 4, 10, 60,
50 Hz	4 per sec	or AUTO
AUTO	AUTO	

One sweep width is equivalent to one IF bandwidth.

COMPUTER CONTROL INTERFACE

The digital interface serves as a link between the receiver and a remote computer or controller, converting the serially encoded computer data to the parallel language of the receiver. The interface serves a dual function: (1) It allows the computer to select the frequency, bandwidth and mode of the receiver (together with AGC and AFC control when required), and (2) it provides the computer with complete status information of the receiver.

Signal seeking and slewing can also be computer controlled. Parity check is provided on the incoming and outgoing control words. This feature is most useful when remote control is required by means of long distance telemetry links. The receiver rejects an invalid word and provides for an error signal indicating presence of the invalid word.

BANDWIDTH FILTERS

The basic receiver is supplied with two of the following bandwidth filters with the remainder available as options: 400 Hz, 1 kHz, 4 kHz, 10 kHz, 60 kHz, and a special differential delay filter of 2.2 kHz bandwidth which is intended for receiving data. The filter in use is selected by means of front panel pushbuttons. In all receivers the bandwidth is automatically set for 2.7 kHz when using SSB modes.

SQUELCH

The squelch option provides a means of identifying signals above a preset threshold. The threshold is either manually selected or, when used in conjunction with the indefinite hold AGC option, automatically selected. The manual preset level has a range of 60 dB in 10 dB steps and a vernier range of ±15 dB.

INDEFINITE-HOLD AGC

This option provides a method of improving the retention of a weak signal. Once a signal is in the passband, the AGC INDEF HOLD ON pushbutton is depressed and the receiver gain is limited indefinitely at whatever level is attained at that instant. AGC action above this level is still maintained. Indefinite hold is cancelled whenever the AGC INDEF HOLD OFF release button is depressed, restoring AGC action to all signals within the dynamic range of the receiver. When used in conjunction with the AFC sample/hold, this option provides for automatic tracking of level and frequency for intermittent signals.

SIGNAL SEEKING

This option provides automatic signal searching when used in conjunction with the squelch module. Searching for signals exceeding the squelch threshold is performed at an integer increment identical to the selected IF bandwidth.

RD-280 Receiver

Signal acquisition is indicated by an illuminated sign on the front panel. Signal seeking can be initiated either by remote control or by front panel pushbutton.

Specification:

Receiver Range: 2-80 MHz
Channel Spacing: 100 Hz with additional fine tune for infinite resolution
Operating Modes: CW, LSB, USB, AM, FM
Bandwidths: 0.4 kHz, 4 kHz, 2.7 kHz (SSB), 60 kHz (additional bandwidths optional)
Noise Figure: Better than 13.5 dB
Dynamic Range, 3 dB Desensitisation: 85 dB above 10 dB (S+N)/N at 100 kHz removed [4 kHz bandwidth]
Intermodulation Distortion: 80 dB below one of two 10 mV undesired signals outside the IF passband but within the RF passband
Spurious Responses: Typically 90 dB down
Frequency Readout: 6-digit nixie display
AGC:
Variation: Less than 6 dB variation for inputs from 10 dB (S+N)/N to +10 dBm
Attack Time: 15 ms maximum
Decay Time: 325 ms slow decay followed by 1-1/2 second exponential decay
MGC: Minimum range 124 dB
BFO: Functional in CW mode. Adjustment range ± 2 kHz min.

MANUFACTURER:

Cincinnati Electronics Corporation, 2630 Glendale-Milford Road, Cincinnati, Ohio 45241, USA.

1875.153
R-281 SEARCH RECEIVER

DESCRIPTION:

The R-281 Computer-Controlled Search Receiver is a 2-80 MHz digitally controlled swept receiver capable of being swept in discrete increments over programmable frequency segments within its frequency range. The remotely selectable IF bandwidths vary from 1 kHz to 60 kHz. The output of the receiver is a log-video signal which may be externally analyzed on a display console. Complete control of frequency sweep range and IF bandwidth is accomplished by placing a digital word in the receiver. Injection signals required within the receiver are generated by a direct digital frequency synthesizer which assures overall system stability equal to that of the external standard. In the event that the external standard is not present, automatic operation will continue with reference maintained by an internal standard with a stability of 1 part in 10^6.

External control of the RF gain is provided with a range of 30 dB. The receiver digital interface serves as a link between the receiver and a remote computer or controller, converting the serially encoded computer data to the parallel language of the receiver. The interface serves a dual function: (1) It allows the computer to select the frequency and bandwidth of the receiver; and (2) it acts as a working register and memory for internal control and operation of the receiver.

Specification:

Frequency Range: 2–80 MHz
Bandwidth: 1, 2, 4, 6, 10, 20, 40, 60 kHz
Channel Spacing: 1 kHz
RF Gain – Remote: 30 dB
Remote Digital Control:
Frequency
IF Bandwidth
Frequency step increment
Noise Figure: Better than 13.5 dB
Dynamic Range, 3 dB Desensitisation: 85 dB above 10 dB (S+N)/N at 100 kHz removed (4 kHz BW)
Intermodulation Distortion: 80 dB below two 10 mV undesired signals outside the IF passband but within the RF passband
Spurious Responses: Typically 90 dB down
Local Oscillator Radiation: Less than 1 μV at the receiver input port
Outputs:
Video output
0.15 V max w/noise
1.0 V w/max signal input
Detector:
Logarithmic amplifier
80 dB input range
20 dB output range
Linearity ± 2 dB
Frequency Scanning:
Scan Rate:
2048 steps/sec (1, 2, 4 kHz Bandwidths)
512 steps/sec (6, 10, 20, 40, 60 kHz Bandwidths)
Switching Speed: 100 μs (60 kHz Bandwidth)
Increment Step: Equal to IF Bandwidth 1, 2, 4, 6 kHz (6 kHz Bandwidth Only)
Sweep Width: Controlled by increment step pulses

MANUFACTURER:

Cincinnati Electronics Corporation, 2630 Glendale-Milford Road, Cincinnati, Ohio 45241, USA.

1873.153
MODEL R-1437 RECEIVER

DESCRIPTION:

The Sylvania Model R-1437 is a solid-state, hand-portable panoramic VHF receiver. It weighs less than 12 kg (without accessories) and may be carried and operated by one man. It may also be vehicle- or aircraft-mounted. The internal battery supply is recharged automatically when the unit is operated from an external power source. The receiver handles AM, FM and CW signals.

The receiver tunes automatically or manually between 25 and 85 MHz, in two electronically switched bands. Separate but simultaneous displays of each band appear on the face of a cathode-ray tube. The setting of the manual tuning control is indicated by a coincidence step in the appropriate trace. The operator may examine any portion of the swept frequency range by switching to sector sweep. Sector width is variable by means of a manual control. Sweep rate is manually adjustable from 0.1 to 40 sweeps per second.

To monitor a particular signal, the operator adjusts the Main Tune control to bring the coincidence step to the chosen signal on the spectrum display. Then he switches to manual tuning for adjustment with the Main and Fine Tune controls, and monitors the signal through headphones. A separate output is provided for feeding an external recorder. A tuning dial indicates the signal frequency within one per cent, or within ±100 kHz if the internal calibrator is employed. This calibrator places audible and visible markers every 2 MHz throughout the receiver's spectrum. A front-panel switch permits choice of a demountable whip antenna, an external 50-ohm antenna, or the calibrator.

The operator may select AGC or manual gain control for AM signals, and may select either of two IF bandwidths, 75 kHz (mainly for FM signals) or 12 kHz. The bands 25-to-45 MHz and 45-to-85 MHz are covered by separate internal tuners, each having its own RF amplifier, mixer, oscillator and buffer stages. A master sweep generator tunes both, and switches them alternately into and out of the antenna-IF path. The same sweep generator controls the CRT display. The AM-CW detector and FM limiter-discriminator are manually selected. The recording output amplifier is fed directly by either detector; the headphone amplifier is fed through a 3 kHz filter.

The battery supply consists of 10 nickel-cadmium cells, which provide 8 hours' normal operation when fully charged. Full recharging in the slow-charge mode takes about 50 hours.

Specification:
Frequency Range: 25 to 85 MHz in two overlapping bands
Detection Modes: AM, FM, CW
Panoramic Display: 25 × 76 mm cathode-ray tube, simultaneous display of both bands
Tuning: Automatic or manual
Outputs: 600-ohm headphone. 600-ohm external recorder
Antenna: Side-mounted whip or 50-ohm external
Tuning Accuracy: +1 percent (±100 kHz with calibrator)
Tuning Indication: Front-panel digital indicator
Sensitivity: −110 dBm for tangential signal at recorder output
Intermediate Frequency: 10.7 MHz (±1 percent)
IF Bandwidth: 12 kHz or 75 kHz selectable at front panel
IF Rejection: 60 dB (minimum)
Image Rejection: 60 dB (minimum)
Sweep: Full-range or sector
Sweep Speed: Continuously variable, 0.1-40 sweeps per second
Calibration: Harmonics of a 2-MHz crystal

MANUFACTURER:

Sylvania Electronic Systems, PO Box 188, Mountain View, California 94042, USA.

1888.153
MODEL 3600 MICROWAVE RECEIVING SYSTEM

DESCRIPTION:

The Model 3600 Microwave Receiving System has been developed as a low-cost, multiband equipment to cover the range 0.5 to 18 GHz. The design allows for a number of additional equipment options which include spectrum displays, falling raster displays, pulse analysis displays and frequency synthesiser local oscillators. The main receiver section consists of the RF tuners, junction box, IF processor, and a control and display panel. Interfaces are buffered and signal conditioning circuits are all contained within the basic receiver assemblies.

Six independent tuners are used, with microwave ICs for the double balanced mixer, bandpass filters, and the 160 MHz IF pre-amplifier. YIF-tuned local oscillators are employed with matched preselectors.

The IF processor conditions a 160 MHz IF signal received from the remote RF tuners for signal analysis. Detected video signals drive CRT displays and perform signal analyses such as auto/cross correlation, pulse analysis, modulation analysis, and signal-in-noise processing by means of peripheral equipment.

All control functions of the Model 3600 are carried out digitally. A fully automatic receiving system is available which uses a digital minicomputer to provide the parameters normally selected by the operators. In addition to setting initial receiver operating conditions, the computer program organises data collection from the receiver outputs and performs analysis on received signals. Signal analysis includes measurement of frequency, amplitude and modulation characteristics together with direction and time of arrival. Normal computer programming of the system can effect other emitter parameter measurement and storage, such as high priority signal alarms, and computer-controlled ECM initiation.

Specification:

RF Tuner	Frequency Range (GHz)
36001A	0.5 to 1.0
36002A	1.0 to 2.0
36003A	2.0 to 4.0
36004A	4.0 to 8.0
36005A	8.0 to 12.4
36006A	12.4 to 18.0

Frequency Tuning Modes:
Full Band Sweep: Digitally Tuned Across Entire Frequency Band
Sector Sweep: Sector Widths of 100, 200, 400 and 800 MHz with the Centre of the Sector Positioned Digitally with the Manual Tuning Shaft Encoder.
Manual Tune: Digitally-tuned by the Rotation of n Incremental Shaft Encoder. Manual Tuning is Bidirectional
IF Bandwidths: 20 MHz, 5 MHz, 1 MHz
Tuning Increments for Sweep Mode:
20 MHz Bandwidth: 10 MHz Steps
5 MHz Bandwidth: 1 MHz Steps
1 MHz Bandwidth: 500 kHz Steps
Tuning Increments for Manual Tuning:
Fine Tune: 1 MHz/500 kHz Steps
Coarse Tune: 10 MHz Steps
Sector Sweep Width Selections:
100 MHz (±50 MHz fo)
200 MHz (±100 MHz fo)
400 MHz (±200 MHz fo)
800 MHz (±400 MHz fo)
Spurious-free dynamic range: 70 dB
Image rejection: 70 dB
IF rejection: 90 dB
LO radiation: −100 dBm
Frequency accuracy: 0.2%
Sweep rate: 100 GHz/sec
Signal detection: CW, AM, Pulse, FM
RF input VSWR: 1.3:1 max
Receiver outputs: Log Video, Linear Video, Stretched Log Video, FM Video, Horizontal Sweep Voltage, Blanking, IF frequency
Control: Digital with Integral Computer Interface
Frequency readout: Integral Five-Digit LED display

MANUFACTURER:

American Electronic Laboratories, PO Box 552, Lansdale, Philadelphia 19446, USA.

1716.053
WJ-1240 RECEIVING SYSTEM

DESCRIPTION:

The WJ-1240 is a computer-controlled receiving system for reconnaissance and surveillance applications over the radio frequency band 0.1 to 40 GHz, and it also has independent digital tuner control and parallel video display. The equipment consists of a modular integrated electronics package comprising the computerised WJ-1240 receiver itself, display and controls, and a direction finding antenna system.

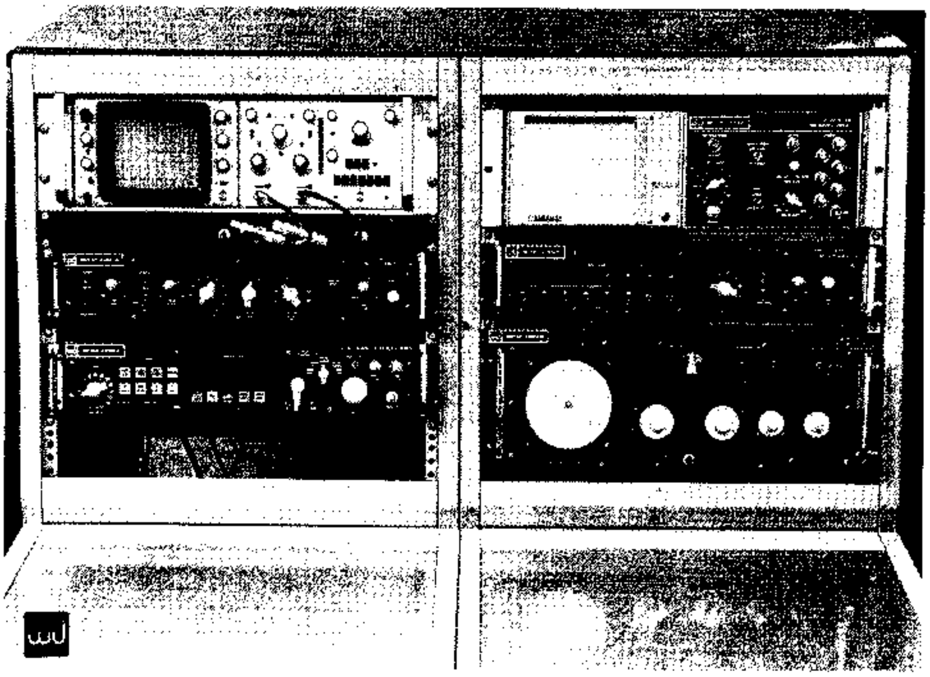
Independent tuner control permits multiple situation surveillance and provides independent video outputs for each tuner. This control operates in the absence of the computer for manual systems or as a standby mode of operation in computer-controlled versions. A Refresh Display with adjustable decay time retains singlepulse signals for detailed visual observation. Display traces are automatically scaled during sector scan.

Several antenna assemblies may be used with the WJ-1240 depending upon the total frequency coverage demanded. The WJ-8312 provides direction-finding facilities over the range 0.1 to 18 GHz. Other Watkins-Johnson arrays which can be employed are the L4/A (40-550 MHz), L/5A (12-40 GHz), and the L/6A.

The WJ-8312 consists of a rigid box structure supported on the turning gear pedestal and carrying a series of microwave receiver horns. Intercepted signals are directed into the horns (which are of dimensions appropriate to the frequency bands covered) by a flat plate reflector which rotates with the whole assembly. This reflector carries at its upper edge a log-periodic array for reception of the lower frequencies.

MANUFACTURER:

Watkins-Johnson Company, 3333 Hillview Avenue, Stanford Industrial Park, Palo Alto, California 94304, USA.



WJ1240 Receiving system console

1381.053
L-3/A-WJ-1140 MICROWAVE DIRECTION FINDING SYSTEM

DESCRIPTION:

This is an integrated microwave direction-finding (DF) system, produced by the combination of the L-3/A broadband DF antenna system and the WJ-1140 modular microwave receiving system.

The broadband DF antenna system (L-3/A) is designed to function as a component of an electro-mechanical reconnaissance system when used in conjunction with the WJ-1140 receiver system. The L-3/A provides a visual display of the direction of arrival (DOA) of incoming RF signals that have been processed through the receiving portion of the overall DF system.

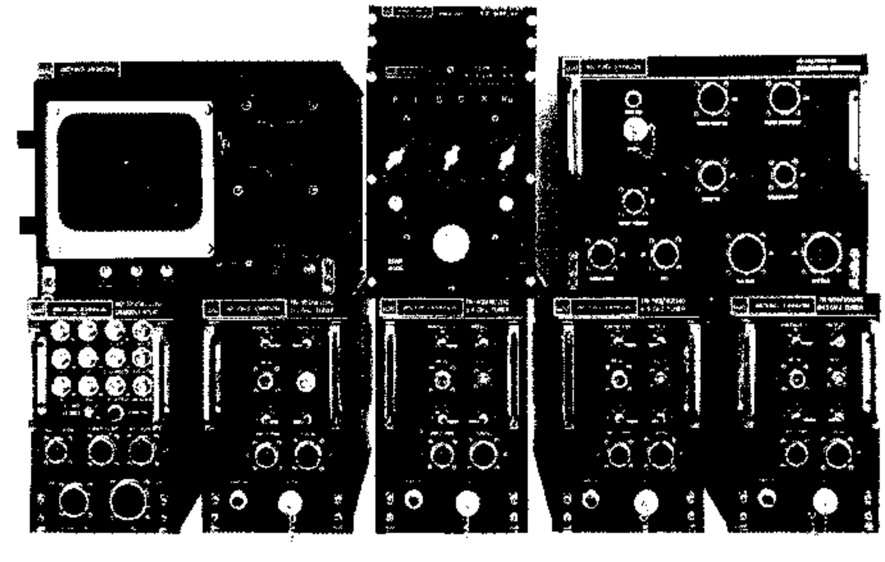
Lightweight and compact mechanical packaging makes the L-3/A suitable for usage in airborne configurations as well as for shipboard and fixed/mobile ground installations. The frequency coverage of this antenna system is 550 MHz to 12.4 GHz in five bands. Variable azimuth rotation sweep from 0 to 1,000 rpm is accomplished through a control on the console. A fixed rotation rate of 2,000 rpm can also be selected.

In addition, the antenna can be steered to any desired azimuth point by a manual control knob located on the indicator. The radiation patterns of the antenna are relatively broad, with circular polarisation. This offers an optimum compromise between probability of signal intercept, direction-finding accuracy and gain. The RF output of the L-3/A system is entirely compatible with the WJ-1140 and the interface is accomplished through the use of standard RF coaxial cabling and connectors.

The WJ-1140 receiving system offers a wide variety of options, both in hardware and usage. The design of the basic receiving system consists of RF tuners to cover desired frequency ranges, a demodulator, a control unit and a numeric frequency display. In addition, an array of peripheral display and control equipment is available for modular arrangements, appropriate to the mission to be performed.

Used in conjunction with the L-3/A, the WJ-1140 would involve RF tuners covering the ranges 550-1,000 MHz, 1,000-2,000 MHz, 2,000-4,000 MHz, 4,000-8,000 MHz and/or 8,000-12,400 MHz. Signals acquired by the L-3/A are simultaneously available at all times to the WJ-1140 tuners without the requirement of RF band switching. Incoming signals are then processed through the appropriate tuners and mixed down to an IF frequency of 160 MHz for processing by the demodulator.

In the next steps, demodulator output appears as a logarithmic video, a linear video and a display video signal of choice. The display video signal, enhanced by video amplifiers to boost its level for display purposes, is fed to the indicator unit of the L-3/A, which in turn provides a polar display and is slaved to the rotation of the antenna itself. The display video provided by the WJ-1140 is then superimposed on the rotating cursor of the indicator unit and DOA is read directly from the compass rose on the display.



WJ1140 Microwave DF System equipment comprising; top row (l to r): display/control unit, receiver control (with RF display on top), computer interface unit; bottom row (l to r): demodulator, four tuner units covering 1 to 12 GHz

By the use of another broadband antenna system, the L/5A, frequency coverage is extended from 12GHz to 40 GHz. This has similar pedestal and turning gear to the L3/A, but instead of rotating horn elements, the L5/A has fixed horns near the centre of rotation, directed up on a spinning reflector plate which is responsible for 360-degree azimuth coverage. To extend frequency coverage downward a companion antenna/receiver combination (L4/A/RS-160) is available covering the band 40 to 550 MHz.

MANUFACTURER:

Watkins-Johnson Company, 3333 Hillview Avenue, Stanford Industrial Park, Palo Alto, California 94304, USA.

1382.063
WJ-1007 MICROWAVE COLLECTION SYSTEM

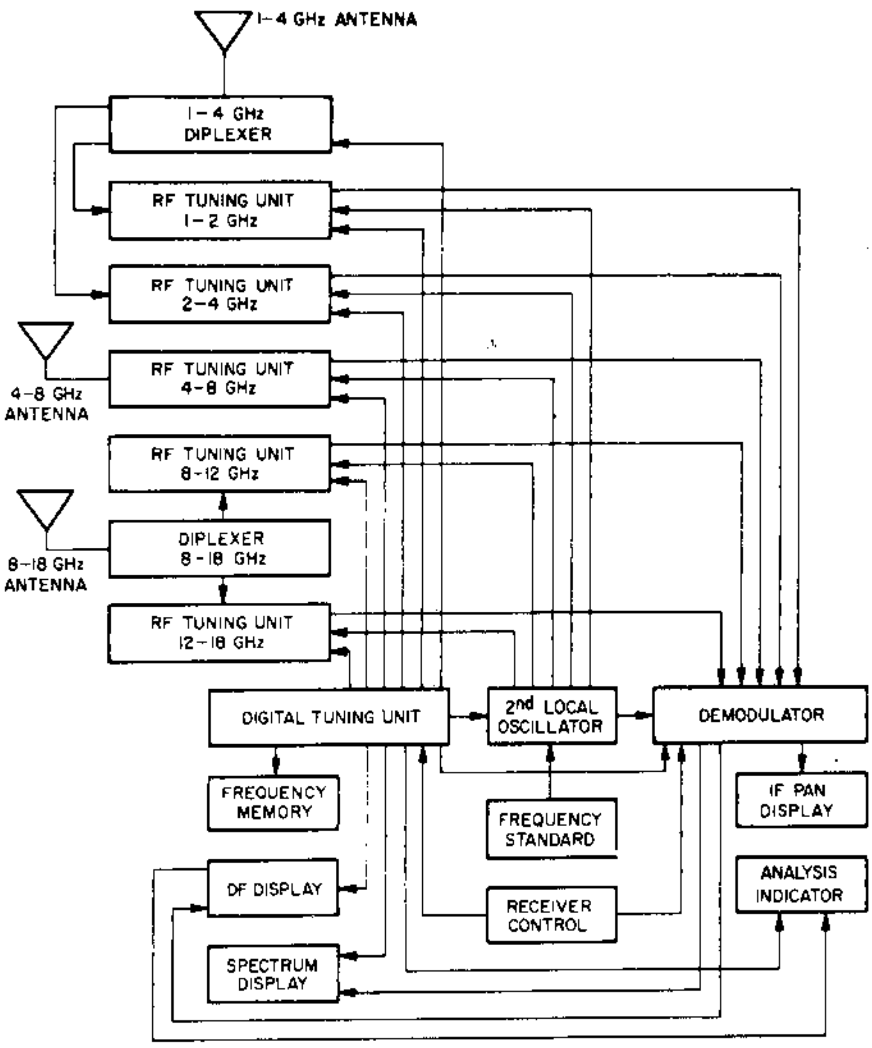
DESCRIPTION:

This system is a microwave electromagnetic surveillance system capable of receiving, detecting and analysing state-of-the art of electromagnetic emissions in the frequency range 1 to 18 GHz, and is designed for either airborne, shipborne or ground-based electronic intelligence or radio frequency interference missions.

Basically four signal functions are provided by the WJ-1007: acquisition, control, analysis and recording. Each function is represented by one or more modules. The system is capable of detecting and categorising the parameters of currently used types of electromagnetic emission. The system sweeps the entire 1 to 18 GHz frequency spectrum in one operation. There are five frequency bands (1 to 2, 2 to 4, 4 to 8, 8 to 12 and 12 to 18 GHz). There is no mechanical tuning involved within these bands, nor mechanical switching required between bands. Fully-electronic tuning is a result of incorporation of YIG filters as preselectors and in oscillators. A memory module is included to permit programming the spectrum so that certain frequencies may be recalled or bands of frequencies automatically locked out.

The WJ-1007 uses a superheterodyne receiver with high sensitivity. A spectrum display unit, which is one of the several presentations available, gives a panoramic display of the complete frequency range. A multi-gun CRT provides five separate amplitude-versus-frequency traces which the operator can view.

When the system detects a signal of interest, the operator can operate a lock-on facility which will cause the receiver to cease sweeping and lock-on to the particular signal. Once the receiver is locked-on to such a signal the panoramic display sweeps automatically to the analysis mode and presents an enlarged time display showing repetitive pulsed signals on five separate traces. At the same time digital displays indicate transmitted frequency, pulse width and pulse repetitive period. The operator can, if desired, record RF frequency, pulse width, pulse repetitive period, time, latitude, longitude and true bearing, by suitable operation of the controls.



Block diagram of WT-1007 microwave collection system

OPERATION:

Five RF Tuning Units process incoming signals and provide the first conversion to a nominal 250 MHz IF output (190-310 MHz). One tuning unit is used for each of the microwave bands (L, C, S, X and Ku). The tuning units contain a YIG preselector and postselector to provide image and spurious response rejection for the first IF conversion A travelling-wave-tube amplifier is provided between the YIG filters to insure adequate low-noise amplification. A local oscillator is provided to tune each band in 100 MHz increments.

The passband of the YIG (yttrium-iron garnet) filters is controlled electromagnetically. The RF energy for each band is fed through separate YIG filters and travelling-wave-tube amplifiers. These amplifiers provide the receiver with an extremely low noise figure. The outputs from the amplifiers are then coupled to another bank of YIG filters to provide an additional stage of postselection prior to being fed to the first mixer-preamplifiers.

The mixer-preamplifiers use balanced mixers and solid-state preamplifiers providing the 250 MHz IF output frequency at a power gain of 25 dB. Their output is fed to an IF commutator switch located in the Demodulator Unit. Oscillator injection is supplied by YIG-tuned harmonic generators which are driven by the Local Oscillator Synthesizer Unit. C and X band harmonic generators are each followed by a travelling-wave-tube amplifier to increase the output level, and a BWO is used for Ku band. L and S band harmonic generators are coupled directly to the mixer stages without additional amplification.

The Local Oscillator Synthesizer Unit produces the basic oscillator frequencies for both first and second conversion. The output fed to the harmonic generators in the RF Tuning Units (first conversion) is fixed at 100 MHz. The second output is fed to the second conversion circuitry in the Demodulator Unit. This output is stepped from 260 to 360 MHz in 100 kHz increments.

The Frequency Memory Unit is used primarily to provide automatic bandwidth lock-out capability for the receiver system. It may be programmed to lock-out up to 20 MHz segments of the spectrum which are of no interest, whether signals are present or not. This equipment has a word organised memory with storage for 18 frequencies to 0.1 MHz resolution. Although used to control the receiver system its operation is subordinate to the Digital Tuning Unit (through which it has its only physical and functional interface). The memory has four mutually exclusive modes of operation. Three of these modes enable the operator to alter or sample the contents of the memory. The fourth mode, sweep, performs the bandwidth lock-out function.

The bandwidth lock-out function enables the operator to quickly scan for new signals without having to personally discern between new and old signals, and to prevent his having to continually restart the sweep every time an old signal is encountered. It performs this function by overriding signal intercepts whose frequencies lie within the bandwidth limits stored within the 18 memory cells. When an intercept occurs, the memory is interrogated, and a comparison made between the frequencies in storage and the present intercept frequency of the sweep counter. If a coincidence occurs, a resumé sweep gate is generated that automatically causes the receiver to continue its sweeping. On demand, the operator may select any frequency memory location and load the contents into the sweep counter. This automatically sets up the receiver to the desired frequency.

Direction finding facilities (rotating antennas and display unit) can be added to the system.

MANUFACTURER:

Watkins-Johnson Company, 3333 Hillview Avenue, Stanford Industrial Park, Palo Alto, California 94304, USA.

1372.063
AIL TYPE 707 SPECTRUM ANALYSER

DESCRIPTION:

This is a solid state instrument whose measurement capabilities lie in the 10 kHz to 40 GHz frequency band. Within this range full display scans are possible from 10 GHz to less than 10 kHz. A unique feature of this unit is the incorporation of an internal tracking pre-selector, which rejects all erroneous signals by 80 dB. This technique eliminates the usual clutter witnessed on spectrum analysers. A further feature is the ability to display simultaneously, on the 10 cm square screen, signals whose amplitudes vary by as much as 100 dB and their frequencies by as little as 1 kHz. Also, the signal frequency is displayed on a light emitting diode (LED) read-out to within ±0.2 per cent.

Of significance during spectrum surveillance work is the 10 GHz scan width enabling the S, C and X bands, ie 2 to 12 GHz, to be viewed simultaneously.

By use of the instrument, valuable information can be gained in the time domain, for example low PRFs, pulse rise times and modulation envelopes. For this application the scan width can be set to zero for any scan time between 10 microsecs/cm to 1 sec/cm.

OPERATION:

The instrument operates in two modes – a wide and a narrow scan mode. In the former it is a swept-front-end double conversion receiver. In the narrow scan mode a microwave VCO is automatically phase-locked to a crystal reference. The IF is then swept by a stable VHF VCO. At scan widths below 1 MHz/cm, an automatic phase-lock eliminates the need for switches, meters and tuning beat controls.

DEVELOPMENT:

This is the commercial version of equipment which had its origins in electronic warfare.

MANUFACTURER:

AILTECH a Cutler-Hammer Company. Farmingdale, New York 11735, USA.

1717.053

AN/GLR-9 RECEIVING SYSTEM

DESCRIPTION:

The AN/GLR-9 is a wide-band signal intercept and monitoring system, with a frequency coverage, in various versions of the equipment, extending from the HF band up to the radar X-band. The basic equipment comprises three common units, Signal Display Unit, Powered Housing Unit, and Signal Processing Unit, to which are added such RF Tuning Heads as are required to fulfil the operational function. In some instances more than one Powered Housing Unit (PHU) will be needed to contain Signal Display and RF Tuning Heads required. A suffix code to the equipment designation denotes the frequency coverage, as follows:

AN/GLR-9 (V): 20-1000 MHz
AN/GLR-9 (V)2: 20-300 MHz
AN/GLR-9 (V)3: 30-300 MHz
AN/GLR-9 (V)4: 250-1000 MHz
AN/GLR-9 (V)5: 1000-4000 MHz
AN/GLR-9 (V)6: 20-4000 MHz

Control of the system is effected from the Signal Processing Unit, the functions of which include:

(1) Selection of RF Tuning Heads.
(2) Routing of SDU output from the RF Tuning Head in use to the input of the signal display unit.
(3) Selection of IF bandwidth.
(4) Selection of mode of operation – AM, FM, CW or pulse, for the signal format to be processed.
(5) To provide audio and video outputs from the demodulated signal.
(6) Switching of input from a common antenna to the operating RF tuning head.

There is a wide range of plug-in RF Tuning Heads, and designation and frequency coverage are as listed below:

SH-200P-1: 20-45 MHz
SH-201P-1: 30-100 MHz
SH-202P-1: 90-300 MHz
SH-203P-1: 250-500 MHz
SH-204P-1: 490-1000 MHz
SH-205P-1: 990-2000 MHz
SH-206P-1: 1990-4000 MHz
SH-207P-1: 4.7 GHz (C-band)
SH-208P-1: 7.12 (GHz (X-band)
SH-270P: 20.70 MHz
SH-271P: 55-260 MHz
SH-272P: 225-400 MHz

Under the designation ESH-200 Series, a range of electronically swept RF tuning heads is available. They provide the same frequency coverage as the SH-200 Series units listed above and the prefix letter 'E' differentiates between the two models.

MANUFACTURER:

Astro Communication Laboratory, 9125 Gaither Road, Gaithersburg, Maryland 20760, USA.

RECONNAISSANCE AND SURVEILLANCE EQUIPMENT

FRANCE

1070.353

CYCLOPE AIRBORNE INFRA-RED RECONNAISSANCE SYSTEM

DESCRIPTION:

Small, lightweight, passive infra-red line-scan reconnaissance equipment developed for aircraft, pod or drone installation. I/R photography from heights between 200 and 400 metres is possible with the Cyclope system, and a band of terrain which is covered by an angle of view of 60 degrees on each side of the aircraft or drone can be surveyed.

The system operates in the middle region of the I/R band and the quoted thermal resolution is 0.25 deg C. Mechanical means are used for scanning and analysis. Provision is made for either immediate or delayed radio transmission of data, image recording, and image reconstruction on 70 mm film at a ground processing station.

The only other details so far revealed are a weight of 12 kg and volume of 20 dm^3.

SUPER CYCLOPE

In 1973 a Super Cyclope equipment had entered development. It is described as a second-generation system operating in the 8-12 microns band, suitable for use in either aircraft or RPVs or reconnaissance missiles. A catadioptric optical system is used, other parameters including the following:

Field of view: ±60°
Resolving power: ±1.25 mrad for V/H of 1·6
V/H ratio: from 0.3 sec^{-1} to 3.2 sec^{-1}
Thermal resolution: better than 0.3°C
Roll stabilisation: ±15°

Data obtained by the Super Cyclope is normally collected on board by a high-resolution photographic unit (1,800 points per line), but it can also be recorded on board by magnetic tape or transmitted in real time back to a ground station.

DEVELOPMENT:

Developed and designed by SAT under French Ministry of Armed Forces contract.

STATUS:

The system had entered French Air Force operational service in Mirage III RD recce aircraft by the end of 1971.

MANUFACTURER:

Société Anonyme de Télécommunications, 41, rue Cantagrel, 75624 Paris, France.

1868.163

PATRICIA RECONNAISSANCE DATA PROCESSING SYSTEM

DESCRIPTION:

The operational purpose of the Patricia system is to accelerate the processing, co-ordination, and interpretation of aerial reconnaissance data obtained by a variety of sensors. These can include airborne cameras, infra-red linescan, side-looking radar, and other recorded data. This objective is achieved principally by the adoption of computer techniques and advanced display methods. In addition to expediting the selection of photographs of designated targets and the rapid preparation of a preliminary mission report, Patricia can also be applied to the planning and preparation of missions.

The system is built into air-transportable shelters and consists of:

(1) A photographic shelter which is used for all film developing and printing work.
(2) A technical shelter which is mostly occupied by the central processor and interface unit which controls and supervises all of the system's equipment.
(3) A selection shelter where the file of each target to be processed is compiled before being transmitted to the interpreters.
(4) Between one and six interpretation shelters for the final analysis of the pictures preparatory to drafting of the final interpretation report.

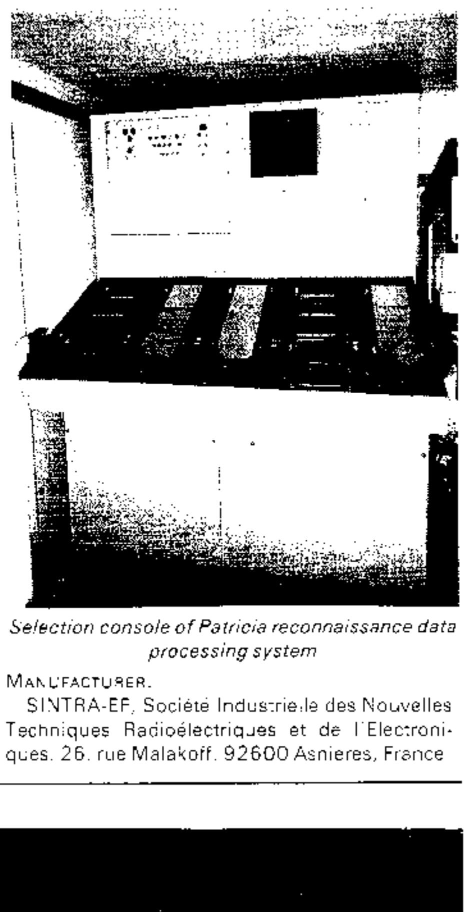
The last of these operations is facilitated by provisions in the Patricia system for the simultaneous display of pictures and data from various sources, and a projected map showing the target area and orientation vector of the aircraft responsible for each set of pictures.

Specific data sources and sensors whose informations are accepted by the system include cameras using film (perforated or not) up to 240 mm wide, infra-red linescan analysers, side-looking radar, pilot's voice recorder, and data gathered by an airborne flight data adapter which is interfaced with the aircraft's navigation computer, altimeter, etc. The airborne equipment includes a cassette recorder on which for a full 1 hr 30 min mission are recorded in digital form.

Two types of console are employed in the ground component of the system, a selection console and the interpretation consoles. The former can simultaneously display up to five strips of standard 5-inch (127 mm) film × 492 mm and has a projected map area measuring 240 × 240 mm. The interpretation consoles have a 1,128 × 500 mm light table, projected map screen of 240 × 240 mm, a history picture projector screen 340 × 340 mm, and a silhouette projection screen of 280 × 280 mm. Storage facilities have an archive capacity of 15,000 target file sheets.

DEVELOPMENT:

Development was carried out for the French DTCA (Direction Technique des Constructions Aéronautique).



Selection console of Patricia reconnaissance data processing system

MANUFACTURER:

SINTRA-EF, Société Industrielle des Nouvelles Techniques Radioélectriques et de l'Electroniques, 26, rue Malakoff, 92600 Asnieres, France

THE NETHERLANDS

1708.353

ORPHEUS AERIAL RECONNAISSANCE SYSTEM

DESCRIPTION:

The Orpheus system has been designed to air force requirements for a tactical reconnaissance system to provide aerial reconnaissance during night and day, at low and medium high altitudes, to be operated with modern high performance fighter bomber strike attack aircraft, requiring a minimum of engineering changes to the aircraft, and without jeopardising the FBA/S capability of the aircraft.

The system comprises a number of reconnaissance sensors housed in an external pod. The pod design is based on the shape and size of the standard napalm fire bomb, its aero-dynamic characteristics and range/fuel consumption penalties being very similar.

A standard aircraft weapon station will carry the system. The recce system is jettisonable in case of emergencies. The external reconnaissance system including all sensors and an air-conditioning system operates independently of the aircraft and is only dependent on the aircraft's electrical power supply system, fixed frequency or not, thus requiring only minor aircraft engineering changes for power cabling, cockpit control panel and V/H signal connection.

R Neth AF Starfighter carrying "Old Delft" Orpheus reconnaissance pod

Reconnaissance sensors are the "Old Delft" far-infra-red linescanner with a 120 degrees scan angle, and four or five aerial cameras providing horizon-to-horizon coverage and forward-looking capability.

The autonomous character of the reconnaissance system's pod concept has, as operational advantages:

(1) A very short reaction time, since unloading of the film magazines of scanner and cameras has been optimised through the use of a quick-disconnect access door, a rotatable scanner and snap-on type film magazines. All films of a standard type can be processed automatically, allowing for the transmission of first phase PI-mission reports within 30

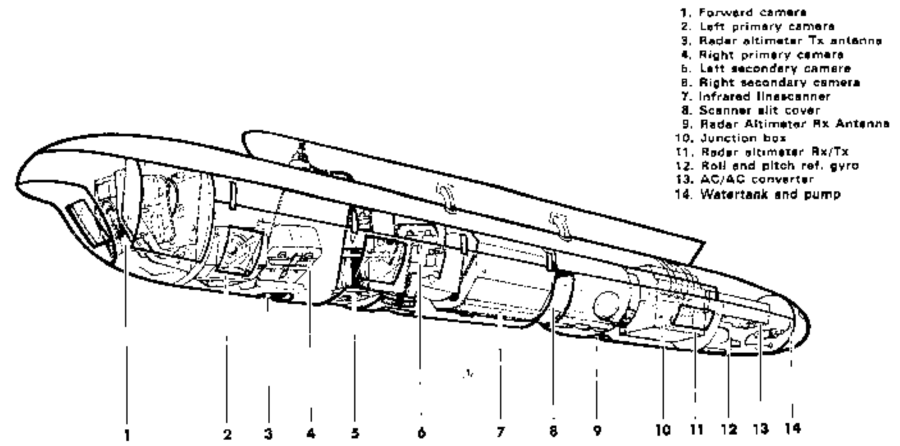
minutes after engine shut down.

(2) The recce-system turn-around and pre-flight inspection is completed well within the time required for the aircraft itself; in-between flight adjustments are not necessary, nor is any special ground equipment required for daily servicing.

(3) Aircraft down-time, required for maintenance and repair of the recce-system has been minimized through the fast exchange possibility of components or modules as a flight line operation, requiring no re-alignment.

(4) Recce-system down-time resulting from aircraft unserviceability has been minimized through a simple system of recce-pod to aircraft bombrack snap-on operation, so as to match serviceable recce systems with available combat-ready aircraft within 30 minutes.

The standard recce-system for the Royal Netherlands Air Force consists of a roll-stabilized "Old Delft" IRLS-5 linescanner (see Entry No. **1709.353**) complete with build-in cooling unit and five TA-8M aerial cameras (see Entry No. **1711.353**), one camera housed in the nose of the pod in forward-oblique position, the other four cameras mounted on a roll-damped camera rack, of which the two primary cameras are in a fixed side-oblique position, while the two secondary cameras can be pre-positioned either high-oblique or split-vertical. The slightly altered version for the Italian Air Force consists of an "Old Delft" IRLS-5 linescanner, a Fairchild panoramic camera and three TA-8M cameras, one camera in forward-oblique position and the two secondary cameras in either high-oblique or split-vertical position. A junction box, radar altimeter, static frequency converter, and an air conditioning system are also installed in the pod.



Arrangement of equipment in Orpheus reconnaissance pod

Full control of the recce-system operations and the system status-monitoring including failure indications, are centralised in the cockpit on a simple control panel. Initiation of the operation of the cameras and the linescanner is established by pressing the trigger switch located on the pilot's control stick's grip. BITE is incorporated for pre-flight checks.

Main characteristics:

Overall dimensions of loaded pod are:

Length: 375.0 cm

Max Diameter: 47.2 cm

Weight: Max 400 kg, depending on sensors used

DEVELOPMENT:

Development of the Orpheus system started in late 1966. Final evaluation flights were carried out in June 1972 by the Air Forces concerned. Two prototypes and two pre-serial models had been built by early 1973.

STATUS:

An order for the serial production was awarded to De Oude Delft by the Royal Netherlands Air Force in August 1972, with Fokker/VFW as sub-contractor for the external pods. Contract negotiations with the Italian Air Force for the serial production of their version of the Orpheus system were finalised in November 1973.

MANUFACTURER:

N.V. Optische Industrie "De Oude Delft", van Miereveltlaan 9, Delft, Holland.

1709.353

IRLS-5 INFRA-RED LINESCAN

DESCRIPTION:

De Oude Delft has developed to requirements of the Royal Netherlands Air Force a far-infra-red linescanner primarily for use as an aerial reconnaissance sensor housed in an external recce-pod, or to be installed within an aircraft.

TThe IRLS-5 linescanner makes use of a rotating 3-sided mirror, achieving a 100% scan efficiency by using two optical channels alternately. The optical switching from one optical channel to the other is arranged by a mirror-chopper mounted on the axis of the scan-mirror. As a result, the detector is always looking at the ground and prevented from looking into the scanner interior between the useful scans, thus, no dead-time between the scans is achieved and a minimum bandwidth of the signal processing is required.

Rotating at 12,000 revolutions per minute, three scanlines are produced per revolution with continuous reception of useful IR-radiation, thus providing 600 scans per second. The angular opening of the scanning beam gives an instantaneous field of view of two milliradians square. The scan angle of 120° perpendicular to the flight path can be placed in 3 positions: vertical, left oblique or right oblique. The scan angle position is controlled in flight from the cockpit by the pilot within 1 second, without interrupting the scanning motions.

The signal recording on film, always the most critical part of a scanning type image-forming device, is realized by utilising the "Old Delft" variable slitlength recorder, which device makes signal registration with contiguous, non-overlapping or under-lapping recording lines possible, as a result of which optimal contrast transfer and signal presentation over the total range of filmspeeds are reached for a very large V/H range.

The recorder head contains three channels, used consecutively. The recording spot is defined by a slit, which is illuminated by a glow modular lamp, and imaged on the moving film at a reduction of approx 17. The three optical beams are folded into the recorder head by means of mirrors and prisms. The complete recording system is mechanically linked to the scan rotor to guarantee perfect synchronism with the rotating scan system. The slit control unit is non-rotating and controlled by a servo system in relation to the variable film speed.

The V/H-range of the IRLS-5 linescanner (still classified data), will cover reconnaissance flights at sonic and subsonic speeds at very low altitude as well as medium-high altitudes, making this linescanner a very flexible sensor from a reconnaissance mission point of view.

To prevent degradation of the ultimate film results through a change in the V/H-ratio, the IRLS-5 is provided with an automatic V/H-adjustment, which may be overruled by the pilot.

The IRLS-5 is completely roll-stabilised for both slow roll and fast turbulence induced roll motions, referenced to a vertical gyro incorporated in the system. Provisions for the recording of certain flight data on the film, such as heading, time, etc, are incorporated in the scanner recording system. The "Old Delft" linescanner is equipped with built-in interchangeable infra-red detector packages; each detector package including a closed-cycle cooling engine, a getterpump, a helium pressure gauge, an IR-detector, a pre-amplifier and an elapsed time indicator.

The IR-detector packages can be supplied:

(a) As a standard: a mercurium-doped germanium detector package (Ge:Hg), covering the 8-14 micron wave-length region, providing for a noise equivalent temperature difference of 0.10°-0.15°C, measured at the output of the pre-amplifier under room ambient conditions. Operating temperature of the Ge:Hg detector is 35°K or less, which temperature is reached in a cool-down time of approx 10 minutes, after which a "cooler ready" signal is provided.

(b) As optional: a photovoltaic indium antimonide (In:Sb) detector package, covering the 3-5 micron wave-length region, providing for a noise equivalent temperature difference of 0.5°C or better.

Interchanging the same type of detector package is a flightline operation which can be performed within 30 minutes and requires no adjustments. Interchanging a Ge:Hg detector package by an In:Sb detector package, and vice-versa, is not a flightline operation as the germanium optics have to be replaced as well to guarantee optimal performance.

Main characteristics:

Scan rate: 600 scans per second

Scan angle: 120° perpendicular to flightpath

Angular resolution: 2 mrad

Thermal resolution: 0.10° —0.15°

Exchangeable detector packages in 8-14 or 3-5.5 micron spectral region; integral closed cycle cooler requires no refill between 90 days maintenance periods.

Recorder with variable slit-length adaptation for optimum display.

Recording on standard 70 mm photographic film, flight data recording on edge of film.

Film transport speed and slit length control unit are automatically varied according to V/H-ratio.

Roll stabilization, functioning over a range of 80° with respect to the vertical.

Automatic failure indications.

Snap-on type film magazines, containing 100 ft (30 m) of 70 mm normal base perforated film.

Power requirement: 2.65 kVA

Dimensions, with cooling units:

Length: 90 cm

Width: 35 cm

Shape: Cylindrical

Weight, including loaded film magazine and complete detector package: 85 kg

DEVELOPMENT:

Development started late in 1966 under a Netherlands Government development contract. First actual flights were performed in May 1969. Military evaluation and qualification were finalised mid-1972.

STATUS:

In serial production for the Royal Netherlands Air Force and for the Italian Air Force.

MANUFACTURER:

N.V. Optische Industrie "De Oude Delft", van Miereveltlaan 9, PO Box 72, Delft, Holland.

1710.353
TA/7M2 AERIAL CAMERA

DESCRIPTION:

The TA-7M2 photo reconnaissance camera system was designed to meet the different requirements for tactical aerial daylight reconnaissance, from very low to high altitudes, requiring only minor modifications to adapt the camera to the operational requirements. Normally three cameras are mounted in such a configuration that an optimum terrain coverage is assured. This camera system is fully controlled from the cockpit.

Each camera consists of a camera body, a data recorder, a film magazine, and interchangeable Deltamar objectives with removable yellow filters.

The frame rate (exposure frequency), which is related to aircraft speed and altitude, V/H-ratio, is selected by the pilot during flight. The shutter speed is automatically coupled with the selected frame rate, while the diaphragm presetting is automatically coupled with the existing shutter speed. The diaphragm is varied from minimum to maximum opening by means of a very sensitive photo sensor, looking at the image plane inside the camera.

The important feature of image motion compensation (IMC) at flying speeds of Mach 1 or more at low altitudes of 100 feet is realized by the continuous film transport. The motion blur is dependent on overlap. The shutter type used is the "Old Delft" microsecond double rotary disc focal plane shutter, easily removable for night photography with flash light, and easily interchangeable to modify the camera into another configuration, providing for continuously variable shutter speeds.

Main characteristics:

Automatic exposure control for each camera independently

Cycling rates: 1.5 to 15 frames per second

Exposure times: 1/500 to 1/9000 second (1/15,000 second on request)

Continuous film transport for IMC

Film size: 70 mm perforated film up to 100 feet length for approximately 450 exposures

Frame size: 57 × 57 mm (2¼" × 2¼")

Density control: automatic iris control

Data recording: in space between successive frames

External speed control junction box for 3-camera configuration

Dimensions (max overall with film magazine and f.70 mm objective): 190 × 200 × 225 mm

Weight, incl 100 feet film, yellow filter and f.70 objective: 6.8 kg

Power requirement: approximately 100 W

Deltamar Objective lenses (optical data):

Lens type (Deltamar):	38/3.2	52/2.7		
Focal length (mm):	38	52		
Relative aperture:	f/3.2	f/2.7		
Field of view:	72°	56.5°		
64/1.8	70/1.6	100/1.4	150/2.8/	
64	70	100	150	
f/1.8	f/1.6	f/1.4	f/2.8	
48°	44.4°	31.5°	21.0°	

STATUS:

Camera systems have been produced in mass, and are still in operational use with the photo reconnaissance squadrons of Italy, the Netherlands and West Germany with the RF-104G and Fiat G-91 aircraft.

MANUFACTURERS:

N.V. Optische Industrie "De Oude Delft", van Miereveltlaan 9, P.O. Box 72, Delft, Holland.

1711.153
TA-8M2 AERIAL CAMERA

DESCRIPTION:

The TA-8M photo reconnaissance camera is a further development of the TA-7M2 (Entry No **1710.353**), in that all the electronic control elements are now incorporated inside the camera body, making an external speed control box superfluous. This type of camera is used as one of the daylight sensors of the "Orpheus" aerial reconnaissance system (Entry No **1708.353**). The camera is of a compact construction and relatively simple design, yet incorporating all features for modern aerial photography. It is easy to maintain and fitted for adaption in several types of aircraft.

Main characteristics:

Typical frame rate: 0.25 to 5 frames per second, or 0.5 to 10 frames per second

Frame rate is variable by a factor of 20 under automatic or manual control

Automatic exposure control for each camera independently

Exposure time: 1/180 sec to 1/7,200 sec

Diaphragm system: automatically controlled, operating directly on the brightness of the actual image plane

Continuous film transport for IMC

Film size: standard 70 mm perforated film on 100 feet core

Frame size: 57 × 57 mm

Film sensitivity: 100-800 ASA

Data recording: between successive frames

Dimensions (overall): 190 × 200 × 220 mm

Weight: 6 kg with loaded magazine

Power requirements: less than 150 W

Objective lenses used with "Orpheus" system:

in forward-oblique position: Deltamar 70/1.6

in primary side-oblique position: Deltamar 70/1.6

in secondary high-oblique position: Deltamar 100/1.4 or 150/2.8

in split-vertical position: Deltamar 52/2.7 70/1.6 100/1.4 or 150/2.8

DEVELOPMENT:

Prototypes were flight tested in 1969; military evaluation and qualification programmes were finalised mid-1972.

STATUS:

In serial production for the Royal Netherlands Air Force, the Italian Air Force, and for the Italian Light Aviation Group

MANUFACTURERS:

N.V. Optische Industrie "De Oude Delft", van Miereveltlaan 9, P.O. Box 72, Delft, Holland.

THE UNITED KINGDOM

1864.353
JAGUAR RECONNAISSANCE POD

DESCRIPTION:

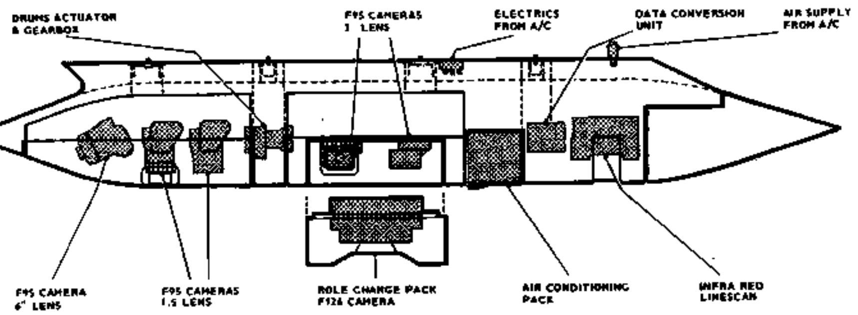
Designed to RAF requirements by BAC especially for the Jaguar, the reconnaissance pod is carried beneath the centre fuselage and is attached by two ejector release units. There are also electrical and pipe connections for air conditioning.

Horizon-to-horizon cover is provided by optical reconnaissance cameras. In addition, infra-red linescan (IRLS) is incorporated to give the aircraft an additional daylight, poor weather and night reconnaissance capability.

A data conversion unit inside the reconnaissance pod takes data from the aircraft's digital computer, which is used to control the navigation and weapon-aiming systems. It then converts it to produce latitude and longitude references on the reconnaissance pictures.

Cameras are installed in two rotatable drums within the pod. The rear drum carries alternative modules, enabling the complete pod to be converted simply and quickly from low to medium altitude operations. In the operating position, the cameras view the ground below through optically ground glass windows. For low-level sorties, the rear camera drum contains two high-oblique across-track Vinten F95 Mark 10 cameras with 3-inch (76 mm) n2 lenses. The alternative module for medium altitude reconnaissance houses an F126 camera with a 6-inch (152 mm) f5.6 lens.

The front rotating camera drum, which is common for low- and medium-altitude missions, contains two low-oblique across-track F95 Mark 10 cameras with 1.5-inch (38 mm) f2.8 lenses and one forward-looking oblique F95 Mark 7 camera with 6-inch (152 mm) f28 lens. In addition to position references being fed through the data conversion unit on to the film, the Jaguar reconnaissance pod has a facility that enables the pilot to annotate with an event marker when he flies over an area of particular interest.



General arrangement of Jaguar reconnaissance pod

Attaching the pod to the fuselage of a Jaguar is a quick and simple procedure, with the aid of a special ground handling trolley.

STATUS:

In production.

MANUFACTURER:

British Aircraft Corporation, Weybridge, Surrey, England.

1865.353
VINTEN RECONNAISSANCE PODS

DESCRIPTION:

The Vinten camera company has developed and produced a number of detachable reconnaissance pods suitable for use with a number of combat aircraft types to permit their use in either role. Examples of aircraft for which Vinten pods have been produced are the Mirage III, F-104, BAC 167, and Saab 105. Three types of pod are briefly detailed below. Mostly, they have been designed to accommodate various combinations of the Vinten range of reconnaissance cameras, but the layout is sufficiently flexible to permit the installation of other sensors when required, such as infra-red linescan or TV sighting equipment.

Vicon 18 Pod:

Standard day reconnaissance system providing 180-degree cover, with additional forward-looking camera or TV sighting camera.

Standard Fit: One forward-facing 70 mm Type 360 or 518 camera (or TV camera); four 70 mm Type 360 or 518 cameras in cross-track configuration for 180° cover

Performance: Mach 0.85 at low level. 5g acceleration

Dimensions: 2.9 m × 45 cm (dia)

Weight: 172 kg (complete)

Vicon Pod 25:

Infra-red pod for low light or night reconnaissance providing 120-degree cover.

Standard Fit: Three Type 591 cameras in the cross-track configuration; camera junction unit; EC&G infra-red flash system Type LS 129A

Performance: Mach 0.9 at low level. 5g+ acceleration

Dimensions: 4.27 m × 48 cm (dia)

Weight: 190 kg

General Purpose Lightweight Pod:

For light aircraft. Can be fitted with four Type 360 cameras or one Type 750 panoramic camera. Both installations provide 180° cross-track cover

Performance: 500 knots at low level

Dimensions: 2.44 m × 50 cm (dia)

Weights: 46 kg (Type 750); 71 kg (4 × Type 360)

STATUS:

In production for various aircraft types. The Vicon 18 is currently in service with numerous air forces.

MANUFACTURER:

W. Vinten Ltd, Western Way, Bury St. Edmonds, Suffolk, England.

1866.353
VINTEN AIRBORNE CAMERAS

DESCRIPTION:

A wide range of airborne reconnaissance cameras has been developed by the Vinten concern. The principal current models are described in the following paragraphs.

Type 591:

The Type 591 camera is designed for high speed low level, low light or night photography using visible or infra-red electronic flash illumination. The use of a 75 mm f1.5 Leitz lens coupled with the high performance of this camera allows an installation of three cameras to provide a cross-track cover of 116° with a 2° side-lap at speeds of up to 600 knots at 60 m. The special large lens aperture ensures maximum benefit from the illumination system whilst maintaining high resolution and minimum vignetting.

The camera(s) fan is ideally controlled by a velocity/height (V/H) computer, ensuring the correct framing speed and image compensation rate throughout the V/H range. An alternative control with manual settings can be used in place of the computer. All inputs from the computer or manual unit are fed to the fan of cameras via a special camera junction unit. The film magazine has a 30 m capacity (500 frames) being sufficient for a line search of 43.4 km (27 miles) at 60 m (200 ft) (10% overlap). The camera and control system is simple to operate and maintenance is minimal. It can be installed in an external pod combined with an IR illumination system, or can be internally mounted in the aircraft.

Type 591 Specification:

70 mm film:

Format: 55.5 mm × 57 mm

High-speed positive action between-lens shutter

Automatic exposure control

Framing speed: 1 to 10 fps fully variable

100 ft magazine with vacuum film pressure plate

Image motion compensation: 195-510 mm/second

Shutter speed maximum: 1/500 second

Overlap (under pilot control): 10% or 55%

Data: Frame identification counter and event marker

Lens unit: 75 mm f1.5 mm Leitz

Type 690:

A 114 mm × 114 mm format camera using 127 mm double perforated film, Type 690 represents a logical evolution of the Type 790 and 890 cameras produced by Vinten for advanced high-speed reconnaissance. These latter cameras embody a 114 mm × 57 mm format, again on double perforated 127 mm film, as programmed for the SAAB S37 Viggen aircraft. The shutter and film transport technology developed for these "half frame" cameras lends itself well to the larger format of the 690 enabling the design to be based upon well-proven principles. A further notable feature developed for the 790/890 series of cameras and incorporated within the 690 system is the facility to synchronise the exposure of all cameras within the fan, thus eradicating the problem of film strand correlation.

Alternative long focal length lenses are available enabling the versatility of the camera system to be extended to the medium and high altitude reconnaissance applications.

Type 690 Specification:

Format: 114 mm × 114 mm

Film: 127 mm wide double perforated. Maximum capacity 125 m thin base (.004 in)

Frame Rate: 1 to 10 frames per second in conjunction with IMC/overlap

Forward Overlap: 20%-60% remotely selected

IMC Range: 45.72 mm to 282.6 mm per second automatically set in conjunction with V/H input signal

V/H Ratio: Maximum 6
Minimum 0.6

Shutter: Focal plane type
Exposure time with standard blind:
Maximum – 0.5 m sec
Minimum – 1 m sec
Exposure time is automatically controlled by AEC

AEC: Automatic through lens photo-detector type sensing
(a) Accuracy ⅓ of 1 f stop
(b) Speed Full range 0-5 sec
Stop to stop 100 m sec
(c) Film Range NATO 4 to 8

Data: 128 bit binary data package (Ferranti) recorded adjacent to each frame
NOTE Alternative types of data can be considered

Lens: (i) 75 mm f2.8 Leitz
(ii) 150 mm f2.8 Leitz
(iii) 300 mm
(iv) 600 mm

Type 750:

Aerial panoramic photography is a method which enables a series of wide angle (180°) photographs to be recorded on one continuous length of film. Each photograph provides a coherent image of the terrain from horizon to horizon under the aircraft or, if used as a forward facing camera, a complete 180° arc forward of the aircraft. High resolution and even exposure of the subject is an important attribute of this type of camera since, by its design, only the centre portion of the lens is used, ie that closest to its optical axis. The picture quality thus achieved is greater than that provided by conventional very wide angle cameras which, in any case, will not perform satisfactorily with a field of view in excess of 100°.

Since only one camera is needed for horizon-to-horizon reconnaissance photography, (replacing the conventional three or four camera fan) ground handling of the film and subsequent photo interpretation is greatly simplified.

The design features a rotating lens optical arrangement in order to achieve high filming speeds with minimum stress on the camera mechanism. It is capable of a performance appropriate to a velocity/height ratio of 5 or 6, ie, 923 km/h (600 knots) at 60 m, and has been deliberately simplified in order to extend its life and reduce maintenance hours. It offers straightforward overhaul methods using minimal test equipment.

The Vinten 70 mm rotating lens panoramic camera is specially designed for along-track/strike recording, or cross-track/forward look reconnaissance photography. Its general construction and high framing rate make it ideal for either application. Overall dimensions and weight have been kept to the minimum. The rotating lens principle, as opposed to the rotating prism, allows the camera to operate at a constant (but variable) speed. This permits picture taking frequencies of 10 or more frames per second, with little mechanical strain on components. It helps eliminate vibration-induced resolution loss and smooths out the film transport mechanism – vital for good panoramic photography. It also ensures the best resolution that the optical system and film can provide, nominally in excess of 60 lines per millimeter.

The integral film magazine has a capacity of 85 m of film with a thickness of 0.1082 mm in daylight loading spools, enabling the camera to be loaded in situ in the aircraft. The film load provides for up to 335 pictures capacity, enough for a line search of:

14 km at 60 m at 923 km/h
21 km at 90 m at 923 km/h
28 km at 120 m at 923 km/h

The above cover is calculated on the following factors:

framing rate: 7.4 pictures per second, and 10 per cent overlap.

Type 750 Specification:

Type: Panoramic, continuous motion (non intermittent)

Lens: 75 mm focal length, f2.8 aperture

Film: (a) Width – 70 mm perforated (b) Capacity – 280 ft at .0043 thick (cassette loading)

Picture size: 235 mm × 57 mm

Rebate (space between frames): 12.2 mm

Cover angles: 180° × 42°

Frame rate (Autocycle): Up to a maximum of 10 frames per second. Related to aircraft V/H ratios 1 to 5 and ground cover overlap required

Film speed: 100 inches per second nominal

Relative shutter speed: 1/300 sec through 1/3,000 sec established by cycling rate and slit width

Shutter slit width: 3 mm and 1.5 mm preset

AEC: Open loop automatic lens aperture control f22 to f2.8. Illumination ratio 64/1 (6 stop change)

Data: (a) 32 or 64 dot Ferranti Data tablet. (b) Frame marker

Mode of Operation: (a) Strike – (Fore/Aft scan)
(b) Recce (Cross track scan)
(c) Forward – (Oblique scan)

Film speeds: NATO 3, 4, 5, 6, 7

MANUFACTURER:

W. Vinten Ltd, Western Way, Bury St. Edmunds, Suffolk, England.

1867.173
VINTEN PHOTO-INTERPRETATION EQUIPMENT

DESCRIPTION:

The Vinten range of photo-interpretation tables has been evolved to offer the photo-interpreter a modern, high-speed, multi-channel film viewing system. They enable the speedy evaluation of reconnaissance film by one or two interpreters.

The powered tables employ variable thyristor-controlled high intensity lighting (1,500 ft/lamberts maximum) to suit variable density imagery and high power microscopes.

Quiet, high capacity axial fans circulate air through the tables to stabilise the light tube temperature, ensuring high light output and long life.

Each strand is driven via detachable and adjustable variable speed electric drive motors at each end and may be driven in either direction. The speed range is 0.3 m (1 ft)/min to 38 m (125 ft)/min.

The lighting and motor controls for the 652 Table are mounted on the front panel whilst duplicate controls are mounted on both sides of the 657 Table to enable two interpreters to work simultaneously.

Storage drawers and flip-up tables are provided in the Table pedestals and provision is made to mount a zoom stereoscope, microscope, TV closed-circuit camera, X/Y co-ordinatograph mensuration unit and desk calculator.

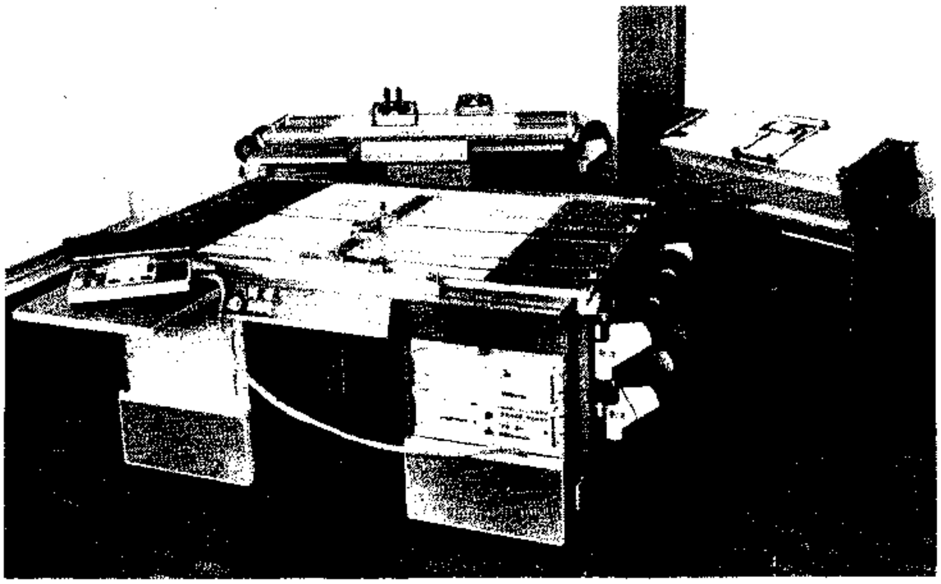
The tables are constructed around an aluminium 'I' beam frame specially designed for strength and stability; the top surfaces being fully machined to a high accuracy to accept precise measuring instruments.

To suit various requirements, two powered tables are offered, one carrying a maximum of four strands × 70 mm, three × 127 mm, or two × 241 mm, the other a maximum of seven strands × 70 mm, six at 127 mm or three × 241 mm.

The Type 666 small unit can be bench mounted and is manually operated. It is ideally suited to the needs of a smaller PR Unit where space is at a premium. It incorporates mountings for a stereoscope and magnifier for detailed examination of negatives. The light source is fully variable and is cooled by an axial fan. The table will accept two strands of 70 mm film, one of 127 mm or one of 241 mm film.

MANUFACTURER:

W. Vinten Ltd, Western Way, Bury St. Edmunds, Suffolk, England.



Vinten Photo Interpretation Table Type 652/7 allows simultaneous viewing of seven strands of film

1878.353
F126 RECONNAISSANCE CAMERA

DESCRIPTION:

The F126 camera is designed as a medium to high altitude reconnaissance camera capable of taking very high quality pictures on a 230 mm × 230 mm (9 in × 9 in) format in daylight. Image movement compensation (IMC) is provided so that sharp pictures are obtained right up to the maximum IMC of 0.3 radians/sec equivalent to an aircraft flying at 1.3 Mach at a height of 1,520 metres (5,000 ft). Variations in incident light level are fully compensated for by an automatic exposure control (AEC) system having a very fast continuous response. To minimise the effects of aircraft vibration a high speed focal plane shutter having preset slit widths giving times of 1/1,000, 1/500 and 1/250 sec is provided.

The camera consists of three main units which are the body, lens cone and cassettes. The body houses the shutter, film drive mechanism and associated electronics. The motor that drives the film at IMC speed during exposure is electronically controlled from a reference voltage proportional to the ratio of aircraft velocity/height (V/H). After the shutter fires, a quick wind (QW) mechanism advances the exposed frame so that another exposure can be made giving an overlap in ground cover of 60%.

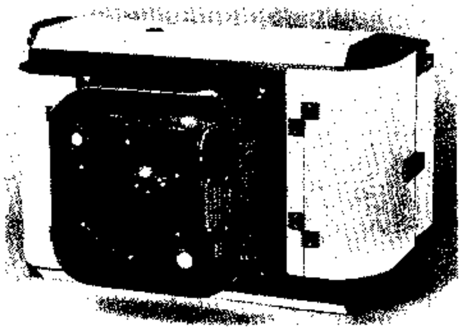
Two lens cone assemblies are currently available: a 152 mm (6 in) and 305 mm (12 in). Other focal lengths up to 915 mm (36 in) are possible. Each lens cone has its own AEC system and is pre-focused so that when it is secured to the body by the four mounting bolts, no adjustment is necessary.

The feed and take-up cassettes are identical. The cassette is loaded with live film in the dark room and then daylight loaded into the camera. A guillotine is provided so that the exposed film can be quickly removed from the camera at the end of a sortie.

The camera is designed for use in multi-camera installation where one of them is selected as a 'Master', providing a synchronising pulse to fire the shutters and QW mechanisms of the 'Slaves'.

STATUS:

In RAF service, with Nimrod, Phantom, and Harrier aircraft, and in the Jaguar reconnaissance pod.



F126 Medium/High altitude reconnaissance camera

MANUFACTURER:

Aeronautical & General Instruments Ltd, 40 Purley Way, Croydon, CR9 3BH, England.

1879.353
F135 RECONNAISSANCE CAMERA

DESCRIPTION:

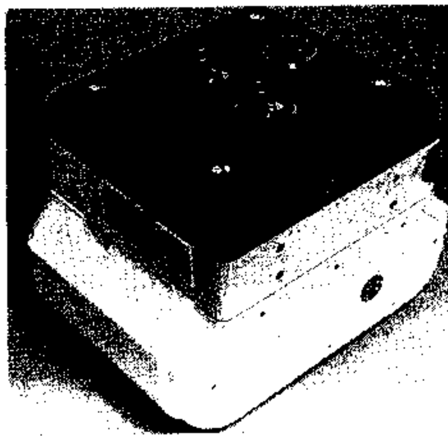
The F135 Camera is designed for use as a low level, high speed reconnaissance camera to take stereo pictures of very high quality during day or night sorties. Image movement compensation (IMC) is provided so that sharp pictures are obtained right up to the maximum IMC of 8.35 radians/sec, equivalent to an aircraft flying at Mach 1 at 40 metres. Variations in incident light level are fully compensated for by an automatic exposure control (AEC) system having a very fast continuous response. To minimise the effect of aircraft vibration a fast between lens shutter of 1/1,000 sec is used until light level falls to a level demanding the full aperture of the lens when the shutter speed is reduced steplessly to x s150 sec.

Twin lens are used to cover two formats 57 × 57 mm (2.25 × 2.25 in) side by side on 126 mm (5 in) film which greatly reduces the length of film that has to be carried. The film and drive mechanism are housed in a light tight magazine that can be daylight loaded on to the camera body, being retained by quick release catches. The motor driving the film at IMC speed is electronically controlled from a reference voltage proportional to the ratio of aircraft velocity/height (V/H). A quick wind (QW) mechanism is incorporated to increase the repetition rate so that ground cover overlap is provided.

The camera body houses the lenses, shutters and AEC together with the associated electronic control. When the shutter fires a synchronising pulse is produced to fire the electronic flash for night photography. Magazines and bodies are completely interchangeable.

Up to 4 cameras can be used in an installation. All cameras are identical but the interconnecting wiring is arranged so that one of them acts as a 'Master' to synchronise the firing of the shutters and QW on the others.

The number of controls to operate the camera has been kept to a minimum. An ON/OFF switch supplies power to the camera keeping it in a STANDBY condition with the AEC operative and



F135 Low-altitude high-speed reconnaissance camera the electronics primed but no film transported. When switched to RUN the camera takes pictures in either 'Ripple' or the '50/50' mode as selected by the mode switch. A 'frames remaining' counter indicates the number of exposures left and a warning lamp lights if the film is not transported or the end of the film is reached. The reference V/H voltage is preferably supplied by the aircraft computer but in cases where this is not available manual velocity and height controls can be fitted.

For night photography the electronic flash is switched on and is automatically synchronised from the master camera. No adjustment of the camera is necessary since the AEC automatically sets the iris to full aperture and the shutter to the 'flash' position when the incident light level is low.

OPERATING MODES:

For good stereo pictures at low altitude best results are obtained if the stereo pairs are separated by about 10% of the ground cover in the direction of flight. This is achieved in the F135 by making one lens look forward by 4 degrees and the other aft. The shutters are arranged to fire in quick succession so that an object in the centre of the format is viewed by one lens from the forward direction and by the other lens in the aft direction. When viewed with a stereo viewer these pictures give excellent stereo over the complete format. To ensure that no ground cover is lost a 10% overlap is provided by quick-winding the film between pairs of exposures. This mode of operation is known as 'Ripple'.

In the other mode of operation known as '50/50' no QW takes place and the shutters are fired alternately at time intervals to give pictures that have 50% ground cover overlap. Stereo can be obtained from these but only over half the format. This mode is intended for night photography where the repetition rate is limited by the recharge rate of the electronic flash.

STATUS:

In RAF service, with Nimrod, Phantom and Harrier aircraft.

MANUFACTURER:

Aeronautical & General Instruments Ltd. 40 Purley Way, Croydon, CR9 3BH, England.

1199.353

INFRA-RED LINESCAN 201

DESCRIPTION:

The Type 201 infra-red linescan is a self contained, single unit reconnaissance system designed for installation in drones, aircraft pods or small aircraft and helicopters. Among the most notable of the features of this recently designed equipment are its small dimensions and light weight – 26.4 × 33 × 31.8 cm, and 11.6 kg. This package, which is shaped to suit drone or pod installation, contains the scanner, associated scanning and recording optics, an infra-red detector, and an electronics pack. The electronics are built in sealed cans with interconnections via sealed plugs and sockets with screened cables. Standard 70 mm film is used for recording, and this is contained in lightweight self-sealed cassettes. Individual units and sub-assemblies are interchangeable for servicing, and the equipment incorporates self-test facilities.

OPERATION:

In the linescan technique of reconnaissance, the terrain overflown is scanned in narrow strips at right-angles to the line of flight, the forward motion of the vehicle thus producing a series of consecutive strips which can be recorded side-by-side to produce a continuous picture of the radiation from the ground below. The Type 201 is responsive to the variations in infra-red radiation from the terrain scanned, and thus provides a means of passive reconnaissance by day or night. As well as producing a map of the terrain, this technique can reveal camouflaged objects and the recent presence of vehicles or aircraft from the thermal 'shadow' they leave behind.

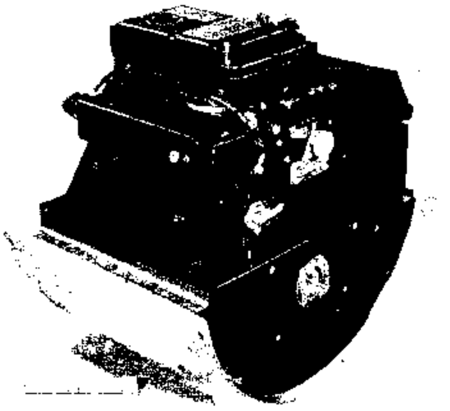
The scanner rotates at a speed of 7,500 rpm and provides a field of view of 60 degrees across track either side of vertical. This yields a coverage of just over 1 km for an aircraft flying at 300 m. Radiation collected by the scanner is focused through an optical system consisting of a pair of parabolic mirrors and a ridge mirror, onto a cadmium mercury telluride detector built into a dewar flask containing liquid air or nitrogen for cooling. Coolant capacity is sufficient to maintain the detector at a temperature of 77 degrees K for at least 30 min at normal ambient temperatures.

The detector is sensitive to radiation in the 8 to 14 micron band of the spectrum, and it reacts to changes in temperature and emissivity of the objects scanned by modulating the current passing through it. These current variations are processed electronically and used to drive a glow modulator tube, a device which produces light proportional to current. This light is used to expose the film on which the record is composed. The glow modulator tube and recorder optics are mechanically integrated with the scanner to provide accurate synchronisation between the detector signals and the recorded images.

Standard 70 mm, aerial FP 3 or equivalent film is used for recording, of which exposure is effected over only 53 mm of its width. The edge of the film may be used for the recording of navigational data, time marks, etc. Film cassettes are contained in the film transport assembly which is attached to the scanner/recorder housing by a quick-release mechanism. A standard cassette holds 5 m of film, which for a mission height of 300 m gives an along-track coverage of 64 km.

To maintain the same scale across and along track, the film is driven at different rates. The rate depends upon the ratio of the speed and altitude of the aircraft, and this is known as the Velocity/Height (V/H) ratio. A simple clutch mechanism is incorporated to keep the film tensioned down stream of the slit apertures in the scanner/recorder housing, through which the film is exposed. V/H ratios between 0.15 and 0.75 can be accommodated by the Type 201.

The built-in self test facility provides checks of scanner running, the glow modulator tube, electronic power supply, film transport mechanism, detector cooling and signal output, and electrical continuity.



Type 201 infra-red linescan sensor package as used in USD-501 reconnaissance drone

DEVELOPMENT:

The Hawker Siddeley Dynamics Type 201 infra-red linescan is the outcome of an international competition which resulted in this company being selected to develop such a system suitable for use in the Canadair AN/USD-501 reconnaissance drone. The linescan package was to be interchangeable with the standard camera pack for this drone. HSD was selected in 1968 for this task, but had in fact done an appreciable amount of design work appropriate to the project prior to this.

STATUS:

A series of flight-trials in an AN/USD-501 drone, carried out at the Royal Canadian Artillery Firing Range at Camp Shilo, Manitoba, was successfully completed early in 1970. The sensor is now in series production for the British and West German Armies.

MANUFACTURER:

Hawker Siddeley Dynamics Ltd, Electro-Optics Division, Manor Road, Hatfield, Herts. AL10 9LL, England.

1638.353

INFRA-RED LINESCAN 212

DESCRIPTION:

Derived from the Type 201, the 212 provides for reconnaissance and survey operations from aircraft and helicopters. A cooling pack is incorporated to extend system endurance, and a pilot control panel forms part of the system. Velocity/Height ratio range is 0.2 to 0.7 radian/sec. The 212 can also incorporate an Indium Antimonide detector which is sensitive in the shorter (3-5 micron) waveband. The 212 is of ruggedised design, and is intended for simple operation and minimum maintenance requirements. Normal photographic processing techniques and equipment are employed.

DEVELOPMENT:

Extensive flight trials have been conducted over varying terrain, and the environments have included conditions ranging from tropical jungle to snow-covered mountain regions. Aircraft employed for these trials have included types as diverse as the Wallis WA 117 autogyro and the Mirage III.

A maritime 212 version, with additional modular electronics for discrimination of details on vessels at sea is in development for an overseas customer. Similar applications for this version are encountered in desert or snow conditions.

STATUS:

The standard 212 is in full production and sales have been made to a number of military and civil organisations.

MANUFACTURER:

Hawker Siddeley Dynamics Ltd, Electro-Optics Division, Manor Road, Hatfield, Herts AL10 9LL, England.

1346.353

INFRA-RED LINESCAN 401

DESCRIPTION:

An equipment for near sonic reconnaissance missions at very low level. In common with other Hawker Siddeley Linescan equipments, scanner and recorder optics are mechanically integrated. This novel arrangement ensures perfect synchronisation and has the added advantage of reducing size and weight. Because of its small size and weight it is particularly suitable for installation in modest size pods.

Compatibility with high performance aircraft is met by robust construction, high pressure air for detector cooling, and a large film capacity. To cater for the high Velocity to Height ratio (V/H) a multi-channel detector and electronic system is employed. This ensures that a high resolution is maintained over the performance envelope. Pilot workload is minimised by automatic control of film and scanner speed, for V/H. Roll stabilisation is incorporated to permit high angles of bank without loss of continuity on the film. Flight navigation data is recorded on the film automatically. Standard 70 mm thin base reconnaissance film is contained in a simple large-capacity magazine. Magazines are interchangeable and easily fitted or removed from the linescan. Cockpit controls include an event marker, film footage counter, and a fault indicator lamp fed by a built-in self test facility.

DEVELOPMENT:

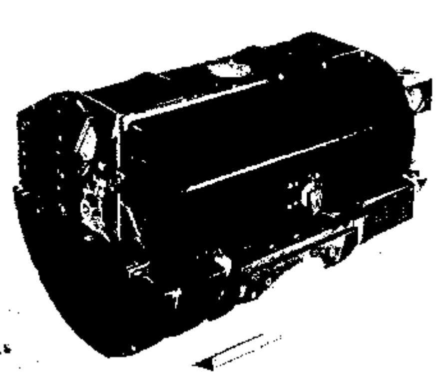
A development contract for the Type 401 was awarded to Hawker Siddeley Dynamics by the RAF in 1970 and was announced in May of that year.

STATUS:

Production against Royal Air Force contracts is in progress. Negotiations with other countries are at advanced stages and range from trials to bid submissions. A number of reconnaissance pod manufactures offer the 401 as a standard option.

MANUFACTURER:

Hawker Siddeley Dynamics Ltd, Manor Road, Hatfield, Herts AL10 9LL, England.



Hawker Siddeley Type 401 infra-red linescan unit

2422.153
IRIS INFRA-RED INTRUDER SYSTEM

IRIS is a rugged low-cost equipment designed to assist in the important task of detecting and monitoring enemy movements – especially in broken terrain or jungle.

DESCRIPTION:

The basis of the system is an infra-red beam projected between a transmitter and a sensor; interruption of the beam causes an alarm to be triggered at a remote monitoring unit. The beam is virtually impossible to detect without interrupting reception by the sensor. The effective part of the beam must be completely obscured to give an alarm, hence, any line-of-sight path between the transmitter and sensor that leaves this beam at least partly clear is usable. In particular, the transmitter and sensor, which are small in size, may be hidden in light foliage amongst or behind small twigs and branches, etc. IRIS can be used both during day and at night over ranges of 200 metres in average conditions, or 50 metres in fog, snow or tropical rain.

Each monitor unit can be associated with four separate "links" – i.e. transmitter-sensor combinations. Each channel has its own warning lamp and counter and there is a common audible warning circuit to which an operator can connect his headphones. The equipment can thus be used for direct monitoring by an operator, the affected link being indicated by the warning light, or for unattended monitoring – the counters indicating how many times each link has been broken since they were last reset to zero.

In good visibility conditions the link can be set up visually using the gun sights on the transmitter and sensor. When this is not possible a small encapsulated Audio Alignment Unit is used, with the operator's headphones, to align the links.

MANUFACTURERS:

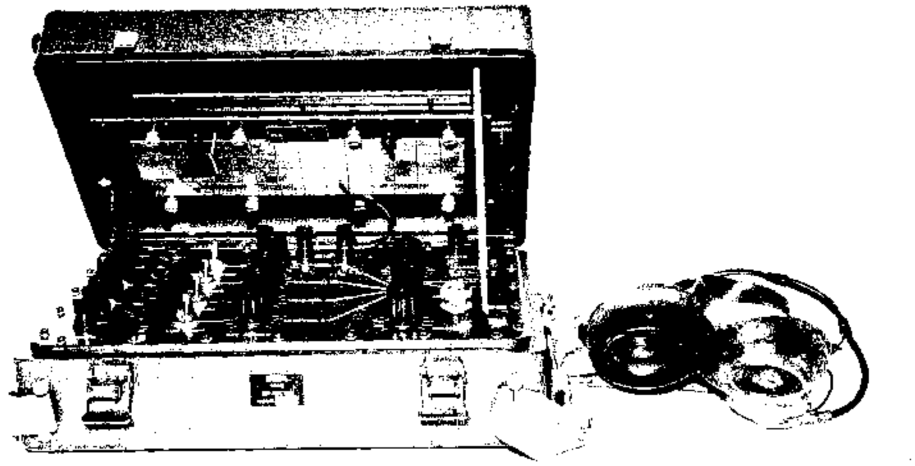
Marconi-Elliott Avionic Systems Ltd, Mobile Radar Division, Elstree Way, Borehamwood, Herts WD6 1RX, England.

2470.153
TOBIAS INTRUDER ALARM SYSTEM

This man-portable intruder alarm system, developed as a private venture by Elliott-Automation is now in use with armies and police forces in many parts of the world. It consists of a display unit having four separate signal channels to which sensors are connected by means of wire. The sensors are deployed near to likely intruder approach routes and may be many miles from the display unit. Ground vibrations set up by an intruder impinging on the sensors cause an electrical signal to be sent along the wire to the display unit. Maximum detection distances will vary with the nature of the ground and other environmental conditions. Thus a number of strategic points may be kept under surveillance by a single operator/sentry.

DESCRIPTION:

TOBIAS makes use of small, rugged low-cost, passive sensors (geophones) which, because they are buried just below ground level, are virtually undetectable. They may be sited near likely intruder approach routes or, for example, round the perimeter. Their deployment area can be many miles from the display unit. The display unit has four independent channels, to each of which up to 20 geophones may be connected. Thus, if desired, a considerable frontage or perimeter can be protected by one system. Maximum detection distance for one geophone depends largely on the nature of the ground and the amount of natural and man-made seismic activity in the area, but for a walking man it is seldom less than 50 metres radius, and 300 metres radius is not uncommon. Visual indication of movement on each channel is provided at the display unit (metres); also an aural display (headset) allows the nature of the measurement on each channel to be registered. The aural display also permits the operator to monitor activity continuously on all four channels simultaneously. Power supply (contained in lid of display unit) is eight 1½ V standard U2 (or equivalent) cells, which will provide a minimum of 72 hours continuous operation.



Tobias Intruder Alarm display unit

Tobias Specification:
Display unit C769 Mk II:
Width: 36.2 cm
Height (max): 15.25 cm
Depth: 24.5 cm
Weight (excluding batteries): 6.35 kg
Sensors:
Body height: 3.8 cm
Body width: 3.8 × 5.1 cm
Overall height including spike: 14 cm
Weight: 170 gm
Batteries: Eight U2 or HP2 cells or equivalent. USA equivalent – 'D' cells
Rated sensitivity: Less than 1 microvolt r.m.s. for a detectable signal with SET LEVEL controls fully clockwise
Radio audio output: 120 mW into 150 ohms
Rejection of induced interference: More than 65 dB
Rated battery life: Not less than 72 hours continuous operation

DEVELOPMENT:

Developed in 1966. Now in service with the British Army and 12 other countries.

MANUFACTURERS:

Marconi-Elliott Avionic Systems Ltd, Mobile Radar Division, Elstree Way, Borehamwood, Herts WD6 1RX, England.

THE UNITED STATES OF AMERICA

2766.153
PERSID-4A INTRUDER ALARM

PERSID (Personnel Seismic Intruder Detector) 4A is a 4-channel, audio-visual, military approved alarm system for use under field and combat conditions.

DESCRIPTION:

PERSID-4A is a small portable unit that is virtually impossible to detect since it uses passive geophone sensors similar to those used in oil exploration. The sensors are buried in the ground near likely intruder approach routes and are linked by wire to a control unit which can be located at considerable distances from the sensors. Each sensor detects subaudible ground vibrations of vehicles, men on foot, and animals identifiable at distances up to 100 yards for men and 300 yards for vehicles, depending on the terrain selected.

These signals are then passed to a central control unit where they are amplified, and processed to an improved audible sound possessing signature characteristics similar to those of the original sound.

Surveillance coverage can be greatly expanded by connecting as many as six geophones in parallel to each of the four input channels. By connecting additional geophones through external selector switches on each of the four input channels, even greater surveillance coverage can be achieved. High intensity sounds such as those produced by shells or hand grenades exploding near geophone sensors will not impair ability of the device to detect the movement of men or vehicles in or around the surveillance area.

Weight of the unit, complete with batteries is only about 1.6 kg. Dimensions are 200 mm × 95 mm × 152 mm. Operating temperature is from −30%C to 65%C at 95% relative humidity.

MANUFACTURER:

Defense Electronics, Division of DEI Industries, Rockville, Maryland 20854, USA.

2724.153
NIGHT OBSERVATION DEVICE – LONG-RANGE (NODLR)

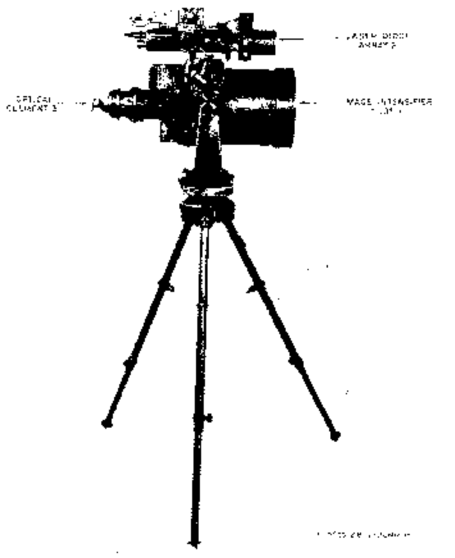
Hardly any information has been released on this device: virtually all that can be said about it is that it is designed to enhance the ability of ground forces to see in the dark. The only pointers to its method of doing this are provided by this information that the equipment incorporates an IBM laser, an RCA image tube and a Malakir cyrogenic cooler.

DEVELOPMENT:

The equipment was developed by Kollsman Instrument under a $2,168,000 US Government contract placed in 1968. 13 sets were ordered and delivery was completed early in 1970. The concerned Government agency is the Night Vision Laboratory of the US Army.

MANUFACTURER:

Main contractor: Kollsman Instrument Corporation, 575 Underhill Boulevard, Syosset, N.Y., U.S.A.



Kollsman long-range night observation equipment

1871.353
RBV CAMERA SYSTEM

DESCRIPTION:

The RCA Return-Beam Vidicon camera system described in this entry was developed for the civilian Earth Resources Technology Satellite programme, but is included here for its obvious relevance to the techniques and possibilities which exist for military reconnaissance satellites.

The 2-inch RBV Three-Camera Subsystem surveys the Earth via three co-aligned camera sensors, each viewing the identical scene but in a different spectral band. When the separate images from the three cameras are processed and superimposed in their respective colours, they provide a single full-colour image containing the radiometric and cartographic information required for the ERTS system.

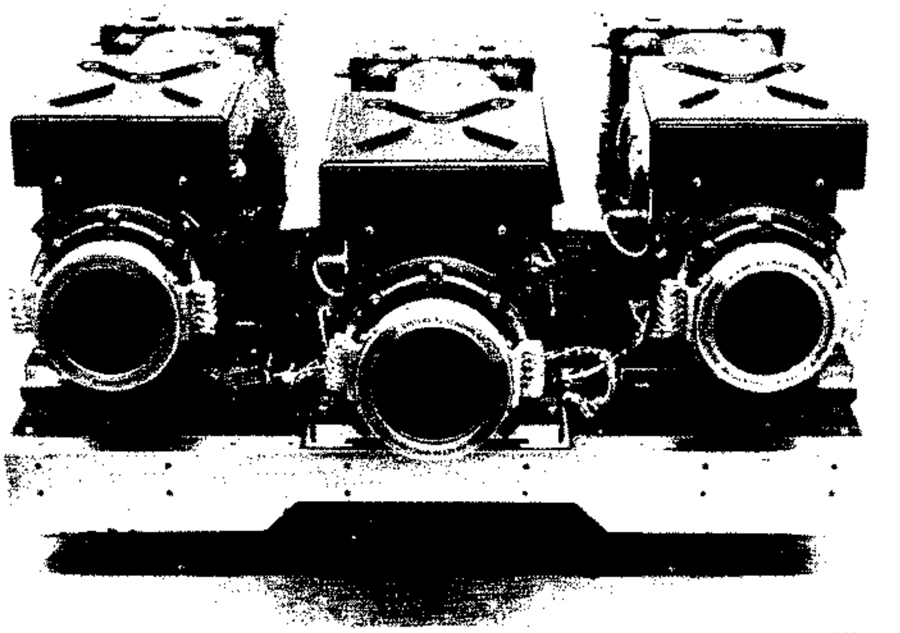
The three spectral regions covered by the three-camera subsystem are the blue-green (0.475 to 0.575 micron), red (0.580 to 0.680 micron), and near-infra-red (0.690 to 0.830 micron). The three cameras are exposed simultaneously to facilitate registration of the three separate images into the final colour composites.

Each photograph processed by the camera subsystem covers an area 100 by 100 nautical miles (185 × 185 km). These individual photographs can be arranged to provide a continuous swath along the spacecraft orbital track.

The overall three-camera subsystem comprises the following seven electronic units: three camera sensors; three camera electronics units; a common camera controller and combiner.

A baseplate unique to the subsystem serves as a precise alignment reference plane and thermal control element.

Each of the three camera sensors includes a return-beam vidicon, electron optics, electromagnetic deflection circuitry, electromechanical shutter, lens, and thermo-electric cooler. The vidicon imaging tube is a magnetically deflected, magnetically focused device with a 2 inch (5 cm) diameter face-plate. Optical filters in the lens assembly of each camera sensor determine the different spectral allocations for each. The lens assembly provides a 15.9-degree field of view across the diagonal portion of the 1-inch-square (6.45 cm^2) usable format of the vidicon face plate. A deposited reseau pattern on the faceplace establishes a geometric reference for the registration of the three separate information channels. The shutter provides for uniform exposure of the vidicon, and it can be programmed for one of three exposure times to accommodate variations in scene illumination. The thermoelectric cooler controls the thermal environment of the vidicon faceplace.



RBV 3-camera system for ERTS. This uses three specially designed Fairchild lenses, each with a different spectral range of correction; green, red, and near infra-red lenses are used

Each camera goes through four operational modes – erase mode, prepare mode, expose mode, and read mode – in taking a picture of a scene. The duration of a picture-taking sequence is 25 seconds, with the erase, prepare, and expose modes being simultaneous for the three cameras and the read mode being sequential.

An electronics unit is associated with each of the three camera sensors. This unit not only develops the various power inputs for the sensor, but it also contains the circuitry for processing the sensor video output. The unit sequences its associated camera sensor as dictated by timing inputs from the camera controller and combiner.

The electronics unit also controls the focus and sweep deflection of the camera sensor, feed-back for the thermoelectric cooler on the vidicon face-plate, and the video gain. Finally, it provides the ability to operate with or without aperture correction.

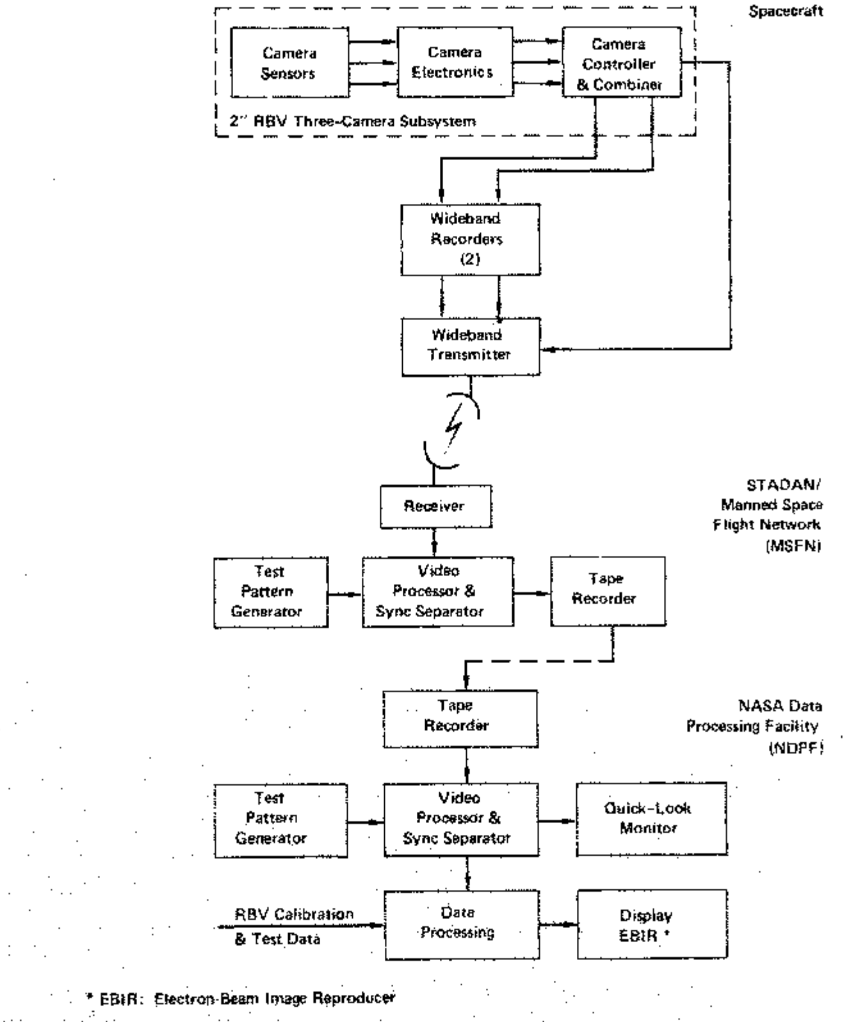
The camera controller and combiner performs two basic functions in the operation of the three-camera subsystem. First, it develops the timing for operation of the individual cameras as an integrated subsystem. Secondly, it assimilates the individual video outputs into a serial video output. It injects the required vertical and composite horizontal sync and the spacecraft time code into the data stream to generate the composite video output. In its interface with the spacecraft, the controller and combiner supplies the composite video output and receives the 1.6 MHz clock signal from the spacecraft for the timing and sequencing operations in the subsystem.

The composite video output from the controller and combiner is supplied to the spacecraft for storage on either of two wideband video tape recorders or for direct transmission via the wideband transmission link. From the spacecraft, the video output may be directly transmitted to the ground-based receiving sites or may be transmitted at a later time via readout from the tape recorders. Signals fed to the spacecraft from the controller and combiner indicate the appropriate times to operate the recorders. The recorders utilise multiple-head recording techniques and the data horizontal line rate is rephased to prevent data degradation caused by switching transients.

The transmitted signal from the satellite is received on the ground at either NASA STADAN or MSFN sites, where it is processed in a video processor and sync separator (VPASS) unit. This unit extracts information for storage in ground-based tape recorders.

The recorded tapes are then played back at NDPF into another VPASS unit, which extracts all necessary processing data. The extracted data includes both vertical and horizontal sync information, identification of the spectral channel being processed, indication of the presence of time-code information in the data stream, and signals for initiating automatic display.

During data processing, additional information (e.g., camera calibration and test data) can be entered so that an absolute measure of the radiometric and positional features of the image can be obtained.



RCA RBV 3-camera system and data processing system block diagram

Performance Characteristics:
Deflection & focus: Electromagnetic
Image size: 1 inch square (6.45 cm^2)
Lens f number: 2.8
Focal length: 126 mm
Field of view: 15.9 degrees
Resolution: 4,500 TV lines
Dynamic range: 30 to 1
Highlight brightness: Channels 1 and 2: 0.78 $\mu J/cm^2$. Channel 3: 1.2 $\mu J/cm^2$
Residual image: Less than 1%
Video bandwidth: 3.2 MHz
Exposure time: 8, 12, 16 milliseconds (selectable)
Three-camera cycle rate: 25 seconds
Frame time: 3.5 seconds
Peak signal/rms noise: 33 dB
Active horizontal scan lines: 4,125
Average subsystem power: 151 watts
Subsystem weight (excluding baseplate): 72 kg

DEVELOPMENT:

Development of the system began in the late 1960s and has been continued. RCA is known to have developed a larger (4½-inch/11.4 cm) Return Beam Vidicon camera system and a Laser Beam Image Reproducer for processing the data obtained from the improved system.

MANUFACTURER:

RCA, Government and Commercial Systems, Astro-Electronics Division, Princeton, New Jersey 08540, USA.

1869.173
RCA LASER BEAM IMAGE REPRODUCERS

DESCRIPTION:

The Laser Beam Image Reproducer (LBIR) equipment is a system which produces ultra-high quality film copies of television pictures, and as described here, has been developed over a period of more than seven years by RCA for the recording of data obtained from satellites equipped with the RCA Return-Beam Vidicon Camera System. The American ERTS (Earth Resources Technology Satellite) programme is an un-classified illustration of the kind of operations which may be undertaken with equipment of this kind and the implications for military use will be generally obvious.

Three generations of LBIR have been developed, the first having been introduced in 1969. This was capable of reproducing single-frame TV images with a resolution of 6,000 lines: the latest version is capable of more than 20,000 lines.

A pictorial diagram of the current LBIR is shown in Fig. 1. The basic imaging process consists of

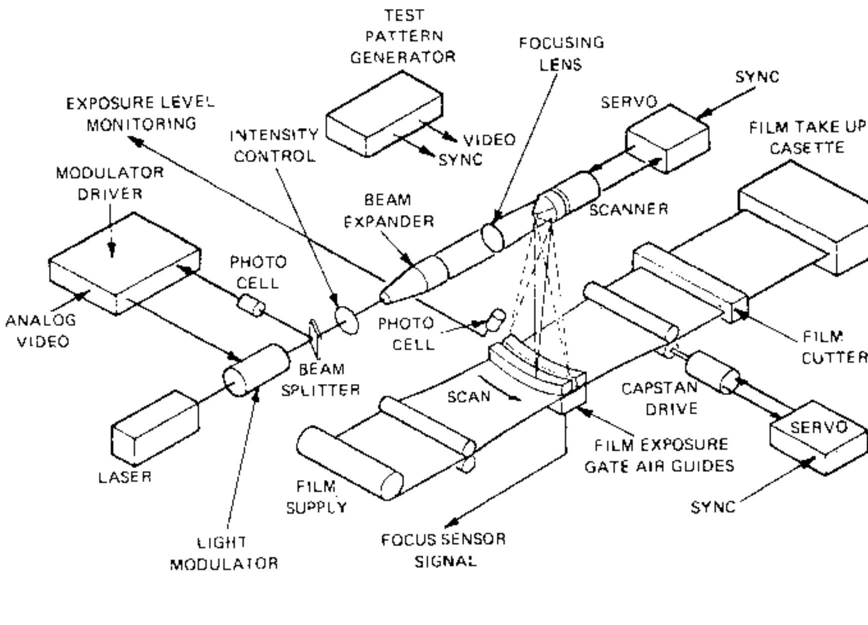


TABLE I – LBIR performance characteristics (2nd and 3rd generation comparison).

Characteristics	Previous LBIR	Present LBIR
Resolution:		
Pixels per scan	6,000	18,000
Corresponding cyles/mm	13.2	39.5
MTF (with film)	80% (Kodak RAR1496)	56% (Kodak 3414)
MTF (electro-optics only)	94%	75%
Grey scale:		
Dynamic range	100:1	250:1
Maximum film density	2.3 (Kodak RAR2496)	2.0 (Kodak 3414)
Video bandwidth	DC-5 MHz (−3 dB)	DC-10 MHz (−0.5 dB) DC-25 MHz (−3 dB)
Signal to noise ratio (electronics)	50 dB	50 dB
Horizontal blanking	10%	10%
Nominal line scan rate	1,250 lines per second	1,000 lines per second
Nominal scanner speed	18,750 r/min	15,000 r/min
Scanner sync jitter	100 ns p-p, < 10 Hz bandwidth	50 ns p-p, < 10 Hz bandwidth
Scanner	1-inch diameter, air bearings	1-inch diameter, air bearings
Number of facets	4	4
Line-to-line spacing	38 μm	12.7 μm
Line-to-line jitter	±10 μm	±0.3 μm
Transport speed range	25 to 100 mm/sec	1 to 100 mm/sec
Recording gate	Fixed curved platen	Air-guide curved platen
Film supply capacity	9½-inches wide by 125 feet (RAR 2496)	9½-inches wide by 250 feet (3414)
Laser power	12 mW *A* 632.8 nm	15 mW *A* 632.8 nm

scanning a finely focused, intensity modulated laser beam across the width of a continuous web of film. The 9½-inch (24 cm) wide film is shaped to a precise curvature by an air bearing exposure gate, and the beam is deflected across the film by a rotating four-sided pyramidal scanning mirror. The optics and scanning geometry are such that the phase-locked constant-speed scanner produces a linear scan rate, with perfect focus and uniform exposure, across the entire width of the film. Vertical scanning is accomplished by moving the film perpendicularly to the exposure scan line.

The performance characteristics of the improved (third generation) LBIR are compared to the previous design in Table I. The modifications and improvement which were implemented to achieve the higher resolution performance are described in the following paragraphs.

The major changes to the previous LBIR during the improvement programme were the substitution of a 25 MHz light modulation system in the place of the original 5 MHz system; the replacement of the scanner mirror with a new one of much higher quality; the addition of a precision air-guide film exposure gate with integral focus sensors; the modification of the film transport servo system to provide much finer line-to-line spacing control; and the use of a higher resolution film. In addition, the film transport and scanner mirror servo electronics were modified to operate at the scan rates commensurate with the higher resolution scan parameters, and the optical components were checked and critically aligned.

The major optical components in the LBIR are the beam expander, focusing lens, and scanner. These components determine the diffraction limited scanning spot size. The beam expander enlarges the modulated laser beam to completely fill the aperture of the focusing lens.

The scanner axis is coincident with the optical axis; each facet, therefore, intercepts 25% of the converging focused beam emerging from the lens, and deflects it radially (the facets are at 45° to the axis).

The rotation of the scanner causes the facet passing through the lower quadrant of the beam cross section to scan the film. All other beams are blocked so as not to expose the film. The optics are focused for diffraction limited performance, with the scanner facet being the limiting aperture.

The scanner shaft is actually the armature of the drive motor. It is supported entirely by air bearings (both journal and thrust) to provide vibration-free rotation (no ball-bearing noise). The scanner servo utilises optical tachometer feedback derived from the scanner mirror facets which are used for scanning. The scan synchronisation jitter is virtually unmeasurable on a line-to-line basis, and restricted to 50 ns peak-to-peak over a cycle period of more than a hundred scan lines.

The air-guide exposure gate provides a uniform cushion of air above and below the film as it shapes it to the precise curvature. The film is supported within the gate by the air bearing and does not touch any part of it. The depth of focus control thus achieved is at least five times better than the allowable depth of focus needed to maintain the MTF (Modulation Transfer Function) performance indicated in Table I. This is one of the most important modifications made in the LBIR for improving the high-resolution performance.

The lower half of the air-guide contains several photo diodes located in positions across its full width. A high-resolution bar target transparency is inserted in the air-guide during optical alignment, and an unmodulated beam is swept across it. Focus adjustment is made while monitoring the diode outputs. This technique results in optimum focus alignment since it is made during actual operating conditions (the scanner at nominal speed, and the air-guide shaping and supporting the film).

The film type used in the new LBIR, Kodak 3414, is a high-definition aerial film. The exposure sensitivity of 3414 is approximately ten times less than the Kodak RAR2496 originally used for the lower resolution recording. The laser power in the LBIR (15 mW at 632.8 nm) was more than adequate for the 2496 film but not sufficient to fully expose the 3414 film. This condition was corrected by eliminating the vertical aperture mask used to create merged scan lines in the lower resolution LBIR. This improved the optical efficiency enough to expose the 3414 film to densities in excess of 2.0.

DEVELOPMENT:

The LBIR was developed originally in 1967 to provide a means of recording the high-resolution imagery produced by the then newly developed RCA 2-inch RBV (Return Beam Vidicon) camera.

The objective of this original effort was to construct a machine which would reproduce the imagery in a 9 × 9 inch (23 × 23 cm) photographic transparency format with no significant degradation of image quality. The resultant prototype LBIR design provided 75% response (including film) at a resolution of 6,000 pixels per scan, had a grey scale dynamic range in excess of 100:1, and had excellent geometric fidelity.

A second-generation LBIR was developed in late 1968 to provide several basic improvements essential for field operational equipment; it provided additional image fidelity improvements as well. Several functions were automated, alignment stability was greatly improved, and a continuous film transport was added to provide operational mode versatility and rapid sequential frame capability. However, the basic image reproduction parameters, such as resolution and grey scale, were not significantly changed. This design satisfied the needs of the three-camera 2-inch RBV system being designed for the ERTS programme.

However, early in 1970, the need for a higher resolution image reproducer became evident. Sensors capable of providing up to four times the LBIR resolution (24,000 pixels per scan) were being investigated for advanced ERTS missions. As a result, RCA undertook a programme to upgrade the LBIR to a third-generation version which would be compatible with these very-high-resolution sensors.

MANUFACTURER:

RCA, Astro-Electronics Division, Princeton, New Jersey, USA.

1870.173

RCA LASER RADAR RECORDER

DESCRIPTION:

This equipment is a development of the Laser Beam Image Reproducer (Entry No **1869.173**) developed by RCA principally for the reproduction of satellite pictures. The Laser Radar Recorder (LRR) is based on the same principle as the LBIR but in this case the light intensity is modulated in accordance with the returns from an airborne side looking radar instead of television camera video signals.

The LSR was developed by RCA for the UPD-5 radar reconnaissance system to record the radar data on a photographic film strip 9 inches (23 cm) wide. The recorder can be used in the aircraft or at a ground station where it can receive the radar signals in real time, telemetered from the aircraft. The former procedure is adopted when the aircraft is operating beyond practical telemetry range, and in these instances the information is stored on the film and processed on return to base.

DEVELOPMENT:

Development was started in 1972 by RCA under a $1.4 million contract awarded by Westinghouse, the prime contractor to the USAF Aeronautical Systems Division for development of the UPD-5 radar.

MANUFACTURER:

RCA, Government and Commercial Systems, Moorestown, New Jersey, USA.

1880.353

FAIRCHILD PANORAMIC CAMERAS

DESCRIPTION:

The Fairchild Camera and Instrument Corporation produces a wide range of cameras for civil and military applications. The principal airborne panoramic reconnaissance models are described in the following paragraphs.

KA-60 PANORAMIC CAMERA

High performance 70 mm panoramic camera primarily used in high performance aircraft for low altitude reconnaissance photography.

Takes overlapping pictures covering the line of flight from horizon to horizon.

Provision is made in the camera for installation of a cathode ray tube or a solid state display which is used with a data annotation system to record pertinent information on each photographic frame.

Specifications:

Type: Reconnaissance, panoramic, rotary prism, vertical or forward oblique, low altitude

Lens: 3 inch (76 mm) f/2.8

Format: 30 cm with data block

Coverage: 40° longitudinal by 180° lateral scan
Film Capacity: 70 mm by 500 feet (152 m), thin base, or 70 mm by 250 feet (76 m), thick base, perforated Aerecon Plus X-EK 3401 or EK 8401
Cycle rate: Auto cycle: 1 to 12 cycles per second. Pulse: 1 second per cycle to 15 seconds per cycle (automatically switched from autocycle at 1 cps)
Overlap: 60 per cent maximum
Performance: (1) Maximum dynamic resolution: 60 lines/mm, high-contrast EK 8401 film. (2) Typical dynamic resolution: 40 lines/mm, high-contrast EK 8401 film
Weight: 19.5 kg

KA-82 PANORAMIC CAMERA

Intended for high quality photographic imagery over a wide range of tactical reconnaissance mission requirements.

Combines high resolution capability of stationary film type of panoramic camera with high reliability of continuously rotating elements.

Features automatic exposure control, forward motion compensation, data recording, manual focus adjustment, 12 or 56 per cent overlap.

Specifications:
Lens: 12 inch (304 mm) f/3.8
Format: 114 × 733 mm
Coverage: 21 degrees longitudinal by 140 degrees lateral scan
Film Capacity: 5 inches by 2,000 feet (12.7 cm × 609 m), thin base, perforated
Cycle Rate: 10.0 seconds per cycle to 1.17 cycles per second (56 per cent overlap); 20.0 to 1.71 seconds per cycle (12 per cent overlap)
Mode of Operation: Autocycle
Exposure Time: 1/30 to 1/12,000 second
Dynamic Resolution: 85 lines/mm to 115 lines/mm, high contrast, EK 3400 film
Weight (with film): 98 kg

KB-18 PANORAMIC STRIKE CAMERA

Provides a light-weight, compact aerial strike capability with low altitude panoramic photography. Fore-to-aft coverage of 180° along the line of flight, and a field angle of 41° throughout the scan.

Specifications:
Format: 9.40 × 2.25 inches (238 × 56 mm)
Mode of Operation Autocycle: 1, 2 or 4 cycles per second
Lens: 3 inch (76 mm), f/2.8
Relative Shutter Speeds: Approximately 1/100 sec to 1/4,000 sec within limits established by cycling rate and AEC
Dynamic Resolution: 60 lines/mm to 70 lines/mm, high contrast (EK 2401 film)
Film Capacity: 70 mm by 250 feet (76 m) (about 300 exposures)
Operating Altitude: 0 to 50,000 feet
Weight (with film): 17 kg

KA-77 PANORAMIC CAMERA

Provides a light-weight, compact, reconnaissance capability for low altitude panoramic photography. Operation in the forward oblique position provides 70 per cent overlap, normally without forward motion compensation. Operation in the vertical position provides horizon-to-horizon coverage with 60 per cent overlap (with forward motion compensation). Automatically records flight data.

Specifications:
Scan Angle: 180° lateral; 40° field view angle
Format: 114 × 462 mm
Mode of Operation:
Autocycle: 1 to 6 cycles per second
Pulse: 2 seconds per cycle minimum pulse
Exposure Control: Automatic shutter speed and lens aperture, AE120, 64, 80
Lens: 6 inch (152 mm), f/3.8
Dynamic Resolution: 40 lines/mm to 50 lines/mm, high contrast (8401 film)
Film Capacity: 5 inches by 500 feet (12.7 cm × 152 m) (standard base). 5 inches by 1,000 feet (12.7 cm × 305 m) (Estar thin base)
Weight (with film): 51 kg

F-415Y STILL PICTURE PANORAMIC CAMERA

Horizon to horizon daylight reconnaissance capability specifically for high-speed, low-flying aircraft.

Moving-film panoramic type, using a 3-inch (76 mm) f/2.8 lens with Automatic Exposure Control.

Supply spool stores up to 1,800 feet of film, providing a capability of over 2,000 exposures.

Specifications:
Scan Angle: 40° longitudinal by 180° lateral
Mode of Operation: Autocycle, 0.63 through 3.1 frames per second, continuous
Relative Shutter Speed: 1/120 through 1/6,000 second
Forward Motion Compensation: 0.189 through 0.93 radians per second
Film Format: 2.25 by 9.4 inches (56 × 238 mm)
Weight, Body and Magazine (with film): 24 kg

MANUFACTURER:

Fairchild Space and Defence Systems, 300 Robbins Lane, Syosett, Long Island, New York 11791, USA.

1881.353

F-639 MEDIUM/HIGH ALTITUDE MAPPING CAMERA

DESCRIPTION:

High-precision frame camera designed to provide highly accurate metric characteristics over the vehicle flight path.

System incorporates a cartographic camera with a 6-inch (152 mm) focal length f/5.6 Geocon I lens and a Fairchild Rapidyne shutter.

Data recording capabilities consist of a resettable exposure counter, 24-hour calendar clock and card for hand-written data, and fixed data consisting of lens, calibrated focal length, camera serial number, lens serial number. Recording of platen and lens cone temperature is provided by means of a binary data readout.

Four primary fiducials locate the principal point of the lens. Two secondary fiducials are recorded on the film at the first pinpoint of light and serve as a reference point for measuring film movement during exposure.

Specifications:
Lens: 6 inches (152 mm) f/5.6 Geocon I
Format: 228 × 228 mm
Film Capacity: 9½ inches × 700 feet (241 mm × 213 m) of thin base film
Mode of Operation: Autocycle, with 55 per cent or 10 per cent forward overlap
Resolution: 35 lines/mm AWAR on EK Type 3400 film, low contrast (2:1), 53 lines/mm high contrast
Distortion: Radial and tangential – 10 microns maximum
Platen Flatness: Within ±0.0001 inches
Weight (with film): Camera, magazine, film

MANUFACTURER:

Fairchild Space and Defence Systems, 300 Robbins Lane, Syosset, Long Island, New York 11791, USA.

1882.353

MINIPAN CAMERA AND MOUNT

DESCRIPTION:

The Minipan camera installation has been developed by Perkin-Elmer to provide target acquisition and strike data regardless of the roll attitude or manoeuvres of the aircraft following a strike. Essentially, the equipment consists of a 35 mm panoramic camera which is provided with a roll-stabilised mount and incorporated in a pod or other housing appropriate to the particular application.

STATUS:

About 200 Minipan cameras are being used on A-4 and Mirage aircraft of various air forces. The Royal Australian Navy has procured the equipment for identification of ships at sea. In this application, the Minipan is mounted in the aft engine door of an A-4 Skyhawk aircraft, and the camera scan – transverse to the line of flight – permits ship identification. The equipment is in use in the Netherlands for bomb trajectory evaluation and the US Army has acquired a small number for use in RPVs.

MANUFACTURER:

Perkin-Elmer Aerospace Division, 2855 Metropolitan Place, Pomona, California 91767, USA.

1883.353

PAVE SPIKE VIDEO FILM RECORDERS

DESCRIPTION:

This specially developed camera system produced by Perkin-Elmer can photograph either the televised video display or the radar image viewed by the observer in the rear cockpit of a Pave Spike-equipped F-4 Phantom aircraft. Operated manually or automatically, both modes synchronise the camera frame rate to the video or radar display, and a fully loaded magazine provides for slightly more than eight minutes of mission recording. The Pave Spike air-to-ground weapon delivery system is described in Entry No. **1533.311** in Section One of this edition.

The specifications included the following design requirements: (1) the optical design must allow direct film recording of the video display without obstructing the operator's view, (2) the unit must not interfere with the pilot's ejection envelope, be easy to install, and allow the film magazine to be loaded and unloaded without camera removal, and (3) the electronic design must synchronise camera operation to the 60 Hz field synchronisation signal available from the video display equipment and the automatic recorder during laser firing.

OPERATION:

The instrument can photograph the video display viewed by the observer in the aircraft and can record either manually or automatically. If the automatic mode is selected, the recorder operates at 10 frames per second whenever the Pave Spike System is performing the lasing function. In the manual mode, recording runs at 10 frames per second, independent of the lasing function. Both modes synchronise the camera frame rate with the video display field synchronisation, thus ensuring that a full frame is photographed under all circumstances. This eliminates the "rolling bar" effect present on systems not synchronised with the field synchronisation signal.

Approximately half the light rays from the video display (Figure 1) are reflected by a high efficiency

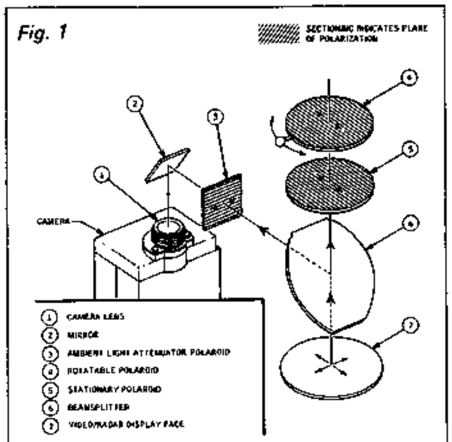


Fig. 1 Pave Spike Optical System

beamsplitter, transmitted through a polaroid filter, and then reflected off a mirror into the camera. The remaining half of the light rays pass through the beamsplitter and are then transmitted through two polaroid elements to the operator.

The amount of light reaching the operator is determined by the angle of polarization between the stationary polaroid element and the rotational polaroid element. This permits the operator to adjust the brightness of the display without affecting the exposure level on the film. The ambient light attenuator polaroid filter between the beamsplitter and the mirror prevents ambient light from reaching the film. The angle of polarisation of this filter is controlled by the stationary polaroid filter.

DEVELOPMENT:

In September of 1972, the US Air Force initiated an RFP (request for proposal) for an instrument to photograph the video display in reconnaissance equipment (Pave Spike System) installed in F4 aircraft.

The Aerospace Division of Perkin-Elmer was awarded a contract to design and build an engineering evaluation and test unit. The instrument was designed, fabricated, tested, and installed in the aircraft within 30 days after go-ahead.

MANUFACTURER:

Perkin-Elmer Aerospace Division, 2855 Metropolitan Place, Pomona, California 91767, USA.

SONAR AND UNDERWATER DETECTION EQUIPMENT

AUSTRALIA

1790.453
MULLOKA SONAR

DESCRIPTION:

Mulloka is the name given to a joint programme by the Royal Australian Navy and the Federal Department of Supply to develop a new sonar, needed because of performance limitations of American and British equipments in Australian waters, it is claimed. A pilot model has been developed and built by the Weapons Research Establishment at Salisbury, South Australia and this has been tested at sea by the RAN. The design of the new sonar has as a particular objective high performance in the detection of targets in the regions of the sea around Australia, and to this end studies have been made of the sound propagation properties of tropical and sub-tropical waters. The latest high-speed signal processing and computing techniques are applied in the new system, other advances being in the adoption of high-efficiency amplifiers, and a new (unspecified) method of driving the transducers.

DEVELOPMENT:

Both Australian and foreign companies participated in the production of the pilot model sonar, but it is planned that production engineering will be undertaken in Australia. This programme has links with the general increase in emphasis on ASW by the Australian Government, a related project being the Barra submarine detection system.

1791.453
PROJECT BARRA

DESCRIPTION

Under the title Project Barra, Australian industry and Australian Government Agencies are collaborating in the study and development of a new system of sonobuoys and the complementary airborne data processing system for the detection of submarines from both land-based and carrier-based maritime aircraft. It is anticipated that the system will be used by both the RAAF and the RAN. The Barra project is one result of several years of successful work under Project Nangana, which is a continuing research programme by the Department of Supply Weapons Research Establishment, Salisbury, South Australia. The latter programme is being pursued in close collaboration with the RAAF and RAN and is concerned with the development of improved methods of submarine detection. The UK MoD expressed an interest in Project Barra and there is some collaboration between the two countries.

In August 1973 the Australian Department of Supply let a $A200,000 contract to Amalgamated Wireless (Australasia) Ltd to act as prime contractor for engineering studies of the new system, this being the first involvement in the development phase on the part of Australian industry. In January 1974 AWA was awarded a second contract, worth $A2-million for project definition and initial development in Phase 2, this to be undertaken in co-operation with Commonwealth Aircraft Corporation, Plessey Communications Pty, and Cablemakers and Electronic Systems. The UK MoD also has given Marconic-Elliott Avionic Systems Ltd a contract for project definition and initial development of airborne system elements to complement the Australian activities.

CANADA

2038.453
AN/SQS-507 (HELEN) SONAR

DESCRIPTION:

The AN/SQS-507 Sonar is a variable depth sonar for detection, tracking and attack. It was designed for the Canadian ASW Hydrofoil Programme, but can be readily adapted to either a conventional speed variable depth sonar or a hull-mounted sonar. The hydrofoil was intended for an anti-submarine role in the open ocean using homing torpedoes with the AN/SQS-507 as the primary sensor. The weapons systems and sensor systems, including the AN/SQS-507 have the capability of being coupled into a central Action Data System.

The variable depth body is launched and recovered while the hydrofoil is hull-borne. For high-speed towing the body is left in the water while the ship is brought to foilborne speeds.

DEVELOPMENT:

Development of the system began in 1965 and the equipment after successfully passing its tests was handed over to the Canadian Forces in 1968. The design and manufacture was carried out by Westinghouse Canada Limited as a part of the systems contract for the Hydrofoil Fighting Equipment Package.

MANUFACTURERS:

Westinghouse Canada Limited, Electronic Systems Division, PO Box 510, Hamilton, Ontario Canada, L8N 3K2.

1792.453
AN/SQS-505 SONAR

DESCRIPTION.

The AN/SQS-505 is a medium size search and attack sonar which is presently in service with the Canadian Maritime Forces and will soon go into service with the Royal Netherlands Navy and the Belgian Navy. For ease of description the system can be examined in five basic groups:

(1) Transducer Subsystems
(2) Transmitter
(3) Receiver
(4) Control and Indicator Group, and
(5) Options

The basic electronics, items 2, 3 and 4, consist of nine cabinets, weighing 6200 lbs. and occupying 260 cu. ft. Average power requirements are 13 kW. The AN/SQS-505 features:

(1) Active omni-surveillance
(2) Independent Omni-passive Search
(3) Non-Interfering Surveillance Modes
(4) Off-tube Storage Displays
(5) Frequency Diversity
(6) Three Classification Techniques Modes
- Display of Target Doppler
- Separate Steerable Audio Channel
- Acoustic short pulse echo classification techniques (ASPECT)
(7) Computer Compatibility
(8) Two-way Computer Communication
(9) Computer aided tracking
(10) Single Sonar Operator
(11) Integrated Test Equipment
(12) On Line Monitoring of the Sonar Transmitter
(13) Overall Receiver Quick Test
(14) Solid-state Electronics
(15) Self-contained Cooling

Transducer Subsystem

The transducer assembly, weighing about 2270 kgs, consists of a cylindrical array of 36 staves, each containing ten single element transducers. It is mounted in one of the following four configurations:

(1) Hull-mounted with fixed dome
(2) Hull-mounted with retractable dome
(3) Hull-mounted with fixed dome and retractable transducer mechanism
(4) Variable Depth Towed Sonar (VDS)

The double walled stainless steel sonar dome, which is about 4.1 m long, 1.4 m wide, extends 1.7 m below the keel, and weighs with the transducer 3,266 kgs, is common to all hull-mounted configurations.

Two types of retracting mechanisms are available for the AN/SQS-505 sonar system. The one lifts the sonar dome vertically, whereas the other rotates the sonar dome up into the sea chest presenting a hard surface which is conformal to the ship's hull, thus reducing drag. A further advantage of the rotating type is that the actuating machinery is outside the sea chest and therefore isolated from the corrosive action of sea water. All sonar dome configurations have space available for an underwater telephone transducer.

The Variable Depth Towed Transducer subsystem consists of three main elements:

(1) The towed body which contains the transducer and the body heading reference
(2) The AN/SQA-502 hoist consisting of the winch, saddle, launch/recovery gear, operator's compartment and associated hydraulics
(3) Armoured tow cable with electrical conductors and fairings.

The towed body is a body of revolution approximately 5.5 m (18 ft) long and 1.8 m (6 ft) in diameter. All-up weight in air including transducer is 6,350 kg (14,000 lbs). The body has low hydrodynamic drag and is ballasted for deep towing of the transducer. A gyro compass mounted in the body provides body heading reference to the sonar equipment for display stabilization.

While towing, the bobbing action of the boom reduces the strain placed on the cable by the vertical motions of the ship in rough seas. A cable winder mechanism which is fitted to the winch removes the necessity for slip-rings and permits straight through connections of the electrical conductors. The tow cable is about 2.5 cm (1 inch) in diameter including a double layer of armour over the nearly one hundred conductors. Steel nosed fairings are fitted to the tow cable for drag reduction. For normal towing and body depth changes only one operator is required. Two are required during launch and recovery.

Transmitter

The transmitter cabinet contains 36 transmitter modules, one for each of the 36 transducer staves. Each module consists of a silicon controlled rectifier in a patented series/resonant circuit.

The operator can select three different modes of transmission:

(1) Omni-directional Transmission (ODT)
(2) Triple Rotational Directional Transmission (TRDT)
(3) Directional Transmission (DT)

Also selectable are the transmission frequency, transmitted pulse length and transmitted power. Built-in test equipment provides on-line monitoring of the transmitter output and permits semiautomatic fault location down to the level of the replaceable module.

Power Supply

A separate cabinet contains a transformer rectifier type of power supply which converts the ship's prime power to DC for operation of the sonar transmitter.

Matching and Tuning Unit

The matching and tuning unit provides matching of the transmitter and receiver systems into the transducer subsystems, either Hull-Mounted or VDS.

Receiver

Three cabinets house the receiver group's solid state electronics. Receiver coverage is 360° in azimuth, omni-directional out to a range of 2,930 km (32,000 yards). The receiver consists of seven subsystems:

(1) Preamplifiers/Beam Forming
(2) Fine Tracking Receiver
(3) Passive System
(4) Signal Conditioning
(5) Signal Processing
(6) Signal Combining
(7) Searchlight Audio

The Preamplifier/Beam Forming subsystem produces 36 pairs of split beams which are then conected to give thirty-six 10° beams covering the 360° azimuth.

Search Receiver

Omni-directional search is obtained by 36 channels each connected to one of the preformed beam outputs. After processing through subsystems 4, 5 and 6 these channels provide the inputs to the PPI, Range, and Doppler displays. During this processing an input is provided for the ship's log information to be fed into the ODN (Own Doppler Nullification) circuits. ODN compensation is +40 knots. Coverage for ∓40 knots of target doppler is provided in the signal processing by a bank of 16 matched filters per channel. After detection in the signal processing there are now 576 (16 × 36) channel outputs which must be presented in a form which can be monitored by a single operator. This is done in subsystem No. 6 by the use of OR-gates providing inputs for Range and Doppler, and PPI Displays

At target range the search receiver produces a 10° arc on the PPI corresponding to the 10° beam in which the target lies which gives the approximate target bearing. An experienced operator can further narrow the bearing to within 2° to 3° by examining and correlating the adjacent 10° sectors for a weak echo coming on the skirts of these beams. For fire control purposes the bearing must be further refined. This refinement is obtained from the Fine Tracking Receiver which is a searchlight channel which can be steered by electronic switches to the sector of interest. It connects the half-beam points of a particular beam from the Beam Forming Subsystem and uses the difference in time-of-arrival of the echo wave between these points to obtain an interpolation of bearing angle within the 10-degree beam. A threshold is preset for the amplitude of the echo above background noise to maintain a bearing accuracy of 1° rms. When used with a digital computer (Command and Control System) the Fine Tracking Receiver can be steered by the computer to provide accurate bearing information on as many as six targets at the same time with a single operator.

A steerable searchlight audio subsystem is connected by an electronic switch after the ODN stage enabling any channel to be selected by means of the cursor bearing control.

Two passive channels are provided, a Scanned Passive channel giving 360° surveillance, and a Steered Passive channel directed by means of the cursor bearing control to any of the thirty-six 10° beams.

All receiver systems operate simultaneously without mutual interference or loss of displayed information except when the 'ASPECT' mode is used.

Built-in test equipment is provided to measure Sonar self-noise level in individual receiver beams, to check performance semi-automatically of all receiver systems, and to permit fault location down to the replaceable printed circuit board or module.

Control and Indicator Group

The control and Indicator Group is made up of three sections.

The Generator Indicator, which forms the left-hand wing of the operator's console, contains timing function generation circuits for the sonar, the waveform generation circuits for the displays and the passive sonar display.

The Sonar Primary Indicator is located in the centre of the console, and contains the PPI Display and the 'A' Scan Range and Doppler Display. When a computer is used it provides the sonar/computer link. The ball tab and computer or target entry buttons allow the operator to insert information into the computer or fire control systems, while at the same time the digital PPI permits data from the computer to be superimposed on the raw sonar video. The cursor is multiplexed with the video and can therefore be present on the display at any time without interfering with the presentation of the sonar or computer produced information.

The right-hand wing of the console contains the Sonar Transmission Control. This unit generates the waveforms which drive the transmitter, and contains the controls necessary for selection of the various modes of operation.

Features of the Control and Indicator Group are:

(1) Stabilised PPI display, relative to North, with stern marker to aid in orientation.
(2) Choice of ship centered or offset PPI display to facilitate surveillance of a particular sector.
(3) Separate CRT for display of range and doppler information.
(4) Five-ping history A-Scan Range display. The use of an off-tube storage facility provides a continuous and unflickering display of the returns from the latest five consecutive transmissions, which then permits effective correlation for target detection and verification.
(5) Cursor controlled doppler display. Continuously updated omni-directional doppler information from the receiver is stored in an off-tube memory, but only the doppler information −230 to +230 metres on each side of the range cursors is displayed, thus automatically correlating the doppler information with the target being tracked by the operator.
(6) ASPECT display. The CRT normally used for the A-Scan Range and Doppler display is used to display ASPECT returns as an aid in classification and to provide more accurate target doppler information.
(7) Continuous Memory Passive Display. By the use of an off-tube storage facility, a continual presentation is given on a separate CRT of the latest 7.5 minutes of receiver output. This facilitates the detection of any persistent underwater noise source.
(8) Active/Steered Audio. An audio channel output may be steered in parallel with the range and bearing cursor to aid in target classification. Outputs are provided for loud speakers and head sets.
(9) Passive Audio. A passive audio output scans the 36 preformed beams once every four seconds. Outputs are provided for loud speakers and head sets.
(10) Digital Readouts for Range and Bearing. The cursor range and bearing settings are continuously displayed in digital form, aiding the operator with a quick visual reference.
(11) Display of Ship's Course and Speed. A continual digital readout is provided for own ship's course, and a dial indicator shows ship's speed.

Optional Equipment

Additional electronic systems components are available for training purposes and for ships equipped with computer aided command and control systems.

(1) A Sonar Remote Indicator, which can be installed in the operations room of the ship, displays sonar and other related tactical information which is received from the sonar primary indicator and the computer.
(2) A Sonar Auxiliary Unit, which normally is located in the sonar control room, houses the following units in its single cabinet:
  (a) A Sonar Signal Injector provides simulated active and passive target signals for training purposes.
  (b) An Analogue Data Recorder Reproducer allows signals entering the Control and Indicator Group to be recorded and reproduced later for test or training purposes. It can also provide background noise and reverberation for combination with simulated target signals from the Sonar Signal Injector.
  (c) A Digital Level Converter provides the interface between the computer and the sonar equipment.
  (d) An Electronic Marker Generator provides the symbols required for presentation on the Sonar Primary Indicator and Sonar Remote Indicator displays.

STATUS:

In service with the Canadian Maritime Forces. Scheduled for service in Royal Netherlands Navy and Belgian Navy.

MANUFACTURER:

Westinghouse Canada Limited, Electronic Systems Division, PO Box 510, Hamilton, Ontario, Canada, L8N 3K2.

1636.453

HS-1000 SERIES SONAR

DESCRIPTION:

The HS-1000 Series Sonar is a family of lightweight omni-directional anti-submarine sonars which have been designed and developed to give small naval vessels a modern lightweight sonar system having a significant search and attack capability.

The HS-1000 Series Sonar includes:

(1) HS-1001: Variable Depth Sonar (VDS) for ASW vessels down to 250 tons.
(2) HS-1002: Hull-Mounted (HM) sonar for ASW vessels down to 100 tons.
(3) HS-1001/2: VDS/HM Sonar with single electronics and transfer switch for ASW vessels down to 250 tons.
(4) HS 1003: VDS Sonar for ASW vessels down to 100 tons.
(5) HS-1002/3: HM/VDS Sonar with single electronics and transfer switch for ASW vessels down to 100 tons.
(6) HS-1007: Medium-sized VDS or HM Sonar of the HS-1000 Series which features higher power for ASW vessels down to 250 tons.
(7) HS-1007/7: VDS/HM Sonar with single electronics and transfer switch for ASW vessels down to 250 tons.

Note: The size of vessels quoted herein specifies the ASW role. However, the physical parameters of this family of sonars make them well suited for naval vessels which are multi-purpose or have ASW as a secondary role.

They provide a digital display of target range and bearing information for use with an anti-submarine weapon e.g. torpedo, missile, projectile, rocket, helicopter, etc. Where a computer or data system is also fitted, this target information may be entered in a digital or analogue form by depressing the target entry button.

Systems are available with either a hull mounted (HM) or variable depth towed (VDS) transducer subsystem. The hull mounted transducer subsystem can be supplied with either a fixed or retractable sonar dome. A single set of electronics can be installed on a ship fitted with both a hull mounted and VDS transducer subsystem. By the use of a transfer switch, the sonar operator can employ either of the transducer subsystems.

Hull Mounted (HM) Transducer Subsystem:

The sonar dome supplied with the HS-1000 series sonar uses an acoustic window of double-walled stainless steel construction. This is matched to the transmission frequency and is acoustically isolated from the ship. The HS-1000 series sonar system offers either a fixed sonar dome or for larger ships a retractable sonar dome. Either a vertical retracting mechanism or a rotating type of mechanism is available.

The rotating type of retracting mechanism has the advantage that in the retracted position it presents a surface which conforms to the ship's hull, thereby significantly reducing drag. Also, all actuators on the rotating type of retracting mechanism are inboard of the sea chest, thus eliminating the severe corrosion problem presented by contact with sea water.

Variable Depth Transducer (VDS) Subsystem:

The towed body used with the HS-1000 series sonar is a body of a new type. The acoustic window is fabricated from stretch formed stainless steel. The body contains both heading and depth sensor, and the transducer is easily removed for servicing.

The towing cable is approximately 2 cm in diameter and has 61 electrical conductors. Gapless type fairing reduces the overall drag on the ship to approximately 2,700 kg at a speed of 30 knots with 100 metres of cable out. The towing system, including the towed body, faired cable (330 ft or 100 m), winch, and launching gear is approximately 10,000 lbs (4,500 kg) and it occupies approximately 108 sq ft (10 sq metres) of deck space. The system bolts flush to the ship's deck and transom, and does not require any "cut-out" in the vessel's stern section. Normal launch and recovery speeds are eight to twelve knots in a sea state three. The maximum towing speed is about 36 knots.

Display:

The display which is digitally generated is presented on a 12 inch (30 cm) PPI. The range scales are selectable, and sound velocity correction is provided in 10 m per second steps from 1,400 metres per second to 1,550 metres per second. The display stabilisation can be selected to be either relative to true North or relative to ship's head. Digital range and bearing readouts are provided. The cursor is electronic, and is multiplexed with the video. This provides a cursor that is present at all times and can be moved at any time without disturbing the video presentation. Cursor control is effected by means of an R.O ball-tracker Target data outputs can be provided, if required, for interfacing with a fire control system. A target entry button is provided to make the data transfer.

Electronics Cabinet:

The electronics cabinet contains all the circuitry associated with sonar operation. The upper two drawers contain the receiver circuits. The centre drawer contains the display, operator's controls and transmitter control circuitry. Immediately below the display is the drawer containing the transmitter power output modules. The bottom drawer contains the power supplies for the electronics, and the energy storage system for the transmitter.

In the accompanying picture the Integrated Test Equipment (ITE) is shown mounted on top of the main electronics cabinet. The ITE unit is removable for locating it in the most convenient position in the sonar room. The ITE provides monitoring of the electronics power supplies, continuous check of the transmitter outputs, semi-automatic test of receivers and display, and the ITE self-check. The ITE permits the sonar equipment to be checked for performance and a fault to be detected and readily located to a replaceable module or printed circuit board with a minimum of skill and training for the operator. Also available to the operator is an overall quick check of the receivers and display. When the O/A Test switch on the control console is depressed signals are injected into the front end of the receivers at the preformed beams and if the receivers and display are functioning properly the appropriate pattern will appear on the PPI.

The Interface and Transfer unit houses the transfer switch used with the VDS/HM configuration. It also contains the tuning circuits to match the sonar electronics to the various cable lengths and transducers. Other circuits in this unit interface the sonar electronics to inputs such as ship's heading and ship's log and outputs such as fire control data. This arrangement not only offers flexibility in interfacing with various ship's systems but also isolates the sonar system from the ship.

Dimensions:

Main Cabinet: Width 25 in (63 cm). Depth 41 in (104 cm). Height 67 in (170 cm). Weight 905 lbs (411 kg).

Integrated Test Equipment: Width 25 in (63 cm). Depth 30 in (76 cm). Height 13 in (33 cm). Weight 89 lbs (40 kg).

Interface and Transfer Unit: Width 24 in (61 cm). Depth 10 in (VLT CM). Height 24 in (61 cm). Weight 69 lbs (31 kg).

HS-1007 Sonar:

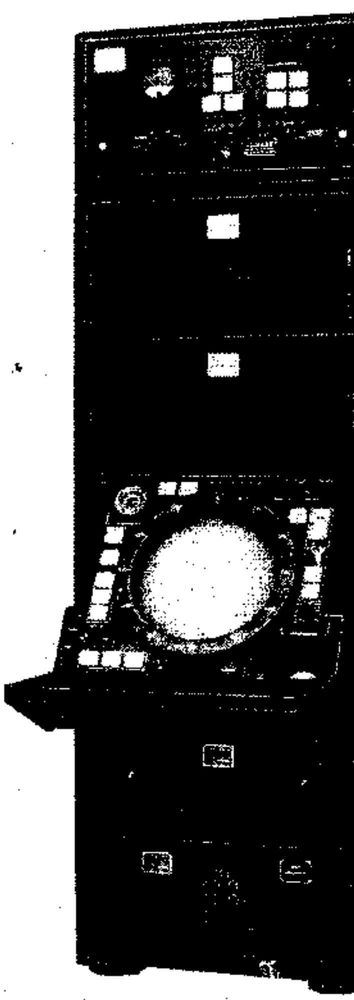
The HS-1007 is a medium sized sonar which utilizes the receivers, display, transducer, HM subsystem, and VDS subsystem of the HS-1000 Series. The transmitter and transmitter power supply are replaced with more powerful units so that four times (omnimode) and twenty times (TRDT mode) more sonar energy is transmitted into the medium. The electronics of the HS-1007 consists of three main cabinets, the receiver/display and control cabinet, the transmitter cabinet, and the transmitter power supply cabinet. The first cabinet has the same dimensions as previously but now weighs 700 lbs (318 kg). Dimensions of the later two cabinets are:

Transmitter: Width 25 in (63 cm). Depth 25 in (63 cm). Height 68 in (173 cm). Weight 850 lbs (386 kg).

Transmitter Power Supply: Width 25 in (63 cm). Depth 25 in (63 cm). Height 68 in (173 cm) Weight 1100 lbs (500 kg).

HS-1003 Sonar:

The HS-1003 Sonar has been introduced to provide small ships down to 100 tons with a VDS capability. The HS-1003 towing and handling equipment, including towed body and faired cable (200 m) weighs 5000 lbs (2270 kg) and occupies approximately 38 sq ft (3.5 sq metres) of deck area. The HS-1003 uses a 12 channel version of the HS-1000 Series electronics.



HS-1001/2 Display/Control console and electronics cabinet, with ITE at top

DEVELOPMENT:

Development of the HS-1000 series sonar commenced in June of 1970 as a jointly sponsored programme with contributions being made both by the company and the Canadian Government. The first prototype unit was completed in December of 1971. Sea trials of this first system were completed in the Autumn of 1972.

STATUS:

The HS-1000 series sonar is in current production and is on order for the West German Navy and one other, believed to be that of a Scandinavian nation. Deliveries had commenced in early 1972. Production is expected to continue into the 1980s. Both HS-1001/2 combined HM/VDS and HS-1001 VDS systems have been ordered.

MANUFACTURER:

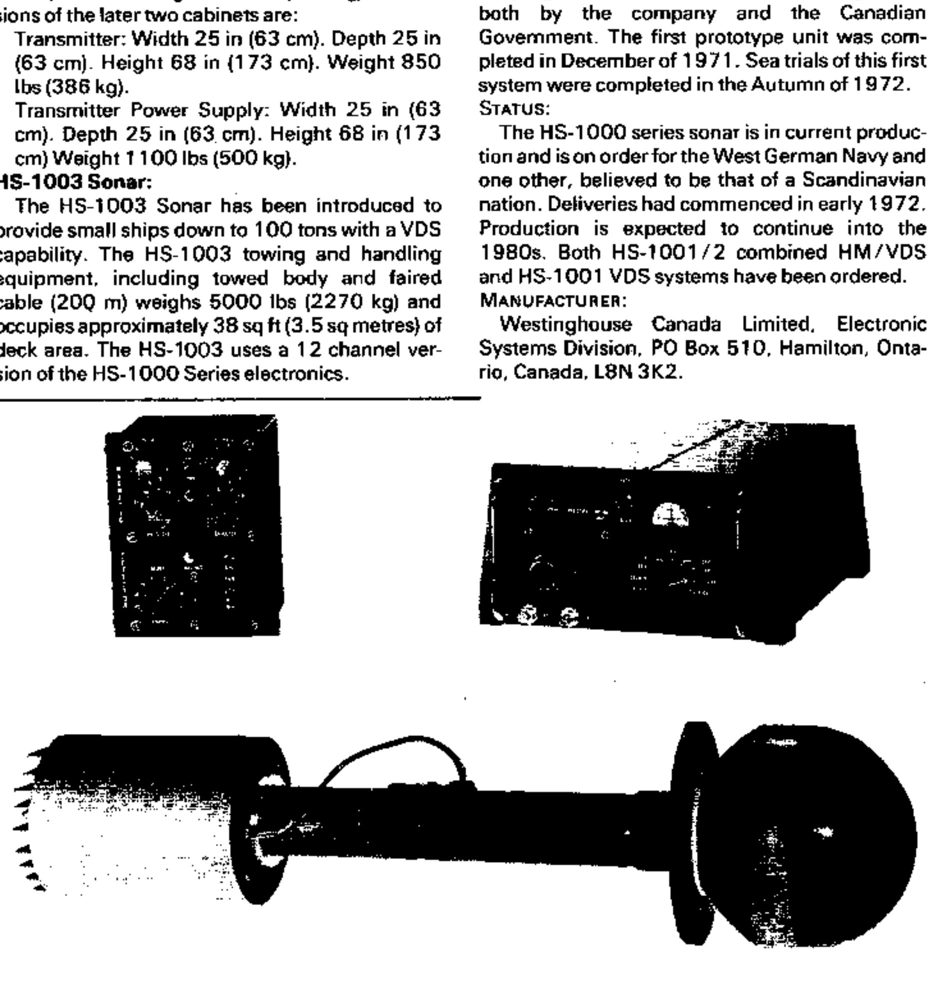
Westinghouse Canada Limited, Electronic Systems Division, PO Box 510, Hamilton, Ontario, Canada, L8N 3K2.

1386.353
ASQ-501 MAGNETIC ANOMALY DETECTOR

DESCRIPTION:

The AN/ASQ-501 Magnetic Anomaly Detector (MAD) is a sensitive magnetometer system developed for airborne submarine detection roles. A basic sensitivity of 0.01 gamma is claimed for this equipment, which has a total system weight of 15.88 kg.

In place of the multiple cell detection method more generally adopted, the ASQ-501 employs a single oriented caesium cell as the principal element. It is an optically pumped system, but the unwanted rotational or heading error effects which are normally minimised by the multi-cell technique, are counteracted in the ASQ-501 by orienting the single caesium cell on a mechanical



CAE electronics AN/ASQ-501 magnetic anomaly detector equipment

gimbal system. This, combined with an inherently stable self-oscillator caesium sensor loop and a low-noise, infinite dynamic range, frequency-to voltage converter, is claimed to yield the most sensitive airborne magnetometer available.
Sensitivity: 0.01 gamma (10.7 Oersteds)
Detecting Head Figure of Merit: 0.24 gamma
Detector: Single oriented caesium cell, optically-pumped self oscillator
Operating Range: 0.20 to 0.70 Oersteds
Larmour Output (Total Field): 27.984 Hz/gamma
Analogue Output No. 1 (Minimally Filtered): 105 mV/gamma
Analogue Output No. 2: 15.0V p-p fsd
FSD Sensitivities: 40, 20, 10, 4, 2, 1, 0, 0.4, 0.2 gamma
HP Filter: 0.04, 0.06, 0.1, 0.15, 0.3 Hz
LP Filter: 0.4, 0.8, 1.2, 1.6 Hz
Military Specifications Compliance: Satisfies MIL-E-5400
Operating Temperature Range: −54°C to +71°C
Storage Temperature Range: −62°C to +85°C
Power requirements: 115 Vac 400 Hz, 3 ph, 120 VA 28 V(ac or dc), 10 VA for Panel Lamps only
Specified reliability: MTBF 1000 Hours

DEVELOPMENT:
The oriented single-cell technique was developed by the Canadian National Aeronautical Establishment. Early models were first flown in 1968, and in 1970 a development model began operational evaluation tests in a Canadian Forces' CHSS 2 helicopter.

STATUS:
Service Test models have been delivered and successfully evaluated by the Royal Navy for use on the RN WG-13, Lynx helicopter. Successful evaluation has also been completed by the RAF on the Nimrod, and by the Canadian Forces on the National Aeronautical Establishment MAD aircraft, with a view to application on the projected Canadian Long Range Patrol Aircraft.

MANUFACTURER:
CAE Electronics Ltd, PO Box 1800, St Laurent, Montreal, 379 PQ, Canada.

1388.393
ASA-65 9-TERM COMPENSATOR

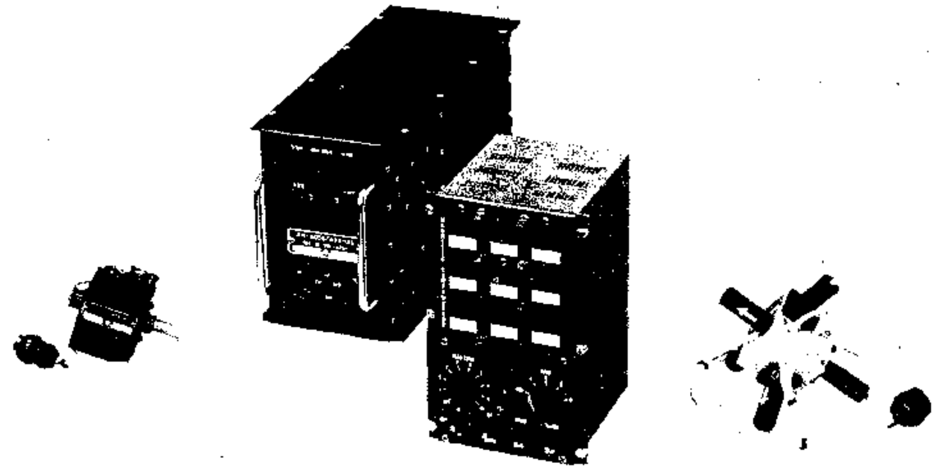
DESCRIPTION
The ASA-65 is an advanced compensator which was developed to eliminate interference from all permanent, induced and eddy-current field sources.

Before the development of the ASA-65, induced and eddy-current fields were compensated for by the design of fixed permalloy strip configurations mounted near the MAD detector, and by fixed coils also installed close to the detector. The strips and coils were designed to create equal and opposite induced and eddy-current fields to those generated by the aircraft. These fixed compensators require custom design for each aircraft type, involving lengthy experimental flying, and do not cater for changes in induced and eddy-current sources during the life of the aircraft. Also they require close tolerance hardware to be installed close to the MAD detector, normally in the non-magnetic MAD boom. Furthermore, fixed compensation systems are not capable of providing adequate compensation levels for new, more sensitive, MAD systems. The ASA-65 has the following advantages:

The CAE 9 Term Compensator (AN/ASA-65) provides automatic compensation for aircraft-generated manoeuvre interference signals.

By minimizing unwanted interference signals, it substantially improves MAD detection range, especially during tactical and turbulent flight conditions.

This equipment compensates all significant permanent, induced and eddy-current interference fields in approximately 30 to 45 minutes. Permanent terms can be trimmed up on each flight in about five minutes, compared to close to one hour for manual compensation systems.



ASA-65 9-Term Compensator for MAD equipment

The automatic nature of the ASA-65 together with simple operating procedures, eliminates the requirements for specialized operator training. Comprehensive tests have shown that experience is not a necessity in achieving satisfactory compensation levels.

The ASA-65 is compatible with all existing magnetometer systems in present use. Accommodation for the varying compensation requirements of different aircraft type is conveniently accomplished by means of internal patch connectors.

The equipment is designed to satisfy the requirements of applicable military specifications, and using state-of-the-art techniques has a demonstrated M.T.B.F. of more than 1,000 hours. The use of completely solid-state circuitry has resulted in a total system weight of less than 13.6 kg.

The compensation figure of merit is stated to be consistently less than one gamma, and the equipment is capable of accommodating maximum compensation fields of 50 gamma on each of the aircraft axes.

STATUS:
Production quantities have been manufactured and delivered to the RAF for the HS.801 Nimrod maritime aircraft, and the ASA-65 is also being delivered for USN P-3C Orion aircraft and S-3A Viking.

MANUFACTURER:
CAE Electronics Ltd, PO Box 1800, St Laurent, Montreal 379, PQ, Canada.

FRANCE

1786.453
PAP 104 MINE DISPOSAL WEAPON

DESCRIPTION:
The PAP 104 system has been developed as a means of remotely placing a mine disposal charge alongside a mine which has previously been located by means of a mine-hunting sonar. It consists basically of four main parts, a wire-guided submersible vehicle which carries the destruction charge and is equipped with a TV camera, a control console, TV monitor and remote control box, the last three items being located on the carrier vessel. Overall dimensions of the submersible are: length 2.7 m, width 1.2 m, height 1.3 m, and weight 700 kg (inclusive of explosive charge). Operating range is 500 metres at depths of 300 m or less, and battery life is two hours at 3 knots. The maximum speed is 5.5 knots.

DEVELOPMENT:
Development of the PAP system was carried out by Direction Technique des Constructions Navales, Groupe d'Etudes Sous-Marines de l'Atlantique in collaboration with Société Eca.

STATUS:
In service with the French Navy. The Navies of Belgium, Britain, West Germany and the Netherlands have decided to equip their mine sweepers and contracts have been placed by Belgium and Holland, with the other two nations expected to conclude negotiations soon.

MANUFACTURER:
ECA, Société Etudes et Constructions Aeronautiques, 17 Avenue du Chateau, BP 16, 92190-Meudon, France.

1159.253
DUBV-23D SURFACE VESSEL SONAR

DESCRIPTION:
The DUBV-23D is a bow-mounted, low-frequency, panoramic sonar for anti-submarine operations. The 48-column transducer array is housed in a bulb at the forepart of the ship, the bulb being of streamlined design to reduce parasitic noises to permit listening at high speeds. The panoramic sonar is intended for both search and attack roles.

In addition to the transducer array, the equipment includes the transmitter/receiver unit, a computer section for the processing of data being fed to weapons, and control and display consoles at the anti-submarine attack station.

The DUBV-23 is of identical design to the towed sonar, DUBV-43, described in Entry No. **1334.253**, and in French vessels the two sonars are used together for anti-submarine warfare.

OPERATION:
Operating modes provide for: panoramic surveillance, sector surveillance, step surveillance, passive surveillance at sonar frequency, panoramic attack transmission, or 'search-light' attack transmission. In addition to the system's own display devices, the DUBV 23D provides for target data outputs to other ship's systems and repeater PPIs.

The following notes refer to combined use of the DUBV-23 and DUBV-43 sonars. Advantages claimed for this method are:

(1) The attack and target data processing section of the DUBV-23 can be connected to the towed sonar by remote control, which provides for control of weapons by the sonar giving best results.

(2) The simultaneous use of a hull transducer and a towed transducer, whose depth can be selected within the limits of 10 to about 200 metres, considerably increases the sound volume and correspondingly limits the chances of attack

by conventional submarines.

(3) The use of a towed transducer array offers a significant measure of protection against performance degradation due to sea-state effects.

(4) It is possible to attack a target whilst continuing surveillance.

(5) Deep submersion of the DUBV-43 sonar permits a doubling of transmitter power, with an appropriate increase in detection range.

Four modes of operation are possible:

INDEPENDENT: The two sonars are completely independent except for reciprocal connections for audio and video sensitivity control during transmission. This mode is normally employed only when one sonar is defective.

23SYN: In this mode the transmissions of the two sonars are synchronised, using the same or different frequencies, with the DUBV-23 as the master. The hull sonar is for attack, and the towed sonar for surveillance.

43 SYN: This mode is identical to the preceding mode, but with the towed sonar as master.

43 ATT: This mode is divided into two phases: The first, Delayed 43 ATT, is a preparatory stage for effecting certain remote switching operations, and the second, Standby 43 ATT, permits processing of data from the towed sonar and its transmission to the weapons via the Attack section of the DUBV-23 sonar. In this mode the attack section of the DUBV-23 and the DUBV-43 must use the same frequency. However, the surveillance section of the DUBV-23 can, if necessary, be operated on a frequency different from that assigned to the DUBV-43.

CHARACTERISTICS:

Transmitter:

Frequencies: 4 operating frequencies in the neighbourhood of 5kHz, of which two are operational

Power: 96 kW (2 × 8 kW)

Type: FF (fixed frequency), FM (linear frequency modulation with non-coherent data processing at reception)

Duration: 4, 30, 150 or 700 ms

Scatter echo: With or without rejection

Doppler effect correction: On all 48 channels

Cadence: Adjustable step by step from 1,500 to 48,000 yards

Receiver: Panoramic, directional, passive listening in sonar band

STATUS:

Quantity production. The equipment is in service with the French Forces.

MANUFACTURER:

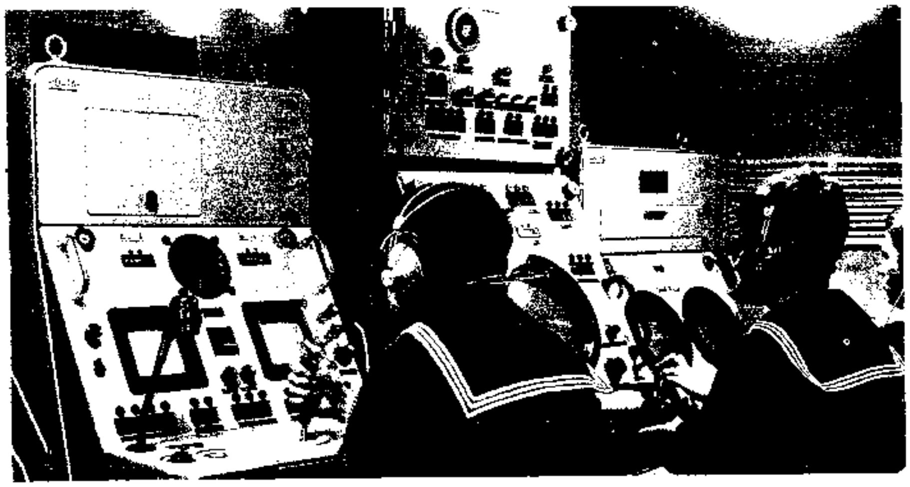
CIT-ALCATEL, Division Marine, 33 rue Emériau, 75725 Paris Cédex 15, France.

1334.453
DUBV-43B VARIABLE DEPTH SONAR

DESCRIPTION:

The DUBV-43B variable depth sonar consists of a streamlined towed body called the 'fish', containing the sonar transducer array. This is towed from the rear of the parent vessel at distances of up to 250 metres and can be set to run at depths between 10 and 200 metres. It is equipped with stabilisers providing for control in roll, pitch and depth. An attack version of the system is also provided with a gyro-compass. Dimensions of the 'fish' are: length 550 cms, width 170 cms, and submerged weight 7.75 tonnes. The towing cable also incorporates 48 pairs of signal conductors. The range of towing speeds is 4 to 24 knots, and detection ranges of up to 25 km are quoted. The DUBV-43B is identical to the DUBV-24C sonar (Entry No. **1217.253**) except for the transducer array, which in the DUBV-24C is in a hull-mounted sonar dome, while the DUBV-43B array is towed. The increased operating depth of the latter permits an increase in radiated power to 96 kW.

The transducer array is 1 metre in diameter and 1.2 metres high. It consists of 24 vertical 'staves' of 8 transducers to give a total of 192 elements.



The DUBV-43 Sonar Control Console

STATUS:

The DUBV-43 is in service with six recently converted anti-submarine escorts (Types T47 and T56) of the French Navy and is to be fitted to the Type C67A series of corvettes.

MANUFACTURERS:

Direction Technique des Constructions Navales, 2 rue Royale, Paris 8, France.

CIT-ALCATEL, Division Marine, 33 rue Emériau, 75725 Paris Cédex 15, France.

1162.453
DUUX-2 A/B/C PASSIVE SONAR

DESCRIPTION:

The DUUX-2 is a passive listening device for submarine noises. It enables a submerged submarine to determine, on the basis of signals received by either base (port and starboard) the bearing and range of a submerged noise source (Surface vessel or other submarine) while maintaining complete secrecy.

There are three versions, details of which appeared in the 1970-71 Jane's Weapon Systems.

STATUS:

Version A: Quantity production.

Version B and C: Preliminary production. Version A is in service with the French Forces. Version B is to be adopted by French Forces, and Version C is to be adopted by German Forces.

MANUFACTURER:

CIT-ALCATEL, Division Marine, 33 rue Emériau, 75725 Paris Cédex 15, France.

1356.453
THOMSON-CSF PASSIVE SONAR

DESCRIPTION:

This is a recent development by the Thomson-CSF company and no official designation and few details have so far been obtained. It is intended for use in submarines of most sizes to provide for the detection and location of surface anti-submarine vessels. It may also be used in conjunction with an active sonar, or a microphone array, and there is provision for integration in an action information and torpedo fire control system. Digital techniques are employed. No further details can yet be revealed.

MANUFACTURER:

Thomson-CSF, France.

1217.253
SONAR DUBV-24C

DESCRIPTION.

The DUBV-24C is a low frequency, preformed channel panoramic sonar designed for search and attack. According to the ASW weapons systems carried on board, the DUBV-24C sonar can be used either alone or in combination with a searchlight attack sonar, or with a passive sonar. It can operate on four different frequencies.

A novel feature of the DUBV-24C is its use of "preformed beams". In conventional sonar systems, the hydrophones are scanned at a rate prohibiting complete echo signal reception, the receiver input being collected by sampling from each transducer by a continuously rotating switch. This sampling process greatly reduces the recognition differential which is proportional to echo length. In the DUBV-24C sonar, the signals originating from the staves of the transducer are electronically formed in beams, and these channels are then processed for maximum improvement of the signal-to-noise ratio. For the same purpose, switching takes place after detection.

To give a simple analogy, this technique is equivalent to providing an all-round watch by using a large number of observers, each watching a sector, instead of having a single observer slowly scanning the complete horizon. The "preformed beams" technology gives the DUBV 24C sonar a very high figure of merit, as compared with other types of sonar systems. The data displayed on the cathode ray tubes and checked by the operator are fed to a computer which transmits processed co-ordinates to the ASW fire control system.

The DUBV-24C SONAR includes:

An ultrasonic transducer protected by a dome which is attached under the hull by hinges parallel to the roll axis of the ship; the transducer drum has 24 vertical staves, with 8 elements in each stave.

A transmitter-receiver which handles the elaborate signal processing of the sonar. this equipment is contained in several cabinets due to its multiple functions and to the large number of channels processed, it is normally located below decks, close to the sonar dome. Signal processing circuits are fully transistorised. This assembly includes a special-purpose computer to provide processed data for the ASW fire control equipment.

Display and control units located in the ASW control room and on the bridge.

Test and training facilities.

The DUBV-24C sonar allows several modes of operation for search or attack, according to bathythermal and tactical conditions.

There are 4 search and 2 attack procedures

1. **Omnidirectional transmission / reception (search).**
   Used particularly in limited range bathythermal conditions. Audio-reception in six sectors
2. **Triple beam (three-ping) transmission/ re-**

ception (search).
Used in long range bathythermal conditions.
Transmission with a triple rotating beam (three searchlight beams).
Omnidirectional reception.
Audio-reception also possible.

3. **Stopped triple-beam transmission/reception (search).**
Similar to the three-ping mode, but with automatic beam stepping.
Audio-reception also possible.

4. **Searchlight attack transmission/reception (attack).**
Simultaneous transmission on three beams at 120° interval.
Bearing controlled by operator.
Accurate bearing and range read on a Target Area bearing deviation Indicator Approximate doppler on an Analyser Indicator scope.

5. **Omnidirectional attack transmission/reception (attack)**
This operating mode allows accurate determination of a rapidly moving target, particularly at close range.
Transmission similar to that used in the omnidirectional t/r mode.
Reception as in directional attack t/r (bearing deviation indicator).
Audio-reception and plotting on a range recorder fed with the audio-signal.

6. **Passive listening (search)**
No transmitting.
All-round reception with automatic sensitivity adjustment according to the average noise in all directions.

DUBV-24C Characteristics:

Transmitter:
Frequencies: 4 operating frequencies in the neighbourhood of 5 kHz, of which two are operational
Power: 48 kW (2 × 24 kW)
Type: FF (fixed frequency) and FM (linear frequency modulation with non-coherent data processing at reception)
Duration: 5, 30, 150, 94 700 ms
Cadence: Adjustable without detection from 3,000 to 48,000 yards (9 scales)
Scatter echo: With or without rejection
Doppler effect correction: On all 24 channels
Receiver: Panoramic, Directional, Passive monitoring in sonar band

MANUFACTURER:
CIT-ALCATEL, Division Marine, 33 rue Emériau, 75725 Paris Cédex 15, France.

1633.253
PASCAL SONAR

DESCRIPTION:
The Pascal Sonar is intended for use on small and medium-tonnage vessels for both surveillance and tracking functions. There are two versions, a hull-mounted type, and a combined hull/towed model. There are three components to the system: a panoramic transducer array of 24 columns, transmitter console, and receiver display console.
Visual presentation of data provisions include a PPI scanning display, a range-plotting interval display on an enlarged screen, and estimated target vector display by 'hodograph' tube. Acoustic data presentation arrangements allow for either headphone or loudspeaker listening. Target data outputs are available for transmission to other ships systems.
Operational modes include (1) passive surveillance on a plotted channel in a ± 500 Hz band in the region of a display frequency between 2.5 and 15 kHz; (2) panoramic preformed channel data processing with doppler, filtering, and detection, integrated on all 24 channels; and (3) coherent data processing in FM mode on plotted channel. There is also a training mode.

Pascal Characteristics:
Transmitter:
Operating frequencies: 10 and 11.5 kHz
Power 5 kW, duration: 25 and 100 ms
Transmission mode: TFF and TFF in FF and TFF in FM
Repeat cadence: 4-8-16 or 32 s

Receiver:
Pass band: ± 200 Hz in the neighbourhood of 10 or 11.5 kHz after Doppler correction
Range scale: 3, 6, 12, 24 km
Channel or column noise measurement accuracy: ± 1 db. measurement of radical component by automatic extraction to ± 2 N.
Determination of oscillation in range and azimuth.
Automatic testing by injection of calibrated echoes

STATUS:
At prototype stage in mid-1972.

MANUFACTURER:
CIT-ALCATEL Division Marine, 33 rue Emériau, 75725 Paris Cédex 15, France.

1634.453
DUUA-2A SONAR

DESCRIPTION:
The DUUA-2A sonar is fitted to modernised Daphne class submarines and a number of "1200-tonnes" submarines, and provides for simultaneous surveillance and attack. It can be used,
(1) for active detection in single, (FP) or frequency modulation (FM) modes,
(2) for passive detection,
(3) as an interceptor, ie location of a sonar source.
The DUUA-2A may also be used for ultrasonic communications purposes and for depth sounding in very deep water.

DUUA-2A Characteristics:
Transmitter: Frequency 8.4 kHz
Power: 30 kW in normal operation, and in 1.5 kW in reduced operation, SGF and IC;
Each emission is manually triggered;
Emission duration 30 ms in SFG; 300 ms in FP; 500 ms in FM
Receiver:
Pass band: ± 170 Hz in FP, ± 350 Hz in FM in the neighbourhood of 8.4 kHz, and ± 500 Hz in EBM in the neighbourhood of a selected frequency between 2.5 and 15 kHz
Range scale in active mode: 3, 6, 12 and 24 km
Transducer: Directional, made of 8 88T 8.5 elements, driven by servo mechanism MSS 5 directivity or site and bearing $2\ \theta_3 = 10°$ at 8.5 kHz. Manual orientation by crank on azimuth or automatic orientation at 4 or 8°/s from −175 to +175° on bearing. Reset between stops at 60°/s. Site positioning from +15° to −30°

STATUS
In production.

MANUFACTURERS:
The transducer assembly is provided by the French Navy.
The transmitter console is produced by Thomson C.S.F.
The remainder of the system is produced by CIT-ALCATEL.

1631.353
HS-71/DUAV-4 HELICOPTER SONAR

DESCRIPTION:
The HS-71 is an active/passive sonar designed for submarine surveillance and location (azimuth, distance and radial speed). It is specially designed for use on board light, versatile, ship-based helicopters of which the WG13 Lynx is a typical example.
The HS-71 differs from conventional sonar in its signal processing system which is designed to give improved detection, especially in severe reverberation conditions such as shallow waters. The sonar can be operated in either the active or passive mode, true bearing, range and radial speed are measured in the former mode, true bearing only in the passive mode.
A combined display unit permits surveillance display (initial detection) or plotting display (precise azimuth determination). Total weight (including electronic rack, winch, cable and dome) −250 kg.

STATUS:
The HS-71 is used by the French Navy under the designation DUAV-4. In series production.

MANUFACTURER:
CIT-ALCATEL, Division Marine, 33 rue Emériau, 75725 Paris Céder 15, France.

1067.453
SONOBUOYS TYPES DSTA3 AND DSTV 2K

DESCRIPTION:
Two types of sonar buoys, DSTA 3 and DSTV 2K, which are dropped from aircraft and used for anti-submarine warfare.
This transistorized equipment has successfully undergone all tests required by the specifications of the French Navy. It is also used by the French Navy Air Force.
The DSTA 3 is an "active" type buoy, which uses a miniaturized active sonar unit for the detection and pinpointing of submarine targets. The position is determined with respect to the buoy. Doppler effect is also exploited to determine the approximate speed of the target. The system also includes:
(1) A UHF telecontrol receiver with several channels, which makes it possible to position the sonar transmitter to "On" or "Off" from the drop aircraft.
(2) A sonar transmitter that sends electric pulses to the hydrophone.
(3) A VHF transmitter which relays the data to the aircraft.
The electric unit is supplied by two cells activated by sea water.
A brake parachute slows the fall and stabilizes the buoy. Impact with the water begins a sequence which quickly sets the buoy into operational condition.
Dimensions: height 1.50 m, diameter 15 cm; weight 25 kg.
The DSTV 2K is a "passive" buoy. It detects submarine noises which it then transmits via radio to the aircraft or to any listening stations equipped with a suitable receiver. It is made up of the following:
(1) A low frequency amplifier that amplifies the signals received by the hydrophone.
(2) A VHF frequency modulation transmitter for transmitting the signals to the aircraft.
(3) A supply system comprising cells that can be started by sea water.
For greater efficiency, the DSTA 3 can be used with the airborne signal processing equipment, DSAA-4 (Entry **1632.253**, below).

MANUFACTURER:
CIT-ALCATEL, Division Marine, 33 rue Emériau, 75725 Paris Cédex 15, France.

1632.253
ACTIVE BUOY SYSTEM TYPE DSAA-4

DESCRIPTION:

The DSAA-4 system provides for accurate location of a submarine and determination of target components (course speed), and is used in connection with DSTA 3 active buoys and DSTV 2 satellite buoys. The use of coherent signal processing is intended to improve performance in terms of action radius and accuracy of detection, particularly in a reverberant medium (shallow waters). The system permits simultaneous processing of 2 buoys. Sonar signals, displayed on an oscilloscope, are copied and processed by a special calculator feeding the data to a tactical plotter board or display console. The use of DSTV 2 satellite buoys (passive) in combination with DSTA 3 master buoys (active) substantially reduces the cost-efficiency ratio, while providing the system with optimum tactical flexibility during tracking.

The DSAA-4 is intended for ASW patrol-boats and helicopters, and two versions are available for light helicopters:

A) Radio relay buoy-carrying light helicopter: Signal and data processing equipment on board the destroyer.
B) Independent helicopter with integrated data processing. The system is supplemented by a calculator which facilitates the work of the operator and which (a) ensures the initial collection of sonar data to start automatic tracking, and (b) ensures operation of synthetic plotting and attack command. For this purpose, the operator is provided with a single combined plot/sonar console.

STATUS:

In series production.

MANUFACTURER:

CIT-ALCATEL, Division Marine, 33 rue Emériau, 75725 Paris Cédex 15, France.

1719.263
SONAR COVERAGE COMPUTER

DESCRIPTION:

This sonar coverage computer produced by CIT-ALCATEL displays on a CRT the sound beam transmitted by one or two acoustic sources into a medium of given sound velocity profile and bottom depth. The beam pattern which is provided makes it possible to estimate the sonar coverage as a function of the sources' characteristics (depth and beam-width). The sound velocity profile is introduced by manual setting of velocity/depth data that are selected from the available BTs. The equipment includes in two units: (1) a specialized digital computer, and (2) a display (CRT) and control unit.

The electronic computers consist of TTL integrated circuits that ensure high reliability, and avoid the need for adjustment.

The sonar coverage computer is used to aid the solution of various detection, location and classification problems.

On board surface ships it provides information for optimum use of hull-mounted and variable depth sonars, and on board submarines it gives quick visualization of the shadow zones and sonar radiated areas.

In ASW aircraft it can be used to determine the optimum positioning (depth and range) of the available acoustic detection equipments such as sonars or sonobuoys.

The sonar coverage computer may also be of great help in ASW training centres and in laboratories dealing with the design of equipments that exploit or have to face the various problems related to the propagation of sound in the sea.

OPERATION:

Sound Velocity profile:

The profile is approximately a sequence of constant gradients layers, i.e. a sequence of linear segments. The introduced data are the sound speed and depth values at each selected angular point at the junction of two consecutive segments. The data setting is extremely flexible: the values can be changed at any moment and in any order, there are no fixed, predetermined values of sound speed or gradient, and the number of points chosen to determine the profile may take any value between 2 and 12. The only limitation to the data setting is that values leading to gradients greater than 5 m/s/m, in absolute value, should be avoided. In fact, such values are not encountered in the sea.

The sea bottom is considered by the equipment as an horizontal plane whose depth may be chosen at any value up to 8,000 m. The rays reflected by the bottom can be retained, restricted or ignored, according to the position of a switch. A particularly interesting feature is that the sound speed need not be calculated at the bottom depth. The latter is set independently, and the computer calculates the corresponding sound speed from a linear extrapolation of the last two data points above the bottom. The last profile layer is thus extended down to the sea bed, whose depth may then be changed according to the exact location in the working area, without having each time to recalculate the corresponding sound velocity.

Transducer Characteristics:

Variable source:

(a) Depth: set at any value between 0 and 8,000 m with a qualification of 1 m. (b) Beamwidth: set by the switch and direction in degree $\pm$ 1 radian max.

Pre-selected source:

Depth is stable and pre-cabled at 5 metres in order to simulate a hull sonar, and width is the same as that of the variable source.

The sea surface is considered as an horizontal plane. The reflections from the top can be retained or restricted according to the same switch controlling the reflections from the bottom.

Display of the Sound Field:

The cathode ray tube is fitted with a remanent layer type P7. The overall range of the sound field visualized on the CRT can set at: 10-20-40-80 and 160 ky. This setting also determines the extreme range that is considered in the computation. The height of water from the surface visualized on the CRT can be set at 1-2-4 and 8km (independently of the water depth). In addition, a depth magnifier makes it possible to insert a further vertical enlargement of $\times$ 10 so that the sound field displayed on the scope corresponds to the first 100, 200, 400 or 800 m from the surface. The sound field is represented by the ray traces for number of rays inside the beamwidth

The angular interval between rays can be chosen by the operator between the 3 values of 1, 0.5 and 0.1 degrees. This would correspond, for the maximum beam width of 2 radians, to between 114, 228 or 1,140 rays. The 0.1 deg interval setting is specially useful for a visual estimation of the energy distribution inside the sound field.

The sonar computer is fitted with analogue outputs, that can be used for presentation on external equipments. Computation of each ray is fast and depends on the ray curvature and maximum range. As an example, the average duration for the calculation and display of one ray up to 50km is of the order of 5 ms, so that a 30-ray sound field is presented in a nearly continuous manner.

A switch allows selection of the visualization of the field emitted, by either one of the sources, or by both sources.

Graduated scales electronically generated are manually set, and the graduations are: 1 kmand 10kmin range, and 10 m and 100 m, or 100 and 1 km, in depth according to the selected scales. The bathygraph curve can be displayed instead of sound field in order to simplify display and control by the operator.

Technical characteristics:

Manual settings:

Bathy sound speed range: 1400-1600 m/s – quantification 0.1 m/s

Bathy layer interfaces range: 0-8000 – quantification: 1 m

Variable depth source range: 0-8000 m – quantification: 1 m

Bottom depth range: 0-8000 m – quantification: 1 m

Limiting angles range: $\pm$ 1 radian – quantification: 1°

Sonar coverage:

Visualized range: 10-20-40-80-160 ky

Visualized depth: 100-200-400-800 m – 1-2-4-8 km

Ray angular interval: —1, —0.5 and 0.1 degree

MANUFACTURER:

CIT-ALCATEL, Division Marine, 33 rue Emériau, 75725 Paris Cédex 15, France.

1724.253
TSM 2400 SONAR

DESCRIPTION:

The TSM 2400 is a new surface-ship active sonar in development for fitting in 'Aviso' class ships and other similar anti-submarine vessels. Few details have been revealed beyond the fact that it is an 'all-round', active sonar for submarine surveillance and attack operations.

MANUFACTURER:

Thomson-CSF, Division Activités Sous-Marine, 06-Cagnes-sur-Mer, France.

1725.253
DIODON SONAR

DESCRIPTION:

The Diodon is a new sonar for fitting in anti-submarine ships of small or medium tonnage. It is an active all-round system employing digital techniques. The main functions are submarine detection and attack. No other details have been obtained.

MANUFACTURER:

Thomson-CSF, Division Activités Sous-Marine, 06-Cagnes-sur-Mer, France.

1726.453
PIRANHA SONAR: DUBM 41A

DESCRIPTION:

The DUBM 41A system is a high-resolution side-looking sonar system designed for the location and classification of objects, such as mines, lying on the sea-bed. The system consists of three towed sonár vehicles, two consoles, and the necessary cables and shipboards hoists and handling gear. In normal operation two of the three sonar bodies are used, with the third kept as a ready spare. A permanent record of the sonar data gathered is made on a facsimile type recorder. The information also is presented simultaneously on two CRT storage tubes, these console-mounted displays providing an image of the sea-bed. The system is designed for use by low tonnage vessels, and in waters of depths of 60 metres or less. The towed sonars operate at about 5 to 9 metres above the sea-bed at speeds of between 3 and 7 knots. The tow cables are provided with deflector vanes which ensure that the sonar bodies are towed at a distance to left and right of the ship's track, and marker floats are provided to indicate the line of travel for each sonar.

The sonar body is a streamlined vehicle fitted with the side-looking sonars, plus an additional sonar array for determining height above sea-bed and for obstacle detection. Servo-controlled fins are provided for depth control and roll stabilisation is incorporated by means of a separate set of four fins. Dimensions of each sonar vehicle are: length 3.725 m, diameter 36 cm, in-air weight 340 kg. Each body has two side looking sonar arrays for the sea-bed scanning, and a group of three directional sensors in the nose. The latter are pointed horizontally, vertically, and at an oblique downward angle ahead. The first of these is for obstacle detection, while the other two provide data for servo control of the depth of the body. The body also contains a case of ten NUPR 1A acoustic markers which can be released by remote control to designate an object or selected position. A separate marker is installed as an aid to recovery should the sonar body break its tow. Manual controls are provided at the operating console to permit manual piloting, either to override automatic control or as a standby mode.

Each of the two sonar bodies operates on its own frequency, the two being separated by 50 kHz, with the area of sea-bed between the two bodies being scanned by both sonars. A typical scanned area covered by the two bodies amounts to a total width of about 200 metres, with maximum sonar range selected. This is 75 m, and there are two other range settings, 50 m and 25 m. At the latter setting, resolution is stated to be better than 10 cm in both the lateral (scan) direction and in the line of travel.

DEVELOPMENT:
Development of the DUBM-41A was conducted in collaboration by the Guerre des Mines de la Marine Francaise (GESMA) and Thomson-CSF.

MANUFACTURER:
Thomson CSF, Division Activités Sous-Marine, 06 Cagnes-sur-Mer, France.

1357.253
DUBM 20A MINE HUNTING SONAR

DESCRIPTION:
The DUBM 20A is a mine detection and classification sonar, and consists of an array providing a 70 degree search sector for the detection of mines and a restricted sector for precise location and identification. The acoustic array is housed in a retractable dome and is stabilised in pitch and roll.

MANUFACTURER:
Thomson-CSF, France.

1358.253
DUBM 40 MINE HUNTING SONAR

DESCRIPTION:
The DUBM 40 is a lightweight mine detection sonar intended for use on launches or hydrofoil craft. It is operated in the active mode for the detection and classification of mines on the sea-bed, and in the passive mode for the location of ultrasonic navigational buoys. A single control console provides for operation of the acoustic head which is towed by a special cable system, and is provided with two CRT displays.

MANUFACTURER:
Thomson-CSF, France.

2092.453
HARBOUR PROTECTION EQUIPMENT

The purpose of this equipment is to detect the passage of submarines or other vessels through a harbour entrance or similarly confined sea passage.

The equipment comprises a series of magnetic detection devices, placed in line on the sea bed across the entrance through which the vessels of interest must pass, each connected to a fluxmeter recorder (CDC type FESD 11). The basic detection device consists of two rectangular coils placed, as nearly as possible, horizontally on the sea bed and connected in opposition so as to cancel the effect of disturbances of the earth's magnetic field. The coils are arranged so that the vessel will pass over them in sequence and each pair is connected to a conveniently located fluxmeter that may be up to 10 km away.

Any ferromagnetic hull passing over the coils will give rise to a deflection of the stylus of the recording fluxmeter. This instrument has two recording paper speeds; and when on watch it runs at the lower speed. When a flux variation that exceeds a preset theshold value is detected, the instrument switches to high paper speed and an alarm circuit is engaged. To avoid overload there is provision within the fluxmeter for automatic sensitivity adjustment.

As a refinement, the magnetic deflection system may be supplemented by an acoustic system, an array of hydrophones also being placed across the protected passage and connected to amplifier, speakers and recorders co-located with the fluxmetric recorder.

MANUFACTURER:
Thomson-CSF, Division Activités Sous-Marine, 06-Cagnes-sur-Mer, France.

1389.353
DHAX-1 MAGNETIC ANOMALY DETECTOR

DESCRIPTION:
The type DHAX-1 MAD is designed for use in aircraft for the detection of submerged submarines by detection of the disturbance to the local natural magnetic field caused by their large ferrous bulk. The system comprises three units: a probe containing two caesium vapour paramagnetic resonance cells (this is usually tail-mounted on the aircraft, and weighs 15 kg), an electronics unit weighing 18 kg, and a control unit (3 kg).

The last of these units incorporates a manual test facility for checking correct operation and calibration of the system in flight. Data from the MAD is fed to the aircraft's ASW tactical data system. No performance details, other than a sensitivity of less than one gamma, have been revealed.

STATUS:
The DHAX-1 is fitted in French Atlantic ASW aircraft, and in those of a number of other nations.

MANUFACTURER:
Thomson-CSF, Division Equipements Avioniques et Spatiaux, 178 Boulevard Gabriel Peri, 92-Malakoff, France.

1390.353
DHAX-3 MAGNETIC ANOMALY DETECTOR

DESCRIPTION:
The DHAX-3 is an improved and more modern version of the DHAX-1 MAD equipment (Entry No. **1389.353**), and primarily designed for deployment at the end of a cable from ASW helicopters. In place of the 4-cell detector unit used in the DHAX-1, the DHAX-3 employs six caesium vapour paramagnetic cells, and is stated to have a very low susceptibility to rotational and heading effect.

Weights of the three units which comprise the equipment are: probe – 6.2 kg, electronics unit – 7.5 kg, and control unit 0.8 kg. These figures suggest that the use of solid-state electronics has permitted a system weight of less than half that of the DHAX-1 to be achieved. No performance details have been released.

STATUS:
In service with French Forces.

MANUFACTURER:
Thomson-CSF, Division Equipements Avioniques et Spatiaux, 178 Boulevarde Gabriel Peri, 92-Malakoff, France.

ITALY

1720.453
IP64-MD64 SONARS

DESCRIPTION:
The USEA IP64 sonar set is designed for installation aboard small or medium-size submarines, and it combines a passive sonar equipment and an active echo-ranging sonar. It is also designed for integration with the MD64 sonar set for range measurement of noise sources by passive means. The receiving transducer elements, which are common to the passive and active mode, are arranged in the bow of the vessel in a long conformal array to enhance the directional capabilities. The transmitting transducer elements are arranged in a circular array located on deck.

Search and detection are carried out primarily by means of the passive listening set, which incorporates advanced correlation techniques and records the received signals on a graph plotter. After target detection, a single transmission pulse in the direction of the target by the echo-ranging sonar is sufficient to provide range and relative speed target data.

The MD64 equipment measures the range of a detected noise source by passive means only. The range of a noise source is determined by the measurement of the relative time delay of sound waves detected by three hydrophones. Two groups of three hydrophones each are provided, for port and starboard measurements. Each hydrophone uses a number of elements phased in the horizontal plane to produce a reception beam, directed toward the source. Operation is automatic and after acquisition of the noise source, the equipment locks on and continuous bearing data is produced. Range is measured continuously and is recorded graphically.

MANUFACTURER:
USEA – Via G. Matteotti 63, 19030 Pugliola di Lerici, La Spezia, Italy.

1721.453
B168 SONOBUOY

DESCRIPTION:
The USEA B168 sonobuoy is designed to meet all the operational requirements of Julie/Jezebel ASW tactics. Principal dimensions are length 1,220 mm, diameter 91 mm, weight 8 kg. Other features are long communication range by means of high power and optimisation of the vertical radiation pattern. Operation is possible on twice the number of radio frequency channels normally employed in the band 162.25 to 173.50 MHz. The B168 can be in operation within 15 seconds of release and having reached a maximum depth of 60 metres.

MANUFACTURER:
USEA - Via G. Matteotti 63, 19030 Pugliola di Lerici, La Spezia, Italy.

1722.353
FALCO SUBMARINE LOCATING SYSTEM

DESCRIPTION:

The FALCO system is an airborne equipment designed to increase the capability for helicopters and fixed-wing aircraft to detect, classify and locate submarines. The system operates on the low frequency noise radiated by targets and gathered by directional low frequency passive sonobuoys.

Noise spectral analysis, target data processing and display are performed by a real time digital computer. It is claimed that the FALCO system is able to determine target position, with an accuracy sufficient to carry out an attack with automatic homing torpedoes, and with errors due to sonobuoys drifting automatically cancelled out. The equipment is produced in several versions

MANUFACTURER:

SELENIA Industrie Elettroniche Associate SpA., Via Tiburtina Km 12.400, 00131 Roma, Italy.

1723.453
SERVOMECCANISMI SONOBUOY EQUIPMENT

DESCRIPTION:

The Servomeccanismi organisation produces three types of passive sonobuoy:

BIT-3: This is an A-size omnidirectional passive sonobuoy for use at depths between 20 and 100 metres, with a selectable life of 1 to 3 hours, and transmitting data over a 31-channel, IW link.

BIT 8: This is similar to the BIT-3 but has different frequency/sensitivity characteristics.

BIR: This is a miniature (500 mm long × 100 mm diameter, 3 kg) sonobuoy for use with helicopters. It is omnidirectional and can be deployed at depths to 20 m. Life is one hour.

Receivers for use with these sonobuoys are the REA-16 and REA-31, having 16 and 31 reception channels, respectively.

MANUFACTURER:

Servomeccanismi Ing. E. Olivetti, Via Mediana Km 29.3, 00040 Pomezia, Italy.

THE NETHERLANDS

1525.263
SP1-03 SOUND RAY PATH ANALYSER

DESCRIPTION:

The SP1-03 is a small special-purpose computer-based equipment providing instantaneous prediction of sound ray paths calculated directly from sound velocity over long, medium and short ranges. The equipment comprises two units, indicator and power supply, with a combined weight of 110 kg. An 8-inch (20.3 cm) diameter CRT display is provided, and sound ray paths are displayed with a spacing of 0.5, the number depending upon beam selection, resulting in a maximum calculation time of 74 milliseconds. The SP1-03 is suitable for both anti-submarine operations and oceanography applications.

Converging rays form a region of low propagation loss which is effective for target detection and location. Convergence zones can be easily predicted from the screen intensity of the display. A Bottom Reflections On/Off switch enables the effects of bottom-bounced sound rays to be studied. A variable depth transducer facility is provided, under control of the operator, and this enables the depth of the sonar to be adjusted to permit looking into shadow zones. The equipment caters for either fixed or variable transducer depth. 15 feet (4.57 m) in the first case and 10 to 10,000 ft (3 to 3,000 m) for the latter. Initial velocity and transducer depth is calculated automatically.

The bottom depth setting is adjustable to a maximum of 20,000 ft (6,000 m), and the reflection attenuation is adjustable from 0 to 20 dB. Sound velocity is variable between 4,700 and 5,100 ft/sec (1,433 and 1,554 m/sec), with a gradient maximum in the layers plus 2 to minus 2 seconds. Five ranges are provided. A high pulse repetition rate is used in the interests of stability. The equipment is fully solid-state and integrated circuits are used in construction.

Operational applications include: on surface ships with hull-mounted variable depth sonars for instant and variable prediction of sound ray paths; on submarines for the determination of optimum listening and escape depths, and defence against helicopters and sonar buoys, for mine-hunting in shallow waters, oceanography and hydrography.

DEVELOPMENT:

Development was undertaken by Van der Heem N.V. in The Netherlands.

STATUS:

The SP1-03 is in operational service with a number of navies.

MANUFACTURER:

Van der Heem Electronics Nv, Den Haag, The Netherlands.

THE UNITED KINGDOM

7002.253
MS26 and MS27 SMALL SHIP SONARS

DESCRIPTION:

Hull mounted ship sonars designed for single operator control in both the surveillance and attack roles. Also used as a 'dunking' sonar in certain helicopters, under the designation Type 195.

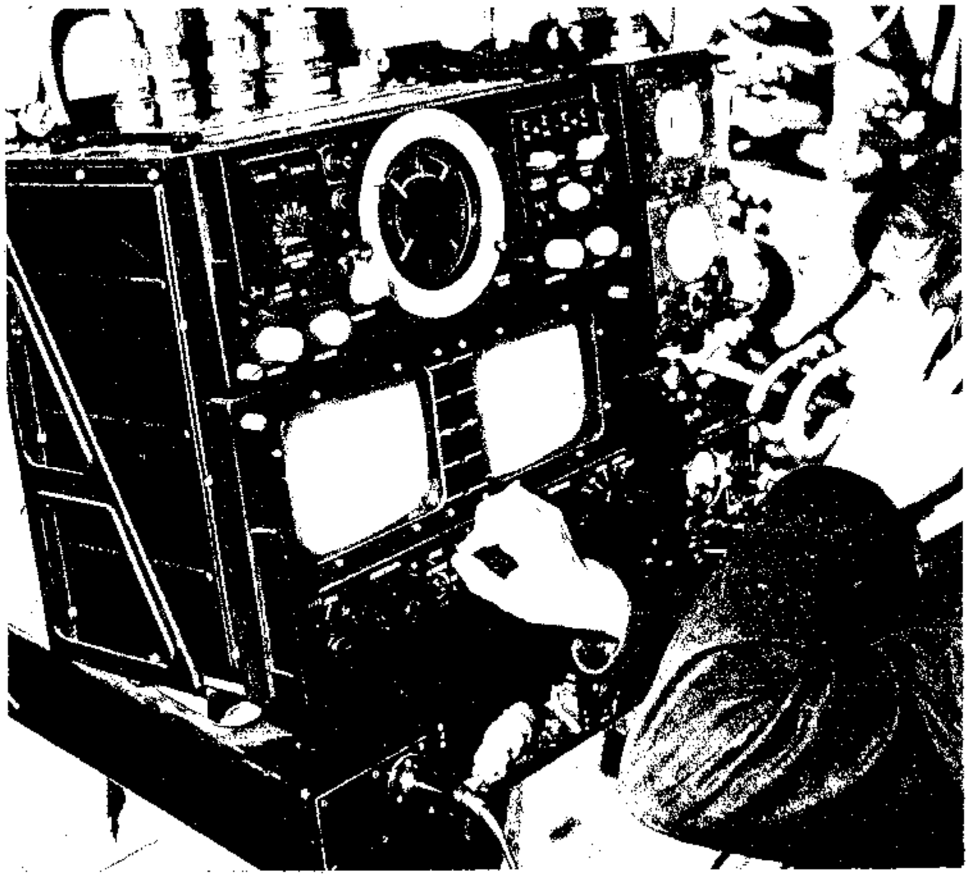
OPERATION:

The MS26 is a self-contained system for ships and patrol craft down to 150 tons. It provides full 360 degrees coverage in four steps of 90 degrees and may be manually controlled to cover a particular sector, or set to carry out automatic search procedure. It incorporates a 'maintenance of close contact' facility for tracking close or deep targets. The single operator controls the sonar through a special console. He is provided with three sources of sonar information – audio, visual doppler and visual sector.

The doppler facility provides increased initial detection range and improved classification capabilities compared with conventional small ship sonars. The MS26 transducer array is mounted within a hull outfit with a glass-reinforced plastic dome.

The MS27 differs from the MS26 only in its associated hull outfit. The MS27 transducer array is mounted in a Royal Navy hull outfit 19 or similar, which makes the equipment suitable for installation in small escorts down to about 650 tons displacement. The MS27 can be used as a surveillance sonar in association with a separate fire control sonar within the same hull outfit. This enables the ship to continue surveillance for new threats whilst engaging a target already detected.

Both equipments use fully transistorised circuits to ensure high reliability, while modular construction techniques permit rapid maintenance and minimise loss of operational time. They also offer a means of economically providing secondary sonar capability in multi role vessels. Under slow speed operation, when the back-



Operator's console of MS26/27 sonar system ground noise is that caused by breaking and pounding of waves, equivalent to, say sea state 4, the theoretical initial detection range can be calculated about 7,000 metres. A practical working range of detection under most conditions is approximately 4,500 metres.

The equipment is sub-divided into small units which may be sited in convenient areas not necessarily adjacent to the control console.

MS26 and MS27 Unit Dimensions:

Operator's console: 53 cm wide, 43 cm high, 30 cm deep, 26.5 kg

Doppler receiver: 40 cm wide, 29.2 cm high, 52 cm deep, 20.7 kg

Sector receiver: 40 cm wide, 29.2 cm high, 38 cm deep, 10.8 kg

Transmitter: 29.2 cm wide, 19 cm high, 52 cm deep, 13.7 kg

Auxiliaries unit: 40 cm wide, 29.2 cm high, 51 cm deep, 27.1 kg

Sonar power supply: 43.2 cm wide, 38 cm high, 50 cm deep, 73 kg

Transducer assembly: 44.5 cm wide, 99.6 cm high, 53 cm deep, 100 kg

MS26 hull outfit: 80 cm wide, 137.3 cm high, 140 cm deep, 1,015 kg

MS26 Sonar Dome: 48.3 cm wide, 72.5 cm high, 132 cm deep, 1,015 kg

STATUS:

Now in quantity production. The MS26 has been adopted by four foreign navies, two of these being NATO member countries.

MANUFACTURER:

Plessey Marine, The Plessey Company Ltd, Ilford, Essex, England.

ADDITIONAL EQUIPMENT:

Various other ancillary units are available which will measure transmitter output power and receiver sensitivity; indicate figure of merit under prevailing noise conditions; provide at points remote to the control console tactical information on target movement; provide in situ system checking which locates any system fault or performance deterioriation; and provide a controlled simulated display for training purposes.

1024.353
TYPE 195 HELICOPTER SONAR

DESCRIPTION:

This is a helicopter-mounted 'dunking' version of the Plessey MS26/27 range of small vessel sonars. The principal difference between the Type 195 and these equipments is the use of a winch-controlled transducer for the detection and location in place of the hull-mounted units employed in the MS26/27. Other essential details are the same and will be found in the entry for the MS26/27 sonars.

STATUS:

The Type 195 sonar is an item of the equipment forming the Westland Sea King ASW helicopter system.

MANUFACTURER:

Plessey Marine, The Plessey Co Ltd, Ilford, Essex, England.

Type 195 dunking sonar in use by Royal Navy Sea King helicopter

1221.253
MS32 SONAR

DESCRIPTION:

The MS32 sonar is an active, panoramic, hull-mounted sonar equipment suitable for fitting in all classes of anti-submarine escort ships. Solid-state electronics are used in construction, these being housed in six cabinets of total weight 2,000 kg, each cabinet measuring 68.5 × 61 × 173 cm. The transducer and directing gear also weighs about 2,000 kg.

The system provides initial detection and classification of targets, and fire control facilities for anti-submarine weapons. Torpedo warning facilities are also available.

Comprehensive signal processing and data display facilities are provided by a sonar room display console measuring 107 × 91 × 173 cm, and weighing 330 kg.

The only indications of performance are those which can be indirectly surmised from the power supply requirements.

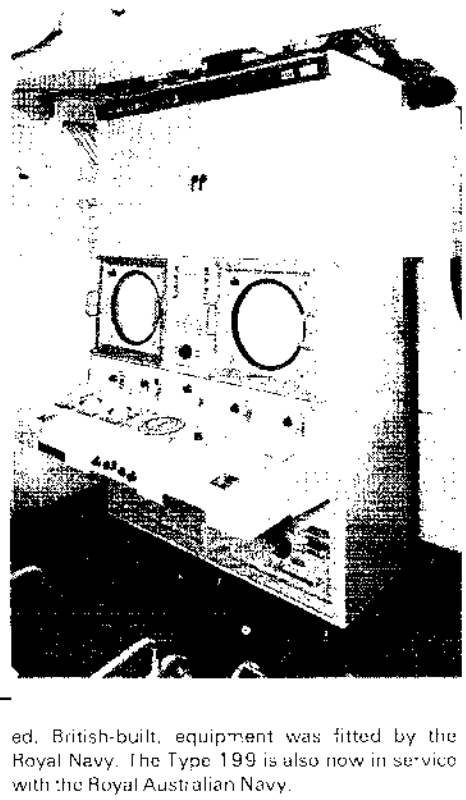
110 or 240 V AC	50/60 Hz, single phase, about 5 kW average peak power.
115 V AC	400 Hz, three phase, 1 kW maximum.
440 V AC	60 Hz, three phase, 100 KVA (pulse).

STATUS:

Development began in mid-1967 and was completed in 1972.

MANUFACTURER:

Plessey Marine, The Plessey Co Ltd, Ilford, Essex, England.


Plessey MS32 sonar display system

2447.253
SONAR TYPE 199

Type 199 is a variable-depth submarine detector. Its principal feature is the towing of the transducer in deep water behind the ship; the purpose of this being to enable the detecting device to operate at various levels and therefore overcome the effects of refraction between different water areas. A further advantage is a considerable reduction in the amount of ship's noise picked up by the transducer.

DEVELOPMENT:

Development started with a contract placed by the Canadian Government with EMI Electronics (Canada) Ltd and the equipment went into service with the Royal Canadian Navy in 1962. In the following year Canadian-built equipment went into service with the Royal Navy. In 1968 an improved, British-built, equipment was fitted by the Royal Navy. The Type 199 is also now in service with the Royal Australian Navy.

TEST AND TRAINING EQUIPMENT:

EMI Electronics provide a base test equipment for checking the towed vehicle.

MANUFACTURER:

EMI Electronics Ltd, Blyth Road, Hayes, Middlesex.

1755.453
TYPE 162M SIDEWAYS-LOOKING SONAR

DESCRIPTION:

Sonar Type 162M detects and classifies both midwater and seabed targets. It displays port and starboard recordings simultaneously on a single straight line recorder, which has a maximum range scale of 1200 yards. Operation is simplified by entirely automatic gain control. Reliability is enhanced with solid state technology and maintenance is facilitated by ease of access and comprehensive built-in testing and monitoring features.

The three transducers are all similar and employ 49.8 kHz barium titanate elements. Their beam pattern is fan-shaped, about 3° wide and 40° vertical angle; the side-looking elements have their axes 25° below the horizontal.

The recorder design uses a double helix (left and right hand) so that there are two points of contact with the moist electrosensitive paper. As the helix rotates, the two points of contact move outwards from the centre. Port and starboard signals are fed respectively to the left and right-hand points of contact so that they are recorded simultaneously. There are two zero lines near the middle of the paper, and the 18 mm gap between them is used for time marks every 5 minutes. The paper width is 286 mm, and each trace occupies 133 mm.

An electronic oscillator provides a controlled frequency supply for the driving motor and interval marks. Motor speed changes, for the three range scales, are made by frequency division so as to avoid the use of a change speed gear box, and a stroboscopic arrangement is included so that the helix speed may be easily checked.

A loud-speaker, and a socket for headphones, enable signals to be monitored aurally if required.

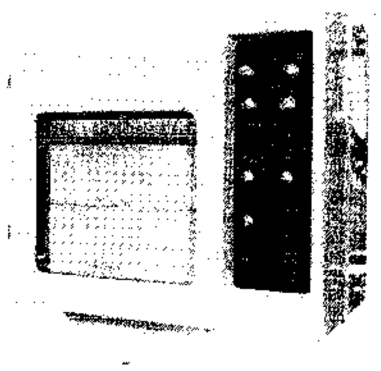
The three range scales are 0-300, 0-600 and 0-1200 yards, and accuracy is better than 2 per cent assuming a sound velocity of 4,920 ft/sec. The paper speed changes automatically when the range scale is selected, and the speeds are 6, 3 and 1.5 in/min respectively. At a ship speed of 10.8 knots the display scales are the same across the paper and vertically. A take-up spool is fitted but its use is optional. A fix marker draws a line across the width of the paper when a button is pressed, and it can be operated in conjunction with a Type 778 echo sounder or other equipment.

The Receiver/Transmitter contains:

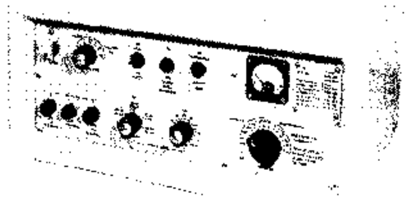
(a) the transmission system in which a crystal oscillator supplies the correct energising frequency, which is gated to form pulses of 0.75 ms duration at intervals commanded by the recorder; the pulses are amplified to deliver 80W to each of the wideways looking transducers and 40W to the centre (downward looking) transducer. There is a switch to cut out either the port or starboard transducer when not required, and the centre transducer is automatically disconnected on the longest range scale.

(b) the reception system, which includes signal amplifiers, mixers, transmit/receive switches, initial reverberation suppression and automatic gain control. By careful selection of time constants, it has been found possible to preserve a sufficient level of sea bed reverberation to display target shadows, and yet to permit weak echoes from distant targets to be seen in the presence of the reverberation. This system is so effective that the operator has no need of a manual gain control.

(c) the monitoring and test facilities, which enable all supply voltages and the functioning of the transmitter and receiver to be checked and test signals to be injected.



Type 162M sonar transmitter-receiver unit



Type 162M sonar recorder

STATUS:

Prototypes underwent sea trials during 1973, and production equipment installations began in 1974.

MANUFACTURER:

Kelvin Hughes, New North Road, Hainault, Ilford, Essex, England, IG6 2UR.

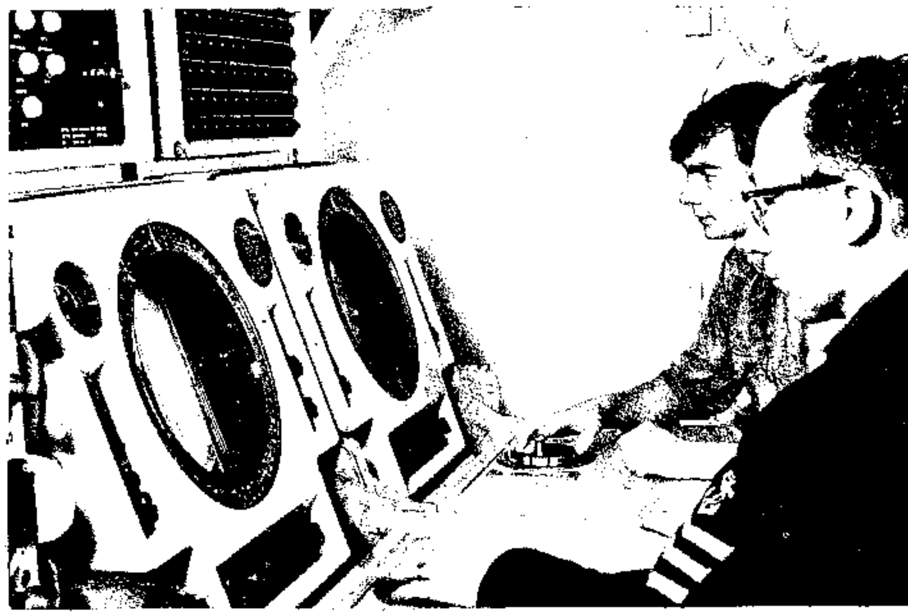
1373.253
RN MINE HUNTING SYSTEM (ACOUSTIC) Mk 1

DESCRIPTION:

This system is based on the RN Type 193 sonar for the detection, classification and neutralising of ground mines, and moored mines which are not capable of being swept. The complete system comprises additional elements such as an accurate navigation sub-system, pilotage radar, and mine destruction equipment. It is also used in the Decca Minehunting System and operates in the Vosper 45 metre glass-fibre minehunter. It is also suitable for use with the Sperry CAT mine disposal weapon or the French PAP 104 system (**1786.453**). All other details of this system remain classified.

MANUFACTURER:

Plessey Marine, The Plessey Company Ltd, Ilford, Essex, England.



Operator's console of the RN Mine Hunting sonar system

1787.453
Mk 1C ACTIVE SONOBUOY T17164

DESCRIPTION:

As the result of an extensive research and development programme, Plessey Marine has made design changes and repackaged the existing Mk 1C active sonobuoy into a unit of "A" size dimensions. The use of solid-state electronics coupled with a complete reassessment of mechanical design has resulted in a unit weighing only 8.85 kg, which compares with typical weights of about 39 kg for conventional sonobuoys. Volume of the Mk 1C T17164 is 0.011 cubic metre, which compares with 0.11 cubic metre for conventional units.

The sonobuoy is constructed in two main sections. The top section contains the rotochute, RF transmitter, and batteries, whilst the lower section contains the compass unit, transducer and rotation mechanism. The sections are connected together with a part complaint cable.

The sonobuoy can be released from the aircraft either through the bomb bay or the sonobuoy shute and its rate of fall is limited to 18.3 m/s (60 ft per sec). When it strikes the water an interior rod disengages the rotochute assembly which is jettisoned and thus enables the folded dipole antenna to erect. The two sections of the sonobuoy automatically separate on striking the water and the complaint cable contained in the upper section is paid out whilst the lower section sinks to a predetermined depth. When this section has reached its selected depth, the paddles are deployed allowing the transducer array to open to its operational position. The motor drive to the paddles engages and the lower unit rotates against the reaction of the paddles. The unit rotates in steps, pausing at each point to carry out the transmit/receive sequence, which includes compass interrogation to provide bearing information. The output frequencies are fed via the cable to modulate the RF transmitter. Operation continues for over 60 minutes until RF shut down and final scuttle.

MANUFACTURER:

The Plessey Company Ltd, Plessey Marine, Ilford, Essex, IG2 6BB, England.

Sonobuoy T17164 with bomb-bay adaptor

1374.253

MINE HUNTING SONAR 193M

DESCRIPTION:

The 193M is a redesign by Plessey of the Type 193 minehunting sonar, the adoption of solid-state electronics and other advances in technology have resulted in a reduction in installed weight to about 860 kg, which compares with a figure of some 2100 kg for the older Type 193. Among the operational improvements are extensive use of digital displays and direct insertion of range data to the PPI.

Two frequencies are employed by the 193M sonar, the lower for search and the higher for classification. The transducers for these signals are carried beneath the ship on a stabilised, steerable mounting, the whole assembly contained within an inflated fabric dome. The returned echoes are presented to the operators on separate CRTs at the control console. One of these displays range and bearing of targets within the sector being scanned by the search transducer, while the other is used for the presentation of the classification channel data. The controls for adjusting the transducer position, signal parameters such as frequency and pulse length and for co-operating with the rest of the mine-hunting and destruction team, are also provided at the console. Type 193M data can also be fed into other ship's systems.

DEVELOPMENT:

Development of the Type 193M was undertaken by Plessey, based on proposals made to the company in 1968.

STATUS:

In service with the Royal Navy. It is also used in the Decca Minehunting System and operates in the Vosper 45 metre glass-fibre reinforced minehunter vessel. It is suitable for use with the Sperry Cat mine disposal weapon or the French PAP 104 system (**1786.453**)

MANUFACTURER:

The Plessey Company Ltd, Plessey Marine, Ilford, Essex, IG2 6BB, England.

Type 193M sonar operator's console

1223.263

PLESSEY ACOUSTIC RAY TRACE INDICATOR

DESCRIPTION:

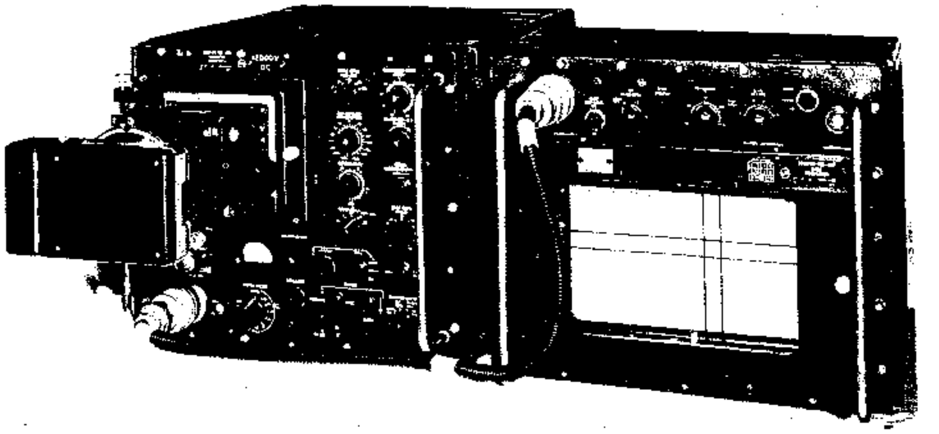
The acoustic ray trace indicator (ARTI) is a data processing system developed to permit the rapid application of corrections for variation in the ocean environment to sonar systems, enabling more accurate predictions of transmission paths and sonar coverage.

The equipment consists of three portable units, each housed in a separate instrument case:

Data converter. This unit contains the devices for data input setting from each of the possible sources, the input data store and the first stages of the computation. The overall case size is 441 × 356 × 251 mm.

Sonar ray computer. This contains the major part of the computer, with the output display. Overall size is 441 × 356 × 480 mm.

Accessory outfit. The third unit provides storage space for the polaroid camera and all connecting cables and accessories.



Plessey Acoustic Ray Trace Indicator equipment

The ARTI equipment can accept input data from any temperature or velocity-profile source, but has been specifically designed to accept plots automatically from either the RN sound velocity recorder, or from the XBT expendable bathythermograph (which see). It incorporates an analogue computer which integrates the sonar plot with the temperature/depth or velocity/depth data and predicts ray paths at one degree intervals within the sonar beam. It is designed so that the specific parameters of any sonar equipment can be manually preset.

OPERATION:

Problems relating to the nature of the environment, as much as intrinsic sonar performance, are limiting factors in the conduct of underwater detection and tracking operations. Sonar energy, instead of travelling in straight lines, is refracted due to salinity, pressure and temperature gradients within the medium. Predictions of sonar range and the volume surveyed by a given equipment are thus predicated by the accuracy with which transmission paths can be forecast.

Bathythermograph plots enable predictions of ray-bending of varying accuracy to be made, accuracy generally depending upon the extent of the computational facilities available. Accurate transmission path data normally demands extensive and laborious calculation, which does not comply with the modern requirement for rapidly available data.

The ARTI equipment has been designed to provide the necessary computational capacity on an automatic basis, coupled with a suitable means of presenting the resultant information.

The data converter unit of the system enables the operator to transfer five salient points from the bathythermograph trace into an electronic store, in a matter of seconds. The computer will then produce immediately the resulting sonar beam patterns on its CRT display, calculated for any desired sonar transducer depth, angle and beamwidth. The display shows reflections from the sea surface, and if required, from the bottom which is adjustable in depth and slope. A further useful facility is the provision of markers along the sonar beam, enabling sonar transmission range to be correlated with actual horizontal range. Five alternative horizontal ranges and five depth ranges can be selected to produce a display suited to short ranged sonars, or right out of the limit of the longest range sonars, and for shallow water or the greatest ocean depths. A record of any display can be obtained very quickly using the Polaroid camera supplied as part of the equipment.

STATUS:

The ARTI equipment had reached prototype stage early in 1970 and entered quantity production for the Royal Navy in 1971. A number of foreign navies are reported to be interested.

MANUFACTURER:

Plessey Marine, The Plessey Co. Ltd, Ilford, Essex, England.

1788.453

PLESSEY UNDERWATER PROGRAMMES

DESCRIPTION:

The following paragraphs list major underwater projects in which Plessey is known to be engaged but about which detailed information has not been released.

PMS 35

This is a small frigate digital sonar which is now in development.

Nuclear Submarine Sonar

This is a long-range detection equipment for the latest British nuclear submarines. It is not known what stage has been reached in this programme.

Intruder Detection System

SADE – Sensitive Acoustic Detection Equipment. This is for the defence of strategic shore installations against undersea intruders in miniature submarines, underwater demolition swimmers, etc.

Noise Aanlysis System

This programme is related to acoustic ranges for noise analysis of ships and submarines.

Project 15 Sonar

Under the designation Project 15, a new advanced fleet escort sonar for the Royal Navy is under development.

Mark 44 Mod 1 Torpedo

This is a short-range homing torpedo for use against submarines and intended for launch from ships or helicopters.

STWS-1

The STWS-1 is a self-contained anti-submarine weapon system for surface escorts incorporating a triple tube for launching Mk 44 and Mk 46 torpedoes.

MANUFACTURER:

The Plessey Company Ltd, Plessey Marine, Ilford, Essex, IG2 6BB, England.

2536.253

AN/SQS-26 SONAR

Claimed to be the most advanced surface ship sonar operational in the US Navy, the AN/SQS-26 is a large and complex system comprising 576 transducer elements, formed in a cylindrical array, and 37 cabinets of signal processing, transmitting and display equipment. The cylindrical array of transducer elements is located in a large bulb dome below the waterline of the ship's bow. The system may be operated in either an active or passive mode to detect, identify and track multiple targets.

AN/SQS-26, which has been re-designated AN/SQS-53, has been specified for the 30 "Spruance" class (DD-963) destroyers being built for the US Navy by Litton Industries, and the sonars are being built by General Electric on a sub-contract from Litton.

They will form part of a total ASW system that includes advanced fire control equipment and an array of weapons including ASROC, conventional torpedoes and depth charges. The long effective range and deep penetration of the AN/SQS-53 will give the destroyer a valuable ASW capability; the DD-963 will also be the first major combatant ship of the US Navy to have sonar linked directly to a digital computer for target data processing.

MANUFACTURER:

General Electric Company, Heavy Military Systems, Syracuse, New York, USA.

Bow housing of SQS-26 sonar

2534.253

AN/SQS-36 AND AN/SQS-38 MEDIUM-RANGE HULL-MOUNTED SCANNING SONARS

These equipments have been designed for the medium-range detection of submarines in deep and shallow water. The AN/SQS-38 is the more modern of the two; the AN/SQS-36 has been in service with the US Navy since 1964.

Associated with these equipments, and using the same electronics, are the AN/SQS-35/36 and AN/SQS-35V Hull/Variable Depth Sonars which use one set of electronics to work with either a hull-mounted or a VDS transducer – selection being made by a push-button on the operator's console.

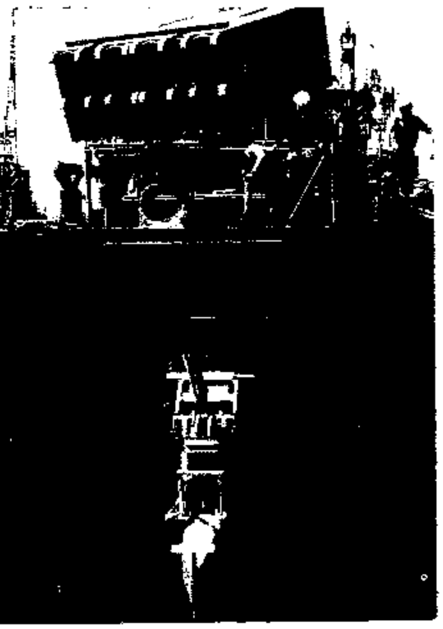
All four equipments are single console systems. The AN/SQS-36 and the AN/SQS-35/36 are primarily miniaturised vacuum-tube equipments; the AN/SQS-38 and the AN/SQS-35V are completely solid-state equipments.

DEVELOPMENT:

Development of the earlier versions was begun in 1959 for the US Navy, prototypes were made in 1962 and the equipment went into service with the US Navy in 1964. Since then the Italian and Norwegian Navies have adopted the system and other navies may yet do so Weapons associated with the system are the Mark 44 Torpedo and ASROC (USA), Terne (Norway) and Lanciabas (Italy). Seventy-five equipments have so far been delivered.

MANUFACTURER:

Edo Corporation, International Division, 14-04 111 Street, College Point, N.Y., USA.



AN/SQS-35(V) variable depth sonar seen aboard the escort ship USS Francis Hammond

1789.453

AN/SQQ-14 SONAR

DESCRIPTION:

The AN/SQQ-14 system is essentially a variable-depth, dual-frequency sonar for detecting and classifying bottom mines in shallow water. It utilises a towed body in the shape of an elongated sphere towed through a centre well on a US Navy minesweeper.

A unique aspect of the AN/SQQ-14 design is the towing cable. This consists of discrete, 18-inch sections of articulated struts with universal joints at each section, permitting the cable to flex in any vertical plane, but restraining it from torsional motion. This configuration imparts a constant heading to the towed body, thereby eliminating the need for a gyroscopic heading reference system.

STATUS:

Operational.

MANUFACTURER:

General Electric Company, Heavy Military Electronic Systems, Syracuse, New York, USA.

1807.453

AN/SQS-56 SONAR

DESCRIPTION:

AN/SQS-56 is the designation given to the new sonar being developed for the latest US Navy PF (Patrol Frigate) Class of ships. Few details have been released apart from the fact that the SQS-56 is a digital, computer-controlled system of lightweight and small dimensions. Despite this, performance is reported to be high in terms of both acoustic power and display capabilities. It can be manned by a single operator who can carry out search, detection and tracking of targets in either active or passive mode operation. The integral general-purpose digital computer provides the means for interfacing the sonar with shipboard weapons or data automation system.

STATUS:

The prototype model had been delivered to the USN by May 1974 for installation on a test ship. Technical evaluation by the Naval Undersea Centre will be followed by Operational Test and Evaluation conducted by the Commander, Operational Test and Evaluation Force. Upon completion of these tests the prototype will be accepted by the USN and designated AN/SQS-56(XN-1). Under current plans this model will be returned to Raytheon for production engineering and subsequent delivery to the first PF. SQS-56 sonars will be procured for another 49 PF ships, plus a number of sets for use at training establishments.

MANUFACTURER:

Raytheon Company, Submarine Signal Division, Portsmouth, Rhode Island, USA.

1635.453
BATHY THERMOGRAPH DATA RECORDER RO-308/SSQ-36

DESCRIPTION:

The BT Recorder is an integral part of US Navy/Lockheed P3C Orion aircraft ASW system. The equipment converts sea water temperature information provided by the AN/SSQ-36 Bathythermograph Buoy-Transmitter set and AN/AAR-72 Radio Receiving set to two output forms:

(1) A permanent record of the vertical temperature profile (temperature vs. depth) on a paper strip chart.

(2) A parallel mode, 8-bit, binary coded data word for delivery to the AN/AYA-8 Data Processing System.

The BT Buoy is dropped from an aircraft in the target area. Sea water is utilised as the activating agent and after an initial, predictable delay, the Buoy releases a temperature sensing probe (TS probe). The TS probe is the variable element in a frequency generation circuit. A radio frequency signal, transmitted by the BT Buoy is modulated at a frequency correlated to the temperature of the water. On board the aircraft the ARR-72 Radio is tuned to the BT Buoy carrier frequency. Water temperature information is converted to an audio frequency signal and delivered to the BT Recorder.

MANUFACTURER:

Western Components Division, Archbald, Pennsylvania 18403, USA.

2580.253
EDO MODEL 610 LONG-RANGE HULL-MOUNTED SCANNING SONAR

Designed for the long-range detection of submarines in deep and shallow water, the Edo Model 610 Scanning Sonar has two active consoles – and can thus perform an effective search while-track-function. Facilities offered include a search capability in three 120° sectors, passive correlation and reverberation processing. The transmitter and receiver beams are preformed. Output is available for fire control system. All mode changes and range scale changes are controlled by console push-buttons, and displays include a doppler display on each of the active consoles and a passive sonar bearing-time recorder display.

DEVELOPMENT:

Model 610 was developed by the Edo Corporation as a private venture starting in 1965. The first prototype was completed in 1966 and the first production model completed its sea trials in 1969. At least twelve equipments have so far been ordered for use in the Royal Netherlands Navy and the Italian Navy and other sales are pending. Associated weapon systems include the Mark 44 Torpedo (US) 375 Rocket Launcher (Sweden) Lanciabas (Italy) and Ikara (Australia).

MANUFACTURER:

Edo Corporation, International Division, 14-04 111 Street, College Point, N.Y., USA.

1637.353
AQS-13 HELICOPTER SONAR

DESCRIPTION:

The AQS-13 is a helicopter 'dunking' sonar system providing all-round active search facilities, and probably also possessing a passive operating mode. No detailed information is available.

STATUS:

The AQS-13 is widely used by American forces and has been supplied or ordered for naval helicopters of Italy, Iran, and unspecified South American countries. A second major contract for the AQS-13 for use by Italian Navy AB-204 and AB-212 helicopters was placed in March 1974.

MANUFACTURER:

The Bendix Corporation, Electrodynamics Division, 11600 Sherman Way, North Hollywood, California 91605, USA.

2581.253
EDO MODEL 700 SERIES SONARS

Basic equipment of this range of single operator sonars is the Model 700 Medium-Range Hull-mounted Sonar. Major variants are the Model 700/701 VDS and the Model 700/701 Hull-mounted/VDS.

The basic equipment has a 254 mm panoramic display and a doppler display. All mode and range-scale changes are made by push-button controls on the operator's console.

DEVELOPMENT:

Like the Model 610 (**2580.253**) the model 700 series has been developed by the Edo Corporation as a private venture for sale on the International Market. Development started in 1966 and the first prototype was completed in 1968. Sea trials of the first production model were completed in the following year. At least twenty of these equipments have so far been ordered, customers including the Royal Netherlands and Japanese Navies, and other sales are pending. Associated weapon systems include the Mark 44 Torpedo (US), the Bofors 375 Launcher (Sweden), Lanciabas (Italy) and Ikara (Australia).

MANUFACTURER:

Edo Corporation, International Division, 14-04 111 Street, College Point, N.Y., USA.

DATA PROCESSING EQUIPMENT

SWEDEN

2345.163
FIELD ARTILLERY COMPUTER EQUIPMENT – SAAB ACE-380

DESCRIPTION:

ACE-380 is a mobile (two-man-portable) field artillery computer equipment which can be operated by one man to compute, store and retrieve data on both fixed and moving targets. It is easy to operate, incorporates built-in error detection facilities and computes firing data within one second. Main capabilities are:

Target data storage for 500 targets.
Firing data for up to 40 ballistics inclusive of corrections and daily adjustments.
Storing of complete target data with corrected firing information for 20 targets.
Automatic or semi-automatic input from forward observer radio link data receiver.
Automatic output of firing data to gun data link.
Automatic input from transmitter of muzzle velocity data.
Prognosis of air for 30 levels above ground.
All data stored within the equipment displayed immediately on request and easily updated.

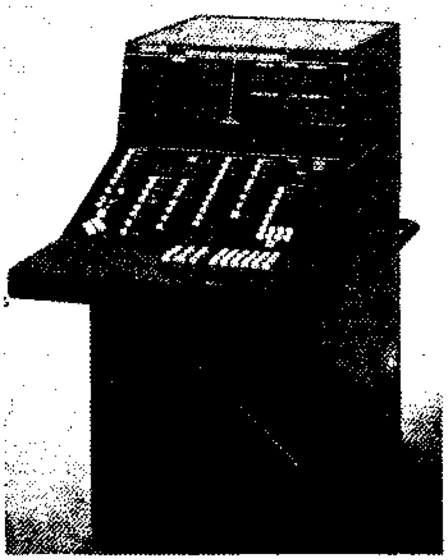
These facilities are provided by a multi-purpose digital computer with a ferrite core memory and a real-time programming system.

Keyboard and display panels are designed with separate functional fields for each group of input parameters. Operation is simple and can readily be learnt by a soldier with some artillery experience. Input data is inserted into the computer either manually or automatically from fire control apparatus. Data on any target can be called up and displayed by pressing the appropriate key: it can then be checked, and manually adjusted if necessary, and returned to store. When the input data are complete the computer is commanded to "compute" and the computer output can then be transmitted verbally or automatically to the firing positions.

The computer, developed by Saab-Scania, has a memory capacity of 16,000 words – extendable to 64,000. Other types of modern multi-purpose computer can be used, however, provided they meet the appropriate operational and environmental specifications.

MECHANICAL AND ENVIRONMENTAL CHARACTERISTICS:

Width: 545 mm
Depth: 1,100 mm
Height: 1,085 mm
Weight: 50 kg
Power: 22-28V d.c. 150 W
Operating temperature range: –30°C to +45°C
Storage temperature range: –50°C to + 70°C
Moisture: 0 – 100% RH



ACE-380 Field Artillery Computer Equipment

MTBF: 1,500 hrs on active service

MANUFACTURER:

Saab-Scania, Missile and Electronics Section, S-581 88 Linköping, Sweden.

2344.163
FIELD ARTILLERY FIRE CONTROL EQUIPMENT 9FA 101

DESCRIPTION:

This is a digital system for the control of field artillery. In its simplest form it consists of a d.c. powered combined input keyboard, computer and output display; but for most practical purposes it may be assumed that the system will be augmented by the inclusion of display repeaters at the gun emplacements. A further possible extension is the addition of a radio data link (called HADAR) between forward observers and the 9FA 101 computer station.

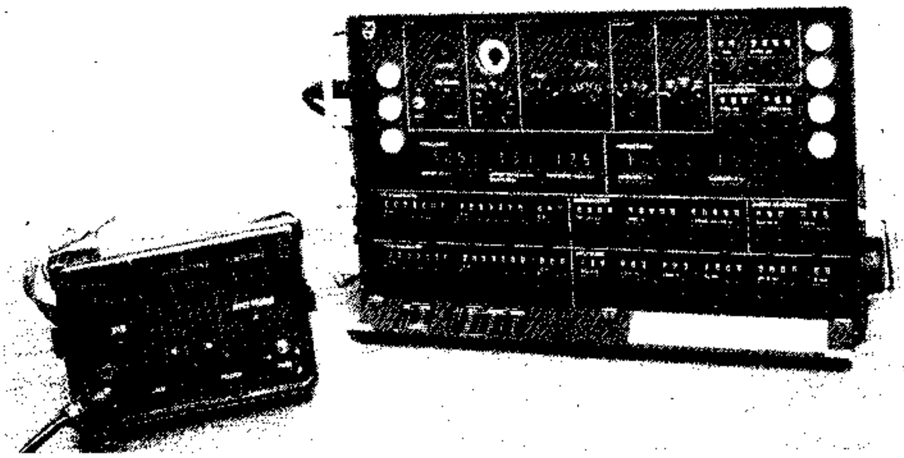
Data are supplied to the computer by keying the appropriate co-ordinates, etc., and in some instances by setting multi-position switches. When data on any target are complete the computer is caused to calculate the train, elevation and fuse information required for any designated gun. These calculations are displayed on the main control instrument but they can also be displayed on small repeaters (gun indicators) mounted on the guns. These repeaters incorporate lights and buzzers to give firing commands, or indicate that new target data have been computed, and incorporate a speech channel for communication.

A further sophistication of the system can be achieved by adding gun direction equipment consisting of a gun indicator with an optical telescopic sight with an automatic input.

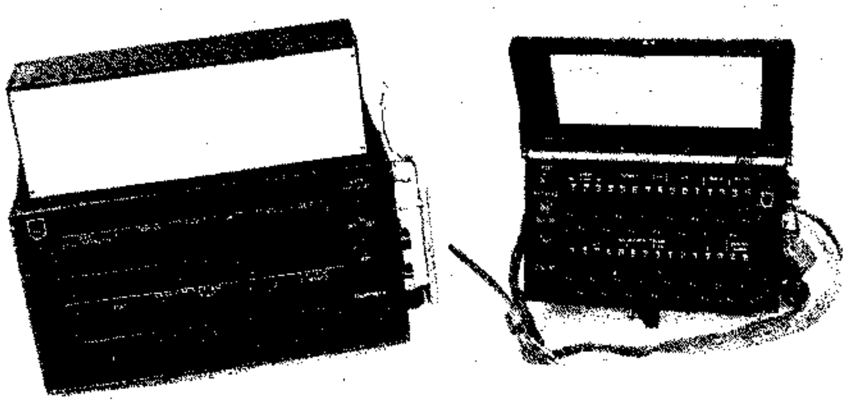
Main tactical functions performed by the system are:

Calculation of firing data on the basis of manually set or automatically fed input values.
Tactical switching between a maximum of 28 selectable ballistics.
Input of fire observation data in accordance with the line-of-collimation principle.
Computation of co-efficients for utilisation of the experimental fire correction.
Input of altitude observation data for fuse setting.
Input of speed and course of moving targets.

As already noted, there is also available a data transmission equipment called HADAR which is compatible with the 9FA 101 and enables a forward observation post to communicate conveniently and unambiguously with the command post.



Ballistic computer and gun indicator of 9FA 101 Field Artillery Fire Control Equipment



HADAR data reporting equipment

CHARACTERISTICS:

Type of computer: Special purpose, fixed programme and constant memory
Word length: 17 bits
Number representation: Serial binary, negative numbers in 2-complement
Time of computation for firing data: Approximately 1 sec
Build up: Integrated circuits
Power: 24 V d.c. approx. 75 W for the ballistic computer. 14 V d.c. approx. 15 W for the gun indicator

Size and weight: Ballistic computer: width 605 mm, height 366 mm, depth 223 mm. Weight 31.5 kg

Gun Indicator: width 267 mm, height 180 mm, depth 134 mm, weight 3.7 kg

Environmental: The equipment is built for use under the severest military conditions. It has been designed to meet the requirements for environmental endurance laid down by the Swedish Army for portable equipment corresponding to DEF 133, class 13, in applicable parts. The fixed memory ensures no programme loss after power failure and other disturbance.

STATUS:

The 9FA 101 system has been tested for two years by the Swedish Army and has been ordered for series production.

MANUFACTURER:

Philips Teleindustri AB, Fack, S-175 20, Järfalla 1, Sweden.

2346.163
TANK FIRE CONTROL EQUIPMENT – BOFORS TYPES S & C

DESCRIPTION:

Bofors make two basic types of tank fire control equipment. Type S for turretless tanks such as the STRV 103 (also made by Bofors – see entry number **5003.102**) and Type C for tanks with turrets.

Basis of both systems is the computation of lead angle by reference to the target range and the rate of change of target bearing (and taking into account ballistic data and wind speed and direction). The computation is simplified by using the measured range to define an integration time corresponding to the time of flight of the shell and then measuring the target angular displacement in that integration period. This measured displacement is then used to displace the line of sight so that when the operator is 'on target' the line of fire is appropriately displaced from the line of sight.

In their most complete form the fire control systems use a laser rangefinder for the critical range measurement; but simpler systems with provision for the insertion of range data obtained by other means can be provided.

Having initially lined up his sight with the target and having measured the target range, by means of the laser rangefinder or otherwise, the operator presses a button which initiates the integration process. While this process continues the operator must keep the target in his sight – which will be easier with sight and weapon stabilisation but is not impossible without. When the integration is complete the appropriate lead angle is injected into the sighting system and once the operator is 'on target' after the lead angle has been injected the gun may be fired with a high probability of success.

The main difference between the S and C systems is that the latter does not incorporate provision for computation of elevation lead angle. This facility is necessary in the S system because of the restriction of elevation movement for the gun of the STRV 103. Whereas in a turret tank the appropriate gun tangent elevation can be set independently of the nature of the terrain, the STRV 103 gun must be caused to fire (computer controlled) as the gun moves through the optimum elevation angle.

MANUFACTURER:

AB Bofors, S 690 20 Bofors, Sweden.

THE UNITED KINGDOM

2400.163
AMETS – ARTILLERY METEOROLOGICAL SYSTEM

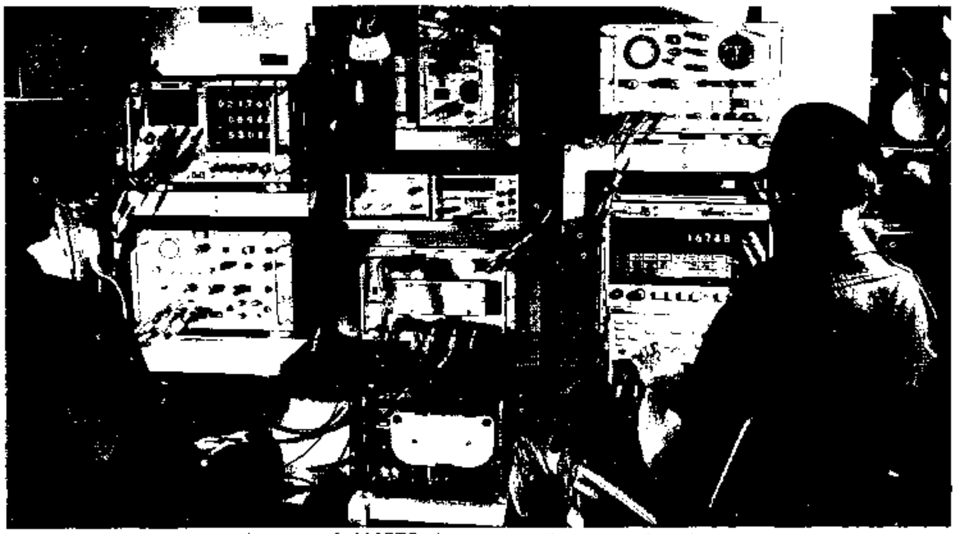
AMETS is the name given to a self-contained, computer-based, mobile meteorological system developed for the British Army by Marconi Space & Defence Systems Ltd. and Plessey Radar, for obtaining and processing information on atmospheric conditions automatically. It is capable of processing data from a wind-finding radar and radio sonde complex to an altitude of 20 kilometres every hour, and incorporates a facility to output partial messages within 5 minutes of the radio sonde passing through the relevant height band. A single AMETS will normally provide all meteorological data needed in the area of one Army Division.

AMETS uses a normal radio sonde but with a temperature sensor only. The outputs from radio sonde and radar are fed into a computer which can then calculate the required meteorological information. Measurement of surface pressure, and the average humidity figures which can be provided for the particular zone of operation are stored in the computer memory. The loss of accuracy resulting from this considerable simplification of radio sonde is negligible for artillery purposes, yet it offers appreciable gains in terms of operational simplicity, cost and reliability in military field conditions.

CONSTRUCTION:

The data processing part of the system is based on the 920B computer, produced by Marconi-Elliott Computer Systems, and already in use in a wide variety of military applications including FACE. The Plessey WF3M radar is built to full military standards, and is derived from the Plessey WF3 windfinding radar used for civil meteorology.

AMETS is mounted in a single instrumentation vehicle with a small trailer carrying the radar. In addition there will normally be a command post vehicle, and reconnaissance and stores vehicles to carry hydrogen and other troop stores. The instrumentation vehicle will carry all the data processing equipment, the radar and radio sonde monitoring and display units and a full range of diagnostic test equipment.



Interior of AMETS data processing control and display cabin

STATUS:

In service

MANUFACTURERS:

Marconi Space & Defence Systems Ltd., Military Division, Chobham Road, Frimley, Camberley, Surrey

The Plessey Company Ltd., Addlestone, Weybridge, Surrey.

2415.163
FACE – FIELD ARTILLERY COMPUTER EQUIPMENT

DESCRIPTION:

FACE is a field gunnery computer system specifically designed to perform quickly and accurately the lengthy calculations which are involved in producing artillery firing data. Traditionally, these calculations have been performed using range tables and simple analogue instrumentation. The first design studies for FACE began in 1963, initiated by the Ministry of Defence, and with the Royal Artillery and the Royal Armament Research and Development Establishment in collaboration. The first service models were issued to the British Army in 1969.

FACE undertakes two specific roles. Firstly, as an artillery survey computer it carries out all the calculations necessary in this task. Secondly, and more important, as a gun data computer it processes all the information required to place a shell accurately on the target and displays this information on a console. A single FACE system can handle the information relating to three batteries of eight guns each.

For each calibre of weapon in the gun data role and for the artillery survey role there is a programme tape stored in a sealed cassette, and the data on this tape can be read into the computer by the programme loading unit; this covers ballistic and other fixed data besides the computer operating programme.

Other data which, while not fixed, does not vary over appreciable periods of time, such as gun muzzle velocities and battery position, is entered manually by the operator, and once entered can be easily up-dated. An important feature is the ability of the system to accept meteorological data in the form of a punched paper tape, which can be prepared on the teleprinter which forms part of the system, and then read into the computer with a break in computation of firing data of less than a minute. This also enables new meteorological data to be accepted more frequently, which leads to more accurate shooting.

The basis of FACE is the Marconi-Elliott 920B digital computer, and the memory capability of the computer has been employed to remember drill sequences for the operator, and so make the system less complex to use.

OPERATION:

While the guns are deploying for action the console operator in the battery command-post vehicle begins to receive setting-up data. This is added to the information already in the computer's store which includes a latitude function allowing for earth rotational effects and the muzzle velocity for each gun for each charge. The first input is the geographical reference of the centre of the battery position – the "battery grid"; next, the position of each gun in relation to the battery centre, and the temperature of the ammunition charges. Then meteorological information is received by radio and is also entered into the computer. The equipment is now ready to receive data for shooting, in the form of target position and height, the type of ammunition to be used, etc. Once all the relevant information has been fed into the computer, it produces answers which are passed to the guns; the orders to fire can then be given.

The forward observer, noting the fall of shot, radios corrections relative to his line of sight back to the command-post. The console operator feeds these straight into FACE which computes updated gun data for relay to the guns.

Frequently, gunners are required to deliver fire in support of a pre-arranged battle plan. In practice, battle conditions often call for changes to this fire plan: because FACE has great speed and flexibility, these changes can be easily accommodated.

The new 105 mm, 155 mm and 175 mm guns have been in service for some time. They are all multi-charge weapons, having both high- and low-angle fire capability, and each employs many projectile types to give a wide choice of performance. Their versatility could not be fully exploited without the assistance of FACE. It is, however, equally applicable to rockets and guns of any other calibre.

FACE installed in a Landrover

STATUS:
In service with the Australian and British Armies.

MANUFACTURER:
Marconi Space and Defence Systems Limited, Military Division, Chobham Road, Frimley, Camberley, Surrey.

THE UNITED STATES OF AMERICA

2827.163
TACFIRE – TACTICAL FIRE DIRECTION SYSTEM

DESCRIPTION:

TACFIRE is an automated system of great complexity for the direction of artillery fire. Essentially devised for US Army operation in war situations where artillery formations are of battalion size or larger, and deployed over an area which can be covered by man-portable communications equipment, it embodies concepts which are of more general applicability – as also is some of the peripheral hardware.

Conceptually, the successor to the FADAC system (**1125.163**), TACFIRE's principal purpose is the achievement of a high degree of efficiency in the use of artillery fire. In the simplest possible terms it comprises a central powerful computer, which stores all the data that may be relevant to any likely tactical situation, a number of peripheral input devices, a central situation display system linked to a number of satellite systems equipped with input devices and situation displays and, finally, a large number of gunners who ultimately receive instructions to fire.

An artillery battalion – the smallest formation to which the complete TACFIRE system could be relevant – comprises three six-gun batteries and may have up to ten forward observers. Each of these observers has a device called a Fixed Format Entry Device (FFMED) which he can use to call for artillery fire. The message that he sends is digital and in a 1.3 second burst over land line or radio link to the central computer. If his request for fire is granted he can also use his FFMED to transmit corrections after the preliminary ranging round and call for Fire For Effect (FFE) when no further adjustment is required. Subsequently he will use his FFMED to confirm destruction of the target or otherwise update the computer.

The computer is located at a Fire Direction Centre (FDC); and when a request is received there it is checked and acknowledged to the forward observer and then entered into the computer. It is then processed, taking into account all the relevant data in the computer store and the situation, together with a suggested action, is presented to the Fire Direction Officer (FDO) by means of a Digital Plotter Map (DPM), possibly supplemented by an Electronic Tactical Display (ETD) – though this is usually found only at Divisional level – and an Electronic Line Printer (ELP). The FDO is equipped with an Artillery Control Console (ACC) which he can use to query the computer and which he also uses, when he has decided on the action to be taken, to route a message to the selected battery or batteries via the FDC.

At each battery there is a Battery Display Unit (BDU) comprising a Data Terminal Unit (DTU) and an ELP. Messages received are checked and acknowledged to the FDC and printed out for the battery commander. When a round is fired, the commander reports it to the FDO who instructs the forward observer to report the fall of shot. The battery command post can also be equipped with a transmit/receive Variable Format Message Entry Device (VFMED) which can be used to communicate ammunition or gun status to the FDC.

At the present time there is no provision for extending the system to provide data at the individual guns (cf **2344.163**) but this facility may be added later.

The foregoing is a simplified description of a very complex system; some further details of system components are given below.

Units normally associated with a Division Artillery Fire Direction Centre (FDC):

(1) Computer Centre Equipment (at FDC)
Computer (L-3050M)
Data Terminal Unit (DTU)
Artillery Control Console (ACC)
Digital Plotter Map (DPM)
Electronic Tactical Display (ETD)
Electronic Line Printer (ELP)
Removable Media Memory Units (RMMUs)
Random Access Memory (RAM)

(2) Remote Equipment:
Fixed Format Message Entry Devices (FFMEDs) with Air Observers (AOs) and other acquisition agencies
Variable Format Message Entry Device (VFMEDs) with Survey Teams and at Missile Battalions

Units normally associated with a Battalion Fire Direction Centre:

(1) Computer Centre Equipment (at FDC) Computer (L-3050M)
Data Terminal Unit (DTU)
Memory Loading Unit (MLU)
Artillery Control Console (ACC)
Digital Plotter Map (DPM)
Electronic Line Printer (ELP)

(2) Remote Equipment:
Battery Display Units (BDUs) at Batteries
FFM-EDs with Forward Observers and at other locations

Computer:

The L-3050M computer is the heart of the TACFIRE System. It is a general-purpose, microelectronic computer specifically designed for tactical use. It has commands added to the normal general-purpose computer commands to facilitate solution of the real-time command and control system problems required in TACFIRE.

The DivArty and Battalion computers are identical, except for an auxiliary operation kit for DivArty. The auxiliary operation kit contains a central Processing Unit (CPU) identical to that employed in the main computer to provide backup for full operation without degradation in case of main computer CPU failure.

Artillery Control Console (ACC):

The ACC is the primary man-machine interface at the FDC. It provides a true, real-time, general-purpose entry/query capability for a large data base and permits requests for calculations via messages composed in user language. It has two separate Display/Editor Assemblies with CRT screens for alphanumeric information display; one for receipt of incoming messages and the other for message composition and editing.

The keyboard consists of a standard ASCII alphanumeric keyboard plus editor controls. The switch panel has special action switches and a designator matrix for 64 of the most frequently used designators. The panel can be changed in the field to accommodate the specific needs of the user by composing a new matrix on the editor and requesting a computer printout on the Electronic Line Printer (ELP). The print-out fits under the plastic plate in place of the old designators.

Digital Plotter Map (DPM):

The DPM is a large-scale, automated display device that allows FDC personnel to plan operations, monitor activities, and retain an overview of the tactical situation. The DPM used at DivArty also meets Battalion requirements. It features:

4- by 4-foot (122 × 122 cm) plotting surface
Plots on overlay of standard Army field maps, or on map itself
Plot lines, boundaries, site symbols, and other required data
Computer driven (direct) or manually operable
Accuracy to +1/32 inch (0.8 mm)

Electronic Tactical Display (ETD):

This augments the DivArty DPM to provide an electronic tactical map capability. It permits almost instantaneous composition of different tactical displays for situation assessment using offset, expanded and selected site symbol categories. Other features include:

17-inch (432 mm) CRT display
Light pen selection of displayed data
Computer driven-display map lines and 250 site symbols
Easy orientation of DPM display

Electronic Line Printer (ELP):

The ELP is a nonimpact printer using a CRT and thermo-electric process to print on direct-write paper. It features high-speed printing (600 characters per second) and direct drive by the computer.

Production of permanent (archival) records.

Removable Media Memory Unit (RMMU):

Bulk memory storage required for the DivArty FDC is provided by the RMMU and the Random Access Memory (RAM). The RMMU provides memory storage of 300,000 words for additional DivArty data and programs.

Memory Loading Unit (MLU):

Operating in conjunction with the computer is the Memory Loading Unit, an auxiliary tape memory unit providing storage capacity of 300,000 words for additional quantities of data and program and providing the initial loading capability for the main computer memory.

Random Access Memory (RAM):

The RAM provides additional bulk memory storage for increased DivArty data and programs. It has a memory capacity of 10 million bits (400,000 words).

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Random Access Memory (RAM):

The RAM provides additional bulk memory storage for increased DivArty data and programs. It has a memory capacity of 10 million bits (400,00 words).

Data Terminal:

This unit is used at all DivArty and Battalion FDCs and in remotely used BDUs and VFMEDs. It operates in the half-duplex mode over standard Artillery communication nets shared by many subscribers and shared with voice communication.

Battery Display Unit (BDU):

The BDU, located at the firing batteries, displays and provides hard copy printout of fire orders and other messages sent to the batteries. It provides alarms and certain discrete illuminated indications. The BDU works on existing Artillery communication nets (radio or wire) in conjunction with voice.

Message Entry Devices:

The fixed Format Entry Device (FFMED) is a small rugged, lightweight, hand-held device used by FOs (and other field personnel) for entering digital messages into the FDCs. Messages are sent digitally via the setting of 25 front-panel switches. The unit works over existing Artillery communication nets using radio or wire line in conjunction with voice transmissions.

The Variable Format Message Entry Device (VFMED) provides two-way digital communication from remote units such as Survey Parties and Missile Battalions to DivArty FDCs.

STATUS:

In development for the US Army.

MANUFACTURERS:

Data Systems, Division, Litton Industries, 8000 Woodley Avenue, Van Nuys, California, USA.

1627.063

UNI-COMP SIGNAL ANALYSIS SYSTEMS

DESCRIPTION:

The Uni-Comp Incorporated signal analysis systems comprise a number of hardware options for use with the company's Comp-16 and Comp-18 miniature digital computers. Typical applications are in radar, sonar, and acoustic data reduction and analysis, and intelligence and monitoring operations. The range of hardware includes:

Super Fast Fourier Transform (SFFT) – 030
Vector Complex Multiplier (VCM) – 031
Matrix Complex Multiplier (MCM) – 033
Vector Complex Co-ordinate Converter (VCCC) – 032
Multiply/Divide/Square Root (MDSR) – 002

The above optional hardware modules are used to increase the computational speed of signal analysis systems versus a software approach. They are low priced accessories and enhance the opportunities for real-time analysis and processing.

The system is a flexible approach to the acquisition, and analysis of analogue signals created by various types of transducers. Designed around UniComp's 16 or 18 bit mini-computers, it can perform the following basic operations:

(1) Time sampling of one or more input analogue signals.
(2) Analysis of the acquired data using Fast Fourier Transforms, correlation analysis, convolution, power spectrum analysis, Hanning weighting, and combinations of these.
(3) Recording the raw and processed data on magnetic tape for later analysis or processing.
(4) Displaying the raw and analysed data in real-time for operator examination.

Alternatively, the system can create analogue signals containing specified frequency characteristics. Also, signals received can be modified according to desired criteria and re-created in different forms. An example is the selective shift of frequencies, phases, and amplitudes.

The 'Super-fast Fourier Transform' hardware option adapts the COMP-16 or COMP-18 general purpose computers to on-line real-time systems where simultaneous time and frequency domain analysis is required. The hardware is flexible and adaptable to a variety of systems configurations. The hardware consists of an indexing unit and complex arithmetic unit which together perform Fourier transforms on blocks of data in memory. The size of data blocks is controlled from the computer, and must be a power of 2, hence the buffer is usually 128, 256, up to 8,192 samples but other sizes can be accommodated.

The power of 2, to be used in the analysis is sent from the computer to the hardware indexing unit. A start command is then given which starts either the forward or reverse Fourier transform process. Data is moved from the computer's memory, operated on and put back in memory. The data is operated on in the complex arithmetic unit. This unit incorporates a new algorithm for complex multiplication which performs the following operation:

$$X = (REAL \cdot \cos(THTA) - IMAG \cdot \sin(THTA)/2$$
$$Y = (REAL \cdot \sin(THTA) + IMAG \cdot \cos(THTA)/2$$

Where REAL and IMAG are data supplied from memory and THTA is an angle supplied by the hardware indexing unit.

New algorithms have been incorporated in the hardware which reduce the basic FFT computation cycle by a factor of four over other methods. Control is provided for selecting either the one or two word complex format. With the two word format, up to 16 or 18 bit accuracy is preserved; however, twice as much memory is used for the same number of samples. If one word format is selected both real and imaginary samples reside in one computer word. This forces the sample size to be less than 8 (or 9 for COMP-18) bits. However, the Fourier transform is completed in ¾ of the time required for two word format.

The following estimated times are provided for the Fourier transform task for a block at N real samples complex or N/2 samples:

Time = 1·5·(N-1)·(2N) microseconds

Complex points	Real points	Time for F.F.T.*
256	512	6 milliseconds
512	1024	14 milliseconds
1024	2048	30 milliseconds
2048	4096	68 milliseconds
4096	8192	148 milliseconds

*Time assumes all data blocks are core resident.

MANUFACTURER:

UniComp, Inc., 18219 Parthenia Street, Northridge, California 91324, USA.

1125.163

FADAC SYSTEM

DESCRIPTION:

The Field Artillery Digital Automatic Computer (FADAC) System is comprised of the Computer, Gun Direction, M18 (FADAC); Test Set, Computer Logic Unit, AN/GSM-70 (FALT); and Reproducer, Signal Data, AM/GSQ-64 (MLU). The Teletypewriter Set, TT-537/TG is used by the US Army for FADAC Artillery Survey, LANCE, Engineering Survey, and Met Data Reduction applications as the means to produce typed information as an output from the FADAC. A 3 kW Generator is used to provide the necessary electrical power.

FADAC is an electronic, general purpose, digital computer designed primarily for the automatic computation and display of firing data for tubed artillery, free flight rockets, and various types of missiles. In the role of fire control, the computer is capable of storing data for five batteries of any two calibres of cannon artillery. Data can be provided for each of these batteries by simple operator selector of the battery solution desired. For example, the computer can have ballistic data for both the 105 mm and 155 mm howitzer stored in its memory at one time. By insertion of new programmed information into the FADAC memory (by means of the MLU) and changing the input matrix panel, the operator can make program changes to permit solution of rocket, missile or other artillery problems such as survey counter-battery counter-mortar fire, fire planning, flash and sound ranging, reduction of meteorological data and master control for programmed automatic check-out equipment.

FALT is a test set used with the MLU to locate malfunctions in the FADAC. With proper test tapes, the FALT also has the capability of self-testing itself or can be used to test other FALTS.

The MLU is a photo-electric tape reader and is used to load the memory of FADAC. It is also used with the FALT to perform diagnostic test (trouble-shooting or check-out) of the FADAC.

GERMANY (FEDERAL REPUBLIC)

1619.163
FLER-H TANK FIRE CONTROL COMPUTER

DESCRIPTION:

The FLER-H is a hybrid computer of modular construction, principally designed and developed for use in tank fire control systems, but capable of other military applications such as anti-aircraft and artillery systems. The main elements of the computer are the computer core store and the computer control unit, plus a number of peripheral units. These include a vertical sensor for trunnion cant and terrain slope; an air data sensor; and a powder temperature measurement unit. The store is mainly comprised of integrated circuits, and, the processing of non-linear data such as elevation angle and correction data is effected by hybrid multipliers and using polynomial approximation. Modular ballistic units provide for the known parameters of the various types of ammunition used. Other input data apart from that previously mentioned consists of range, target tracking in azimuth and elevation, crosswind component, gun tube wear, departure error and parallax. Outputs of the FLER-H cover the correction angles in the form of AC electrical signals to control the sights and the weapon.

DEVELOPMENT:

Development has been carried out jointly by AEG-Telefunken and Philips Teleindustri AB.

1626.163
FALKE AND MARDER COMPUTERS

DESCRIPTION:

Falke and Marder are similar versions of AEG-Telefunken TR-84M digital computers, the main differences being in the mechanical packaging and input/output arrangements. The TR-84M is one of several military processors developed from the civil TR-8 range of machines, and others in the military range are the TR-84F, TR-86M, and TR-88M.

The Falke and Marder versions were developed for the West German Defence Ministry Falke artillery computing system, and the Marder programme, respectively. In the complete Falke system, five TR-84M computers are employed for the following functions:

(1) For sound ranging data reduction to locate enemy guns.
(2) For flash spotting data reduction with the same objectives as (1).
(3) Processing radiosonde data and compiling meteorological messages.
(4) Artillery and ballistics computations at gun positions.
(5) Fire control and battery co-ordination.

The basic specification of the TR-84M, which is housed in a NATO Type II case, comprises a core store of 4096, 18-bit words expandable up to 16,384 words; 10 MHz clock frequency; a command store capable of accommodating 30 commands; 2 microsecs cycle time; 4 microsecs add time; 8 microsecs multiplication time. There is a comprehensive library of software for artillery applications.

Other members of the series have been configured for other military applications. The TR-84F is for airborne roles, the TR-86M for communications and control and fire control applications, and the TR-88M for other military control systems. For some functions 'back-to-back' working of two computers is provided for. The TR-86M is believed to be employed in some installations of the Hollandse Signaalapparaten M-20 Series naval fire control system.

STATUS:

Development was carried out by AEG-Telefunken in the late 1960s and quantity deliveries had commenced by 1969.

CANADA

1483.363
SENSOR DATA PROCESSING SYSTEM

DESCRIPTION:

The Canadian Armed Forces Maritime Command is using a sophisticated airborne Anti-Submarine Warfare (ASW) sensor system which has been developed over a number of years since 1969 at a total cost of nearly $10,000,000. This was awarded to Computing Devices of Canada for development of both hardware and software based on the ALPHA computer, originally developed by Computing Devices' parent company in the US, Control Data Corporation.

The Computer Sensor Processing system accepts raw signal information from sensors such as airborne sonar and converts the analogue signals into digital information. This is processed by the ALPHA computer and its associated peripheral equipments. The computer is programmed for detection and pattern recognition. In the event of a pattern being recognised indicating the presence of a submarine (in the case of the ASW) the computer uses the input data to provide bearings and sound an alert, with an indication of the type of target detected.

The ASW system currently in use with the Canadian Maritime Command has been in operational use since 1965, and comprises the following modules: ALPHA central processor, 16k core memory, interface to Canadian Armed Forces equipment, independent input/output processor, two Dynatape magnetic tape mass storage systems, magnetic tape unit controller, cooling system and the power distribution box.

Recent system enhancements indicate that this system may become the advanced OMNI and directional Sensor Data Processing system suitable for application in the new ASW patrol aircraft under consideration by Canada. Latest system addition is the Fast Fourier Transform (FFT) analyser which will enable the combined signal and data processing system to handle a wider range of sensors without the necessity of any costly aircraft re-equipping.

The FFT peripheral equipment is a general purpose, high speed signal processing unit intended for military applications requiring compactness, and high performance coupled to low power consumption. The FFT – which makes extensive use of medium scale integrated circuits and MOS technology – has been specifically designed as a peripheral to the ALPHA-based system, hence obviating the need for interfacing hardware.

As well as use with sonar devices, the system is suitable for on-line processing in conjunction with electronic warfare devices, communications equipment, infra-red systems, seismic devices and radar.

MANUFACTURER:

Computing Devices of Canada Ltd, PO Box 8508, Ottawa, Canada KIG 3M9.

ANCILLARY EQUIPMENT— GUNS AND MISSILES

BELGIUM

2598.183
SABCA TANK FIRE CONTROL SYSTEM
DESCRIPTION:

The SABCA Tank Fire Control System (TFCS) is in full production for the Leopard tanks of the Belgian Army. Delivery will start at the end of 1975. A pre-production run of four equipments was ordered at the end of 1971 and these are undergoing trials by the Belgian Army.

SABCA is prime contractor for the system with two main sub-contractors: OIP (Société Belge d'Optique de Précision – Gent) for the sight and CBL (Compagnie Belge des Lasers – Gent) for the laser (CGE licence). The specific responsibility of SABCA is for the computer, sensors, mirror drive, system integration and installation kit.

The SABCA TFCS uses high accuracy analog computation technique in the ballistic computer and non-standard condition sensor normalisation circuits. The high performance laser uses logic circuits for range computation.

A combined laser/optical sight makes use of a ruggedized two-degree of freedom gimballed mirror drive, in order to keep the reticle always centered in the field of view regardless of the lead angle value. The mirror drive approach also automatically keeps the laser and optical axes exactly aligned at all times.

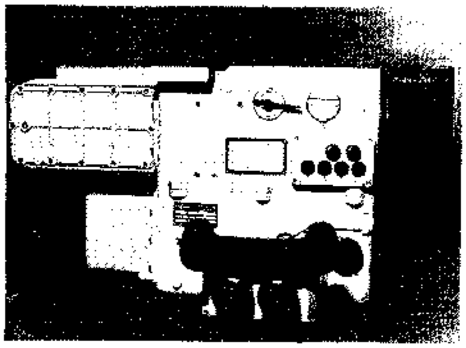
System built-in test, both continuous and triggered, gives a high confidence level in the system operation, and automatically designates the faulty unit in case of failure. The whole is designed for simple and easy maintenance and maximum accessibility.

A Firing Simulator for combat tanks called TALAFIT is also produced by SABCA and a prototype has been delivered to the Belgian Army. Full production will begin in 1974. TALAFIT consists of a simulator unit and a control panel for the instructor. It is installed on the gun turret in front of the gunsight window. The gunner is presented with a fixed battle scene with standing and moving targets, which he has to detect, identify and to engage.

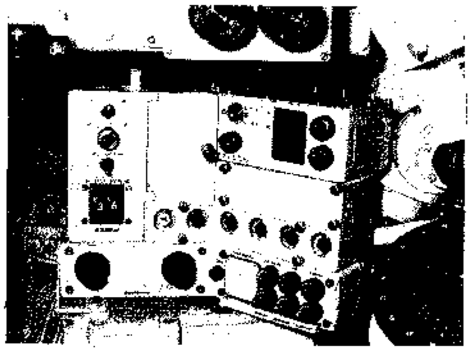
The instructor is able to observe aiming and operating errors and to check the gunner's reaction time. It is also possible to interconnect several trainers for gunnery competitions, each trainee being installed in his own tank.

MANUFACTURER:

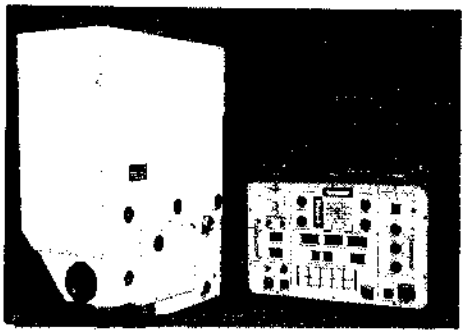
SABCA Chaussée de Haecht 1470, 1130 Bruxelles, Belgium.



TFCS Laser Sight Unit



Gunner's Control Unit of SABCA TFCS



SABCA TALAFIT

DENMARK

1576.153
DR 513 BALLISTIC RADAR
DESCRIPTION:

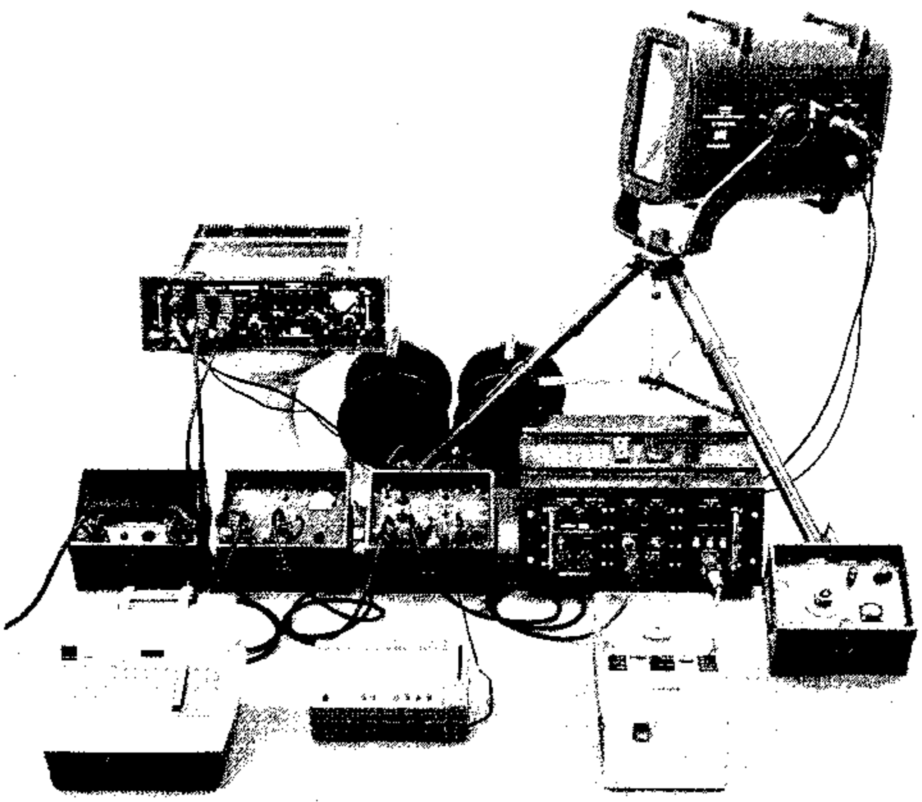
The doppler radar DR 513 is a ballistic measuring instrument designed for muzzle velocity measurements on various kinds and sizes of projectiles. The equipment is equally well suited for use in the field and on shooting ranges. The basic doppler equipment consists of the Antenna Unit, Data Unit, and Test Unit.

The antenna unit contains a horn antenna with a dielectric lens and the receiver-transmitter assemblies. The mechanical as well as the electrical construction of the antenna unit is designed to withstand a very high degree of shock and vibration, making it possible to place the unit next to or even on top of the firing equipment. By this means the geometrical error is minimised, and thus the accuracy of the equipment is increased.

The doppler signal from the antenna unit is transferred to the data unit by means of a coaxial cable. The doppler signal is led through filters to an assembly where the "velocity" is measured at two points of the trajectory. The result is displayed on the front panel. By means of the test equipment it is possible to simulate a moving target, making it easy to check the whole radar equipment.

To extend the possibilities of the basic radar equipment a number of additional units are available. Through use of the entire system, and the collected information, it is possible to make advanced trajectory analyses such as digital and analogue measurements throughout the trajectory.

By means of punched paper tape, the results and additional information can be transferred to a computer for further processing.



DR 513 Muzzle velocity doppler radar system

CHARACTERISTICS:

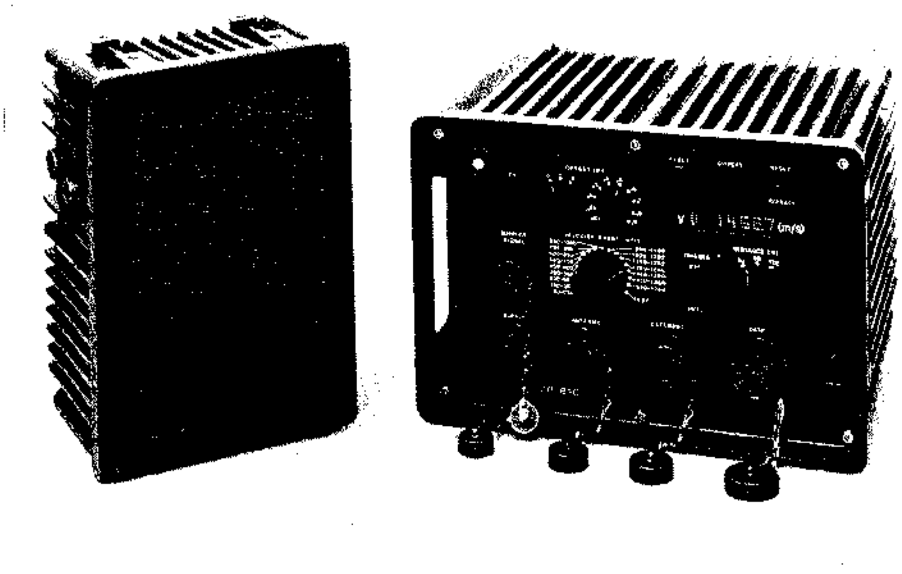
Technical Specifications (basic equipment):
Antenna unit: Horn antenna with dielectric lens
Beamwidth, Horizontal: 14 degrees
Beamwidth, Vertical: 6 degrees
Polarisation: Horizontal

Transmitter:
Frequency: 10493 MHz (standard)
Power output: 300 mW (minimum)

Receiver:
Duplex: Ferrite circulator
Noise figure: 13 dB

Velocity range: 50 2000 m/sec
Data display: Nixie tubes
Power supply: 24 V d.c. + 10 per cent
Dimensions and weights:
Antenna Unit: 620 × 400 × 270 mm
47 kg
Data Unit: 500 × 200 × 330 mm
24 kg
Measuring points: 30 and 40 m (standard)
Measuring base: 2 m (standard)
STATUS:
The equipment was developed by Terma Elektronisk Industri A/S, Arhus N, Denmark, and has so far been delivered to forces and weapon manufacturers in Denmark, Norway, Sweden, Finland, West Germany, Holland, Switzerland, Italy, Yugoslavia, Great Britain, Mexico, Singapore, Malaysia and Pakistan.
MANUFACTURERS:
Radartronic A/S, Helsingforsgade 14, 8200 Arhus N Denmark.

2286.153
DR 810 BALLISTIC RADAR
DESCRIPTION:
DR 810 (Doppler Radar 810) is designed to measure muzzle velocities (MV) under field-service conditions. The equipment consists of an Antenna Unit and a Data Unit and is constructed so that it requires a minimum of operation. The measurement procedure is fully automatic and the measurement result is presented in metres/sec. immediately after firing.
This is obtained by placing the Antenna Unit on the elevating non-recoiling parts of the gun so that the radar beam always covers the projectile's trajectory. The velocity is measured in several points of the trajectory and the muzzle velocity is found by extrapolation back to the muzzle.
CHARACTERISTICS:
a) The muzzle velocity is displayed in metres/sec. immediately after firing with an accuracy of 0.1%.
b) Average muzzle velocity of the last 2-8 shots can also be displayed automatically after each shot.
c) Velocity range 50-1750m/s.
d) Programmable Data Unit for optimal accuracy on different kinds of measurement problems.
e) Built-in interface capability for external data handling equipment (e.g. fire control computers).
f) The short processing time gives the ability of measuring the muzzle velocity of automatic weapons.
g) The Antenna Unit can be placed on the elevating non-recoiling parts of the gun or on a tripod next to the gun.
h) Automatic indication of measurement errors.



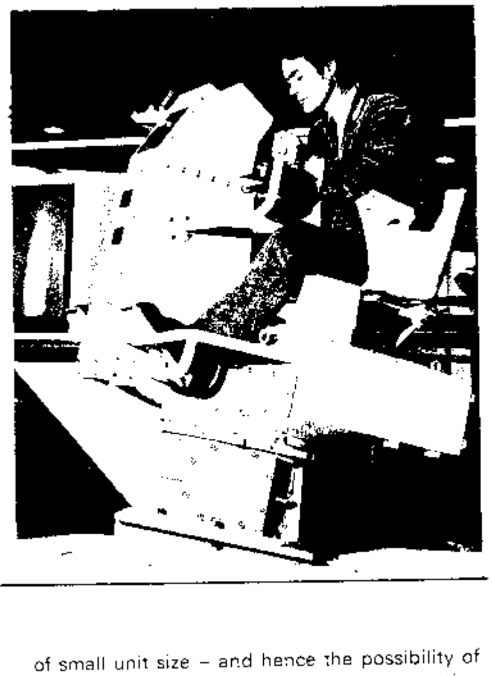
Units of DR 810 radar

i) The first measurement point can be selected 30, 60, 120 m from the muzzle in order to avoid muzzle flash disturbances.
j) Automatic correction of the parallaxe between the projectile trajectory and the Antenna line of sight.
k) 24 V DC and 220 V AC operation.
l) Crystal controlled transmitter frequency.
Antenna Unit:
Size (H × W × D): 305 × 217 × 163 mm
Weight: 13 kg
Data Unit:
Size (H × W × D): 250 × 367 × 316 mm
Weight: 22 kg
DR 810 is tested after IEC – 68 – 2

MANUFACTURER:
Radartronic A/S, Helsingforsgade 14a, 8200 Arhus N, Denmark.

FRANCE

2162.283
OPTICAL FIRE CONTROL AND TARGET DESIGNATION EQUIPMENT
DESCRIPTION:
This optical fire control and target designation set is a complex, lightweight one-piece unit which is easy to operate, and suitable for use on all kinds of surface vessels. It could also be installed in appropriate types of land vehicle.
Three operating modes are available: gun fire or missile-launching control; air and surface firing observation; operation with line-of-sight controlled by an external equipment. The set incorporates the equipment necessary for aiming and stabilising the optical line of sight (servo-control system and rate-gyro unit) and defining fire control co-ordinates and transmitting them to a weapon. If desired, the set may be associated with a cine camera, a low-light or normal TV camera and/or a laser range-finder. Adaptation to a particular weapon or system is achieved by changing modules.
CHARACTERISTICS:
Elevation: $-25°$ to $+65°$
Traverse: unlimited
Maximum angular velocity: elevation or traverse, 2 rad/sec
Weight: 330 kg approx
Clearance radius: 0.75 m
STATUS:
In series production for the French Navy and others.
MANUFACTURER:
CSEE – Compagnie de Signaux et d'Entreprises Electriques, 2-9 rue Caroline, Paris cédex 17, France.



CSSE Optical fire Control and Target Designation Equipment

ITALY

2234.283
GUN REMOTE CONTROL EQUIPMENT
DESCRIPTION:
This equipment has been designed to provide accurate and rapid control of the movement of guns and similar heavy devices on training and elevation mountings. The initial application will be to 3-inch and 5-inch guns but rocket launchers and radar antennas are other suitable applications.
The basic idea is that of taking advantage of the low inertia of a small DC electric motor and multiplying the mechanical output of such a motor by a factor consistent with the mechanical power required by coupling a series of motors in parallel by mechanical means. In this way the total inertia of the mechanical array is maintained at a lower level for a given power output than that of an equivalent single motor. The motors – which are, of course, low inertia types – are driven by an electrical system which uses silicon controlled rectifiers.
Primarily aimed at providing a means for rapid slewing in training and elevation with low angular error, the equipment offers the added advantages of small unit size – and hence the possibility of compact installation – low power consumption and ease of repair and maintenance.
DEVELOPMENT:
Development was started as a private venture in 1968, the first prototype was completed in May 1969 and service entry was planned for October 1969. Twenty-six installations have been ordered for use with gun mountings in the Italian, German and Canadian Navies.
MANUFACTURER:
OTO Melara, Via Valdilocchi, La Spezia, Italy.

2247.293

ALBATROS MISSILE LAUNCHER

This equipment is intended for use in the Albatros weapon system (**1551.281**) employing the Sparrow RIM-7H or the Aspide 1A missile. It is an 8-compartment launcher designed for installation on warships ranging in size from corvettes upwards. The launcher consists of a training mounting on which the group of eight launching cells is mounted and can be elevated or depressed.

Each cell contains a missile with folded wings, hanging from a launching rail. The cells are airtight and provided with an autonomous climatization system.

The forward hatch will open automatically an instant before firing and the light rear cover will be broken during firing by the exhaust pressure. Should an accidental ignition occur, the missile will remain hooked on the rail, the adjacent cells will not suffer, and the gases will escape through the rear blast cover.

DEVELOPMENT:

Development started in 1968 on an Italian government contract and firing tests were successfully concluded in 1971 at the Sardinia missile range. Technical and operational evaluation was carried out by the Italian Navy in 1972/73 with a prototype of the launcher installed on an operational ship.

CHARACTERISTICS:

Training:
Arc: +165°
Speed: 45 deg/sec
Acceleration: 30 deg/sec/sec
Resetting time for 120 deg: 5 sec
Static error: +1 deg

Elevation:
Arc: −5 +65 deg
Speed: 25 deg/sec
Acceleration: 30 deg/sec/sec
Resetting time for 60 deg: 4 sec
Static error: +1 deg

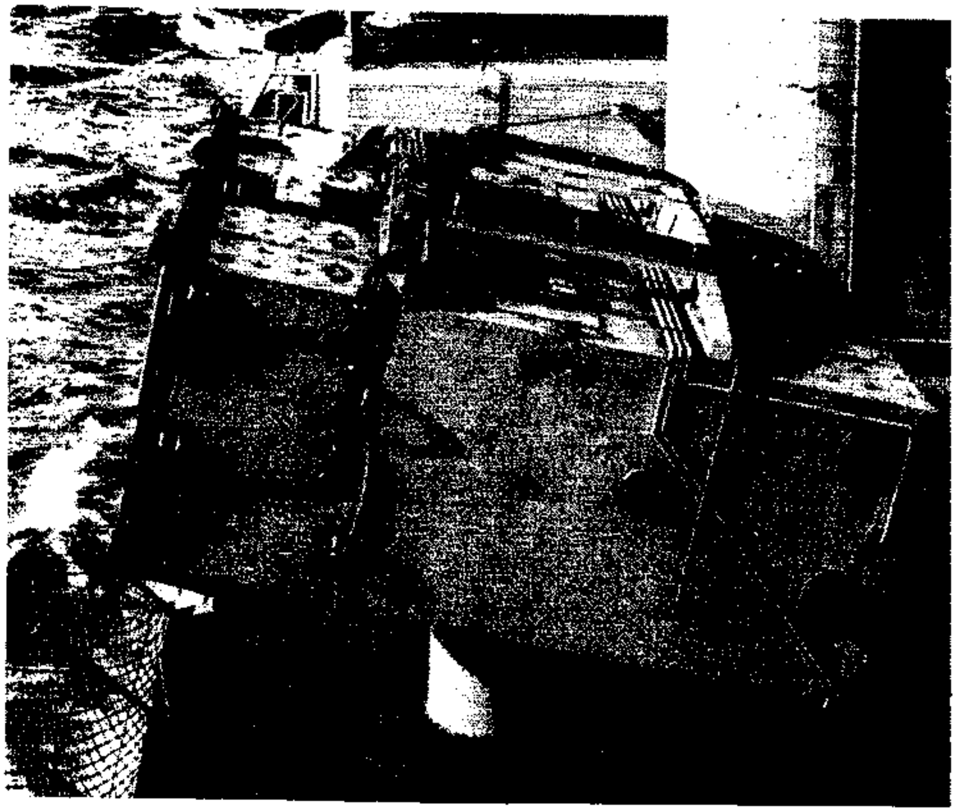
Electric supply requirements:
115 V 400 Hz three phase
440 V 60 Hz three phase
28 V DC

Total rated power: 30 kVA

Environmental conditions:
Operating temperatures:
min: −10°C
max: +38°C plus solar radiation of 1,000 W per sq metre
Storage temperatures:
min: −10°C
max: +75°C

Weight less missiles: 7 tons

Applicable specifications are the MIL Standard and Italian Navy specs.



Albatros missile launcher

MANUFACTURERS:

OTO Melara, Via Valdilocchi, La Spezia, Italy.
Selenia Industrie Elettroniche Associate SpA, Via Tiburtina, Km 12.4, Roma, Italy.

SWEDEN

2399.183

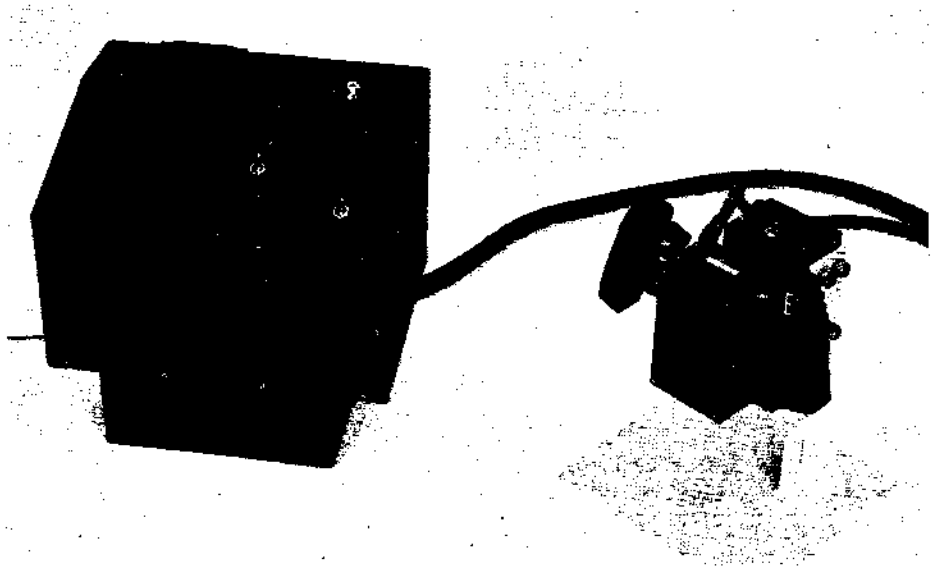
TANK FIRE CONTROL SYSTEM

DESCRIPTION:

This is a computer-controlled fire control system designed for use in the Swedish IKv91 light tank (**5063.102**) but capable of further development to meet the requirements of other tanks and of more sophisticated gun-laying.

Heart of the system is a ballistics computer which accepts any or all of the following preset or continuous inputs.

Range from a laser range finder or manually set
Ammunition characteristics of up to three different types
Muzzle velocity and powder temperature for each type of ammunition
Air Pressure
Air Temperature
Cross wind
Angular velocity of target in azimuth and elevation as measured by the gunlaying system
Deviation angles in azimuth and elevation (according to type of ammunition)
Trunnion tilt
Parallax correction gunsight to barrel



AGA Tank Fire Control System with computer box cover closed

The computer is an all-electronic device using dc voltages to form control analogues but with digital control of logic and switching functions. Using the input data listed above, it calculates the lead angle and superelevation needed to hit the target whether the latter be stationary or moving. The trunnion tilt is measured by a single pendulum with its axis, parallel to the gun axis; and since the gunner's line of sight is also parallel with the gun axis, the tilt is measured in the weapon-gunsight coordinate system and is thus independent of any inclination of the chassis in other directions. This tilt correction is optional, however, and can be switched off if required.

Gun-laying can be performed either by the gunner or by the tank commander. Rate-aided control is used in both azimuth and elevation, giving high maximum laying velocities. The exact relation between the desired angular velocity demanded by the layer and the real velocity produced by the servos is controlled by accurate tachometers mounted on the servos.

The laying handle is operated by both hands and embodies a switch to introduce or remove lead angle computation according to the nature of the target, another to select laser range finder or manual range and, of course, the firing switch. It also includes a "dead man's grip" which switches off the servos when the handle is released. The servos are also switched off when hatches which can interfere with the gun are open. A further safety precaution is afforded by control of the permissible gun elevation which varies with direction relative to the chassis. An important feature is the quite independent line of sight which allows the operator to leave the lead angle switch on at any target manoeuvre aspect.

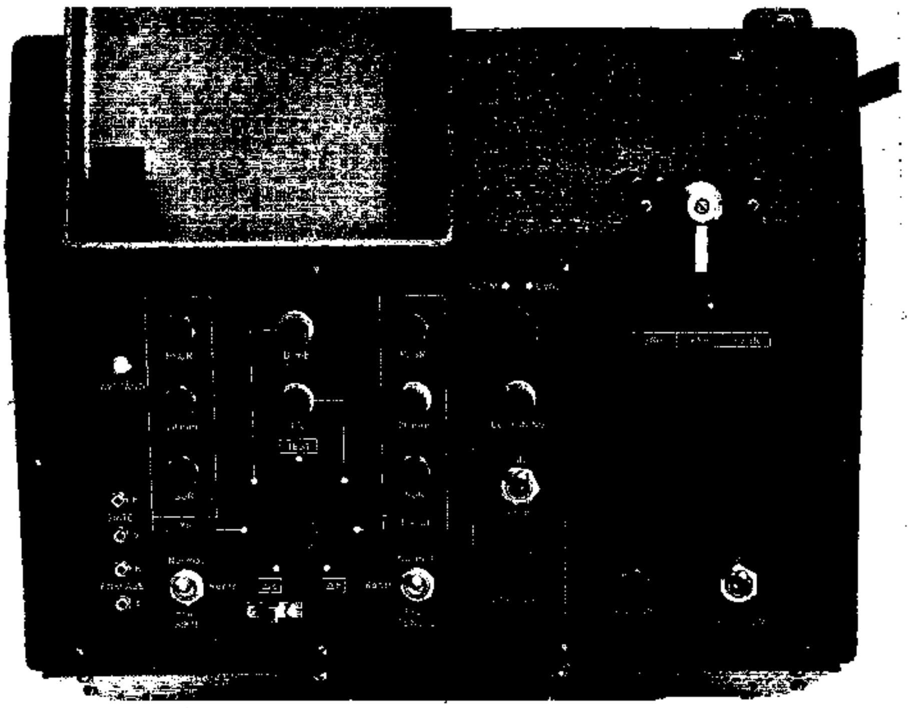
The computer is housed in a single box on the front panel of which are mounted all necessary controls. Most of these are covered by a hinged lid in operational conditions, the controls available in such conditions being the ballistics selector – a large 3-position switch – and the manual range and crosswind setting controls. A display panel in the centre of this part of the front panel normally presents the manual range selected but can also be used to set crosswind. When the hinged lid is raised, this same display is used to present the set values of the ballistics and other controls as selected by a selector switch; it can also be used as a voltmeter for troubleshooting.

EXTENSION POSSIBILITIES:

As designed for the IKv91 the fire control system is used to engage targets when the tank is at rest. AGA, however, have also designed a system which can be used for fire control from a moving tank. A vertical reference gyro (also made by Aga) replaces the simple pendulum device and additional control circuits are used to establish a completely independent line of sight also in this system. Advantages of this approach to the problem (ie an independent line of sight in both systems) are said to be the possibility of obtaining high dynamic gunlaying accuracy without the need for powerful and costly gun and turret servos; and, resulting from this, the possibility of low-cost retrofits in older tanks.

CHARACTERISTICS:

Range: 200-2,000 m
Elevation: $-10°$ to $+15°$
Tracking speed: azimuth: 80 mils/sec; elevation: 40 mils/sec
Slewing speed: azimuth: 400 mils/sec; elevation: 200 mils/sec
Minimum speed: 0.1 mil/sec
MV: nominal + 50 m/sec
Powder temperature: $-45°$ to $+55°C$
Air temperature: $-45°$ to $+55°C$
Air pressure: 900 to 1,100 mb
Tilt: $+15°$
Jump: +3 mils



Computer box with cover open

STATUS:

After a development lasting less than a year, highly successful operational trials were carried out by the Swedish Army in the Summer of 1972.

The IKv91 installation is now in series production.

MANUFACTURER:

AGA 181 20 Lidingö 1, Sweden.

2324.153
ANTI-AIRCRAFT FIRE CONTROL SYSTEMS

DESCRIPTION:

Several mobile anti-aircraft fire-control systems designed and supplied for use with 40 mm or 57 mm Bofors anti-aircraft guns by L.M. Ericsson but no longer in production are still in service with the Swedish Army. Available information relating to three such systems is set out below.

1. Ericsson / Arenco Radar System

This comprises an Ericsson PE-48/T X-band radar (**2325.153**) and an Arenco Electronics computer mounted together with operator's equipment on a substantial platform which is levelled by hydraulic jacks. The radar tracks in range and angle and supplies data for processing by the computer which in turn provides fire control signals for two 40 mm or 57 mm guns.

2. Ericsson / Contraves Radar / Optical System

This comprises an Ericsson PE-452/T X-band radar (**2327.153**) mounted on a Contraves optical-tracking fire control unit which also contains a Contraves fire control computer. The radar measures range only; and radar range and optical angular data from the inputs to the computer which in turn provides fire control signals for two 40 mm guns. The chassis on which the system is mounted can be manhandled over short distances and is levelled by screwjacks.

3. Ericsson / Contraves Radar System

This comprises an Ericsson PE-453/T X-band radar (**2328.153**) mounted on a chassis which incorporates a Contraves fire control computer. The radar tracks in range and angle and the computer controls two 40 mm guns. The chassis is levelled by screw jacks.

A fourth Ericsson radar, the S-band PS-171/R (**2326.153**), is used as an early warning/putter-on. It is contained in a cabin on a four-wheeled trailer with the aerial on the roof.

STATUS:

All the above systems are believed still to be in service with the Swedish Army; but production has ceased and final deliveries were made in 1967.

MANUFACTURERS:

Systems and radars: Telefonaktiebolaget L.M. Ericsson, MI Division, S-43120 Mölndal, Sweden.

Computers: Arenco Electronics and Contraves AG.

Guns: AB Bofors.

2604.153
ISIDOR MUZZLE VELOCITY METER

DESCRIPTION:

Jointly developed by L.M. Ericsson and SATT Elektronik the Isidor muzzle velocity meter is intended for use with artillery under active service conditions.

The equipment consists of a light (4 kg) rectangular microwave antenna unit, which can be mounted on any convenient part of the gun structure so that the radiation axis is parallel to the barrel, and a calculator unit. If the gun does not provide a convenient attachment point for the antenna unit there is provision in the calculation process for the insertion of a parallax correction.

The antenna unit contains a solid state transmitter which energises the antenna through a circulator and supplies a reference signal to a balanced mixer in the receiver chain. The output from this mixer forms the input to a pre-amplifier and high-pass filter from which signals are taken by cable to the calculator unit. At this unit the doppler frequencies are measured and the corresponding velocities displayed – after corrections for parallax and retardation have been applied – as the difference between preset nominal and measured velocity for single rounds or as the average of a number of rounds.

Range capability of the equipment is more than 2,000 times the calibre of the shell – the purpose of this not inconsiderable range being to permit measurements to be made with high velocity guns around whose muzzles a cloud of ionised gas forms after every shot, making it difficult if not impossible for a radar device to 'see' the shell as it leaves the barrel.

Measurement accuracy of the equipment is said to be 0.5% and measurements can be made within the range 175 m/sec to 1,100 m/sec. The whole equipment meets Swedish Army environmental requirements.

MANUFACTURER:

Telefonaktiebolaget L.M. Ericsson, MI Division, S-43120 Mölndal, Sweden.

THE UNITED KINGDOM

1038.183
CHIEFTAIN TANK GUN CONTROL EQUIPMENT

DESCRIPTION:

Gyroscopic control is applied to the gun traverse and elevation axes through a servo loop. This stabilises the gun so that it is unaffected by any movement of the hull of the vehicle occasioned by rapid manoeuvre or movement over rough terrain. The system is used in the Chieftain tank and is largely responsible for the high in-motion performance achieved with its 120 mm high velocity gun. The basic principles of the servo system are similar to those employed on the Centurion. The mechanical considerations involved, however, differ considerably. There are three modes of operation.

OPERATION:

Non-Stabilised Mode: When the vehicle is stationary and the equipment is used in the unstabilised mode, the gunner is part of a fast response servo system controlling traverse and elevation while observing the target through a telescopic sight of high magnification. Separate controllers are available for traverse and elevation, or a 'duplex' controller for one-hand operation may be provided. The gunner can rapidly traverse and elevate in a few seconds and track a moving target to within about one minute of arc whilst awaiting the order to fire from the Commander.

Stabilised Mode: With the vehicle in motion, particularly over rough country, accurate laying would normally be impossible. In the stabilisation mode a pair of rate gyros mounted on the gun cradle produce electrical signals proportional to the angular velocity in space of the gun in traverse or elevation. These signals are combined with the output from the tachometer-generators to form a 're-set' signal injected into the appropriate servo channel. The effect is to keep the muzzle of the gun pointed at the same point in space.

Thus, in a Chieftain moving at speed across rough country, if the gunner now makes only the normal tracking corrections, the gun will continue to point at the target irrespective of the attitude of the hull of the vehicle.

Emergency Mode: The turret can be traversed at fixed speeds to right and left and the stopping position selected. In addition, a purely manual mode is provided in which the speed of traverse and elevation is limited by the ability of the gunner to rotate the heavy turret.

DEVELOPMENT:

Joint programme, GEC Electronics and the Fighting Vehicles Research and Development Establishment.

MANUFACTURER:

Marconi Radar Systems Ltd, Control Engineering Department, New Parks, Leicester, England.

2596.183
GUN CONTROL AND STABILISATION SYSTEMS GCE576 AND GCE581

DESCRIPTION:

These modernised gun control and stabilisation equipments have been designed primarily for installation in the Centurion tank. The purpose of the development is to enable countries who wish to retain their Centurion tanks in active or reserve service for several years to come to replace the obsolete thermionic Gun Control Equipment FV/GCE No 1 with a modern system. The reason for offering two versions of the equipment is that some Services wish to retain the original servo motors and metadynes mounted in the vehicles, and the GCE581 equipment is designed to operate with these machines. Using the original electrical machines means that the peak turret and gun speeds and accelerations are as for the original FV/GCE No 1 thermionic equipment; however, many of the advantages stated below are common to both versions of the equipment, and because better gyroscopes and higher amplifier loop gains are used, the stabilisation accuracy of the GCE581 system is much better than the FV/GCE No 1 equipment.

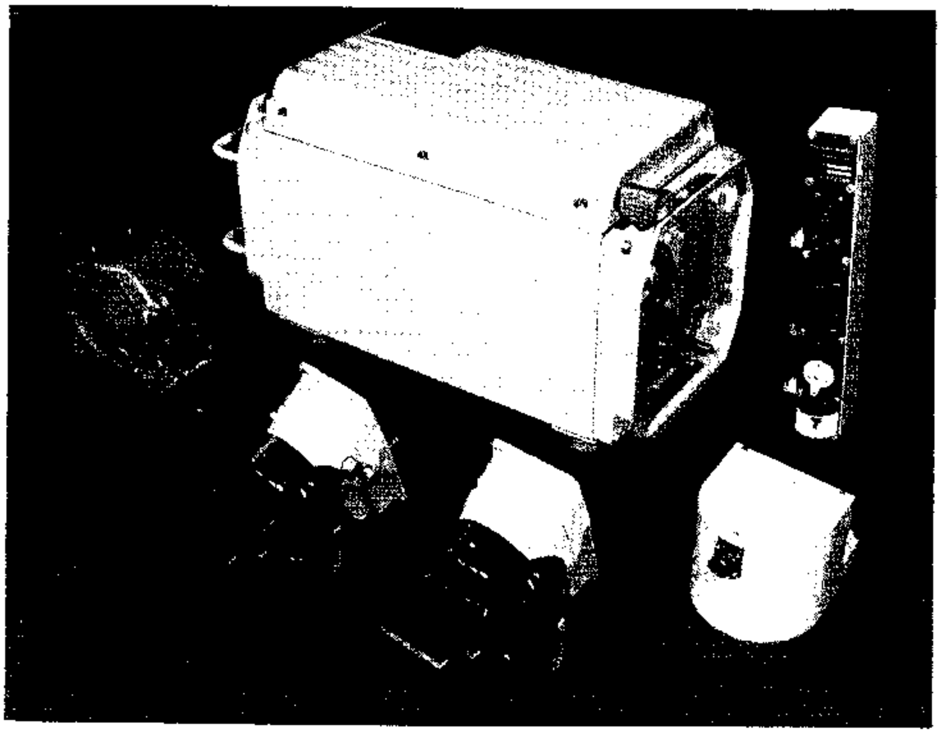
If a better performance as regards turret and gun speed is required, then it is necessary to change the metadyne and servo motors used with FV/GCE No 1 for more powerful machines, and Marconi equipment GCE576 uses such machines in conjunction with a new control cubicle.

The control cubicle itself uses modern components throughout, and improved testing and monitoring facilities are included so that faults can be rapidly traced and diagnosed, and the equipment set up quickly.

All units in the cubicle can be changed on a plug-in replacement basis, allowing repairs to be carried out rapidly by relatively unskilled staff. The size and weight of the cubicle has been reduced. All connectors are NATO-approved quick-release types.

The separate elevation and traverse gyros are replaced by a single modern 2-axis low drift gyroscope unit. A two-handed duplex gunner's controller replaces the original separate controllers, and allows more accurate and easier gun laying. The 400 Hz supply for the gyroscope spin motors is generated by a solid-state inverter mounted in the control cubicle, which replaces the motor-alternator set used with the FV/GCE No 1 system. The run-up time for the equipment is less than one minute, and in fact the system can be used after only twenty seconds, which considerably reduces the time required for the tank to achieve action-readiness. The power taken from the vehicle supply in the standby conditions (with the control equipment switched ON but the metadyne OFF) is reduced to less than 4 amps from 20 amps.

Relative performances of the two systems are:



New items of Marconi GCE576 and GCE581 systems showing the Control Cubicle with (left to right) the single 2-axis gyro unit, gunner's controller, commander's controller, elevation tachogenerator and switch unit

	GCE576	GCE581
ELEVATION motion of gun		
Max Controlled speed mil/sec (°/sec)	100 (5.7)	100 (5.7)
Maximum Acceleration mil/sec² (°/sec²)	240 (13.5)	440 (25)
Traverse motion of turret and gun		
Max Controlled Speed mil/sec (°/sec)	100 (5.7)	100 (5.7)
Max (slew) speed mil/sec (°/sec)	311 (17.5)	417 (23.5)
Maximum Acceleration mil/sec² (°/sec²)	550 (31)	666 (37.5)

It is seen that the GCE576 system allows an increase in traverse speed of 35%, and an increase in acceleration of 22% in traverse.

The stabilisation performance of the GCE576 system is such that a 2 mil diameter target is held for 56% of the total time when the vehicle is traversing a rough-country course at 10 mph.

Since the GCE581 system is not able to produce the same peak accelerations as can the GCE576, it will hold a 2 mil diameter target for 50% of the time.

It should be stated that these figures include all sections of the test course and that during severe hull manoeuvres or disturbances the gunner would not attempt to fire, giving effectively a better average stabilisation figure. For GCE576 the standard deviation from point of aim is 1.3 mils.

The mechanical condition of the vehicle must be reasonable but does not need to be first class in order to obtain a good performance when the Marconi gun control equipment is fitted.

MANUFACTURER:

Marconi Radar Systems Ltd, Control Systems Department, New Parks, Leicester, England.

2597.183
POWER TRAVERSE SYSTEMS FOR LIGHT FIGHTING VEHICLES

DESCRIPTION:

A power traverse system has been developed to meet the requirement for a power traverse facility in several AFV's, such as the Scorpion light tank and Fox armoured car.

The system can be fitted onto other AFV's which mount turrets having approximately the same weight and dimensions as the two vehicles referred to above, and by carrying out some modifications to the traverse gearbox a similar arrangement can be retro-fitted into Saladin armoured cars.

The manual traverse gearbox is replaced by a power traverse gearbox which fits directly in place of the present gearbox.

A control amplifier allows the motor speed to be varied from low speeds up to slew.

The gunner has a robust hand wheel which can be used to traverse the turret manually. When the handle is lifted against a light spring pressure, the power control mode is selected, and the handle is held in this position by a catch on the gunner's handle to prevent the gunner tiring. When the catch is released the handle falls back to the neutral position.

In order to engage the traverse hand drive, the gunner pulls down the handle, again against a light spring pressure, and engages the hand-drive gearing.

This allows the turret to be turned by hand, and thus operates as an emergency mode should any fault occur on the power system.

Some gunners also like to carry out the final laying of the gun by hand, and the arrangement described allows this to be done.

When the gunner selects the power traverse mode, zero turret speed is always demanded until he turns the handle in the direction in which he wishes to traverse the turret. Slew is achieved by moving the handle 30 degrees left or right, and the characteristic of the control is shaped so that accurate control of the turret at low traversing rates can be achieved easily.

The amplifier assembly is designed to be mounted at the base of the commander's sight, and the commander has a controller at his position which allows him to override the gunner and to turn the turret and gun onto any target which he selects.

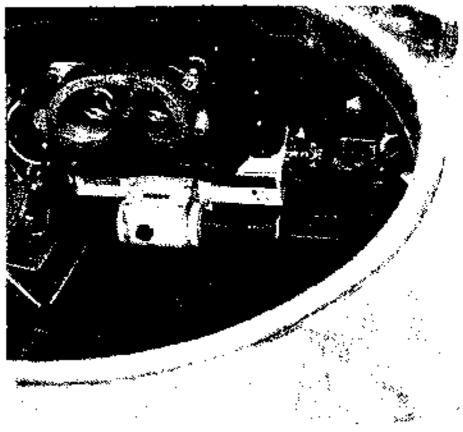
Full control of the turret over the complete speed range can be achieved by either the gunner or commander.

The existing manual traverse indicator can be mounted onto the Marconi power traverse gearbox, or a digital pickoff can be mounted which is used with a Marconi electronic traverse indicator, with digital readout of turret position in mils.

Special emphasis has been placed on ease of operation of the system. The gunner can control the turret from "creep" speeds, up to 427 mils/second under power without removing his hand from the manual traverse handle.

The commander can take control of the turret at all times when the system is in the power mode.

The control amplifier uses solid-state electronic components throughout, and is ready for immediate operation at switch-on. The amplifier output stage uses switching techniques which results in minimum power being dissipated in the amplifier assembly itself, and increases the electrical efficiency of the system. Electronic circuits limit the peak output current during a motor acceleration phase to 25 amps.



The commander's controller installed in Scorpion

The totally enclosed motor has an integral brake fitted, which is lifted when the gunner or commander demands power traverse, and therefore gives a fail-safe system. A pre-set slipping clutch mounted in the gearbox prevents damage should the gun strike an obstacle, but this clutch exerts sufficient torque to prevent slip occurring when the vehicle hull manoeuvres rapidly. An anti back-drive mechanism prevents the gunner's handle being turned when the gun hits an obstruction, or when the vehicle jinks. The equipment conforms with UK MoD (Army) standards, including MVEE specification 2051, and the operating temperature range is −40°C to +70°C.

For use in the Fox vehicle, the same amplifier assembly is offered in conjunction with a traverse gearbox designed for fitting the restricted space of the Fox turret.

As an alternative solution, a modification kit can be supplied which allows the existing design of hand traverse gearbox in the Fox vehicle to be modified for power operation, this being used in conjunction with the standard amplifier assembly.

The gunner's controller installed in Scorpion

It is a relatively simple matter to modify the output circuit of the power amplifier so that higher output currents may be supplied (up to 75 amps) should a requirement arise to control a more powerful motor driving a larger turret on a new design of vehicle.

CHARACTERISTICS:

Additional Weight (approximate):
Power Amplifier and Commander's Controller: 4.9 kg
Motor 2.0 kg
Relay Box and Cable Harness 5.0 kg

Maximum designed turret slew speed: 427 mils per second (24°/sec) on slopes up to 20°

Supply Voltage: 28 volts dc

Peak Current: 25 amps when slewing

Normal operating current: 10 amps

MANUFACTURER:

Marconi Radar Systems Ltd, Control Systems Department, New Parks, Leicester, England.

2435.153
PROJECTILE VELOCITY MEASURING RADAR

DESCRIPTION:

An integrated range of velocity measuring equipment is manufactured by Ferranti Ltd. Included in the range is PACER, which is intended for battlefield use and provides a direct read-out of muzzle velocity, and PVME (Projectile Velocity Measuring Equipment) which is a flexible and precise instrument, for use at proof-ranges and research and development establishments.

PACER:

PACER utilises a small rugged radar head with a solid-state transmitter which is activated only during measurement. The display unit incorporates simple operating controls and a nixie read out which indicates true muzzle velocity in metres per second. The mean error on MV measurement is ±0.3 metres/second over a velocity range from 200 to 1,600 metres/second. Measurements down to 100 metres/second can be made at reduced accuracy. PACER can be operated from 24 volt dc (5A typical) or from ac mains. It is rugged, weatherproof and designed for field use. It can be deployed from a vehicle and brought into operation by one man. Internal test and validity check features are provided.

PVME:

The equipment is configured to meet the needs of proof ranges and R & D establishments for an accurate and flexible doppler system. Accuracies in velocity measurement of 1 part in 10^4 can be achieved over a series of velocity measurements at precisely timed intervals along the trajectory.

The measuring path-length, the delay which defines the start of the first measurement and the interval between successive measurements are under the control of the operator and all measurements are duplicated using doppler receivers of differing bandwidth.

Three methods of read-out are provided:

1. An oscilloscope provides an analogue display of velocity against time as an indication that the physical measuring conditions are satisfactory.
2. The processor unit can store (for subsequent display) the timings of the projectile (to 1 microsecond) through the first three measuring intervals.
3. An optional 'accessory module' enables these timings and those for successive measuring intervals to be punched onto paper tape for subsequent print-out or computation.

Combined Systems:

The PACER display unit can be used with a PVME system to provide immediate read-out of muzzle velocity. The PACER radar head can be used in conjunction with the PVME processor and accessory module where small size and enhanced blast-resistance are of more importance than extreme radar range.

MANUFACTURER:

Ferranti Ltd, Military Systems Dept, Simonsway, Wythenshawe, Manchester M22 5IA, England.

2468.183
POWER TRAVERSE SYSTEM FOR LIGHT FIGHTING VEHICLES

DESCRIPTION:

Developed to meet a demand for power traverse facilities on various AFVs, including the Fox armoured car (**5064.102**) and the Scorpion/Scimitar family of light fighting vehicles (**5040.102**), this system is appropriate to AFVs carrying turrets of the same general dimensions as these vehicles.

The manual traverse gearbox has been modified to provide variable speed powered traverse, yet maintain its interchangeability with the manual gearboxes already fitted. An override and speed control facility for the vehicle commander is provided. This is normally mounted beneath the commander's sight but its location can be varied.

The traverse handle is normally retained in the lower (or manual traverse) position by light spring pressure. Power slew is engaged when the handle is brought to a set position and pressed upwards to overcome the spring pressure. Movement of the gunner's handle through approximately 40° in the direction in which slew is required causes the turret to slew at a single speed. Rotation continues until the handle is returned to the set position. The control handle is spring biased to the centre and downwards and prevents accidental operation of the motor. The gunner is provided with power slew only, fine laying being achieved with the manual traverse. The commander's override facility is operable only with power slew engaged by the gunner and gives full variable speed, fine lay being provided so that the commander may lay the gunner on the correct line in azimuth.

CHARACTERISTICS:

Additional weight for power modification: approx 5 kg

Maximum designed turret slewing speed: 427 mils/sec

Minimum turret tracking speed: 0.9 mil/sec

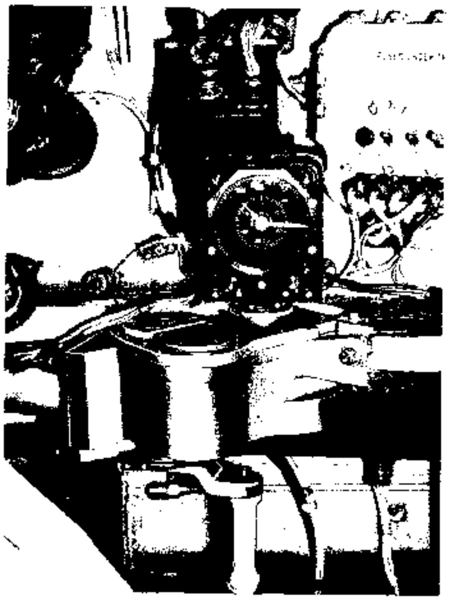
Maximum gradient of operation: 20°

Supply voltage: 28 V DC

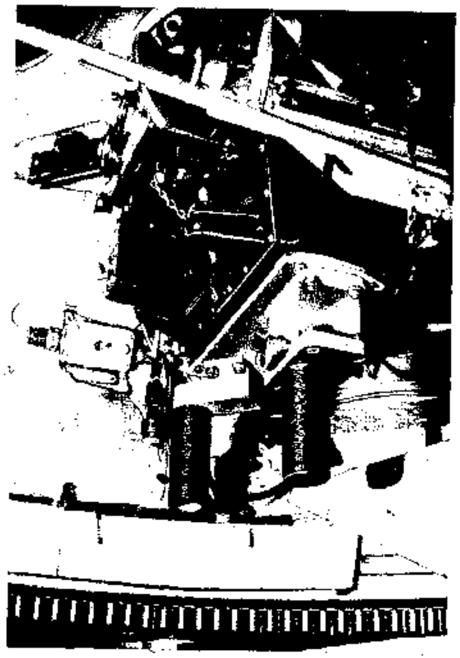
Normal operating current: 10 A

MANUFACTURER:

Dunlop Ltd, Aviation Division, Holbrook Lane, Foleshill, Coventry, CV6 4AA, England.



Commander's control in a Scorpion tank



The gunner's control

2469.183
WEAPON STABILISATION SYSTEM

DESCRIPTION

The weapon stabilisation system made by the National Waterlift Company in the USA and described in entry **2740.183** is also made under licence from NWL in the United Kingdom.

No information is available concerning differences between the US and UK versions of the equipment. All performance and operational data appear to be the same for both installations; but it is assumed that the British-made equipment uses at least some British made components and that there has therefore been some redesign to accommodate such changes.

MANUFACTURER:

Dunlop Ltd, Aviation Division, Holbrook Lane, Foleshill, Coventry CV6 4AA, England.

THE UNITED STATES OF AMERICA

2829.183
ADD-ON WEAPON STABILISATION SYSTEM

DESCRIPTION:

This is an electro-hydraulic add-on stabilisation system developed as a private venture by Cadillac Gage and adopted by the American, Belgian and Federal German authorities for retrospective fitting.

The stabilisation system is basically a feedback positioning system utilising conventional rate gyros with electronic integrators as reference elements. Position information obtained is processed and applied to the electro-hydraulic servo valves in each axis. These valves, in turn, supply the required hydraulic fluid to the elevation and traverse mechanisms to correct the attitude of the gun. Additional system state variables are measured, processed, and added to the position loop to provide damping, permitting extremely high system gains.

To enable the operator to superimpose corrections upon the system, electrical transducer outputs are added to those from the gyros in such a manner that handle position commands a system velocity similar to that commanded by the control valves in the power control system.

Widely varying vehicle battery voltages are converted by the system power supply into the closely regulated AC and DC voltages necessary to operate the stabilization system. Regulation of this unit is such that voltage variations caused by other electrical systems in the vehicle do not affect the performance of the stabilization system.

MANUFACTURER:

Cadillac Gage Company, P.O. Box 1027, Warren, Michigan 48090, USA.

2549.183
HYDROMECHANICAL TRANSMISSION

DESCRIPTION:

Designed for use with SP guns and other tracked and wheeled vehicles, this system provides an infinitely variable ratio for the propulsion and steering transmission of tracklaying vehicles and hydromechanical transmission for wheeled vehicles at optimum engine fuel consumption.

A closed-loop control, combined with the infinitely variable ratio characteristic of a split hydraulic/mechanical power path transmission continuously matches the operator's vehicle speed command and road load requirement to the optimum engine conditions, by automatically adjusting the transmission ratio.

STATUS:

Development started as a joint company/government venture in 1960. Prototype installations for wheeled and tracked vehicles were completed in 1963 and 1965 respectively. Vehicles in which the system has been demonstrated include: the XM 104 SP 105 mm Howitzer, the M 113, the XM 729 armoured vehicle, the XM 759 Marginal Terrain Vehicle, the XM 701 MICV 65 and the XM 723, MICV 70. Under a contract to FMC Corporation, GE has manufactured eight 500 hp XM 2 transmissions. In a recent endurance demonstration an XM 2 completed a 10,000 mile run at the GE Pittsfield, Mass. course. Current user of the system is the United States Army.

MANUFACTURERS:

Electronic Systems Division (Ordnance Systems), General Electric Company, 100 Plastics Avenue, Pittsfield, Mass. 01201, USA.

XM2 Hydromechanical power train

MICV in which the GE XM2 transmission completed a 10,000 mile endurance run

2548.183
ALL-ELECTRIC STABILIZED GUN DRIVES

DESCRIPTION:

These gun drives, developed as a private venture by the Electronic Systems Division (Ordnance Systems) of the General Electric Company, are designed to enable an AFV to fire accurately while on the move, even over rough terrain.

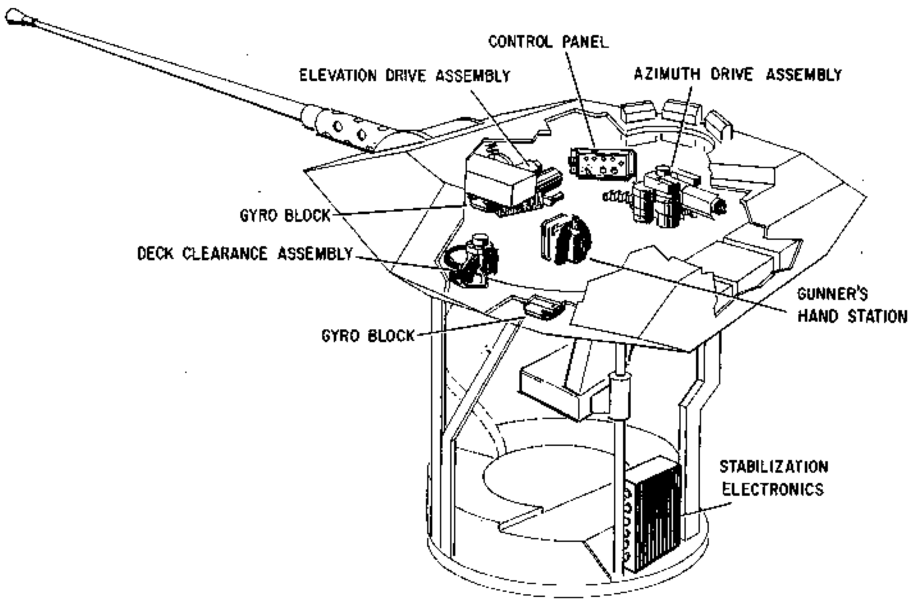
A typical layout of the components of the system is shown in the accompanying diagram, and it will be seen that the installation uses references and rate gyroscope as primary sensors. Outputs from these are processed at low level and the results used as inputs to the power electronics unit, which uses transistors in a switching mode of operation to control the turret and cupola elevation and traverse drive motors. As can be seen, the manual elevation and traverse facilities are retained. The system incorporates circuitry for built-in test equipment (BITE).

STATUS:

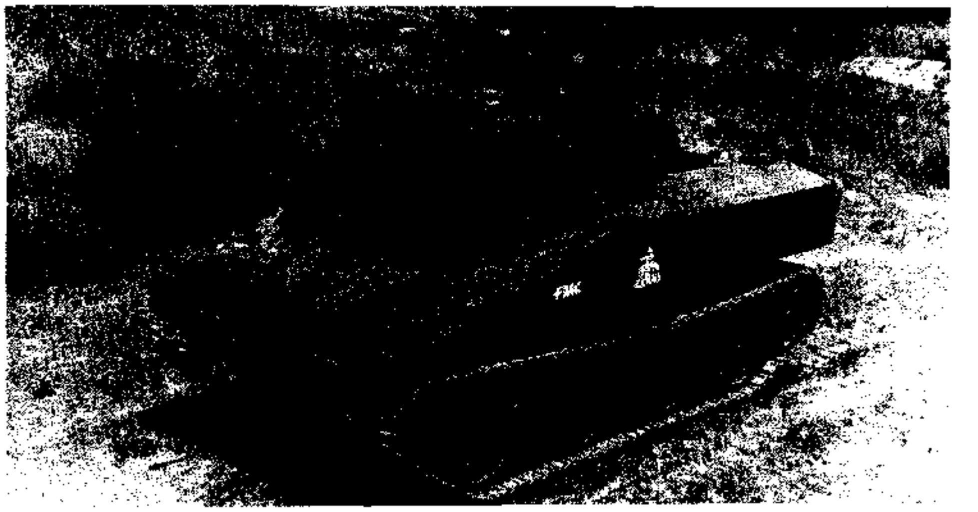
Development was started as a private venture in January 1965 and the first prototype completed in September 1966. Demonstration installations were made in the M60 (**5024.102**) and M60A2 (**5025.102**) tanks and in the XM 701 (MICV 65) and XM 800 (**5070.102**) Armoured Reconnaissance Scout Vehicle. Under a development contract with the FMC Corporation, San Jose, California, GE has delivered four prototype equipments and spare parts for stabilisation and drives on the turret of a tracked version of the ARSV being developed for the US Army.

MANUFACTURERS:

Electronic Systems Division (Ordnance Systems), General Electric Company, 100 Plastics Avenue, Pittsfield, Mass 01201, USA.



GE ARSV WEAPON STABILIZATION SYSTEM COMPONENTS



All-electric stabilized gun drive installed in a XM800

2545.293
MISSILE LAUNCHER/CANISTER

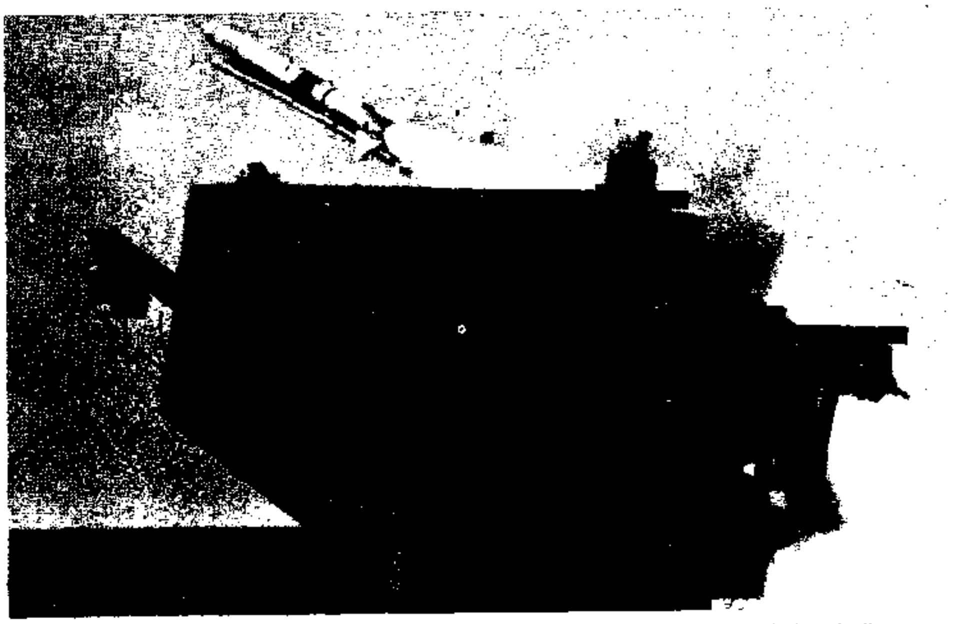
DESCRIPTION:

Sponsored by US Naval Ordnance Systems Command and developed by the Naval Ordnance Station, Louisville, Kentucky, an inexpensive launcher/container for shipborne missiles has been successfully tested in a series of static and mobile firings at White Sands Missile Range and from the USS *Norton Sound*.

The launcher/canister is simpler and smaller than a conventional track-guide box launcher and provides reliability, maintenance, and reloading features which are attractive. Using the new device, a missile can be loaded at shore ammunition depot, shipped as a sealed unit to the firing ship, loaded on a launcher mount, plugged in to electrical connections and fired directly from the canister – all without having to be touched after initial loading. This increases missile reliability and decreases maintenance requirements.

The novel feature of the launcher/canister is its launcher guide method. The missile rests on a launch pad made of inexpensive plastic foam, rather than being hung from a track as in conventional launchers. The foam pad is launched from the canister with the missile, but soon falls away due to aerodynamic drag.

The tests of the launcher/canister have been conducted using Sea Sparrow missiles with folding wings. Other possible missile applications are Harpoon, Standard, ASROC, Chaparral and Agile.



Missile launch from the new canister. Note the foam supporting pad beneath the missile

RESPONSIBLE AUTHORITIES:

Naval Ordnance Systems Command (ORD-5531), Washington DC.

Naval Ordnance Station, Louisville, Kentucky, USA.

2713.293
MISSILE LAUNCHER R-202

DESCRIPTION:

This missile launcher has been designed primarily for use in naval conversions from gun to missile armament. Suitable for launching Sparrow or similar missiles (see, for example, entry number **2770.231**) the design of the launcher permits the deck house and missile loading system to be worked out by the shipyard to meet the operational requirements of the user.

In one possible arrangement the missile would be stored in the deck house on rack with launch rails pre installed in them. Two missiles would be stored on the loaders with wings and fins in place and ready for ramming to the firing positions.

All loading functions are performed from the local control panel, except that wings and fins are manually installed on the missile. The missile loader is provided with a vertical lift actuator which provides means for removing the missiles from the overhead track and also provides for engaging the missile with the launcher. There are two distinctly separate missile loaders which may be rammed simultaneously or independently as dictated by the exact missile status at the time of loading. Each loading position has an individual door to minimise weight, size, and servo drive requirement.

SUGGESTED CHARACTERISTICS:

Weights: Launcher (above deck) 725 kg. Loader (below deck) 1,680 kg. Launch rails (each) 25 kg. Solid state electronics 900 kg
Power: 16 kW peak; 9 kW average
Traverse: 360°
Elevation: −15° to +85°

MANUFACTURER:

Raytheon Company, Bedford, Massachusetts 01730, USA.

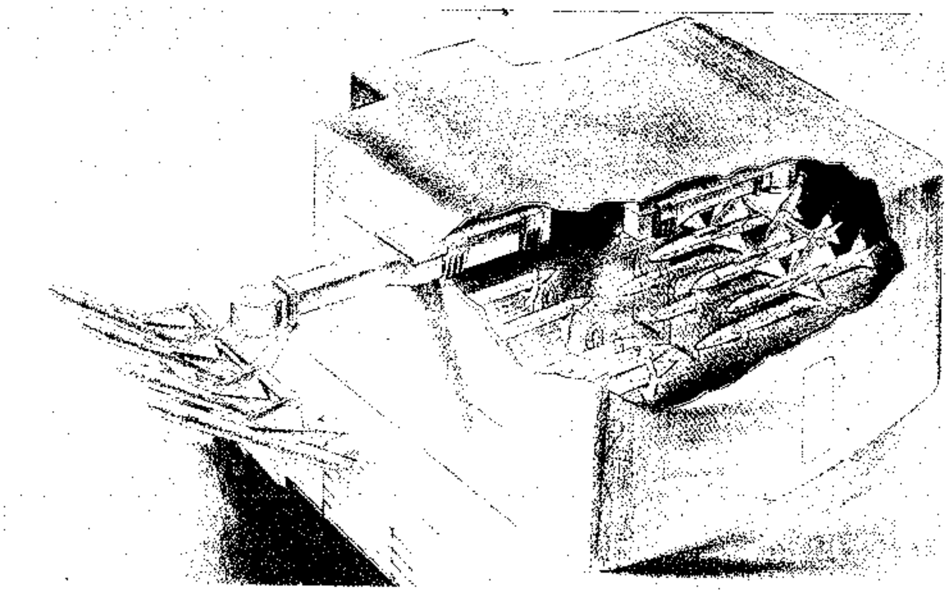
2714.293
MISSILE LAUNCHER R-204

DESCRIPTION:

Designed for naval use, the R-204 missile launcher is capable of firing four Sparrow III missiles either singly or in rapid succession to combat an enemy air attack. The R-204 is of simple construction consisting of an extendable boom and a missile support assembly. This assembly contains a pillbox pivot, a pylon mounting bar, and four pylons together with their associated launch rails. It also contains the necessary electronic circuits for readying the Sparrow III for launch. This two-axis launcher has limits of 360 degrees in train and −15 to +65 degrees in elevation.

During attack, the launcher boom is extended by its power drive. The missile support assembly is slaved in its two axes to commands from the fire control system. Simultaneously, signals are injected into the missile to command its actions after launch.

When the missile is free of the launcher, it can effect the manoeuvres necessary to fly towards the target intercept point. These features – the missile support assembly's ability to rotate about its two axes and the Sparrow III's degree of manoeuvrability – combine to provide a large defended zone.



R-204 missile launcher

In a typical ship's installation, the centre of rotation of the missile support assembly in train is beyond the edge of the ship, thereby permitting missiles to be launched from 000 to 160 degrees on both sides of the ship. The defended zone is larger than 180 degrees because of the missile's ability to turn after launch.

Because the extendable boom is above deck level and can be completely withdrawn into a missile handling room, deck space is conserved.

MANUFACTURER:

Raytheon Company, Bedford, Massachusetts 01730, USA.

2740.283
N W L WEAPON STABILISATION SYSTEM

The National Waterlift Company has developed a compact and accurate weapon stabilisation system which is particularly well suited to fitting into gun carrying armoured personnel carriers or light combat vehicles which have a two man turret and a medium calibre weapon. However, the basic concept is equally adaptable to vehicles weighing up to 50 tons and carrying normal tank armament.

This NWL "Second Generation" Weapon Stabilisation System, by the use of high-quality components in a system of low overall complexity, has the following important characteristics:

High dynamic accuracy during angular vehicle excursions.

No loss of weapon static accuracy when firing from a standing position under stabilisation.

Smooth and controllable tracking at very low rates.

Very high system slew rates.

Ability to lay rapidly and accurately on point targets.

Man-machine relationship designed for maximum use of gunner's abilities.

Ruggedness, consistent with roughest field use.

Modular construction, with many modules common to both elevation and traverse controls.

System designed for various levels of battle damage.

NWL Stabilisation System	Traverse	Elevation
Manual Characteristics		
Displacement	52 mils/revolution	64 mils/revolution
Maximum slew rate	100 mils/second	140 mils/second
Sensitivity	.037 inch/0.1 mil	028 inch/0.1 mil
Power Characteristics		
Minimum Tracking Rate	.10 mils/sec	.10 mils/sec
Maximum Slew Rate	54°/sec	72°/sec
Handle Travel	+80°	+40°
Maximum Handle Backlash	1½°	1½°
Sensitivity	1½ mil/sec/degree	1½ mil/sec/degree
Stabilised Characteristics		
Maximum Tracking Rate	.15 mils/sec	.15 mils/sec
Maximum Slew Rate	54°/sec	72°/sec
Maximum Drift Stationary	.1 mil/minute	.1 mil/minute
Maximum Error	2 mils/30°/sec	2 mils/50°/sec
Average Error	.5 mils/15 mph zig-zag	.5 mils/15 mph

DESCRIPTION:

The NWL system is composed of the following major components:

Inertial Sensors – the gyroscopic devices used in the system have low null uncertainty and wide dynamic range, and the ruggedness and long operating life required for use in the combat vehicle environment.

Electronic Power Supply and Servo Amplifier – the electronic power supply accepts the unregulated vehicle battery voltage and changes it to the various regulated voltages both AC and DC, that are required by the servo amplifiers and the system sensors.

The servo amplifier consists of two highly similar channels of signal processing circuitry. Each channel accepts various sensor signals, processes them, and as a result supplies current to the electrohydraulic servo valve to cause the weapon to perform as desired.

Both the power supply and the amplifier have been designed for low power drain and use solid state components exclusively. They have built-in EMI suppression and are both short and open circuit protected.

Gunner and Commander Controls – the gunner and commander controls are designed to provide an optimum man-machine relationship. They provide the means of slewing the weapon system rapidly, tracking smoothly and controllably at very low rates; and laying the weapon rapidly and accurately on point targets.

Traverse and Elevation Servoactuators – specifically designed to meet the stringent requirements of stabilising weapon-carrying land vehicles. They utilise a new electrohydraulic servo valve designed by NWL.

Hydraulic Power Supply – an efficient, quiet, reliable hydraulic power supply is provided to convert the vehicle's unregulated DC electrical energy to regulated hydraulic energy. This energy is used on demand to operate the system in both the hydraulic power mode and electrohydraulic stabilised mode of operation. The power supply allows a fully operational system to remain on silent watch for long periods with pump operation.

System Test Package – in addition to the basic system components a system test package has been designed which enables relatively unskilled personnel to troubleshoot the entire stabilisation system.

Wherever possible components are interchangeable between axes for simplification of manufacture and maintenance.

OPERATION:

Manual: In the manual mode, the gun movement is entirely by a hand driven mechanical gearing. It is therefore simple, reliable, and silent.

Power: The power mode provides complete hydraulic actuation of traverse and elevation when a DC supply is connected to the hydraulic pump. It is a simple, demand-type system, giving excellent sensitivity.

Stabilised: In the stabilised mode all components of the system are employed, but failure of any part will revert the system to the power mode.

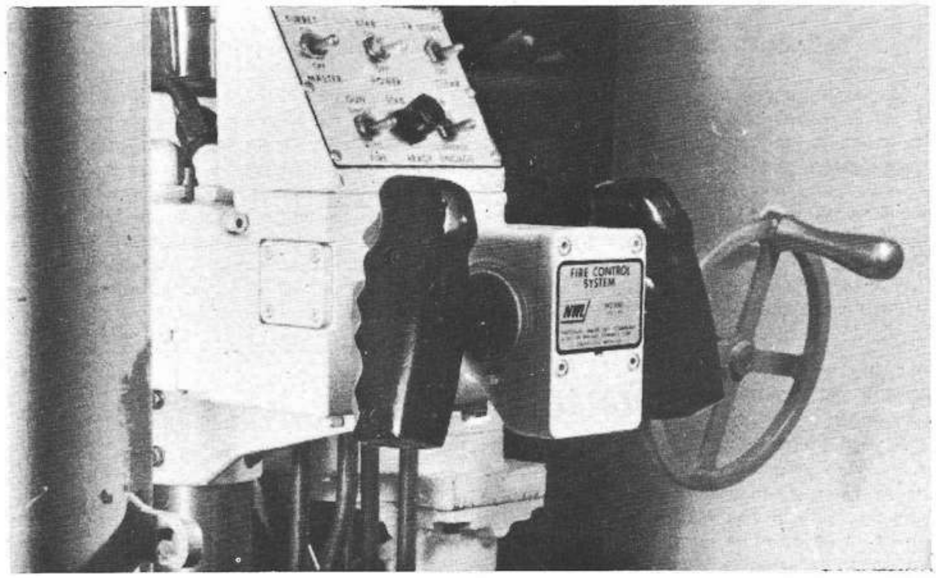
The system has been tested under quasi-battle conditions at speeds up to 25 mph in a 20 ton tracked vehicle, and has shown itself to be both accurate and reliable. One advantage which is claimed for it is the ability of the system to be mounted in the vehicle in its separate component parts, linked by cables or hydraulic pipes. This eases the difficulty of stowage inside a small turret.

MANUFACTURER:

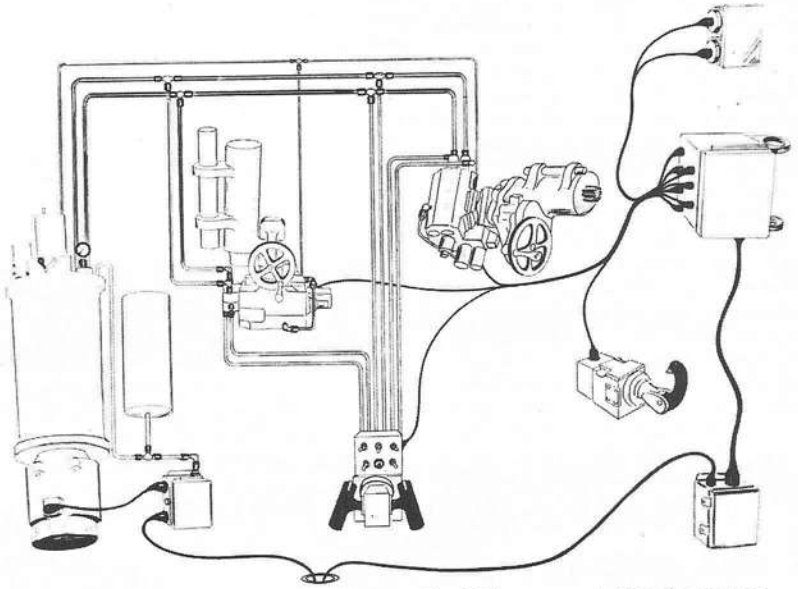
National Water Lift Co, 2220 Palomer Avenue, Kalamazoo, Michigan 49001, USA.

UNITED KINGDOM AND EUROPEAN LICENSEES:

Dunlop Co Ltd, Aviation Division, Holbrook Lane, Coventry CV6 4AA, England.



The gunner's controls and switch panel



A diagrammatic view of the component parts of the NWL weapon stabilisation system

2828.183
STABILISED GUN CONTROL SYSTEM

DESCRIPTION:

This is an electro-hydraulic system that provides the control means for positioning the turret, gun, and cupola, in the M60A1E2 Tank. The hydraulic power system can be controlled by directing hydraulic oil through gunner's or commander's control assemblies directly or by electronic signals from rate-sensing devices in the hull, turret and cupola to hold either or both weapons in position for stabilised operation.

The system operates either in a power or stabilised mode and is put into operation by applying 24 V DC to the electric motor in the hydraulic power supply and electronic power supplies which in turn generate voltages necessary to operate the electronic system of the turret. The motor-pump combination operates to generate, store, and supply hydraulic oil at 2,000 psi pressure to the turret and the cupola. This pressurised oil is used to operate hydraulic actuators which elevate or depress the main gun or cupola weapon, and to drive hydraulic motors which traverse the turret or cupola through gearbox and ring gear systems.

In the power mode, only the hydro-mechanical components are used. The gunner in the turret and the commander in the cupola each have a set of control handles that are used to direct the pressurised hydraulic fluid to the hydro-mechanical components to control the positioning of their weapons. In addition, the handles contain triggers for firing the weapons, pal, switches for releasing the traverse mechanism brake and two thumb switches for insertion or removal of target lead information.

When the system is in the stabilisation mode of operation, both hydro-mechanical and electronic components are used. The hydraulic components are controlled by electrical signals from gyros and handle linear variable differential transformers. These signals are processed by the electronic components to maintain the two weapons in the position determined by the gunner and commander.

The hydraulic power system also can be used operated in the Emergency Mode. In the Emergency Power Mode all electronic components are switched out of the system and electrical power is used only to operate the motor pump, power valves, deck clearance switches, trigger circuits, and electrical traverse brakes. When no electrical power is available, the turret can be operated manually in azimuth by means of a hand crank located on the traverse gear box, and in elevation by means of a rotary hand pump. The hydraulic power system to the cupola can be operated in the manual mode by manually actuating the cupola power valve and supplying pressurised oil to the cupola from a hydraulic hand pump located in the turret.

Four stabilisation options are provided, Stabilization Stationary, Stabilization Travel, Main Gun, and Target Designate. Stabilization Stationary is used when the vehicle is not moving, and Stabilization Travel is used when it is. The main difference is in the system's turret response to movement of the operator's control handles which is slower when the vehicle is stationary than when it is moving. This provides finer gun-laying capability when the vehicle is stationary.

In normal stabilised operation, the main gun and cupola weapon are stabilised independently, with the gunner or commander maintaining control over the main gun or cupola respectively. When the Main Gun Mode is put into operation, the cupola weapon becomes synchronised with the main gun and the gunner's handles control both systems. The commander can take control of both systems by pressing the over-ride palm switches on the control handles.

In the Target Designate mode, the main gun lines up with the cupola weapon. After the main gun establishes line-of-sight with the cupola weapon (approximately 1 second duration) both stations revert back to normal stabilized operation and the commander can move the cupola away from the main gun position to observe other targets.

MANUFACTURER:

Cadillac Gage Company, P.O. Box 1027, Warren, Michigan 48090.

RANGEFINDING AND SIGHTING EQUIPMENT

FRANCE

7030.393
APX-BEZU M260 GYRO-STABILISED SIGHT

DESCRIPTION:

The APX-BEZU M260 Gyro-stabilised sight has been designed for survey of land, target detection and acquisition, and for guiding missiles in manual remote control with a hit probability of 90 per cent.

OPERATION:

The sight has a periscopic view and is composed of a binocular sight and double lens with two magnifications – 2.5 and 10 – and a panoramic sight containing the gyroscopic unit. Stability of images is obtained by a 45° mirror slaved to a gyroscope, together with a shock absorbing device.

The mirror can scan land in elevation and azimuth at a velocity ranging from 20°/s (0.1 mrd/s) to 10°s (180 mrd/s). The field of sight is 5° 30' (100 mrd) with magnification 10 and 22° (400 mrd) with magnification 2.5. The complete scanning field is 136° in azimuth and 82° in elevation. On the wide field, a luminous circle represents the small field. The angular difference between the optical axis and the axis of the vehicle is indicated. Controls are centralised on the two handles, and the body of the sight is telescopic, which permits variations of height of the sight. In the high position, the operator, with no magnification has a complete field observation. A fire simulator, as well as a television or film camera can be fitted to the equipment.

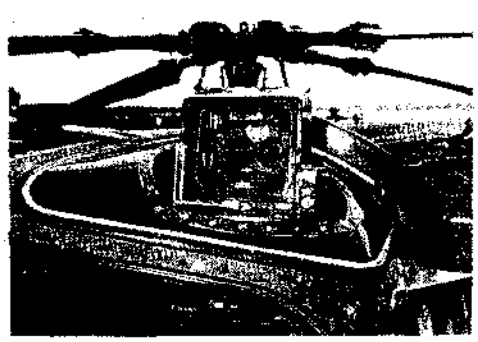
STATUS:

The APX-BEZU M260 sight was mounted and tested on many helicopters, including Alouette II and Alouette III in France; Scout, Wasp and Wessex in Great Britain; and Bell Agusta in Italy. It is part of the equipment of Alouette III and Wasp helicopters. This sight has also been used on fast patrol boats by several countries.

MANUFACTURERS:

Designed by DTAT, Ateliers de Construction de Puteaux and the SERE Company. Produced by SFIM, 13 Avenue Ramolfo-Garnier, F9130-Massy, France.

Licenced manufacture is in progress in the UK by BAC's Guided Weapons Division at Stevenage, Herts.



APX-BEZU M260 sight as installed in Westland Wasp helicopter

1642.393
THOMSON-CSF LOW LIGHT TELEVISION

DESCRIPTION:

The Thomson-CSF company has produced, in response to a French military requirement, a helicopter borne night vision system based on a low light level television equipment. The system comprises three main units: a remotely controlled camera and its associated stabilised mounting; display unit; and a remote control unit. Another version has been developed for fitting to the AMX-10 tank.

The camera uses a 'Super Nocticon' tube with a silicon target, and an automatic shutter is provided for protection against bright light. The optics include variable focus between 50 and 240 mm, variable aperture, and the zoom facility provides for an angle of view variable between 30 degrees for search and 6 degrees for identification of target. The stabilised mounting was developed by SERE-Bezu, and is engineered for location in a cut-out in the underside of a helicopter. The camera axis is fixed relative to the aircraft, and the line-of-sight is maintained against attitude changes by means of a gyro-stabilised mirror between the viewing aperture and the camera optics.

The display unit has a rectangular CRT screen of 11 cm diagonals, and there are provisions for mixing the TV picture with symbols produced by a nav/attack system. The control box provides for remote operation of the camera and direction of the mirror to give pan and tilt movements of the sight line.

DEVELOPMENT:

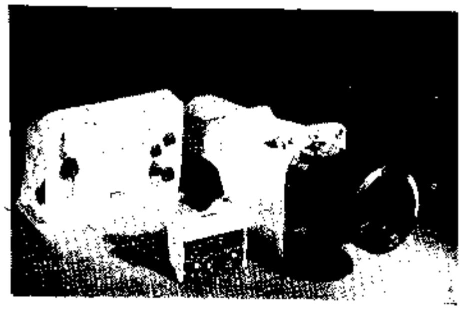
The system was developed under French Government contract.

STATUS:

Flight trials of two equipments started in 1972 on a French Army helicopter and a maritime aircraft. The tank version is said to be in production.

MANUFACTURER:

Thomson-CSF, France.



Low light-level TV system designed for AMX 10 tank

7032.393
APX M334 GYRO-STABILISED SIGHT

DESCRIPTION:

The APX M334 sight has been designed to survey land, detection and acquisition of targets, and guidance of missiles in manual remote control.

OPERATION:

This periscopic viewing equipment is composed of a monocular angularly positioned and single-lens sight, a body made of a prism correcting the image slanting and Galilee's system ensuring two manifications – 2.5 and 10 – and a panoramic head including a gyroscope similar to the one of the APX-BEZU M260 sight.

Mirror scanning of land in elevation and azimuth, and hoods of panoramic head are slaved in azimuth to the mirror. Scanning speed is adjustable from 3' 30"/s to 5° 40'/s at magnification 2.5; from 5' 1"/s to 1° 25"/s at magnification 10; and 28°/s for target acquisition.

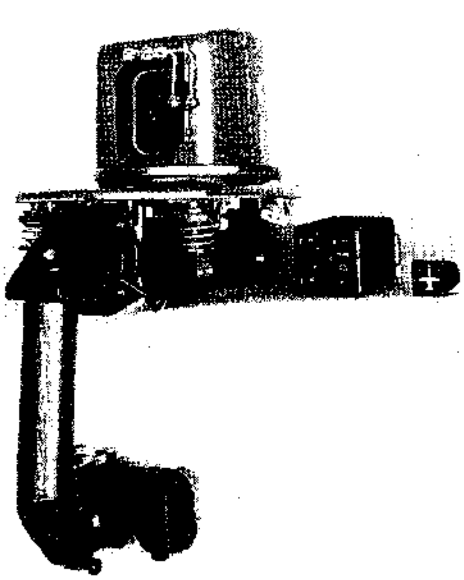
The field of sight is 5° 30' at magnification 10, and 22° at magnification 2.5. Total scanning field is 262° in azimuth and 82° in elevation. On the wide field a luminous circle represents the small field, and angular differences between line of sight and the axis of the vehicle can be indicated. The eyepiece is retractable when the equipment is not in use, enabling the operator to have complete eye vision. To render observation more comfortable, a pseudo-binocular version of the sight has been developed.

STATUS:

In production.

MANUFACTURER:

SFIM, 13 Avenue Ramolfo-Garnier, F91301-Massy, France.



APX M334 Gyro-stabilised sight and control box

2059.193
RANGEFINDER M208 FOR AMX30 TANK

DESCRIPTION:

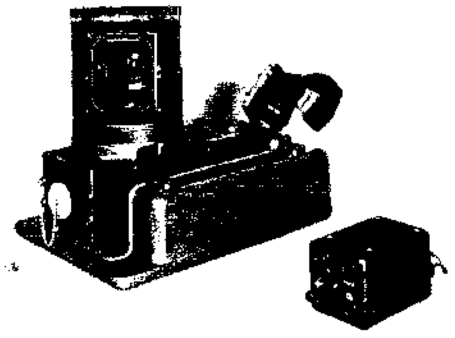
This rangefinder is for use by the tank commander to determine both the range of a target and the elevation setting for different types of 105 mm ammunition. It can be used either as a superimposition rangefinder or as an aiming telescope. By means of a linkage the eyepiece remains in a fixed position while the rangefinder follows the elevation and depression of the gun cradle.

CHARACTERISTICS:

Rangefinder:
Base: 2 m
Magnification: × 12
Field: 50 mils
Measuring distance: 600-3,500 m
Telescope:

Magnification: × 6
Field: 100 mils
Range: 600-3,500 m
Combined weight: 81 kg
MANUFACTURER:
SOPELEM, 102 rue Chaptal, 92-Levallois-Perret.

1737.193
APX M396 STABILISED SIGHT
DESCRIPTION:
The APX M396 has been derived from the APX M334 (Entry No. **7032.393**), and is also referred to as the 'Cabin Version' of that sight. It is intended for observation, target detection and acquisition, and missile guidance applications in vehicles liable to high amplitude motion over a wide frequency range, such as fast patrol boats and helicopters. Stabilisation is by means of gyros, supplemented by elastic suspensions and damping. Detection and acquisition can be effected at ranges up to 10 km. Magnifications of 2.5 and 10 are provided, the respective fields being 400 milliradians and 100 milliradians. Magnification change is accomplished in 0.15 sec.
STATUS:
Development has been completed and production had been started by early 1973. Evaluation has been carried out in an Atlantic aircraft of the Marine Francaise.
MANUFACTURER:
SFIM, (Société de Fabrication d'Instruments de Mesure), 13 Avenue Ramolfo-Garnier, F91301-Massy, France.


APX M396 stabilised sight and control box

2079.193
RANGEFINDER M292
DESCRIPTION:
A small monocular rangefinder designed for use with the ACL-STRIM light anti-tank weapon (**2055.103**). The device comprises a sighting telescope and a coincidence rangefinder and is preadjusted for measuring two selected distances bracketing the intended firing range.
CHARACTERISTICS:
Telescope: Magnification × 4, Field 150 mils
Rangefinder: Periscope height 140 m, Magnification × 12, Vertical field 16.6 mils, Horizontal field 33.3 mils, Selected measured distances 300-450 m, Accuracy 10 m
MANUFACTURER:
SOPELEM, 102 rue Chaptal, 92-Levallois-Perret.

2107.193
AIMING TELESCOPE M262
DESCRIPTION:
This equipment is designed for use with the 90 mm gun on the AML-90. The telescope is made in two parts which can move relative to each other: the part with the objective moves with the gun cradle while the eyepiece remains in a constant position within the turret.
Two variants of the telescope are available: one has a movable graticule suitable for use with both HE and hollow charge ammunition and the other has a fixed graticule that can be selected for one type of ammunition only.
CHARACTERISTICS:
Magnification: × 6
Field: 190 mils
Eyepiece: Adjustable
Elevation: −8° to +32°
Weight: 5.5 kg
Micrometer: Illuminated for night firing
MANUFACTURER:
SOPELEM, 102 rue Chaptal, 92-Levallois-Perret.

2103.193
BINOCULAR TELESCOPE M267 and PRISM HEAD M270
DESCRIPTION:
The M267 binocular telescope is a tank commander's instrument for use with the secondary armament of the AMX-30 tank (see **2094.193** for infra-red equivalent). It is used in conjunction with the M27 prism head.
Theis prism head consists of a prism that can be rotated in the elevation plane to reflect light towards the M267 scope or towards the OB-23-A infra-red telescope, the objective lenses being fitted in the base of the head. The prism is mounted behind thick protective glass and the whole is enclosed in a steel armour-plate housing. Projecting from the side of the M270 is a swivelling arm on which the LMG (and its infra-red searchlight if fitted) is mounted. The weapon elevation aiming and the corresponding −10° to +45° swivel of the prism are controlled simultaneously by a handwheel in the roof of the turret.
The M270 head may also be used to aim the 20 mm cannon, in which case the prism head is electrically servo-controlled by the movement of the cannon.
CHARACTERISTICS:
Binocular telescope: Magnification: × 10. Field: 100 mils
Overall specification: Weight: 8 kg, Operating temperature range: −40° to +55°
MANUFACTURER:
SOPELEM, 102 rue Chaptal, 92-Levallois-Perret.

2108.193
INFRA-RED AIMING TELESCOPE (M262 MODIFIED)
DESCRIPTION:
This instrument is a modification of the M262 telescope (**2107.13**) for operation with the 90 mm gun of the AML-90 in infra-red light. Illumination is provided by a PH-2-A searchlight fastened to the gun. A linkage similar to that in the M262 keeps the eyepiece in a substantially constant position when the gun is elevated or depressed. The telescope has a fixed graticule with variable illumination.
CHARACTERISTICS:
Magnification: × 5.4
Field: 7°
Elevation: −8° to +20°
Graticule adjustment: × 25 mils vertically and laterally
Focus: Adjusted to 1,000 m
Range: 1,000 m with PH-8-B searchlight
Duration of use: 40 hours
Operating temperature range: −40° to +55°
Periscope Height: 418 mm
Weight: 28 kg
MANUFACTURER:
SOPELEM, 102 rue Chaptal, 92-Levallois-Perret.

2093.193
INFRA-RED AIMING TELESCOPE OB-17-A
DESCRIPTION:
This equipment is designed for use with the 105 mm gun on the AMX-30 tank in conjunction with the PH-8 B IR searchlight.
Alignment of the optical and gun axes is preadjusted and fixed. Correct elevation is automatically engaged when the telescope is slipped into its housing. A built-in collimator and lamp produces an illuminated reticle in the centre of the field of view which gives the line of sight. The illumination of this reticle can be adjusted.
CHARACTERISTICS:
Magnification: × 5.4
Field: 7°
Elevation: −8° to + 20°
Graticule adjustment: + 25 mils vertically and laterally
Focus: Adjusted to 1,000 m
Range: 1,000 m with PH-8-B searchlight
Duration of use: 40 hours
Operating temperature range: −40°to + 55°C
Periscope Height: 418 mm
Weight: 28 kg
MANUFACTURER:
SOPELEM, 102 rue Chaptal, 92-Levallois-Perret.

2094.193
INFRA-RED BINOCULAR AIMING TELESCOPE (OB-23-A)
DESCRIPTION:
This equipment is designed for use by the AMX-30 tank commander with the tank's secondary armament. It is used in association with the M270 prism head (see **2103.193**) when the turret LMG is being fired or with the servo-controlled prism head for the 20 mm cannon. Illumination is either by a PH-9-A searchlight fitted on the LMG or by the PH-8-B searchlight on the 105 mm gun (see **2093.193**) for the 20 mm cannon.
The telescope contains two IR channels in a single light alloy housing. Aiming is aided by a variable graticule displayed on the visual field.
CHARACTERISTICS:
Magnification: × 4
Field: 9°
Elevation: −10° to +45°
Duration of use: 25 hours
Operating temperature range: −40° to +55°
Weight: 8 kg
MANUFACTURER
SOPELEM, 102 rue Chaptal, 92-Levallois-Perret.

2109.193
INFRA-RED DAY/NIGHT DRIVING PERISCOPE OB-16-A
DESCRIPTION.
This periscope is mounted in the driving turrets of AMX-30 tanks and similar vehicles. It is provided with a binocular infra-red system for night driving and a monocular system for daylight use. Both infra-red and visible light channels are in the same light alloy housing.
CHARACTERISTICS.
Infra-red System: Magnification: × 1, Field: 35°, Focus: 40 m
Daylight System: Magnification: × 1. Field: 24°
Duration of use: 40 hours
Operating temperature range: −40° to +55°C
Weight: 6.5 kg
MANUFACTURER:
SOPELEM, 102 rue Chaptal, 92 Levallois-Perret.

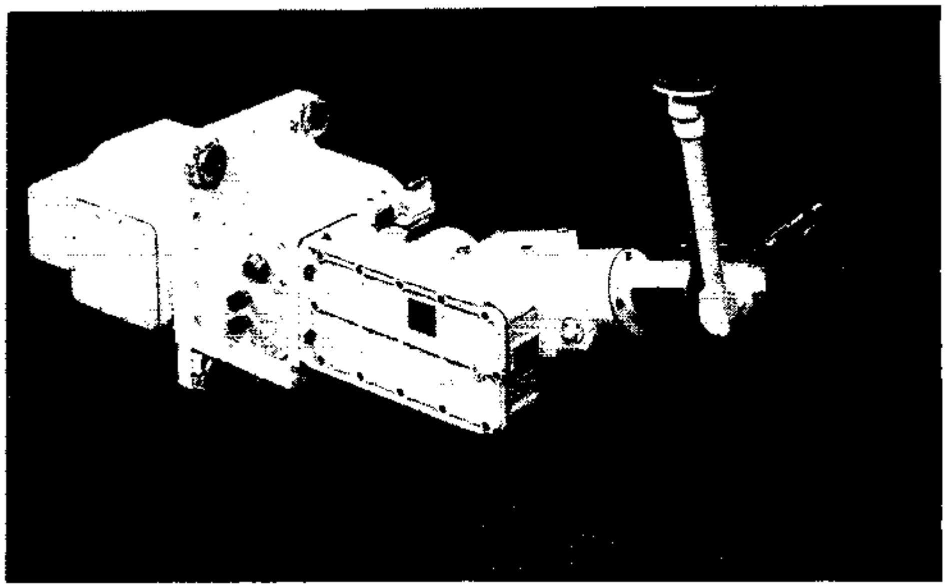
2099.193
INFRA-RED PERISCOPE OB-11-A
DESCRIPTION:
This periscope is designed for use with the AMX-13 main armament and in conjunction with the PH-2-A searchlight mounted on the moving part of the turret.
A luminous collimator is brought into operation when the operator leans on the periscope fore-head rest: the brightness of this can be adjusted. Optical adjustment is by two knurled knobs giving ±10 mils in elevation and ±20 mils in azimuth. Sighting index marks on the graticule show distances in hectometres up to 20 hectometres for the AP shell.
CHARACTERISTICS:
Magnification: × 5
Field: 7°
Focus: Adjusted to 700 m
Range: 800-1,000 m
Duration of use: 40 hours
Operating temperature range: −40° to +55°C
Weight: 7.6 kg

MANUFACTURER:
SOPELEM, 102 rue Chaptal, 92-Levallois-Perret, France.

2105.193
TELESCOPE-PERISCOPE M112
DESCRIPTION:
This combined monocular telescope and binocular periscope is designed for use with the AML-60 light armoured car. By changing the micrometers, however, it can be adapted for use with the twin 30 mm cannon of the AMX13T tank.
Elevation aiming control is linked to the weapon but provision is made for manual scanning. The micrometers can be illuminated for night firing.
CHARACTERISTICS:
Telescope: Magnification: × 5. Field: 230 mils
Periscope: Magnification: × 1. Static field 570 mils. Field including eye motion 1,140 mils
Elevation aiming: −22° to +47°
Weight: 6 kg

MANUFACTURER:
SOPELEM, 102 rue Chaptal, 92-Levallois-Perret, France.

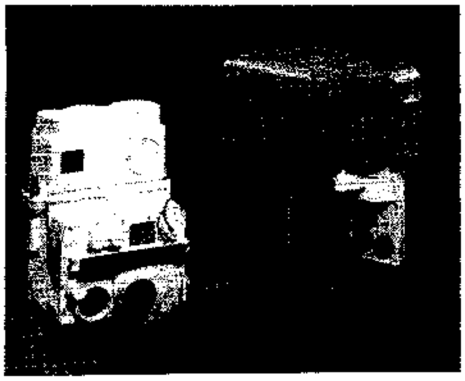
1796.193
APX M401 OPTICAL SIGHT AND RANGE-FINDER
DESCRIPTION:
The APX M401 equipment consisting of a laser rangefinder, an aiming optical system and an optical deflection device, is part of the automatic firing control system intended for the AMX-10C tank.
In addition to its observation and aiming functions, it provides automatically information on the distance of the target to the firing control system.
Its accuracy is ±5 metres regardless of the distance of the target within the limits of the range.
The maximum measurable distance depends on the visibility and can reach 10 km. The unit comprises a pilot light indicating the possible presence of two echoes, a unit memorising the two echoes and a switch allowing a manual selection of the echo to be displayed.
CHARACTERISTICS:
Emitter:
Laser material: neodymium glass
Wavelength: 1.06 um
Pulse duration: 25×10^{-9} s
Energy: 100 mJ
Peak power: 4 MW
Divergence: 0.5 mrad
Repetition rate: 1 measurement every 2 seconds
Receiver:
Detector: Avalanche photodiode



APX M401 Optical sight and laser rangefinder

Field angle: 0.5 mrad
Rangefinder: 265 × 180 × 120 mm. 4 kg
Supply unit: 440 × 160 × 160 mm. 11 kg
STATUS:
The APX M401 was designed under DTAT contract and had reached prototype stage by early 1974.
MANUFACTURERS:
CGE-Laboratoires de Marcoussis, Route de Nozay, 91460-Marcoussis, France.
SOPELEM, 102 rue Chaptal, 92306-Levallois-Perret, France.

1797.193
APX M409 OPTICAL SIGHT AND RANGE-FINDER
DESCRIPTION:
The APX M409, consisting of a laser rangefinder, a daylight sight, a night-time sight and a prism head, is intended for the AMX-30 tank.
In addition to its observation and aiming functions, it provides directly to the tank commander information on target range.
Its accuracy is ±5 metres regardless of the distance of the target within the limits of the range. The maximum measurable distance depends on the visibility and can reach 10 km. When distances relating to two targets are measured simultaneously, the two readings are displayed at the same time one above the other.
Through a blanking device, it is possible to eliminate any echoes from less than a predetermined surface.
CHARACTERISTICS:
Emitter:
Laser material: Neodymium glass
Wavelength: 1.06 micron
Pulse duration: 25×10^{-9} s
Energy: 100 mJ
Peak power: 4 MW
Divergence: 0.5 mrad
Repetition rate: 1 measurement every 2 seconds
Optical sight and rangefinder: 350 × 200 × 150 mm. 10 kg
Supply unit: 320 × 200 × 160 mm. 25 kg
STATUS:
The APX M409 was designed and developed under DTAT contract. It is now in series production for AMX 30 tanks ordered by a foreign army.
MANUFACTURERS:
CGE-Laboratoires de Marcoussis, Route de Nozay, 91460-Marcoussis, France.
SOPELEM, 102 rue Chaptal, 92306-Levallois-Perret, France.



APX M409 Optical sight and laser rangefinder

1798.193
IPY 43 PORTABLE LASER TARGET MARKER
DESCRIPTION:
The IPY 43 is a one-man portable laser target illuminator/designator for battlefield use. The size and configuration of the equipment can be seen in the accompanying illustration. An optical telescopic sight is incorporated to assist in acquiring the target and to ensure its accurate marking for the co-operating attack aircraft or other weapon.
CHARACTERISTICS:
Laser material: Neodymium doped YAG
Wavelength: 1.06 micron
Pulse duration: 20×10^{-9} s
Energy: 60 mJ
Peak power: 3.5 MW
Divergence: 0.3 mrad
Repetition rate: Adjustable from 1 to 10 pulses per second
STATUS:

Developed under OTAT contract, the IPY 43 had reached the pre-production stage by early 1974.

IPY 43 Laser illuminator

MANUFACTURER
CGE-Laboratoires de Marcoussis, Route de Nozay, 91460-Marcoussis, France.

1317.393
THOMSON-CSF SERIES 120-190 ATTACK SIGHTS

DESCRIPTION:
These displays comprise three units: a collimating head, projecting a coloured display; an electronic unit, for signal processing; a pilot's control unit (not required if the HUD (Head-Up Display) is operated through the control unit of the NAV/Attack system).

Collimating Unit: The coloured display required for an operating mode is obtained with servoed reticules, controlled by signals from the electronic unit. Up to four different sets of reticules may be used. After optical mixing of reticules' images, collimation is effected by a large 120 mm lens.

Electronic units: This fulfils the following functions: interface with the Nav/Attack system associated to the HUD elaboration of the display control signals delivered to the collimating head, according to the operating mode; permanent auto-test of the HUD; power supply.

OPERATION:
The following modes are available:
(1) **Air-to-air** (operation with a fire control radar, such as the Cyrano).
(a) **All weather interception** with display of flight information (horizon, altitude, airspeed), and target information (elevation/azimuth, range, closing speed).
(b) **Missile launching**: Missiles of all types can be launched, and the HUD may accommodate any type of approach; snap-up or down, head-on etc.
(c) **Gunfire**: The HUD is designed to permit automatic gunfire at optimum radar range, in all-weather conditions, with no limitation (such as altitude, speed etc).
(2) **Air-to-ground**
(a) **Conventional armament** (gun-rocket-bombs): The HUD provides the following display for air-ground attacks: target position, for all-weather approach and ranging (laser or radar, with subsequent display of range to target); bomb impact line roll stabilised, drift corrected, enabling accurate automatic release of low drag and high drag bombs; and altitude levels.
(b) **Special weapons**: The HUD is designed to enable operation of a large variety of special weapons e.g. missiles of all types, A.S.30, Martel, cluster bombs etc, etc.
(3) **Navigation and landing**
(a) **Navigation** (cruise, terrain following, target approach): The following data can be displayed: horizon; heading and heading commands to keep a selected track; altitude and altitude commands; airspeed (or Mach number) and airspeed commands; flight director.
(b) **All weather approach:** This provides for the additional display of the axis of an instrument landing system.

Thomson-CSF 120 Series attsck sight collimating head

(c) **STOL landing:** This is a special display which enables a precise control of flight path angle and airspeed, resulting in an accurate impact on the runway threshold (within +30 metres), with the proper air-speed.

STATUS:
Systems of this type are in production for the Jaguar version for the French Air Force and for the Mirage FI.

MANUFACTURER:
Thomson-CSF, Division Equipments Avionique et Spatiaux, 178 Boulevard Gabriel Péri, 92-Malakoff, Paris, France.

1518.393
THOMSON-CSF R SERIES GUNSIGHTS

DESCRIPTION.
The series R gunsights produced by Thomson-CSF range from the simplest sight appropriate to basic training aircraft, to systems where the gunsight is performing many of the functions of a head-up display, accepting flight director information from a comprehensive navigation and attack system.

Three main types of R series gunsights are manufactured

Type R20 – Single moving reticle.
Type R30 – Two reticles, one fixed, one moving.
Type R300 – Two reticles. 1 fixed, two crosses used as a reference, a heading and rangine moving scale; 1 fixed. Stadimetric ranging with aircraft span set in. Optional roll indication.

Matching the progressive sophistication of the three R series sights listed above, various equipment combinations provide a corresponding increase in the range of operational facilities provided.

The basic R20 single sighting head provides for infra-red missile launch, and visual gunfire with gyroscopic sighting for two preset ranges in the air-to-air mode. In the air-to-ground mode the modes are, gun and rocket fire with fixed depression angle manually set in flight, and low and high-drag bombing with fixed depression manually set in flight.

Thomson-CSF R Series gunsight equipment

The R30 consists of sighting head, control box and electronic unit. Additional facilities provided in the air-to-air mode (over those of the R20) are radar or manual ranging and altitude correction; and in the air to-ground mode, roll stabilisation, corrections for ballistic deflection by drift insert, and the possibility of operation with a bombing computer.

The R300 consists of the sighting head, control box, electronics unit, and bomb release system, and provides additional facilities in the air-to-ground mode. These include: computed depression values based on weapon ballistics and aircraft parameters; automatic or manual release; roll stabilisation; windage and angle of attack corrections for rocket attack.

All three versions are intended for operation in conjunction with altitude and airspeed sensors, vertical gyro platform, angle of attack sensor, radio altimeter, doppler.

STATUS:

In production.

MANUFACTURER:

Thomson-CSF, Division Equipements Avioniques et Spatiaux, 178 Bvd Gabriel Péri, 92-Malakoff, France.

1519.393

AGAT AIR-TO-SURFACE WEAPON AIMING SYSTEM

DESCRIPTION:

The AGAT weapon aiming system for tactical aircraft has been developed by Thomson-CSF for Mirage and F1 aircraft, and includes the Gunsight type 121 of the series referred to in Entry **1317.393** above.

The AGAT system provides facilities for the delivery of all types of airborne ordnance including guided missiles. The system can be readily integrated with other navigation and attack system components, or it can be used as a self-contained navigation and attack system in its own right. It requires inputs from the aircraft air data computer and from other equipment.

AGAT consists of the following major components:

Gunsight type 121
Attack computer type 32
Laser rangefinder type TAV-38
Navigation map display type LC 102

The bombing computer type 32 is digital in operation, and can be used for automatic or manually initiated bombing with or without visual corrections from the pilot using the attack sight. Visual attacks are more accurate but may be impossible in bad weather. The system generates aiming data for free fall or retarded bombs as well as for gun and rocket fire in the visual mode. Attacks can be made without the pilot being required to fly a rigidly prescribed course, and he is free to carry out evasive action during the attack phase.

In operation the computer calculates the ballistic range of the bomb using pre-set data and sensor information when available. It also continuously calculates the aircraft range to the target using navigation data and laser information during the attack phase. Targets may be attacked using off-set aiming points.

Bomb release is signalled in the automatic mode when target range and bomb ballistic ranges are equal. In the visual mode the computer output controls the attack sight aiming mark, and the pilot releases the bomb when the aiming mark and target are coincident.

For en-route navigation and to indicate blind attacks the pilot uses the LC 102 centralised navigation indicator which is a form of moving map display.

STATUS: In production with the French Air Force

MANUFACTURER:

Thomson-CSF, Division Equipements Avioniques et Spatiaux, 178 Bvd Gabriel Péri, 92-Malakoff, France.

1736.393

TAV-38 LASER RANGEFINDER

DESCRIPTION:

The TAV-38 Laser Rangefinder is designed to provide air-to-ground ranging facilities up to ranges of 10 km in clear-sky conditions. The equipment comprises two units – Laser Head and Power Unit. The latter unit weighs 12 kg and has no moving parts. It provides the high energy DC voltage to the flash exciter tube and the auxiliary supplies to the system. The laser head weighs 8.5 kg, and houses the laser cavity, with its neodymium rod, flash exciter and triggering device. It also contains the receiver circuitry which incorporates an avalanche photo-diode, the digital range counter and transmission/reception optics.

Among the design features contributing to light weight and modest dimensions is an original type of exciter yielding more power to the neodymium rod, thus reducing the heat that needs to be carried away. The laser/internal cooling arrangements make the unit suitable for use under a wide range of ambient temperature conditions.

OPERATION:

Ranging is effected by measuring the time interval between the emission of an energy pulse and the return of reflected energy. Measurement is by means of a digital counter, with a clock frequency of 29.98 MHz, which corresponds to a distance increment of 5 metres. The digital output is converted into serial binary format for output. The wavelength of the emission is 1.06 micron.

The deflector system developed by Thomson-CSF enables the direction of the beam emitted by the laser rangefinder to be referenced to the boresight provided for the pilot by a collimator. The angle of deviation thus obtained is plus or minus 10 degrees in both elevation and azimuth.

DEVELOPMENT:

The type TAV-38 is the result of collaboration between Thomson-CSF and Marcoussis Laboratories CGE Research Centre, the former being responsible for the beam deflector system and the latter for the TAV-34 laser rangefinder.

STATUS:

The system has been ordered for a number of Mirage F-1 aircraft for export.

MANUFACTURERS:

Thomson-CSF, Direction Commerciale AVS, 178 Blvd Gabriel Péri, 92-Malakoff, France.

Laboratoires de Marcoussis, Centre de Recherches de la Compagnie Générale d'Electricité, Route de Nozay, 91460-Marcoussis, France.

TAV 38 Laser rangefinder

1377.393

TA 101 and TAY 18 AIRBORNE LASER RANGEFINDERS

DESCRIPTION:

Mechanically, these two airborne laser rangefinders are essentially identical, the principal difference between them being in the laser source employed in each version, and the corresponding differences in performance characteristics.

In the case of the TA 101, a neodymium-doped glass laser is used, and in the TAY 18 a neodymium-doped YAG laser. The equipment is comprised of two units, laser head and electronics unit. The latter weighs 10.5 kg for each model, and weights of the TA 101 and TAY 18 heads are 10.5 kg and 11 kg, respectively. Maximum range of the TA 101 is 10 km, and that of the TAY 18 is 8 km; minimum range in both cases is 320 metres, and ranging accuracy +5 m.

Other characteristics of the two models are as follows:

	TA 101	TAY 18
Wavelength	1.06	1.08 micron
Pulse duration	30.1-9-9	20.1-9 sec
Energy	0.2-0.3	0.06 Joule
Min pulse spacing	2 secs	0.1 sec
Pulse rate	10/min	100/min

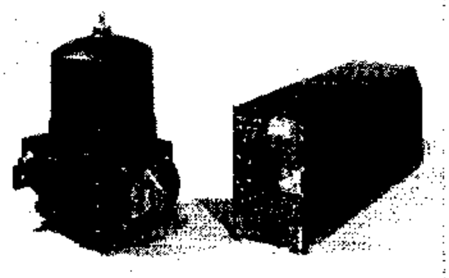
The laser head incorporates a mirror in the optical system that is provided with servo controls operating in azimuth and elevation, permitting alignment of the laser boresight with an operator's line of sight.

DEVELOPMENT:

The equipment has been developed for the French Jaguar aircraft programme.

STATUS:

The pre-production stage had been reached at June 1971.



TA 101 and TAY 18 airborne laser rangefinders

MANUFACTURER:

CGE Laboratoires de Marcoussis, 91460-Marcoussis, France.

1795.393

TAV 19 HELICOPTER LASER RANGEFINDER

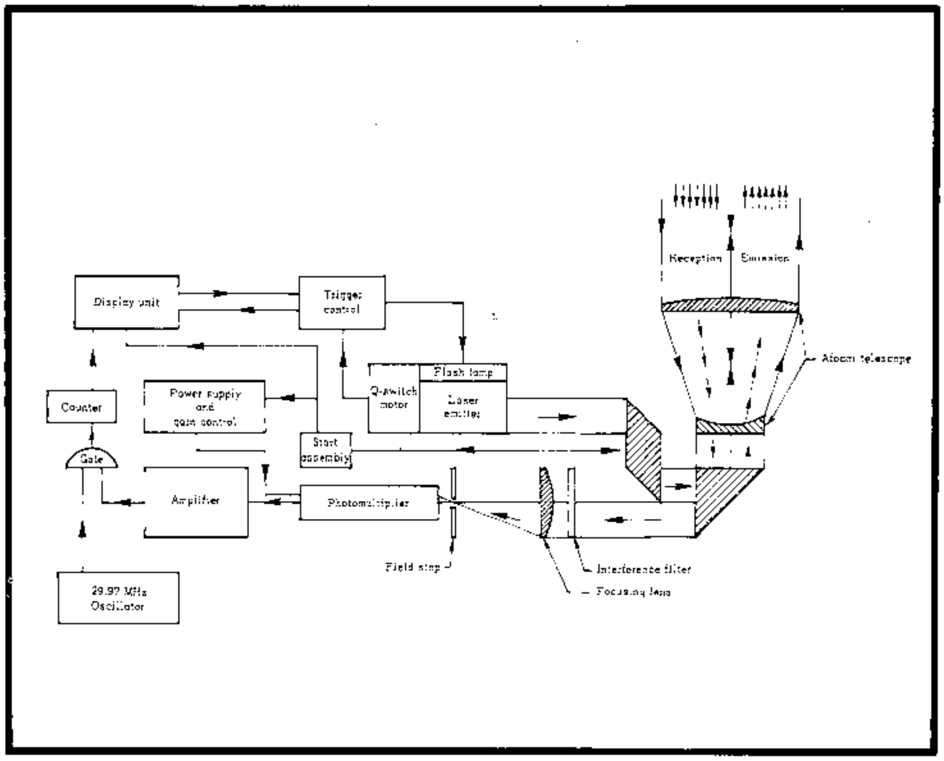
DESCRIPTION:

Designed for helicopter based rangefinding, the laser rangefinder TAV 19 was conceived for use with the Model M260 gyrostabilised view-finder of the Alteiers de Constructions de Puteaux (APX). It allows the measurement of the distance to a target identified previously in the view-finder.

Its accuracy is ± 5 metres, at any distance within the useful range. The maximum range depends on visibility and may reach 10 kilometres. The minimum range is 320 metres.

The TAV 19 rangefinder emits a very short laser pulse which is scattered by the target and picked up by a receiver placed near the transmitter. The distance is proportional to the time interval between the emission of the pulse and the reception

TAV 19 helciopter laser rangefinder



TAV 19 Schematic diagram

of the echo This interval is measured by an electronic counter with the help of a reference clock.

The TAV 19 rangefinder includes two separate subunits: the rangefinder head and a power supply unit. The component parts of the rangefinder head (laser transmitter and receiver) are fixed on a plate which is mounted directly below the APX view-finder. After the cover is secured, the entire unit is maintained sealed by the use of two o-rings. The rangefinder is equipped with a firing switch. After identification of the target, the operator presses a button in order to initiate the laser pulse. The range is displayed numerically in the right eyepiece of the view-finder.

The light pulse is emitted by a neodymium-doped glass laser. The beam is sent through an afocal telescope designed so as to reduce the beam divergence. A small fraction of the emitted energy is picked out and sent onto the light-sensitive layer of a photomultiplier tube, through an interference filter and a field stop. The resulting pulse, after shaping and amplification, gives the start signal to the electronic counter. The echo received from the target follows the same optical path and produces the stop signal for the counter.

CHARACTERISTICS:
Laser Emitter
W.AVELENGTH: 1.06 micron
Pulse duration: 30.10 ^{9} second
Nominal energy: 1 Joule
Peak power: 30 megawatts
Beam divergence at the output of the optical system: 1.5 milliradian
Repetition rate: 3 pulses per minute
Reception System:
Field angle: 1.5 milliradian
Bandwidth: 30 MHz
Minimum detectable power: 4.10 ^{7} watt
Weights:
Rangefinder head: 7 kg
Power supply: 15 kg
Dimensions:
Rangefinder head: 380 mm × 240 mm × 150 mm
Power supply: 290 mm × 265 mm × 200 mm

STATUS:
At prototype stage in early 1974.

MANUFACTURER:
Laboratoires de Marcoussis, Centre de Recherches de la Compagnie Générale d'Electricité, Route de Nozay, 91460-Marcoussis, France.

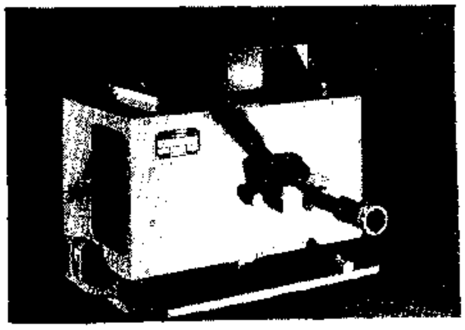
1799.293
TMV 26 NAVAL LASER RANGEFINDER

DESCRIPTION:
The TMV 26 naval laser rangefinder is designed to be integrated with the director system of 100 mm naval gun turrets to provide fire control ranging facilities on sea and shore targets against which radar ranging facilities may be inadequate. Accuracy is ±5 metres irrespective of target range, within the operating limits of the system. The maximum attainable range is dependent upon atmospheric conditions but can extend to 16 km.

CHARACTERISTICS:
Emitter:
Laser material: Neodymium glass
Wavelength: 1.06 micron
Pulse duration: 20.10^{-9} sec
Energy: 100 m Joule
Peak power: 4 MW
Transmission field: 1 mrad
Receiver:
Detector: Avalanche diode
Reception field: 1 mrad

STATUS:
The prototype stage had been reached by early 1974.

MANUFACTURER:
CGE-Laboratoires de Marcoussis, Route de Nozay, 91460-Marcoussis, France.



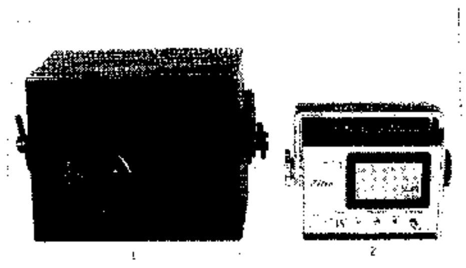
TMV 26 naval laser rangefinder

GERMANY (FEDERAL REPUBLIC)

1802.193
RZ 502 THERMAL IMAGING EQUIPMENT

DESCRIPTION:
The thermal imaging unit type RZ 502 due to its 50-element detector array provides a high-resolution thermal image which is displayed on the monitor at a rate of 60 half-pictures/sec, which appears as a real image to the human eye. This high-resolution thermal imaging unit serves for observation or reconnaissance. It can be installed in vehicles or helicopters. Independent of night or day conditions, the unit detects differential thermal radiation of man made or natural bodies. Haze, slight fog and dust have little or no effect on the image quality, even when the object to be detected is invisible to the naked eye. This also applies for objects (possible targets) in undergrowth which normally represent excellent camouflage. In conditions of this sort, the thermal imager will often reveal the target through its camouflage.

CHARACTERISTICS:
Optics:
Objective: SiGe achromate
Focal length: 100 mm
Aperture: 1.67



RZ 502 thermal imaging camera and display unit

Dia. of entrance pupil: 60 mm
Field of view: 6° × 10°
Detector:
Detector material: InSb
Type of detector: array, 50 elements
Size of elements: 100 micron × 50 micron
Geometric resolution: 1 mrad × 0.5 mrad
Spectral range: 3 micron to 5.5 micron
Cooling temperature: 77°K
Cooler: Joule-Thomson
Coolant: nitrogen gas
Coolant pressure: 400 to 120 atm.
Monitor
No. of lines: 100
Frame rate: 60 half-pictures/sec
Image diagonal: 90 mm
Electrical Data:
Nominal voltage: 24 V DC
Operating voltage: 18 to 30 V DC
Max. power consumption: 45 W approx

STATUS:
In production.

MANUFACTURER:
Eltro GmbH, 6900 Heidelberg 1, Postfach 520, West Germany.

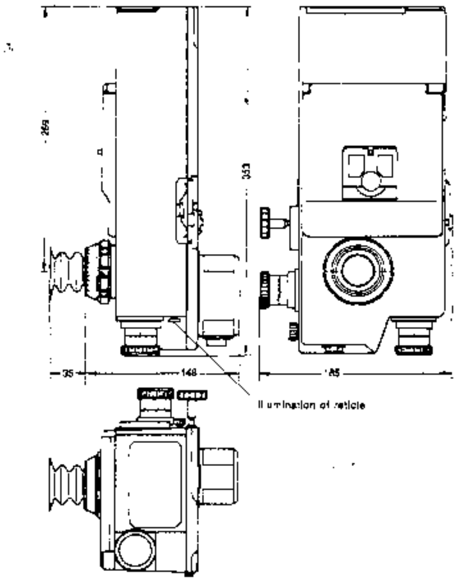
2186.153
IR GUN SIGHT TYPE BM 8001

DESCRIPTION:

This infra-red gunsight has been designed for use on the M47 and M48 battle tanks, on the Marder APC and on other armoured fighting vehicles. In a suitable mounting the gunsight can be interchanged with a daylight periscope, and it can be lined up to match the alignment of the daylight instrument with very little adjustment.

Reflected radiation from targets illuminated with infra-red from an associated IR searchlight or other source is reflected on to an image converter tube by means of a fixed mirror; and the converted image is viewed through an eyepiece. The instrument has a wide field of view (200 m in 1,000 m distance) and is rugged and easy to operate.

MANUFACTURER:
Elektro Spezial GmbH, 28 Bremen 44, Hans-Bredow-Strasse, Germany.



Three views of the BM 8001 gunsight showing dimensions in mm

2187.153
IR PERISCOPE TYPE BM 8004

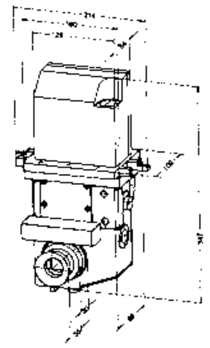
DESCRIPTION:

This infra-red periscope has been designed for use on the Hotchkiss and HS 30 armoured vehicles. Radiation reflected from a scene illuminated by an IR searchlight mounted in the vehicle, or by some other light source, enters the periscope and is reflected on to an image converter tube by a mirror that can be adjusted to alter the periscope's field of view in elevation. The image converter is then viewed through an eyepiece, and the relatively wide field of view (130 m at 1,000 m) makes it possible to pick out targets quickly.

The periscope is of robust construction and is completely self-contained – power being supplied by a nickel-cadmium battery. The equipment is sealed and can withstand immersion in fresh or salt water for up to 2 hours without deterioration in performance. To keep the internal circuits and mechanisms dry a silica gel cartridge is mounted in the side of the instrument.

All controls are easily accessible and the battery, image converter tube and silica gel capsule can readily be changed.

MANUFACTURER:
Elektro Spezial GmbH, 28 Bremen 44, Hans-Breddow-Strasse, Germany.



Outline of IR Periscope Type BM 8004 showing dimensions in mm

1727.153
DRIVER'S PERISCOPE TYPE BM 8005

DESCRIPTION:

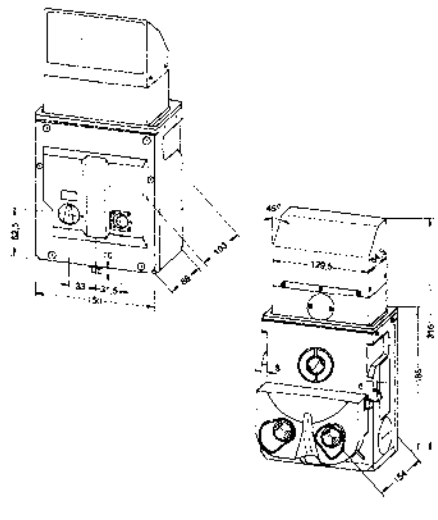
The BM 8005 has been designed for the Marder personnel carrier, Leopard Main Battle Tank, and other armoured vehicles having a standard vision port of 65 × 130 mm, or the M113 and other vehicles with an adaptor.

The passive driver's periscope is a binocular night vision device (one optical path for each eye), operated on the principle of image intensification and particularly developed for armoured vehicles provided with the standard vision block port of 65 mm by 130 mm.

The periscope serves mainly as a driver's vision device enabling night driving, without the assistance of any artificial light sources, down to a minimum illumination level of about 5.10^{-5} ft-c.

In addition the periscope can advantageously be utilised for surveillance purposes. As a particular advantage the periscope is also sensitive to near infra-red radiation. In respect to mechanical loads and temperature resistance, the periscope meets the relevant military specification requirements.

MANUFACTURER:
Elektro Spezial GmbH, 28 Bremen 44, Hans-Bredow-Strasse, Germany.



General arrangement drawings of BM 8005 driver's periscope, showing dimensions in mm

INTERNATIONAL

1628.153

UAL 11201 TANK LASER/UAL 11501 ARTILLERY LASER

L. M. ERICCSON, Sweden, and ISKRA ZZA, Yugoslavia, co-operate in the production of laser rangefinders for tank and artillery applications. The Tank Laser, UAL 11201, and the Artillery Laser, UAL 11501, use the same kind of laser transmitter, where the laser medium is a Ne-doped glass rod.

UAL 11201 is a laser rangefinder intended for tank weapon fire control and having a maximum range of about 7 km. The Tank Laser consists of one unit which is powered from the electrical system of the tank.

Two target ranges in the same line of sight can be registered and the operator decides which value is to be displayed. The Tank Laser is also equipped with an echo counter which indicates the total number of targets within the laser beam. Range information, number of target echoes and "Laser Ready" are presented in the image. Range information can be fed to a fire control computer via the range data output connector.

UAL 11501 is intended for rangefinding over comparatively long ranges (up to 15 km) for field artillery fire control. Built-in electronic angular pick-offs deliver information about azimuth and elevation directions to the target.

The Artillery Laser system consists of a transceiver unit, a power unit and a tripod. Two target ranges in the same line of sight can be registered and the operator decides which value is to be displayed. This laser is also equipped with an echo counter which indicates the total number of echoes within the laser beam. Range and angular information, number of target echoes and "Laser Ready" are presented on separate displays on the operator's panel. Range and angular information can also be fed to a fire control computer via the data output connector.

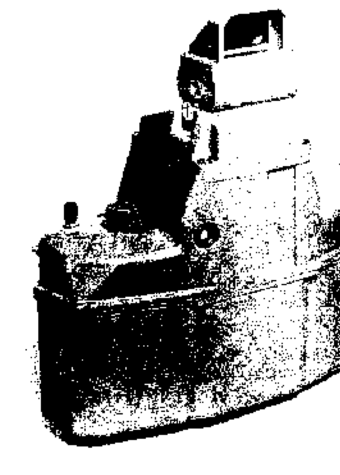
STATUS:

In production.

MANUFACTURER:

Telefonaktiebolaget, L. M. Ericsson , MI Division, S-431 20 Mölndal, Sweden.

IKSRA, Zavod za avtomatizacijo, Ljubljana, Yugoslavia.



The UAL 11201 tank laser in joint production in Sweden and Yugoslavia

THE NETHERLANDS

1800.193

TYPE HV7 X 200 AT NIGHT SIGHT

DESCRIPTION:

This is a night observation and aiming device consisting of an image intensifier system for medium range forward edge of battle surveillance or in a supplementary role as an aiming sight on crew-served weapons. No artificial illumination of any sort is needed. Special ballistic graticules can be incorporated to suit specific weapons. For general surveillance, the system is either tripod or vehicle-mounted. The spectral sensitivity characteristics of the tubes employed permits detection of the presence of enemy near-infra-red emitters.

Entirely self-contained, the unit comprises a high-speed mirror objective, a 3-stage fibre-coupled image intensifier assembly with power supply, eyepiece system, and graticule projector with adjustable illumination. Monocular or binocular eyepieces are available. There is an automatic brightness control, and a manual gain control. The typical detection ranges are up to 1000 metres for infantry and 3000 metres for tanks, depending upon factors such as ambient light level and contrast. A typical system weight is 12.8 kg.

MANUFACTURER:

N.V. Optische Industrie "De Oude Delft," PO Box 72, Delft, The Netherlands.

1801.193

TYPE TP1MS NIGHT PERISCOPE

DESCRIPTION:

The TP1MS is a passive night periscope for combat vehicles. It is a small, binocular, wide-angle, passive night vision image intensifier system for direct visual observation by the driver of the road and terrain in front of the vehicle under ambient night illumination conditions. The system will enable movement of combat vehicles at a speed of approx 40 km/hour under starlight conditions without the aid of artificial illumination, and with a maximum security from detection.

The viewer consists of an entrance prism, two objective lens systems, two image intensifier tubes, two oculars, and an incorporated high tension unit. The required 20-30V DC is drawn from the vehicle's power supply. An adjustable diaphragm is incorporated to suppress any disturbing effects of the night sky illumination. The field of view of 56° in the horizontal plane gives the driver a clear view of the roadside.

The high-tension power pack is stabilised and will automatically protect the tube against high photocathode illumination, automatically restoring to normal use again afterwards.

CHARACTERISTICS:

Total magnification: × 0.9

Field of View: Horizontal 56°; Vertical 45°

Centre resolution: under starlight conditions – 1 m lux, 1.0 mrad

Range: up to 200 m

Weight: 6.5 kg

Number of tubes: 2

Tube type: special diode, photocathode S25, phosphor screen P20

Cathode sensitivity: 250 Au/1 m

Power supply: 20-30 V DC

Entrance optics: Focal length 45 mm relative aperture 1:1.1. Fixed focus 15 m to infinity

Ocular system: Binocular and adjustable between +5 and −3 dpt

Operating temperature: Between −40°C and +50°

Storage temperature: Between −45° and +60°

MANUFACTURER:

N.V. Optische Industrie, "De Oude Delft", PO Box 72, Delft, The Netherlands.

1732.153

TYPE LAR LASER RANGEFINDER

DESCRIPTION:

The laser rangefinder, type LAR is an instrument specially developed for direct fire control support. It combines a rangefinder, with 5 metres' range accuracy independent of the distance, with instant electronic measurement of azimuth and elevation bearings. Combined in one box, it will fit easily in an armoured observation vehicle or on a jeep. Basically designed for mobile use, the LAR may also be used as man-portable unit operating from a tripod. An external powerpack will supply sufficient energy for at least 150 measurements. The LAR forms a modest two men load.

Basically the LAR is designed to measure ranges up to 10 kilometres for normal artillery purposes. If an operational specification calls for a maximum range of 20 kilometres, this requirement can be fulfilled as well. The system is readily adaptable to naval or coast artillery applications.

The laser rangefinder system LAR consists of a rugged ranging unit with built-in observation/aiming telescope and electro-optical azimuth and elevation encoders, a tripod for fieldwork and a re-chargeable 24 V NiCd battery in carrying case or in beltform. The ranging unit operates by sending out a short duration pulse of laser light, emitted by a Q-switched Neodymium glass laser transmitter. The operational wavelength is 1.06 microns and therefore invisible to the human eye. The reflected light from the target is processed in the receiver and converted into an electrical signal. An electronic counter is controlled by the outgoing and incoming signal(s) and connected with the display panel to provide distances reading accurate to ±5 metres.

The encoders provide continuous information of both the azimuth and elevation of the target. After a range measurement is performed, range as well as azimuth and elevation information is stored in the memories. An outlet is provided for transmission of these data to a computer of an integrated artillery fire control system. Angle measurements are also possible without previous range measurements. The system has a multiple target discrimination capability, with two memories. This makes it possible to measure the range of two targets within the beamwidth of the receiver detector field.

The average pulse repetition frequency is 6 per minute, and intermittent operation of 15 per minute is possible for a short time. The data stored in the memories is available for one minute, after which the unit will switch itself off into the "STANDBY" position in order to save battery power.

Type LAR Specification:

Ranging unit:

Laser type: Neodymium glass

Q-switch: rotating prism

Wavelength: 1.06 microns

Output beamwidth: 1 mrad

Output energy: approx 300 mjoule

Pulse repetition rate: 6/min average 15/min intermittent

Performance: min: 400 metres; max: 10,000 metres (20,000 metres if required)

Range accuracy: ±5 metres

Resolution detector field: 1 mrad (0.5 and 0.3 mrad also possible with reduced range)

Depth discrimination: ±30 metres

Azimuth encoder:

angle: 0-6,400 mils

accuracy: 1 mil

Elevation encoder:

angle: +450 mils

accuracy: 1 mil

Telescope: 7° (120 mils)
Magnification: × 7
Eyepiece adjustment: +5 dptr
Reticle: vertical and horizontal scales of 5 mils with aiming circle of 1 mil, adjustable illumination
Safety filter: built-in KG3 filter for eye protection
General data:
Computer output: BCD code (1-2-4-8) TTL logic
Power supply: 24 VDC nominal
Operational temperature limits: −40°C to +55°
Battery: NiCd, 24 Volts, 4Ah, rechargeable
Capacity: 150 measurements at +15°
Weights:
Ranging unit, (including telescope and angle measuring system): 25 kg
Tripod: 7 kg
Battery: 2 kg

Manufacturer:
N.V. Optische Industrie "De Oude Delft", PO Box 72, Delft, The Netherlands.

1733.153
TYPE LAT TANK LASER RANGEFINDER
Description:
The universal laser rangefinder type LAT has been designed to measure the distance from a tank to a potential target at a range between 400 and 6,000 metres, with an accuracy of +5 metres. A maximum range of 10,000 metres is possible under good weather conditions. The target is observed and tracked through the aiming sight of the tank. The system consists of a ranging unit and two control boxes, interconnected through cables.

The system can be mounted on many types of tanks, where, due to the fact that the space inside the turret might be very limited, the most economic solution is to attach the ranging unit to the gunshield or turret. Modular construction of the ranging unit makes the system easy to adapt to user requirements. This implies that arrangements are possible to incorporate the laser rangefinder modules into an optical sight or periscope.

The universal tank laser rangefinder, type LAT, consists of a rugged ranging unit and two control boxes. They are interconnected through heavy cables. The ranging unit operates by sending out a short duration pulse of laser light, emitted by a Q-Neodymium laser transmitter, an optical receiver, operating wave length of 1.06 microns. This light is invisible to the human eye. The reflected laser light from the target is processed in the receiver and converted into an electrical signal. An electronic counter is controlled by the outgoing and incoming signals and connected with the display panels on the control boxes. Distance readings are accurate to +5 metres. After a range measurement is performed, range data are stored in the memories, where they remain until the next measurement is performed.

An outlet is provided for transmission of these data to a computer of an integrated fire control system. The digital information is available in BCD code (1-2-4-8) for TTL interface. The system has a multiple target discrimination capability with two memories. This makes it possible to measure the range of two different targets within the beamwidth of the receiver detector field. Undesired target reflections can be eliminated by use of the minimum range gate. The average pulse repetition frequency is 6 per minute. Intermittent operation of 15 per minute is possible for a short time.

Type LAT Specification:
Ranging unit:
Laser type: neodymium glass
Q-switch: rotating prism
Wavelength: 1.06 microns
Output beamwidth: 0.5 mRad
Output energy: approx 300 mJoule
Pulse width: approx 30 nSec
Pulse repetition rate: 6 per minute average/15 per minute intermittent
Performance: 400-6,000 metres
Range accuracy: +5 metres
Resolution detector field: 0.5 mRad (0.3 mRad is also possible with reduced range)
Depth discrimination: 30 metres
Calibration telescope:
Field of view: 2° (34 mils)
Magnification: × 7
Control boxes:
Range display: decimal; 400-9,995 metres, the range of two targets can be displayed successively
Multiple target indication: signal light to indicate more than 1 echo received
Minimum range: continuous min range setting through control knob
General data:
Computer output: BCD code (1-2-4-8) TTL interface
Power supply: 19-29 VDC
Operational temperature: −40°C to +55°C
Weight: 18 kg

Manufacturer:
N.V. Optische Industrie "De Oude Delft", PO Box 72, Delft, The Netherlands.

NORWAY

1804.193
LP3 LASER RANGEFINDER
Description:
The Simrad LP3 laser rangefinder is a man-portable, tripod-mounted combined sight and laser rangefinder. It enables range, bearing and elevation data for targets to be rapidly acquired and used directly by weapons or fed into computerised artillery fire control systems. A quick-aiming sight is provided to permit rapid orientation against targets appearing only briefly, such as shell bursts or gun flashes. A Q-switched Neodymium-doped glass laser is used, providing a peak power of 1.5 MW. With a pulse length of 30 nanoseconds this amounts to an equivalent radiated energy of about 45 mJoules. A pulse rate of 12 per minute can be sustained during continuous operation, or 30 per minute for intermittent operation. A photodiode optimised for 1.06 micron is employed as a detector in the receiver. The maximum and minimum ranges are 20,000 metres and 200 metres, with the minimum-range setting continuously variable between 200 and 6,000 m.

Range presentation is by LED numeric indicators, with a measured resolution of 5 metres and range discrimination of 30 metres. The associated optical sight has a field of view of seven degrees and a × 7 magnification. Total weight of the equipment, with tripod, is 11 kg.

Development:
The Simrad LP3 laser rangefinder was developed for the Norwegian Army under Government contract. The programme was supported by the Norwegian Defence Research Establishment.

Status:
In production for the Norwegian Army and the forces of unspecified foreign countries.

Manufacturer:
Simrad A/S, PO Box 6114, Etterstad, Oslo 6, Norway.

SWEDEN

2359.153
UAL 11105 LASER RANGEFINDER
Description:
UAL 11105 is a medium range (less than 15 km) portable laser rangefinder intended for such field applications as target observation from close-by position in co-operation with artillery fire control systems.

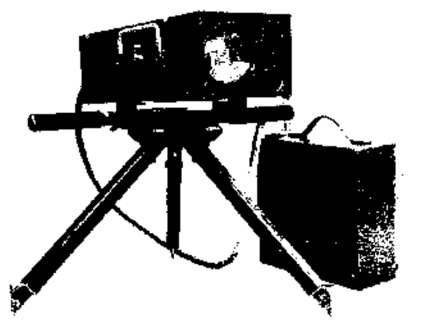
Target observation includes range measurement and determination of azimuth and elevation angles of the target related to a well defined terrain point. The L. M. Ericsson laser, when fully equipped, is a combined instrument capable of performing all these tasks. Range and angular information can also automatically be fed to a fire control computer via a data transmitter.

The periscope form of construction enables the operator to work from behind cover.

Description:
The rangefinder consists of the periscope laser, the tripod and the battery case.

The periscope laser consists of a Q-switched neodymium laser transmitter, an optical receiver, two digital counters, numerical displays, an optical sight for aiming the laser, control logic and voltage converter.

The laser is a sealed unit and is provided with a desiccator. The top cover can be removed for easy service and maintenance.

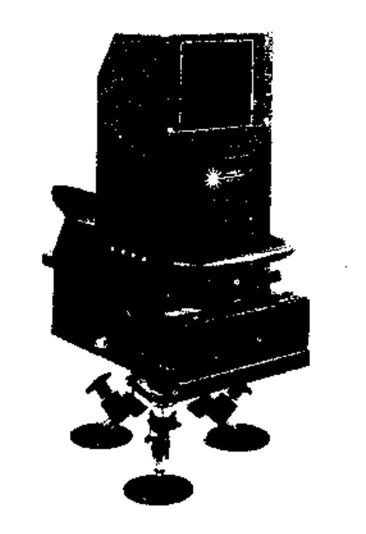


The L M Ericsson portable laser range-finder in basic form

The battery case contains 12 NiCd cells with a capacity of 3.5 Ah. This means about 250 measurements without recharging.

The portable laser rangefinder is also produced in a basic configuration, without the periscope.

Manufacturer:
Telefonaktiebolaget L. M. Ericsson, MI Division, S-431 20 Mölndal, Sweden.



Periscope version of L M Ericsson UAL 11105 laser range-finder

2347.193

TANK LASER RANGE–FINDER

DESCRIPTION:

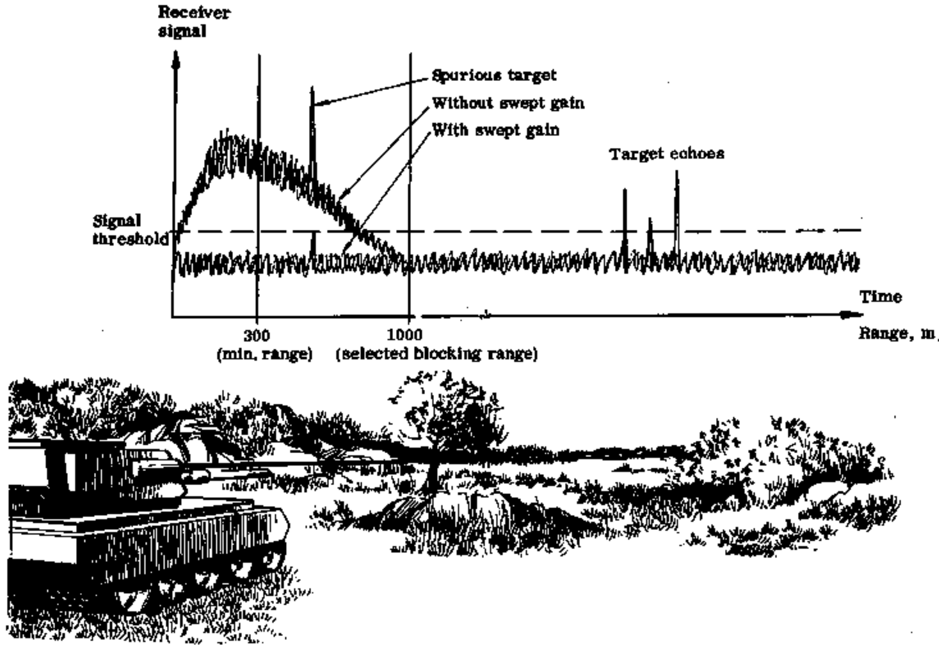
The Ericsson medium-range Tank Laser range-finder is intended for mounting on a tank, armoured vehicle or truck. It is divided into three units – the transceiver unit, the control unit, and the power unit.

The Tank Laser is capable of measuring two different target ranges at the same time, provided the targets are in the line of the laser beam. The different target ranges are displayed simultaneously. The operator selects which range data are to be fed to the co-operating equipment.

The transceiver unit is mounted outside or inside the turret. In the former case some additional armoured shielding is necessary. The transceiver optics are arranged to use the optical sight of the tank when the unit is mounted inside the turret.

The control unit, which is mounted inside the tank, contains three range counters, three range displays, control logics and low voltage supplies for the electronics. The displays are located behind a window on the front panel on which also are mounted the controls and signal lamps. On the rear there are three connectors, one for the transceiver unit, one for input power and one for the interface with the co-operating external equipment.

To eliminate the influence of undesirable echoes caused by atmosphere backscattering, spurious targets (flies, smoke, etc.) and echoes at short ranges, the Tank Laser is provided with swept gain and a blocking circuit.



Tank laser range-finder – principle of operation

Echoes from targets at short ranges are removed by a blocking range that can be set to two different fixed positions by the operator. Other selectable blocking ranges can be provided. An AGC circuit controls the receiver noise level.

MANUFACTURER:

Telefonaktiebolaget L. M. Ericsson, MI Division, S-431 20 Mölndal, Sweden

1213.253

UAL 1012 MARINE LASER RANGE-FINDER

DESCRIPTION:

Range-finder for marine ranging functions, point of impact observation for fire control purposes and similar applications. The UAL 10102 uses a ruby laser giving an output power of 5 MW to provide a range of 30 km. Range accuracy is quoted as plus or minus 10 m. Two pulse rates are available, 15 or 30 pulses per minute. The higher rate can be sustained for 20 seconds after which there is a delay of 20 seconds before the next firing takes place.

There are three principal units to the equipment: transceiver (13 kg), power pack (16 kg), and indicator (10 kg). It may be used separately or in combination with aligning devices such as TV or light amplifiers. When used with a TV camera, the UAL 10102 can be remotely controlled. An optical device in the laser is used for alignment.

The indicator unit has two numerical displays, the main one of which shows the latest measured range. The other, a memory chart, shows the last four measurements preceding the one shown on the main readout. When operating at the high pulse rate, the chart indicator shows instead the difference between the last value before the change-over to high pulsing and the measurement after changeover.

The transceiver unit contains separate tubes for the transmitting and receiving sections. The former houses the ruby laser and transmitting optics, while the latter tube contains receiver and associated optics, photo-detector, and receiver electronics. A fan provides cooling for the ruby rod and flash tube.

The indicator houses electronics for control and ranging logic on 13 circuit boards, and its front panel carries controls and the two displays. The main display consists of a five-digit indicator (Nixie tubes), and the memory display has four rows of four digits each.

OPERATION:

Operation of the transceiver unit is described in conjunction with Figure I. In the laser transmitter power is fed to the ruby (1) from a flash tube (2). The latter is lighted by a starting device (3) which

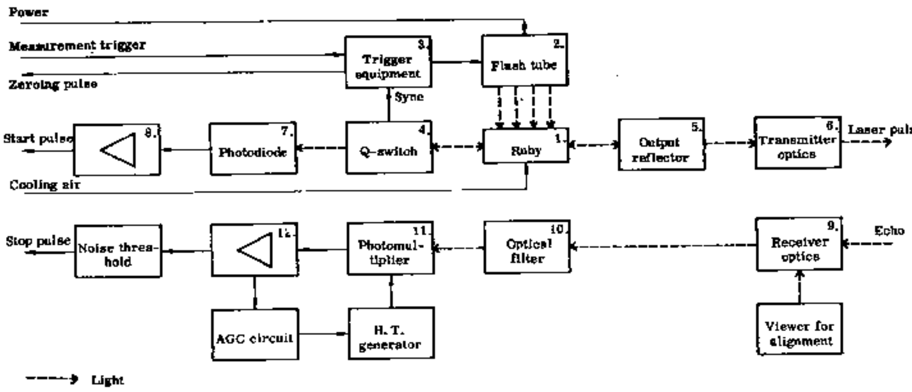


Fig. 1. Transceiver unit

is synchronised with a rotating prism Q-switch (4). When the ruby has stored maximum energy, the prism of the Q-switch is turned to the position which gives maximum feed-back of axial radiation in the ruby. The laser pulse is now built up and passed through the partially transparent reflector (5) and the transmitting optical system (6).

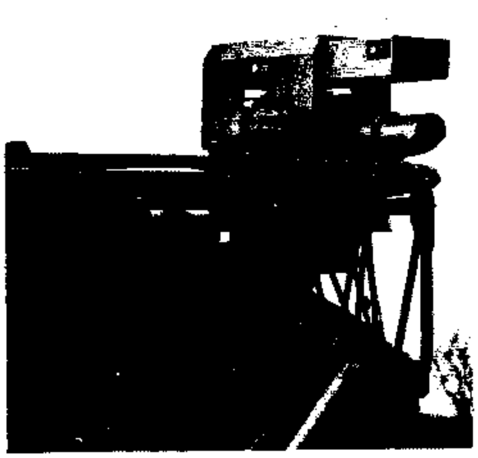
Part of the outgoing laser pulse is detected by a photo-diode (7) which through a driving stage (8) provides a starting triger to the timing counter of the indicator unit.

Reflected laser energy from the target is collected by the receiver optical system (9), passes through an optical pass-band filter (10) and finally strikes a photo-multiplier (11), where a signal is received and fed to a signal amplifier (12), which in turn sends a stop pulse to the counting circuits in the indicator unit.

The indicator unit measures the time elapsed from transmission of a pulse and reception of its reflection from the target, this being converted into an indication of range.

DEVELOPMENT:

L M Ericsson produced its first portable laser range-finder in 1965. The UAL 10102 is the result of continuation of this line of development and is one of a number of equipments of this type produced by the company.



The UAL 10102 marine laser range-finder in a land-based application

STATUS:

The UAL 10102 has been delivered in quantity to the Swedish Naval forces and other Scandinavian countries.

MANUFACTURER:

Telefonaktiebolaget L. M. Ericsson, MI Division, S-431 20 Mölndal 1, Sweden.

1376.393
LME AIRBORNE LASER RANGE-FINDER

DESCRIPTION:

The L M Ericsson airborne laser range-finder is produced in two versions, one pod-mounted and one for internal fitting in the parent aircraft, and is intended for range finding for air to ground attacks with bombs or rockets. The former version has a fixed 'sight-line' relative to the aircraft, whereas the latter has a servo positioned laser head.

The pod-mounted equipment consists of a transmitter/receiver and an electronics unit, both contained within the pod. The latter unit contains a digital range counter, control logic, and low-voltage power supplies. The measured range information is fed to the aircraft fire control computer.

In the other version, the laser transmitter/receiver unit can be positioned in azimuth by signals from the fire control computer, the necessary servo electronics being contained in the electronics unit.

The laser transmitter element is a neodymium-doped rod with a spinning prism, and the rod is excited by a xenon flash-tube. The Q-switch (spinning prism) is driven by a motor which is started just before a range measurement. The laser system is essentially the same as is used in other LME range-finders.

To eliminate unwanted echoes caused by back-scatter from the atmosphere, a preset blocking range facility is incorporated. This facility, in conjunction with an electronic counter which cancels all but the last detectable echo, ensures ranging on the designated target. Receiver noise level is controlled by an AGC system.

Range performance for both versions is 6 km in good visibility conditions, with a minimum range of 600 metres. Accuracy in range is ±10 m and range resolution 10 m.

MANUFACTURER:

Telefonaktiebolaget L M Ericsson, MI Division, S-431 20 Mölndal, Sweden.

1730.393
RGS 2 AIRCRAFT SIGHT

DESCRIPTION:

The Saab-Scania RGS 2 is a lead computing optical sight developed for use with any type of fighter or attack aircraft. Important design objectives were accuracy, small dimensions and weight, and low price. Its operational function is to display to the pilot a movable aiming point projected to infinity. The deflection of the aiming point is controlled in accordance with the characteristics of the preselected weapon, and with certain parameters of the prevailing flight conditions. In one simple configuration, only pitch, roll, and yaw rates are measured and all other parameters, such as speed, altitude and range, are set in manually by the pilot. In more sophisticated configurations, one or more signals are fed to the system from external sources. This flexibility enables the RGS 2 to be applied to a variety of aircraft types with minimum additional design effort.

The system has provisions for the following attack modes: guns, rockets and missiles for air-to-air; guns, rockets and bombs in the air-to-ground role. Stadiametric range (by wing-span setting) measurement is used in the air-to-air gun mode. When bombing, a suitable aiming mark depression (max 170 mils) is preset on the control unit. The dynamic range of the aiming mark deflection is plus or minus 120 mils in both pitch and yaw.

The RGS 2 system is comprised of three units: Optical Sighting Head, Gyro Unit, and Control Unit. Principal dimensions of these items are as follows:

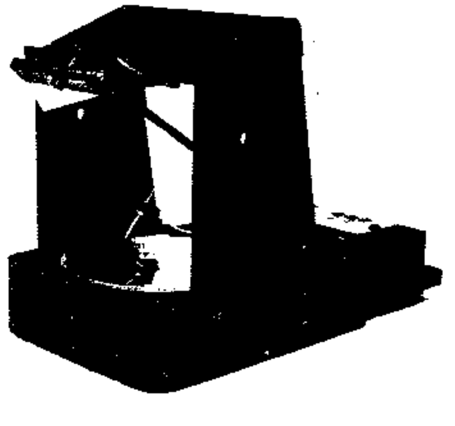
Sight Head: 164 × 134 × 238 mm

Computer and Gyro Unit: 100 × 160 × 250 mm

Control Unit: Size dependent upon system facilities

The sole purpose of the sight head is to generate a moving aiming mark of controllable width. Deflection of the aiming mark is accomplished by a spherical mirror, suspended in gimbals and controlled by a servo system comprising torque motors, feed-back pick-offs, and servo amplifiers. The width of the aiming mark is controlled by a similar servo system acting on a variable reticle placed in the focal plane of the spherical mirror. The whole optical assembly, with the exception of a fixed plane mirror and an ordinary inclined combining glass, is housed in the base of the sight head.

The computer and gyro unit contains three rate gyros and several circuit boards bearing the computing circuits, signal converters, three identical servo amplifiers and power supply circuits. All the pilot's operating controls are on the panel of the control unit.



Saab RGS-2 aircraft sight head

MANUFACTURER:

Saab-Scania, Datasaab Division, S-55002 Jönköping, Sweden.

1629.393
BT9R BOMBING SYSTEM

DESCRIPTION:

The BT9R system consists of the following units: Ballistics Computer, Control Unit, Laser Transceiver Unit, Distance Display Unit (optional), and Release Circuits (optional).

The *Ballistics Computer* is a hybrid electronic computer using both digital and analogue techniques to perform the calculations required to determine the release conditions. It comprises a rack of printed circuit boards mounted in a single light alloy box. Extensive use is made of integrated circuits such as shift registers, analogue multipliers, operational amplifiers and drivers.

The *Laser Transceiver Unit* houses a laser transmitter and a laser receiver with their accompanying optic systems. The laser beams can be deflected +10 degrees by a servo controlled optical device.

The servo is slaved to the drift angle from the Doppler Radar. If no Doppler is used the deflecting device can be omitted.

The *Control Unit* is provided with knobs for manual setting of target altitude, QNH and bomb ballistics factor. If the aircraft is equipped with a Doppler Radar, the Control Unit can be omitted.

The *Distance Display Unit* is an optional unit placed in the cockpit. It gives a visual digital presentation of the measured distance. The Display Unit also contains two indicating lamps and a switch for initiating the built-in test cycle. If the DDU is omitted, the lamps and switches are placed elsewhere in the cockpit.

The *Laser Range Finder* is also available in a pod version.

OPERATION:

System operation involves the following phases:

(1) Determining the aircraft's initial position in relation to the target. Slant range is accurately measured by firing the Laser Range Finder at the pickle point. The corresponding elevation angle is obtained from the aircraft Vertical Reference.

(2) Calculation and storage of the horizontal and vertical distances from the pickle point to the target. Continuous updating of these quantities using horizontal and vertical components of ground speed from the doppler radar or true air speed and angle of attack from the Air Data Computer.

(3) Continuous calculation of the release condition with respect to the aircraft's present position, the magnitude and direction of its velocity vector and the ballistic properties of the particular bomb. If doppler radar signals are available, wind effects are automatically compensated for.

(4) Continuous comparison of the calculated release angle with actual attitude angle. Automatic release signal to the bomb racks when the above quantities balance.

The BT9R is designed to be used at distances up to 6 km, dive angles up to 60° and within the velocity range 500 to 1,100 km/h. The impact accuracy is to a great extent dependent on the accuracy of the input signals, i.e. those represent ing pitch angle, speed, altitude and angle of attack. Other contributing error sources outside the BT9R are the pilot's aiming error, the bomb lock delay and the natural dispersion of the bombs themselves.

MANUFACTURER:

Saab Scania, Datasaab Division, Jönkoping, Sweden.

1231.383
SAAB TVT-300 AUTOMATIC TV-TRACKER

DESCRIPTION:

The TVT-300 is a system for automatic tracking of objects, in which the optical contrasts of the object against its background as seen by a television camera are utilised. The basic system consists of a TV camera on a gyro-stabilised platform, monitor, and an electronics unit containing video processing and servo control circuits. The equipment can be engineered and assembled to serve either fire control or missile guidance applications. Daylight or low light-level TV cameras are used, depending upon operational requirements.

OPERATION:

With the target within the view of the TV camera the operator places an electronic "window" on the target by means of a joy-stick. The "window", the position of which is indicated by an electronic cross-pointer, has an extension of a few per cent of the camera field of view. The operator then initiates automatic tracking whereby the servo control circuits keep the "window" centred on the target contrast and also align the target to the centre of the camera field of view.

Signals corresponding to the deviation of the "window" from the optical axis of the camera are used to control the platform servo motors which – trigged by the deviation signals – train the platform to keep the camera continuously directed towards the selected target. Tracking can be performed on dark or bright contrasts, or on very slight contrast levels. When used in a fire control system the platform angular positions in bearing and elevation are fed – directly or through a computer – for automatic tracking of the guns.

For missile guidance, the TV tracker is placed within the missile. Before launching, the TV picture is visible on a monitor screen in the aircraft, and this is used by the operator to identify the target. This done, tracking is initiated, and after checking that lock-on has been achieved, the missile is fired. The deviation signals from the tracker are applied to the missile guidance controls, to maintain the velocity vector in alignment with the camera's line of sight to the target until impact. As soon as the missile has been released from the aircraft, the pilot is free to take evasive action.

DEVELOPMENT:

This system has been the subject of active development work by Saab-Scania for five years, and it is understood that the Swedish authorities have a missile application under study. The system was operational on a Swedish fast patrol boat in 1972. A more advanced TV/laser fire control system for naval and army applications is currently under development.

STATUS:

The Swedish Defence Materiel Administration (FMV) recently awarded Saab-Scania a production order for delivery of Saab TVT-300/11 Fire Director Systems for installation on board torpedo boats and mine-sweepers of the Swedish Navy. The order, amounting to about Skr 6 millions, was preceded by operational tests and evaluation by the Swedish Navy in competition with similar fire directing systems.

The principal component of the system is the Automatic TV Tracker TVT-300. In the Saab TVT-300/11 the TV camera bearing and elevation values are used to directly control the aiming of AA guns which are slaved to the camera. The system

Saab TVT-300s 11 director

replaces the conventional fire direction and correction devices. Target acquisition and corrections are quickly and accurately made from a close-up view of the target view on the TV monitor.

MANUFACTURER:

Saab-Scania Aerospace Division, Missiles and Electronics Section, S-581 88, Linköping, Sweden.

THE UNITED KINGDOM

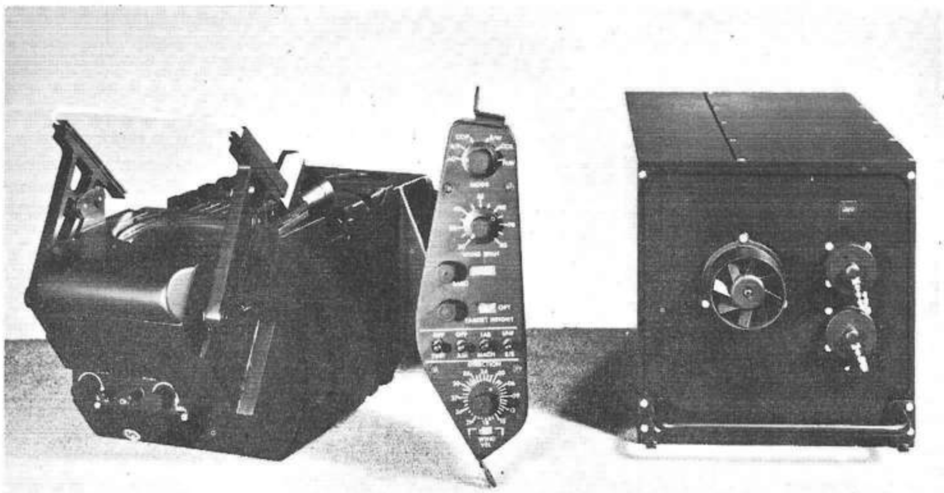
1731.393
TYPE 664 HUD-WAS

DESCRIPTION:

The Type 664 Head Up Display-Weapon Aiming System, is derived from the Elliott ILAAS equipment, developed in 1967 to meet a US Navy requirement for a comprehensive head-up display system. This was followed by the Corsair, A-7 HUD, and over 1500 such systems had been manufactured by the end of 1973. By utilising the spare capacity in the A-7 Electronic Unit digital computer to carry out the weapon aiming computations, a self-contained HUD-WAS was developed to meet the requirement of the A-4 aircraft. The Type 664 is the logical successor of the A-4 equipment, providing an advanced three-box system with a 4096-word digital computer electronic unit which is capable of providing a comprehensive repertoire of air-to-air and air-to-ground aiming modes, and leaving spare capacity available for dealing with other possible tasks.

The Electronic Unit accepts digital and analogue inputs from various sensors (the precise number and type of sensors will vary with aircraft types and missions, but examples are attitude and heading reference, air data computer, angle of attack sensor, radar, radio altimeter, doppler, etc), together with mode and weapon selection data from the pilot's control unit and weapon control panel. These, in conjunction with the ballistic data stored in the system, provide symbology outputs to the pilot's Display Unit which, viewed with the normal flight instrument symbology, provide the pilot with a highly versatile weapon aiming display. This enables attacks to be carried without the constraints of set dive angles, speeds and precise release heights that are applicable to some weapon delivery systems.

The Pilot's Display Unit houses a 4-inch (10 cm) lens system, with an integral standby sight and an electrostatically focussed CRT, designed to give a 25-degree field of view. The mounting in the aircraft is by means of a harmonisation mounting tray. Other facilities include a servoed combiner mechanism, integral EHT supply and integral



HUD-WAS Type 664, showing (l to r) pilot's display, side control panel and electronics unit

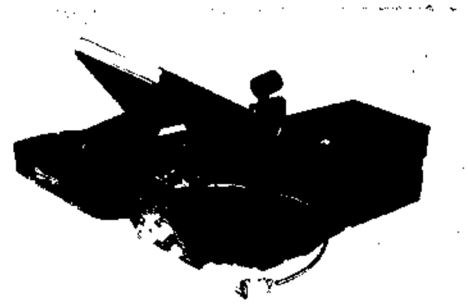
standby sight power supply. There is also provision for a side-mounted camera.

Any symbology format made up from straight lines and segments of circles can be displayed, the precise amount of information available and the symbology presented to the pilot at any one time will vary with customer requirements and operating mode. A declutter switch is provided to remove non-essential information from the display when desired. The Type 664 system can be extended to include the display of a night sensor (Forward Looking Infra-Red or Low-Light Level TV) scene in a raster form, overlaid with normal symbology, thus providing a day and night capability. This is effected by the addition of a video combiner unit.

The Pilots Control Unit enables the selection of weapon aiming, navigation or test modes, together with wind data and target height information if doppler and radar sensors are not available. Weapon aiming modes available include:

Type 666 display unit, showing controls

Air-to-Air – CCIL (snapshoot), Missiles
Air-to-Ground – Rockets, Guns, CCIP, CCRP.
MANUFACTURER:
Marconi-Elliott Avionic Systems Ltd, Airborne Display Division, Airport Works, Rochester, Kent, England.



Type 666 pilot's display unit forming part of HUD-WAS for General Dynamics YF16 light-weight fighter

1805.393
MRCA HEAD-UP DISPLAY

DESCRIPTION:
The Head-Up Display (HUD) being supplied by Smiths Industries for the MRCA has not been described in detail, and the following paragraphs must be regarded as unofficial. They are however indicative of some of the most recent HUD technology and are representative of current practice within the SI organisation.

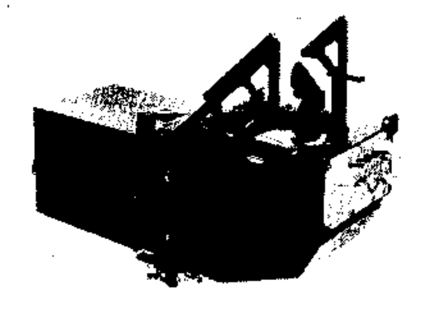
It has been stated that the MRCA HUD system is based on the broad philosophy of that supplied by Smiths Industries for the RAF Jaguar and which was described in some detail in Jane's Weapon Systems 1970-71 (Entries Nos 1127.373 and 1312.383). From the Jaguar system the company has developed a more advanced version and it is assumed that the MRCA equipment will embody many of the features of that system.

In both the Jaguar and the Harrier (which also employs a Smiths HUD) the HUD display computer was designed to interface with a separate weapon-aiming computer. Subsequent work was directed toward providing a weapon-aiming computing capability within an electronic HUD, and this resulted in a single digital computer unit with the necessary capacity for both HUD character generation and control, and weapon-aiming calculations. (Smiths Industries Ltd was named as the sub-contractor to Litef – Litton Technische Werke – for the manufacture of the Spirit 3 central airborne computer for MRCA in February 1972.)

The HUD display computer has four main functional sections: (1) input interface, (2) central processor, (3) output interface, and (4) power supply unit. The first of these sections performs analogue-to-digital conversions where appropriate and provides the essential link between the aircraft systems and sensors, control inputs, and the rest of the HUD system. The central processor carries out all the digital computation. The main programme is contained in a read-only memory which can be reprogrammed, if required, to accommodate changes in display format or other aspect of either system or operation. The ROM has a capacity of 4500 words, which is more than is required for a typical HUD, thus providing spare capacity for growth. A read/write memory of 256 words is used for temporary storage during normal digital computing functions.

The output interface includes a symbol function generator with a 1000-word symbol store containing the information which defines the symbol shapes. Instructions from the central processor feed this information out to X and Y integrators to provide analogue outputs for the pilot's display unit. Digital resolving techniques are used to stabilise certain symbols in roll.

The pilot's display unit converts the electrical signals from the display computer into the display which the pilot sees superimposed on his view of the outside world. The model for the MRCA is a fully line-replaceable unit featuring a 5-inch (127 mm) lens and built-in EHT unit, pilot's control panel and deflection amplifiers. The combining glass is fitted to a movable carriage to increase the field of view in elevation without the need for head movement on the part of the pilot. The servo drive for the carriage is automatically controlled by the display computer.



MRCA pilot's Head-up Display Unit

MANUFACTURER:
Smiths Industries Limited, Aviation Division, Bishops Cleeve, Cheltenham, GL52 4SF, England.

1012.393
ISIS WEAPON AIMING SYSTEM

DESCRIPTION:
The ISIS (Integrated Strike and Interception Systems) series of equipment comprises a range of aircraft sighting systems based on the use of gyro-controlled, lead computing optical techniques. Different versions are available to fulfil air-to-air and air-to-ground missions with varying degrees of complexity, according to operational requirements.

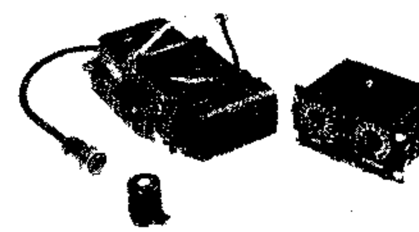
Common to all versions of the ISIS family of weapon aiming sights is the use of a 2-axis rate gyro, the movement of which is controlled by variations in the magnetic restraint imposed upon it in accordance with the requirements of the aiming process. The gyro is located in the sighting head, and has two principal parts, concerned with display and control, respectively. The display portion consists of a circular mirror centred on the rotational axis of the gyro. The aiming pattern is reflected from this into the pilot's forward view so that any deflection of the gyro relative to its housing results in a corresponding deflection of the aiming pattern relative to the centre of the field of view. The control portion of the gyro rotates in a controllable magnetic field, the strength of which determines the amount of deflection produced by a given aircraft rate of turn. The control field may also be intentionally unbalanced to produce required deflections of the gyro, and thus the aiming pattern.

OPERATION:
Air-to-Air: Control of the magnetic restraint on the gyro is particularly applicable to this mode. The constant of proportionality between gyro deflection and aircraft rate of turn is defined as the sensitivity of the sight, which for a given weapon is required to vary with range. This is achieved by coupling the ranging sensor (radar or optical) to a potentiometer which thereby adjusts the field strength operating on the gyro range. The gyro deflection, and hence the lead angle, is then correct throughout the attack path. Fixed range sensitivity operation is possible at a cost in reduced overall accuracy. The effect of gravity upon the projectile is compensated by arranging for a small depression of the sight-line, and the amount of depression is controlled by a similar arrangement for that used to adjust sensistivity, so that the allowance for gravity drop is correct throughout the attack path.

Air-to-Surface: In this mode, where variations in size of probable targets and other considerations may rule out the use of stadiametric ranging, and the gravity drop effect assumes greater importance, a depressed sight-line method of approach is used. The magnetic field controlling the gyro is unbalanced to cause a downward deflection of the aiming pattern, the amount of deflection being dependent upon the aircraft dive angle and speed. In some versions of ISIS switching is arranged to provide the correct sight-line depression for one fixed speed and one range of dive angles. If continuous speed and pitch angle inputs are available, however, these can be used to provide for continuous variation of sight-line depression.

Manual adjustment of sight-line depression can also be provided. A fixed sensitivity datum is used for each type of weapon in the ground attack mode.

Roll stabilisation of the aiming mark has become a standard feature of many of the ISIS variants where a vertical reference gyro is already installed in the aircraft. This feature reduces the tracking time of the target to a matter of 2 to 3 seconds thus limiting the "exposure time" of the pilot to ground fire.



ISIS F-195R

Additional Facilities: Provision can be made for the ISIS system to accept inputs from other sources such as doppler drift, laser or radar ranging.

DEVELOPMENT:
Design and development was initiated by Ferranti in 1960, and the first aircraft to be fitted with an ISIS system was the Fiat G91Y, under a development programme for the West German Air Force. The ISIS concept is a development of the gyroscopic gunsight (GGS) of which over 50,000 have been manufactured by Ferranti Limited since 1943. The GGS was basically an air to air system and the developed ISIS gyro unit became necessary to operate the system in the more rugged air to ground environment yet retaining the air to air capability.

The basic concept of the ISIS has been developed with the object of enabling the requirements of different users to be met from a range of standard systems – several of which are capable of subsequent extension. Details are given in the adjacent panels.

STATUS:

The ISIS system first entered operational service in 1968 and current users include the Canadian Defence Forces, Italian Air Force, Austrian Air Force, Royal Australian Air Force, Argentine Navy, Singapore Defence Forces, Royal Norwegian Air Force, Indian Air Force, US Marine Corps, Royal Air Force and Venezuelan Air Force.

ISIS equipment has been fitted to the SAAB 105, (ISIS F-105), Fiat G91Y (ISIS B), Aeromacchi MB 326 (ISIS F-126), McDonnell Douglas A-4S (ISIS D-101), Northrop CF5A (ISIS N), Northrop NF5A, HSA Hawk and HAL Gnat 1A (ISIS F-195R) and HAL HF24 (ISIS F-124).

The ISIS D-01 has been delivered to the US Navy for use by the US Marine Corps, in conjunction with a USN laser target designator system.

MANUFACTURER:

Ferranti Ltd, Electronic Systems Dept., Ferry Road, Edinburgh EH5 2XS, Scotland.

1009.393

TYPE AF120 GYRO-STABILISED SIGHT

DESCRIPTION:

A gyro-stabilised optical sighting system developed for weapon sighting and observation purposes from platforms subject to high levels of vibration, such as helicopters, patrol boats, fighting vehicles and hovercraft.

OPERATION:

The AF120 sight takes the form of a periscope, the upper mirror of which is capable of movement in the pitch and azimuth planes under the control of a directly coupled two-axis datum gyro. Controlled motion can be imparted to the field of view in both azimuth and pitch without requiring head movement by the operator. This is effected by controls incorporated in the horizontal handgrip/controller at the lower end of the unit. Azimuth movement is controlled by a thumb-wheel in the handgrip and pitch demands are made by rotating the handgrip itself in the direction in which it is desired to rotate the line of sight. The signals from these controls are fed to torque motors on the pitch and azimuth gimbals which precess the gyro in the required direction at a rate which is proportional to the angle through which the controller has been rotated.

The gyro is housed in an hermetically sealed casing, fitted with a sight-line window, together with the upper mirror. This casing is in turn housed in a more robust casing designed to withstand an external environment, and provided with a window equipped with an electric wiper for rain removal and mechanical washer. When the gyro is precessed in azimuth, a servo link between the gyro and inner head drives the latter into the null position with respect to the gyro.

The outer head is connected by flexible link to the inner head and thus the two sight line windows are maintained in line and in correct position in relation to the upper mirror. When the upper mirror is rotated relative to the lower mirror in azimuth, the corresponding rotation of the viewed image which would normally be present, is eliminated by the inclusion in the optical system of an image tilt compensating prism. This is servo linked to the inner head in such a way as to maintain the viewed image erect.

Two powers of magnification are provided, × 2.5 and × 10 selection being from a control on the handgrip/controller.

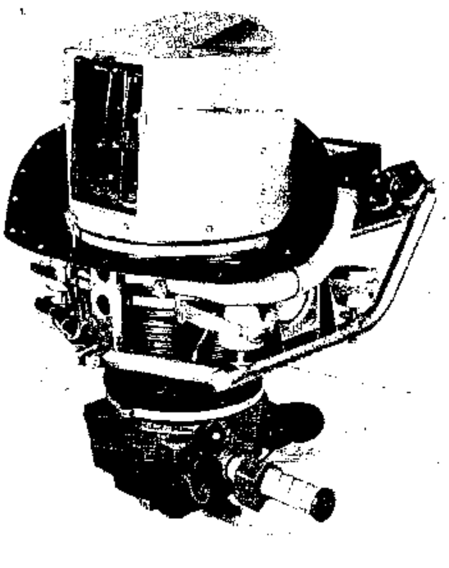
Sight line relative to the vehicle's fore-and-aft axis is displayed in two ways – (1) servo-driven graticules display sight line azimuth for the operator, and (2) a small indicator displays the same information for other crew members.

DEVELOPMENT:

Development was commenced in February 1967 as a private venture by Ferranti and Avimo Ltd, and the first prototype was completed in September 1968. The basic design has been engineered to permit continuing development and a second generation, light weight, modular constructed version of this sight has evolved suitable for fitting to all types of light helicopter.

STATUS:

British Army evaluation trials of the AF120 sight took place in Westland Scout helicopters at the Army Aviation Centre, Middle Wallop, Hants, in 1968, some of these tests being in conjunction with evaluation of the Nord SS. 11 wire-guided missile. Comparative trials were also made of the French APX 260 Bezu sight. A contract was placed in 1970 covering the supply of AF 120 sights for use in British Army Scout helicopters.



Type AF120 stabilised sight

MANUFACTURERS:

The optical sub-system of this equipment is manufactured by Avimo Ltd, Taunton, Somerset, England.

Electronics and gyro sub-systems are the responsibility of Ferranti Ltd, Instrumentation Division, Aircraft Equipment Department, Moston, Manchester M10 0BE, England.

1794.393

TYPE AF530 GYRO-STABILISED SIGHT

DESCRIPTION:

The AF530 sight may be used for observation, target acquisition/recognition/identification and missile guidance. Modular construction, light weight and ruggedness permit its use in a wide variety of helicopter types, land vehicles and light patrol boats. It has been developed for the BAC Hawkswing missile system.

The sight is a gyro stabilised monocular, periscope telescope which provides a stable, magnified image of the selected field of view irrespective of the normal pitch, yaw and vibrational disturbances to which it might be subjected. In addition, the sight incorporates facilities for missile simulator injection and TV camera attachment.

In the helicopter application, the sight is normally installed in the cabin roof with its longitudinal axis fixed to align with the helicopter's fore-and-aft datum. A rotating viewing head protrudes through the canopy and allows the operator to scan the landscape through the monocular which is mounted on a stowable down tube.

Movement of the field of view in azimuth and elevation is achieved by horizontal and vertical orientation of a gyro stabilised mirror mounted within the rotating head. The stabilised position of the mirror can be varied by a thumb-stick controller which also contains a press switch for changing viewing magnification from × 2.5 (low magnification with large field of view) to × 10 (high magnification with narrower field of view) or vice-versa.

OPERATION:

Light from the field of view enters the sight via a window in the rotating head and is reflected into the optical assembly by the mirror, which is suitably inclined to the vertical plane. After reflection, the light passes through magnification change lenses, a Pechan prism (to maintain an erect image) and a relay lens system in the down tube, to the monocular where it is focussed to give an erect magnified image of the landscape within the field of view.

The mirror is mounted in a system of gimbals which move about mutually perpendicular axes, under the action of a gyro, so as to orientate the mirror and maintain a stable image of the selected view.

The desired sight line is maintained by the adjustment of the thumbstick controller which transmits command signals to the gyro's elevation and azimuth torque motors to drive the mirror to the desired position. Azimuth movement of the gyro is limited, therefore to maintain a satisfactory viewing range it is necessary to rotate the complete head enclosing the gyro and mirror. This is achieved by the incorporation of an azimuth sensor in the gyro which produces signals proportional to the gyro's azimuth movement.

Magnification power of the sight can be rapidly interchanged by the operation of a push switch on the tracking controller. This action causes a lens system to be inserted into, or withdrawn from, the light path between mirror and optical assembly.

The relay lens system in the down tube enables the sight to be used in a wide variety of installations where the down tube requirement may differ. An adjustable eye point is also possible with this design.

MANUFACTURER:

Ferranti Ltd, Aircraft Equipment Department, Lily Hill House, Bracknell, Berkshire, RG12 2SJ, England.

1196.393

FERRANTI LASER RANGER AND MARKED TARGET SEEKER

DESCRIPTION:

An aircraft ranging and direction equipment designed primarily for air to surface attacks when it is used, either as a self contained laser ranger or, when operating in conjunction with a Laser Target Marker (Designator), as a simultaneous rangefinder and target seeker. It is specifically intended for use with weapon systems optimised for low level first pass attack when target tracking time is necessarily short and grazing angles are very low. This latter feature, coupled with high accuracy, gives this laser system a distinct advantage over radar ranging equipments.

OPERATION:

The laser ranger operates by directing a pulse of infra-red energy from a YAG laser at the target. Range is then derived by measuring the time interval between transmitting the pulse and receiving the scattered energy returned to the ranger from the target. The laser beam is stabilised against vibration and angular movement to ensure accurate alignment with the target. A high PRF allows continuous range information to be obtained when this is required.

When used in conjunction with a laser target marking system, a Forward Air Controller aims a pulsed laser marker at the designated target and uses a radio link to direct the pilot of the attacking aircraft. As the aircraft approaches the target, the Target Marker is switched on. The target seeker in the aircraft automatically acquires and tracks the scattered laser energy from the target. The tracking operation generates signals which are translated into director information for presentation to the pilot on a head-up display.

Advantages arising from the latter mode of operation include positive identification of the target by someone who normally has relatively more time available than the pilot; pilot work load is reduced by elimination of the task of searching for the target over a wide field of view; an attack can still be made even though the pilot may not see his target due to poor light or because of camouflage.

The laser beam is fully stabilised against aircraft movements and is steerable to plus 3 degrees and minus 20 degrees elevation, plus or minus 12 degrees in azimuth, and plus or minus 90 degrees in roll. Range is quoted as being greater than pilot's visual range up to 9 km.

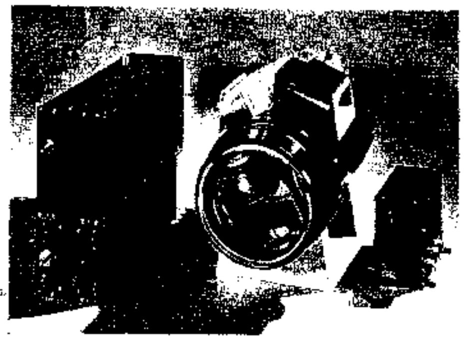
The Stabilised Laser Unit weighs 19.5 kg and is 57.5 cm long by 26.5 cm wide. The height is 30.4 cm. An Electronics Unit containing ranging and power circuits is also provided, measuring 43.2 cm long by 33.0 cm wide by 12.7 cm high and weighs 13.6 kg.

DEVELOPMENT:

Development was started in late 1968 under UK Government contract and the first prototype was completed by mid 1970. A laser ranger and target marker ground equipment to work in conjunction with the airborne equipment is also under development.

STATUS:

The equipment is destined for service with the Harrier and Jaguar strike aircraft of the Royal Air Force during the mid 1970s. It is now the subject of a production order for both aircraft types. A variant is being developed for the Multi- Role-Combat- Aircraft (MRCA) in collaboration with German and Italian industry.



The Ferranti laser ranger and marker target seeker being developed for the trainer

MANUFACTURER:

Ferranti Ltd, Electronic Systems Department, Ferry Road, Edinburgh EH5 2XS, Scotland.

1207.293

SHORTS TARGET DESIGNATION SIGHT

DESCRIPTION:

The target designation sight is used for visual acquisition and tracking of surface and air targets. The sight consists of a binocular mounted on a sight head, fitted to a pedestal which is bolted to the deck. The binocular platform is fitted with handgrips with which the binocular may be rotated and the sight head may be raised or lowered on an elevating shaft to provide height adjustment.

OPERATION:

On acquiring the target in the binocular field of view and centring it on the cross-marking, the operator presses the designated alarm switch on his right hand grip. The target bearing and elevation information is transmitted automatically to the control centre by two synchro elements, one in the pedestal for bearing, the other in the sight head for elevation.

DEVELOPMENT:

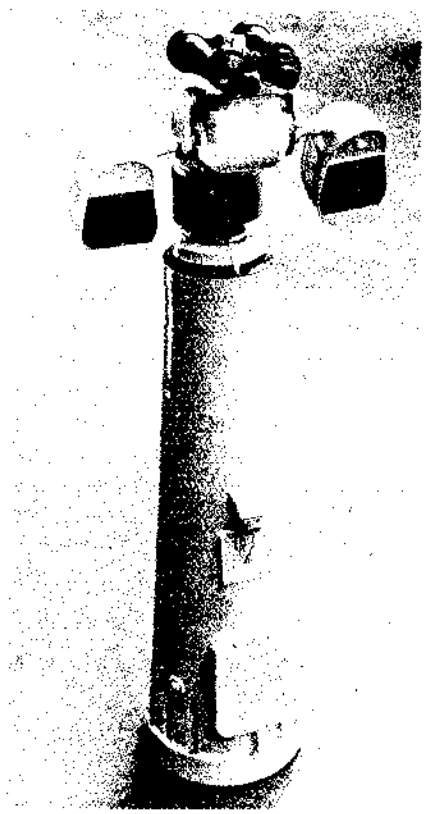
This equipment has been evolved from an element of the Seacat missile system (which see), and is a modification of the pedestal-mounted visual director used with that system.

STATUS:

Orders have been placed for substantial numbers of these sights for use by the Royal Australian and Royal Canadian Navies. The former Service will fit them on frigates and destroyers, and the destroyer-escorts Mackenzie, Saskatchewan, Yukon and Qu'Appelle, and helicopter-destroyers Annapolis and Nipigon of the RCN will be fitted.

MANUFACTURER:

Short Brothers and Harland Ltd, PO Box 241, Airport Road, Belfast BT3 9DZ, Northern Ireland.



Shorts Target Designation Sight

1742.193

FERRANTI LASER TARGET MARKER AND RANGER

DESCRIPTION:

The Ferranti Laser Target Marker and Ranger has been designed to enable Forward Air Controllers to designate ground targets for either co-operating laser seeker equipped strike aircraft or for precision SMART weapons. Aircraft using the airborne laser seeker counterpart are able to carry out single pass attacks without the requirement for the pilot to be visual with his target.

The equipment also has built-in ranging for artillery or other purposes. When integrated with the Pilkington (PE) Ltd. Night Observation Device (NOD), a night operational capability is provided.

The system comprises a Main Unit, Precision Angulation Support System (PASS) manufactured by Marconi Elliott Avionic Systems Limited and a Nickel Cadmium Battery. PASS provides a highly stable support as well as azimuth and elevation control and measurement. The equipment will range on demand and has an endurance to permit target marking for at least 20 minutes (within a specified duty cycle) before battery recharge is necessary. Lightweight, compactness, ruggedness and reliability are key design features.

OPERATION:

The Target Marker is the ground element of the newly evolved system of close air support.

The FAC aims the pulsed laser at the chosen target and uses the radio link to call the strike aircraft. When the aircraft approaches the target area, the Marker is switched on and the airborne Marked Target Seeker acquires and tracks the scattered energy, driving the pilot's head-up display to indicate target position. The pilot may then carry out an attack without ever seeing the target. In the case of SMART weapons, the seeker is built into the missile or bomb.

DEVELOPMENT:

The laser Target Marker and Ranger is being developed in conjunction with the Ferranti Airborne Laser Ranger and Marked Target Seeker for the Jaguar, Harrier and similar strike aircraft.

Late development model of Ferranti Laser Target Marker and Ranger for use by the British Army

STATUS:

The equipment is understood to be in the late stage of development.

MANUFACTURER:

Electronic Systems Department, Ferranti Ltd, Ferry Road, Edinburgh EH5 2XS, Scotland.

1340.293
LOOK OUT AIMING SIGHT Mk 1

DESCRIPTION:

The look-out Aiming Sight Mk 1 is a stabilised visual target search and tracking system intended to provide visual look-out facilities to assist a ship's AIO (Action Information Organisation), and to supplement target data derived from radar or other sources. It is primarily intended for the acquisition of surface or low-flying aerial targets, especially at low angles of target elevation where radar performance may be subject to natural limitations.

The equipment comprises three principal elements: Look-out Aiming Sight, Sight Below-Decks Assembly, and Relay Panel. A fourth unit, the Emergency Fire Control Box, may be included, depending upon system requirements.

The Look-out Aiming Sight is generally of cast aluminium construction, and is power operated and stabilised, the sight line being controlled by the operator by means of a conventional joystick to precess a gyro, from which the resultant signals are fed to the elevation and training (azimuth) servo systems. The operator can pre-select the scope of the joystick control to suit operational requirements. Sighting is by means of binoculars Type G.388. Provision is made for mounting either a cine or television camera for tracking or missile gathering purposes.

Hand elevation and training facilities are provided for servicing.

The sight below-decks assembly is a watertight cabinet housing all the ancillary electrical and electronic equipment associated with the sight, comprising the elevation and training torque motor amplifiers, power supply units, contractors and switchgear. Test and monitoring facilities are also included.

The Relay Panel contains the requisite relays and switching equipment to provide an interface between the Look-out Aiming Sight and the ship's weapon/AIO system. Where an Emergency Fire Control Box is included in the system, the Relay Panel also performs the necessary change-over switching functions to transfer control.

The Emergency Fire Control Box provides all the controls necessary for the direct emergency operation of the gun in association with the sight or other external tracking source, and includes the mechanism necessary for the computation and transmission of gun data appropriate to the target engaged.

OPERATION:

Two basic modes of operation are possible, Control and Follow. In the former mode there are three main operational roles:

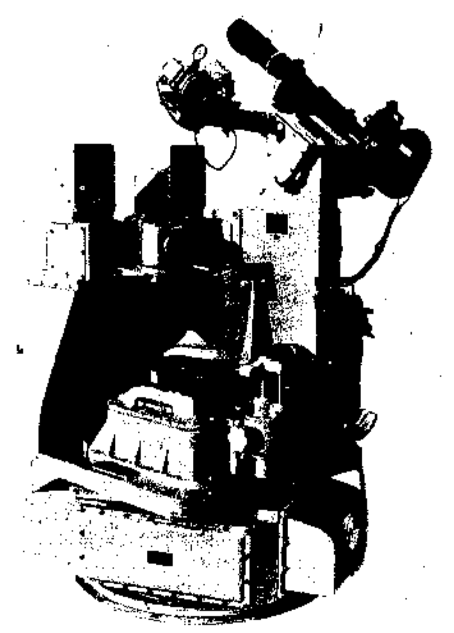
1. To provide visual look-out facilities in support of the ship's AIO, and to supplement target data derived from radar and other sources.
2. To provide means of directly conning a main weapon tracking system onto a visually acquired target.
3. To operate as an emergency gun control system in the event of failure of the main control system.

In the Follow mode the sight can be remotely conned from the AIO, or other command stations, or to a given bearing and elevation for visual investigation and identification of a designated target.

Joystick control response can be varied by the operator to suit operational requirements in various control mode roles as follows:

	Elevation	*Training*
Slewing	5°/sec	45°/sec
AA Control	5°/sec	10°/sec
Surface Control	2°/sec	2°/sec

Limits of travel in elevation are 30 degrees depression to 55 degrees elevation, and training is unlimited. Four sets of elevation and training data are available for transmission to other ship's systems.



Vickers Mk 1 look-out and aiming sight used with the Mk 8 gun mounting. This combines the separate functions of an air look-out sight and an aiming sight in a single fully-stabilised unit

STATUS:

Vickers Ltd, Armament Division, Crayford Works, Crayford, Kent, England.

2432.193
LF2 LASER RANGEFINDER FOR CHIEFTAIN TANK

DESCRIPTION:

The LF2 uses a ruby laser giving 1 MW 0.04usec output pulses. Ranges can be taken from 500 to 10,000 metres with an accuracy of ±10 metres for more than 90% of shots. It was developed initially for the Chieftain tank (**5006.102**) but can be adapted to suit other AFVs where space permits.

The equipment consists of two units – a Head Unit (17 kg) containing the laser rangefinder, and a Power Unit (12 kg) to provide the special electrical supplies. The Head Unit is mounted in Chieftain to look through the gunner's sight aperture and it combines the function of gunner's periscopic sight. This means that the sight, which is boresighted to the 120 mm gun by a mechanical linkage, is also rigidly boresighted to the laser transmitter/receiver under all environmental conditions.

OPERATION:

The gunner elevates and traverses to aim on a target seen with his right eye in the X8 magnification sight. He presses the 'Flash' button and reads the range, given in a separate eyepiece, using his left eye. He then refers back to the telescopic sight where there is ballistic data for the ammunition in use and lays the gun accordingly. The operation is quick and simple to perform and at no time is the gunner's concentration on the target distracted.

The most significant error affecting the engagement of targets at medium and long ranges is the range error: the LF2 minimises this error and also corrects for trunnion tilt. It is, as a result, an accurate, rapid and silent ranging system which permits the weapon system to achieve a high probability of a first round hit at long ranges.

MANUFACTURER:

Barr & Stroud Limited, Caxton Street, Anniesland, Glasgow, W.3., Scotland.

2403.193
AFV No. 52 GUNNER'S SIGHT

DESCRIPTION:

This daylight sight has been designed for use on light armoured vehicles and is installed in the British Army Fox (**5064.102**) vehicle.

AFV No. 52 Gunner's Sight is a binocular instrument giving X1 and X10 magnifications and is particularly suitable for use in poor light conditions. In addition to the changeover facility from X1 to X10, provision is made for the insertion of a circular graticule into the X1 field of view which approximately outlines the corresponding X10 field.

Care has been taken to ensure that the drive lever which connects the sight to the gun mounting follows the line of sight accurately over the full range of movement in the vertical plane.

A washer/wiper system is fitted to maintain clear vision through the external face and the whole equipment has been designed to a stringent environmental specification.

CHARACTERISTICS:

Magnification: X1 or X10
Focus: Infinity
Eyepiece: Exit pupil diameter 6.1 mm. Eye clearance: Full field 29 mm. Focus: −0.75 dioptre to within 0.25 dioptre (fixed focus)
Eyepiece heaters: 30 W, thermostatically controlled
Field range: 14° depression to 41° elevation
High power graticule: In right eye system only. (Graticule adjustable ± 10 mils)
Graticule edge illumination: 0.8 amp bulb, variable control
Injected graticule in X1 magnification mode: 18 W bulb, variable control

MANUFACTURER:

The M.E.L. Equipment Company Ltd, Defence Systems Division, Manor Royal, Crawley, Sussex.

2404.193
AFV Nos. 68/71/75 COMMANDERS SIGHTS

DESCRIPTION:

These daylight sights have been designed for use on light armoured reconnaissance vehicles and are installed in the British Army Scorpion (**5040.102**) and Fox (**5064.102**) vehicles.

AFV Nos. 68/71/75 Commanders' Sights are binocular instruments giving both X1 and X10 magnifications and are particularly suitable for use under poor light conditions. The change from one magnification mode to another is by means of a 'flip' control: a coloured filter can be inserted if required.

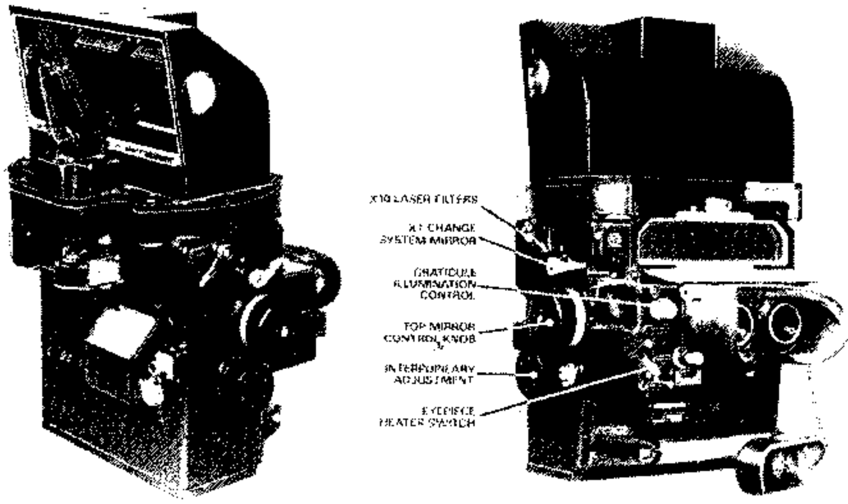
A washer/wiper system is fitted to maintain clear vision through the external face and the whole equipment is designed to a stringent environmental specification.

CHARACTERISTICS:

Magnification: X1 to X10
Focus: Infinity
Eyepiece: Exit pupil diameter: 6.1 mm. Eye clearance: full field 29 mm
Focus: −0.75 dioptre to within 0.25 dioptre (fixed focus)
Eyepiece heaters: 30 W thermostatically controlled
Field range: −14° to +41°
High power graticule: In right eye system only
Graticule edge illumination: 0.8 amp bulb, variable control

MANUFACTURER:

The M.E.L. Equipment Company Ltd, Defence Systems, Manor Royal, Crawley, Sussex.



AFV No 68 Commander's Sight

2433.193
INFRA-RED BINOCULAR SIGHTS
CU-10 & CU-13

DESCRIPTION:

The Infra-red Vehicle Sights Types CU-10 and CU-13 permit night driving of military vehicles without using visible lights.

Filters, covering the vehicle's headlamps, transmit only the infra-red wavelengths to irradiate the terrain in front of the vehicle, and the reflected radiation is converted by the sight into visible light. The optical specification of these systems ensures that the sights give a driving performance at night which is comparable with that achieved using normal headlamps, even when turning.

CU-10 and CU-13 are binocular periscope instruments with unit magnification, wide field of view and large aperture eyepieces resulting in high optical efficiency and comfort of vision. The eyepieces are either horizontal or inclined to suit the driving position in the vehicle this being the principal difference between the two.

A prism in the top of the periscope, external to the vehicle, reflects the infra-red into the separate optical objectives in each limb of the instrument. These objectives focus the beams on to the photocathodes of two image converter tubes which, when subjected to an E.H.T. potential between anode and cathode, form visible images on their fluorescent screens. These images are then magnified by the eypieces of the periscope which can be focused individually to suit the driver's vision.

The E.H.T. voltage is supplied to the image converter tube through a transistorised oscillator and multiplier circuit contained within the periscope casing and energised from the vehicle supply of batteries.

The instruments have been designed to meet army requirements for servicing and replacement of parts. They have been fully environmentally tested and accepted for military service.

CHARACTERISTICS:

Optical System:
Over-all magnification: X1
Field of view: Horizontal 51°, vertical 34°, objective aperture ratio f/1.4
Graticule: As required
Image converter tube: CV6914
Power Supply:
E.H.T.: Nominal output at 20°C. 16kV + 0.5kV
L.T.: Nominal input voltage (vehicle supply or batteries) 24V d.c. (or as required)
Dimensions: Width 30 cm, depth 21 cm, height 35 cm, weight 10.5 kg

MANUFACTURER:

Barr & Stroud Ltd, Caxton Street, Anniesland, Glasgow, W.3., Scotland.

2434.193
LONG-RANGE VIEWER CU-15

DESCRIPTION:

The function of the Image Intensifier Long-Range Viewer Type CU-15 is to provide an observer with a visual image of objects at low light levels, the maximum range depending on scene illuminations.

The instrument embodies a catadioptric system of high aperture which collects light from a target and brings it to a focus on the photocathode of a three stage image intensifier tube. The resultant electron beam is focused onto the fluorescent screen of the image intensifier tube, and the visual image is viewed through a convenient magnifying eyepiece.

The viewer is located on a mounting which provides movement in elevation and azimuth and can have tripod, bridge rail or other type of support. The objective and eyepiece are separately focused on to the intensifier cathode and screen respectively. The high power objective has a focusing range of 50 metres to infinity, which is controlled from a small lever on the front plate of the instrument. The low power objective is pre-set at a range of 800 metres.

The optical system, which is of dual magnification, has a highly corrected cassegrain system with a meniscus lens front element for high power, and a telephoto lens for low power, both of which work in conjunction with a 7½x eyepiece.

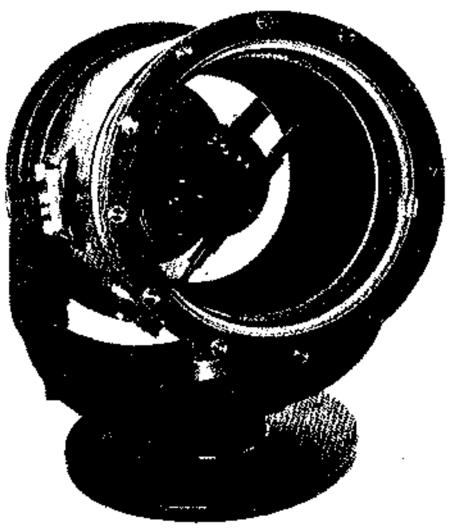
Power for the intensifier tube type 8586/1.4706 is contained within the training handle and replacement batteries can be fitted without re-desiccating the instrument.

CHARACTERISTICS:

Magnification: 5.907X (H.P.) 1.2X (L.P.)
Angular field: 7° (H.P.) 35°20' (L.P.)
Aperture diameter: 203.5 mm (H.P.) 146.1 mm (L.P.)
Effective relative Aperture: f/0.9866 (H.P.) f/1.432 (L.P.)
Tube: Image intensifier Type 8586/1.4706 or equivalent
Overall length: 586.7 mm
Weight of viewer (excluding mount): 25.4 kg (approx)
Weight of Bridge Rail Mount: 4.1 kg

MANUFACTURER:

Barr & Stroud Ltd, Caxton Street, Anniesland, Glasgow, W.3., Scotland.



CU15 Long-range viewer

2436.193
MEL INFRA-RED SIGHTS FOR TANKS

DESCRIPTION:

These two sights (commander's and gunner's) were designed for use with the Chieftain tank but have also been adapted for use with other types of AFV.

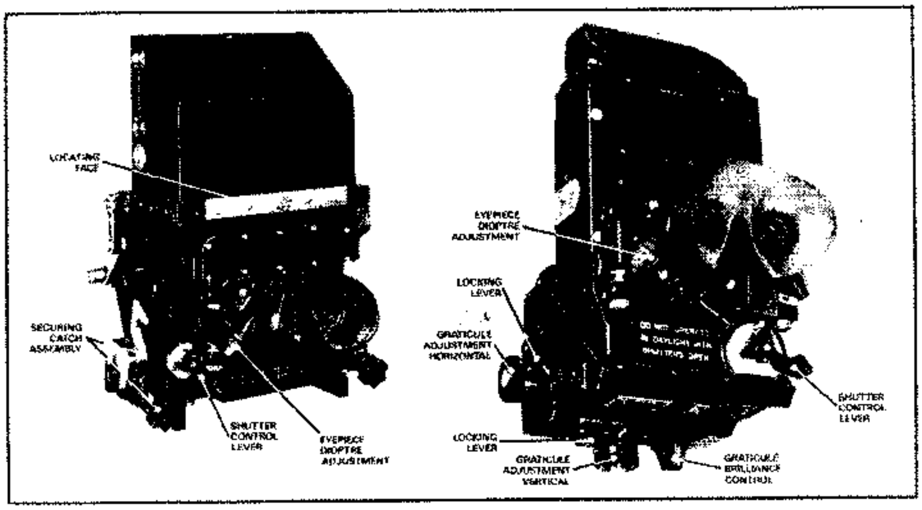
Both the commander's and gunner's sights are of the binocular periscope type and have been designed for rapid interchange with the normal Chieftain daylight instruments. Illumination is provided by the tank searchlight, or other special purpose lamp, fitted with I.R. filters.

Effective range is dependent on I.R. visibility and the contrast between the target and its background. Engagements can be fought at 1,000 metres under conditions of total darkness.

The two instruments are complementary to each other in use and have identical optical elements and performance. Many of the mechanical and electronic parts are also common; but the field of view in the Commander's Sight may be elevated and depressed over a wide angle so that the Commander can survey a large area of ground whereas the Gunner's Sight has a fixed field with an illuminated graticule. Graticules of any required pattern can be supplied.

The sights have been designed to meet a stringent environmental specification, requirements for ease of operation under severe climatic conditions and ease of maintenance in the field.

CHARACTERISTICS:
Magnification: X2.8
Field of view: 13° (205 mils)
Depth of focus: 30 m to infinity at normal focus of 400 m
Image converter tubes: Mullard CV 6099 (NATO 6923)
Objective: Focal length 70.5 mm, transmission 79% at 900-1,050 microns
Eyepiece: Focal length 19.4 mm, setting ±2 dioptres, transmission 78% at 500-600 microns
Service temperature range: —40°C to 70°C
Commander's sight: Line of sight movement —11°/195 mils) t0 +47° (835 mils)
Gunner's sight graticule: Adjustment (Azimuth and Elevation) ±18 mils. Illumination, brightness controlled by stepped potentiometer
Overall dimensions: Commander's sight 43 cm × 33 cm × 28 cm.
Gunner's sight 43 cm × 23 cm × 27 cm
Weights: Commander's sight 19½ kg.
Gunner's sight 12¼ kg
MANUFACTURER:



Commander's and Gunner's Infra-red sights

The M.E.L. Equipment Company Ltd, Defence Systems Division, Manor Royal, Crawley, Sussex.

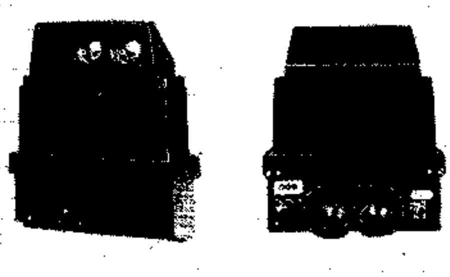
2405.193
PASSIVE NIGHT DRIVING PERISCOPES
DESCRIPTION:
The passive binocular night driving periscope has been designed to be used under starlight conditions. It can also be used at illumination levels up to, and including daylight, the image brightness being adjustable to suit the user. An automatic electronic limiter device protects the instrument against excessive image brightness.

The sight provides a wide field of true stereoscopic vision, enabling the vehicle to be driven at normal speeds. The objective and eyepiece have both been critically designed and corrected, the objective to give optimum performance in the 0.4 – 0.7 micron wavelength range and the eyepiece to be used with a P20 Phosphor. The exit pupil of the eyepiece is 20 mm. Electrical heating coils are built into each eyepiece assembly to prevent misting and condensation.

The periscope has been designed to facilitate rapid interchange with the normal daylight sights from within the vehicle. It is both dust and waterproof, and in the event of damage the head prism can be replaced without affecting the sealing.

With slight differences this instrument is produced in versions for the Chieftain tank, FV 430 Series of vehicles, and the CVR range.

CHARACTERISTICS:
Magnification: X1
Horizontal field of view: 890 mils (50°)
Vertical field of view: 710 mils (40°)
Illumination range: 10^{-3} to 10^{3} lux
Range: 5 cm to 100 m when focussed at 20 m
Exit pupil of eyepiece: 20 mm
Weight: 10 kg approx
DEVELOPMENT:
Jointly by M.E.L. and Philips Usfa.
MANUFACTURERS:
Equipment: The M.E.L. Equipment Company Ltd, Defence Systems Division, Manor Royal, Crawley, Sussex.
Image Intensifier and EHT unit supplied by Philips.



MEL Passive night driving periscope

2431.193
AFV CUPOLA No. 22
DESCRIPTION:
No. 22 Cupola has been designed as a replacement for Nos. 2, 4 and 6 cupolas which are fitted to the Centurion Tank Mk 3, 5, 7, 8 and 10. It incorporates many of the improvements which were introduced on the No. 15 Mk 2 Cupola fitted to the Chieftain Tank and offers a simple method of bringing the facilities provided to a Centurion tank commander up to modern standards.

Vision Devices:
9 unit power periscopes are mounted around the fixed ring of the cupola body, together with the Commander's Sight. All ten instruments can be removed and replaced from inside the vehicle. Periscopes and sight have all been designed so that the sun's rays cannot be reflected in the horizontal plane. Washers and wipers are provided for each external optical surface to maintain clear vision under adverse conditions. The external window of the Commander's Sight is protected by a rigid steel cover.

The Sight is coupled mechanically to the Commander's machine gun so as to follow its movements in the vertical plane up to 45°. Further elevation of the gun is then directly controlled through the sighting block in the hatch. The Commander's Sight can also be used to lay the tank's main armament by using the built-in Reticle Image Projector ("Collimator") on the underside of the cupola. This instrument injects the Gunner's Sight graticule pattern into the Commander's Sight when the two sights are in optical alignment.

For night operations either a 7 inch or a 9 inch diameter spot light is provided on the cupola roof, the spotlight being linked to the machine gun to ensure synchronisation with its movements.

Alternatively, the No. 37 Daylight Sight can be replaced by the M.E.L Type-A 1200-A Infra-red Sight, the spot light, in this case, being fitted with a suitable filter.

Armament:
A 7.62 mm general purpose machine gun is mounted on the left hand side of the cupola and rotates with it. A mechanical elevating gear enables the gun to cover a vertical arc from 10° depression to 95° elevation.

The machine gun can be loaded, cocked, laid and fired from within the cupola with the hatch closed, firing being controlled by an electrical solenoid switch. A further sensing device isolates the solenoid and stops firing when the ammunition belt reaches the point at which a new belt must be connected. The ammunition compartment will accept either the standard 200 rounds box or the NATO 230 rounds box.

Traverse and Fire Control:
Under normal conditions the cupola is rotated relative to the main turret by a handwheel through a gearbox, pinion and circular rack. Arrangements have also been made for the Tank Commander to over-ride the Gunner's turret power traverse system in order to bring the vehicle's main armament on to a target which the Commander has selected. In this mode of operation an automatic contra-rotating gear maintains the cupola's bearing relative to the vehicle.

Hatch:
The hatch is of 25 mm minimum thickness steel armour and is fitted with a torsion bar counterbalance. It can be locked in any one of 4 different positions:
Closed with full sealing against N.B.C. agents and water entry.
Lifted vertically in the "umbrella" configuration so as to give a 50 mm opening round the entire periphery. (75 mm lift is available).
Swung back on its hinge and locked in a position 15° past the vertical.
Fully opened through 180°.

CHARACTERISTICS:
Armour: 25 mm minimum thickness
Height above roof plate: 610 mm
Cupola outside diameter: 1,168 mm
Swept radius: 914 mm
Cupola bearing: 865 mm Cooper Cross Roller
Approximate weight: 770 kg
Turret roof aperture: 863 mm diameter.
Commander's sight: AFV No. 37 or A-1200-A Infra-Red
Unit power periscopes: AFV No. 40 Mk 2
Machine gun elevation: —10° to 95°
Traverse: Manual and power operated
Sealing: N.B.C. and 4.6 m of water
Armament: 7.62 mm GPMG L7 or L8
MANUFACTURER:
The M.E.L. Equipment Company Ltd, Defence System Division, Manor Royal, Crawley, Sussex.

2430.193
LIGHTWEIGHT AFV CUPOLA No. 16

DESCRIPTION:

The No. 16 cupola is intended either as a retrofit APC improvement or for original installation. The cupola is fitted with one, forward-facing, AFV No. 68, X1/X10 periscope sight for the machine gunner, with provision for fitting a night sight, to make up a combined day/night sight. Additionally unit power periscopes are mounted around the cupola rotating ring and disposed so as to give the vehicle Commander virtually a 360° field of view, without having to rotate the cupola.

The sights are designed with their incident and emergent faces angled downwards so that there is no risk of the sun's rays being reflected off them horizontally and betraying the vehicle's position. Washers and wipers are provided for each sight's external face to maintain clear vision under adverse weather conditions.

A 7.62 mm general purpose machine gun is mounted externally on the right hand side of the cupola. It rotates the full 360° with the cupola and can fire a vertical arc from 10° depression to 45° elevation. The gun is loaded, cocked, laid and fired from inside the vehicle, with the cupola hatch shut if required. An interrupter device is fitted which prevents the machine gun, whilst in the depressed position, firing at projections on the vehicle hull.

The ammunition compartment can hold either a 200 round British Army ammunition box, or a 230 round NATO box. When the ammunition belt reaches the point at which a fresh one must be coupled on, a sensing switch automatically opens the electrical firing circuit to the gun. Optionally if required, spent cases can be collected in a fitted box attached to the outside of the cupola. The cases can then be dumped as required by the Commander from inside the vehicle by rotating the cupola over a suitably positioned cam.

Although minor stoppages can usually be cleared by cocking the gun from under armour, more serious incidents may require the Commander to reach outside and handle the gun. In these circumstances he can rotate the cupola to the "3 o'clock" position, open the hatch and lock it in the vertical plane where it will provide a substantial measure of protection for the back of his head and shoulders.

The machine gun, its sight, and a spotlight are all interconnected by a mechanical linkage which ensures that the sight graticule and spotlight beam accurately follow vertical movements of the gun. The spotlight can be fitted with an infra-red filter if required.

CHARACTERISTICS:

Armour: Vertical walls not less than 16 mm. IT90 steel. Horizontal plate not less than 13 mm IT90 steel. Hatch 25 mm L.M. 25 aluminium alloy
Overall height above roof plate: 546 mm
Cupola outside diameter: 787 mm
Cupola flange diameter: 819 mm
Swept radius: (Corner of M/G cradle) 594 mm
Swept radius: To end of M/G muzzle 814 mm
Vehicle roof aperture required: 760 mm diameter
Cupola bearing diameter: 750 mm cross roll race
All-up weight: (Excluding m/g and No. 62, but including lighting and vision equipment) 340 kg
Periscopes: 8-X1 AFV No. 42
Machine gun sight: X1-X10 periscopic, AFV No. 69
Machine gun: 7.62 mm L37, L7 or L8 GPMG.
Elevation: −10° (180 mils) to +55°F (800 mils) through a hand-operated gearbox giving 72.84 mils movement per handwheel revolution (non-linear system).
Traverse: 360° through hand-operated gearbox giving 160 mils movement per handwheel revolution
Sealing: Full NBC protection and proof against 4.6 m head of water.

DEVELOPMENT:

The cupola was designed by MEL in conjunction with the British Military Vehicle and Engineering Establishment and was originally intended to replace the commander's cupola on the American M113 APC. It will be fitted to production Spartan and Striker vehicles (**5040.102**) in 1973. It can, however, also be fitted to the British FV430 series Saracen (**5001.102**) and the Ferret Mk II (**5002.102**).

MANUFACTURER:

The M.E.L. Equipment Company Ltd, Defence Systems Division, Manor Royal, Crawley, Sussex.

1021.293
MARCONI 323 SERIES MILITARY TV EQUIPMENT

DESCRIPTION:

A complete range of militarised CCTV equipment suitable for assembly into systems such as missile tracking and guidance, low-light level applications etc. The principal modules of the 323 Series are the V323 Camera Channel, picture display unit and remote control unit. The former may be equipped with a number of optical systems and any of the daylight and low light sensor tube and intensifier combinations, based on the one-inch vidicon tube. Control and display arrangements also can be supplied to meet user requirements. The existing range of equipment, described in detail below, is that produced for the missile guidance system described in the Systems entry for the Seacat missile.

Camera Channel Type V323:

The camera channel consists of two basic units, the camera and the camera control unit. Modular construction of the equipment allows the camera to be fitted with the vidicon; SEC-vidicon; Electron Bombardment, Inducted Conduction (EBIC) vidicon, or any combination using one of these tubes and image intensifiers. To ensure accurate alignment of the camera tube with the centre line of the optical system, the camera tube scanning and focusing yoke is attached directly to the chosen optical system.

Depending on the sensor combination fitted, the camera channel will operate in either daylight conditions, or from daylight down to starlight illumination.

Television Display Type V6132:

This unit is equipped with a rugged cathode-ray tube having electro-magnetic deflection and electrostatic focusing, producing high resolution at high brightness levels. The display consists of two-main sub-assemblies, the tube module and the power supply unit. These sub-units may be either combined to form a single unit or separated, by up to 4.5 m, and interconnected by multi-way cable.

Optical System

The 'building block' design of the camera system enables any suitable optical system to be fitted to the camera with the minimum of alteration. A typical requirement would be an optical system providing wide and narrow angle fields of view, with some form of reference graticule or cross-wire that may be required to show black in daylight and be illuminated at night. The optical system also normally includes automatic protection for the camera tube to protect it from excessive exposures, due to bright objects such as the sun.

Marconi ST 801 naval search and tracking radar equipped with 323 Series TV camera

Remote Control Unit

The Remote Control Unit enables the operator to control the operational functions incorporated in the camera, optical system and camera housing from a protected position. It may be supplied as a separate unit in its own case or combined with the Display Unit to form a compact control and observation console, in addition to providing controls for such in connection with target identification and kill assessment.

DEVELOPMENT:

Development of this range of equipment originates in studies carried out by Marconi with the Royal Navy from 1960 onwards, and embraces some of the technology acquired in the course of Marconi's work on the TV-guided version of the Martel air-to-surface missiles. Sea trials by the RN of the system used with the Seacat missile are believed to have started in 1967.

STATUS:

The first series of trials is reported to have been successfully completed early in 1969. 323 Series systems have been sold to Contraves for use with Sea Hunter fire control systems to be supplied to two "Northern" navies. In April 1972 a UK MoD contract worth £1 million was announced for the production of two versions for the Royal Navy. One is for fitting on general purpose frigates and guided weapon destroyers, and the other for Type 21 frigates. The first installations are now operational.

MANUFACTURERS:

The Marconi Co Ltd, Electro-Optical Systems Division, Basildon, Essex, England.

1371.393
EMI LOW LIGHT TELEVISION SYSTEM

An extremely versatile, high performance low light television camera is used, capable of producing pictures at lighting levels in which normal television cameras would be unable to operate.

The camera can be supplied in two versions The C2 Ebitron or the C2H Ebitron. The former is capable of producing pictures in half moonlight (or equivalent) and the latter in near dark conditions. Even further sensitivity can be obtained by fitting an additional image intensifier to a fibre optic version of the Ebitron. The Ebitron tube works on the principle of electron bombardment induced conduction, and was specially developed for military purposes. The system can be permanently mounted or a portable version can be supplied using 12 volt DC supplies. A video tape recorder is also available to enable a complete record to be kept of the pictures taken by the camera. This also is available for AC or DC operations. The system is used to replace night and day security patrols, for unobtrusive observation at night and for verification of alarms. For outdoor use, weatherproof housings are provided complete with remote control Pan and Tilt, zoom lens etc.

MANUFACTURER:
EMI Electronics Ltd, Systems and Weapons Division, Victoria Road, Feltham, Middlesex, England.

THE UNITED STATES OF AMERICA

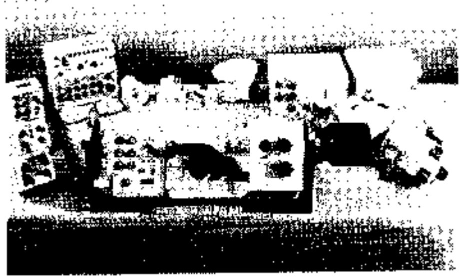
1803.193
TANK LASER SYSTEMS AN/VVS-1

DESCRIPTION:
This system was developed by Hughes for the US Army M60A1 main battle tank. It consists of a laser rangefinder integrated with a complete fire control system which includes its own computer and the relevant sensors for ballistic calculations. The project was undertaken in the early 1970s to increase the first-round hit capability of the M60A1's 105 mm gun, against both standing and moving targets.

The target range data is processed in the solid-state computer together with crosswind component, powder grain temperature, gun trunnion cant, bore wear, air temperature, altitude, and tracking rate to provide the correct azimuth and elevation firing values. The computer can provide computation for nine types of ammunition, and the system incorporates self-test facilities.

DEVELOPMENT:
Hughes has produced several batches of lasers and computer systems under contracts from both the US Army's Frankford Arsenal and from Chrysler Defence Engineering who produce the M60A1 tank.

MANUFACTURER:
Hughes Aircraft Company, Los Angeles, California 90009, USA.



AN/VVS-1 tank laser rangefinder

1008.393
XM76 – ANTI-OSCILLATION SIGHTING SYSTEM

DESCRIPTION:
Telescopic target acquisition and identification equipment, providing stabilisation against vibrating environments such as helicopters, vehicles, boats and ships.

OPERATION:
The sighting system senses motion in two axes by means of rate gyros, and the resulting signals are used to control torque motors acting upon a fluid prism optic system to compensate for the sensed motion, thus stabilising the image of the desired field of view. There are separate, and virtually identical, servo loops for each axis of control. The motion signals measured at the optical head are applied to a control module as error signals, and are then demodulated, amplified and stabilised, power amplified and fed to the torque motors as correction signals. The polarity and magnitude of the corrective signals determines the direction and speed of the torque motors to compensate for the motion of the optical head.

The optical device responsible for effecting motion correction is a fluid prism. This is a variable geometry, liquid-filled prism enclosed by a flexible opaque bellows and two optical flats, front and rear. The flats are movable, transparent windows which serve as the prism faces. There is one flat for each channel, or axis of motion, and each is connected by a linkage to its respective torque motor. Movement of the flat varies the optical geometry of the fluid prism, thereby varying the refraction of light through the prism. These controlled changes result in stabilisation of the image.

The Anti-oscillation Sighting System has also been adapted to armed helicopter fire control. There have been two applications. The first was to improve the accuracy of fire by providing the gunner a stabilised image and X1.5 to X12 optics on the gun sight. The second was also to provide a further increase in accuracy by incorporating resolvers into the optical servo loop, and thus slaving the turret to the optical line of sight of the XM76 mounted on the sighting station in the cockpit.

The sight also incorporates a monocular zoom lens, controlled by two push buttons on the unit. These control the direction of zoom; the X1.5 for zoom-out (decreased magnification) and the X12 for zoom-in (increase magnification). Speed of zoom is determined by the detent to which the X1.5 or X12 button is pressed: first detent for slow zoom, second detent for fast zoom.

DEVELOPMENT:
The XM76 was started as a private venture in 1966 and evaluation quantities were delivered in November of that year.

STATUS:
Orders for 800 units have been placed and deliveries began in February 1969, over 650 having been delivered by May, 1970. Users include the US Army, USAF, US Marine Corps, US Navy and the Government of Israel. Vehicles fitted with the XM76 sighting system include the OV-2, AHIG, OH6A, OH-58A, and UH-1 series helicopters for observation, target acquisition, attack and damage assessment.

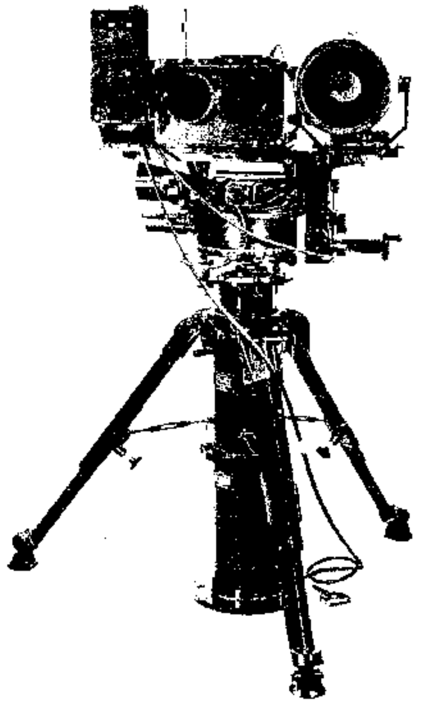
MANUFACTURER:
Dynasciences Corpn, Township Line Road, Blue Bell, Philadelphia 19422, USA.

2668.193
INTEGRATED OBSERVATION SYSTEM (IOS)

DESCRIPTION:
The purpose of the Integrated Observation System (IOS) is to permit the location of military targets accurately under day or night situations and to determine range to targets and, when required, allow for pulse coded designation of those selected targets. This integrated system is mounted on a tripod and consists of an RCA-developed optical equipment mount, an RCA-developed neodymium laser rangefinder/designator, a government furnished binocular and a government furnished night vision device.

STATUS:
Being developed for the United States Marine Corps by RCA Aerospace Systems Division, under contracts totalling $3.2 million.

MANUFACTURER:
RCA Corporation, Aerospace Systems Division, PO Box 588, Burlington, Mass 01803, USA.



AN/UUS-2 laser range finder

2796.193
STABILISED ARMAMENT STATION
DESCRIPTION:

This is a Stabilised Armoured Cupola complete with vision blocks and sights that has been developed by Cadillac Gage for use with AFVs.

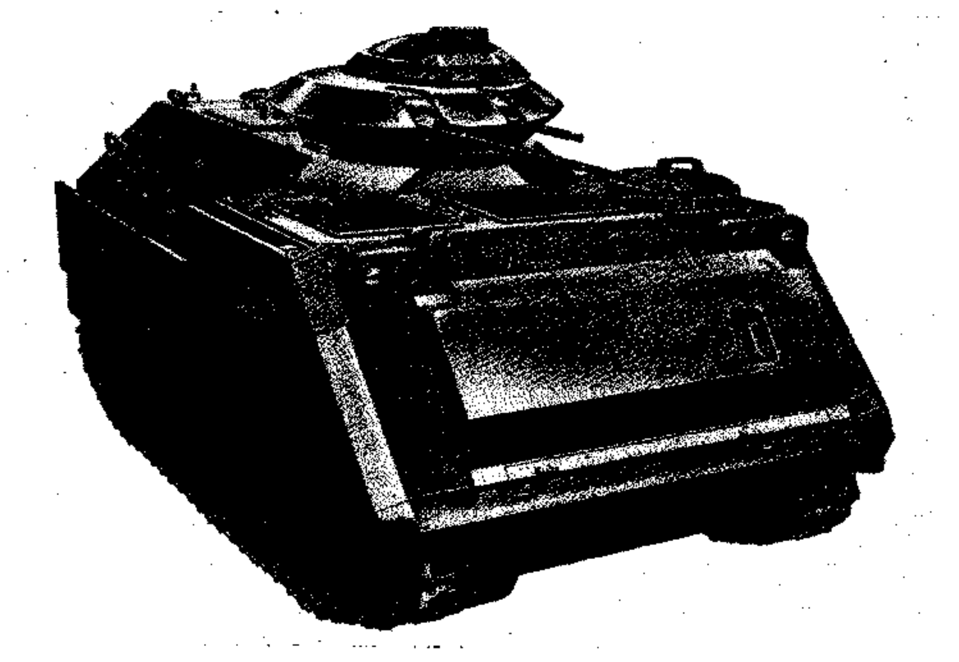
The gunner rides in a basket suspended beneath the cupola and the stabilisation system automatically counteracts movements of the gun platform relative to the weapons so that accurate firing is possible even when moving over rough terrain. The gunner has complete all-round vision, through eight ballistic vision blocks spaced uniformly around the cupola, and is equipped with two gunsights. One of these is a X6 or X8 monocular sight for accurate aiming at long range: the other is a X1 wide-angle sighting and viewing device. The latter has a projected reticle to give eye relief and improve target acquisition. Mounting brackets, drive linkage and bore-sighting adjustments are provided for an externally mounted night sight.

The cupola can accommodate a 20 or 25 mm cannon (or a 40 mm grenade launcher) and one of several different kinds of machine gun. Provision is made in the gunner's basket for the storage of 400 rounds of 20 mm ammunition (or equivalent) and 1,000 rounds of 7.62 ammunition (or equivalent). Also located in the basket are the electronic modules and gun controls and the hydraulic power supply.

Train and elevation motion of the guns is electrohydraulically powered and rate-controlled by the gunner. A manual pump is fitted to provide sufficient hydraulic power to move the guns in the event of electrical power failure.

CHARACTERISTICS:

External power requirements: 24V dc
Sight: 6- or 8-power monocular with unity periscope
Vision blocks: Eight-laminated glass
Armament-main: M139 20 mm cannon



Cadillac Cage armament station installed on XM 765 armoured personnel carrier

Secondary: M73 7.62 mm machine-gun
Cupola ring diameter: 1 metre
Weight: Varies with ballistic requirements
Crew: One man
Superstructure material: XAR-30 welded ballistic plate
Power: Electro-hydraulic
Method of firing: Main: Electro-hydraulic. Secondary: Electrical, emergency manual
Ready ammunition: 400 rounds 20 mm; 1,000 rounds 7.62 mm
Elevation, maximum: 60°
Depression, maximum: 15°
Slew and elevation rate, maximum: 60° per second
Tracking rate, minimum: 1/4 mil per second
Stabilisation: Vertical and horizontal axes

DEVELOPMENT:

Developed as a private venture by the Cadillac Gage Company, Cadillac Gage also make a variety of other armoured turrets and have installed more than 400 of their Universal Machine Gun Turrets on M113 vehicles.

MANUFACTURER:

Cadillac Gage Company, PO Box 3806, Detroit, Michigan 48205.

1630.393
HONEYWELL HELMET SIGHT
DESCRIPTION:

The Honeywell Helmet Sight has been evolved with the related objectives of simplifying target acquisition for airborne weapons, and also improving this function by utilising the wide search-angle and flexibility of the human eye. This is accomplished by arranging for the pilot's line of sight to be determined in relation to all three aircraft axes. This data can be used as pointing information for a wide range of aircraft systems (AI radar, cameras, infra-red seekers, etc.) and for weapon aiming.

The Honeywell Helmet Sight System consists of the following major elements: Helmet Mounted Unit (HMU), Light Source Units (LSU), Sensor Electronics Unit (SEU), and controls mounted on the instrument panel and control stick.

The system operates as follows: one or two light source units, rigidly mounted to the airframe and aimed in the pilot's direction emit fan-like beams of infra-red light rotating at constant velocity. The light beams sweep over a reference photo sensor and two pairs of helmet-mounted photo sensors (one pair on each side of the pilot's helmet). The time intervals between the pulses from the helmet photo sensors and the reference pulse are a measure of the angular position of the pilot's head relative to the XYZ reference axes of the aircraft. The photo sensor outputs are transmitted to the sensor electronics unit where the angular computations are performed and converted into azimuth and elevation information. Additional digital computations such as fire control and missile launch envelopes may easily be incorporated in the sensor electronics unit with little or no increase in system complexity. In versions being supplied to the US Navy, a Honeywell HDC-202 digital computer is included.

DEVELOPMENT:

Development was initiated in 1963 and evaluations have been carried out by all three American Services in a total of eleven aircraft types.

STATUS:

Under USN development and production contracts amounting to $9.3 million, 450 systems are being produced for fitting in F-4J aircraft.

MANUFACTURER:

Honeywell Government and Aeronautical Products Division, 2600 Ridgway Parkway, Minneapolis, Minnesota 55413, USA.

2806.353
SERIES 2500 FIBRESCOPE NIGHT VISION SYSTEM

This is a fibre optic arrangement for the remote viewing of an image intensifier in a night vision system. A coherent fibre optic bundle 25 mm in diameter is used to relay the image and is sufficiently flexible to accommodate bends of an inside radius of as little as 15 cm. Remoting is possible up to 4.5 metres.

DEVELOPMENT:

Begun in 1965 as a private venture, the project was subsequently supported by the US government. The first prototype was completed in 1967. The equipment is currently in service and is used in conjunction with the Iroquois Night Fighter and Tracker System (INFANT) and the stabilised Night Sight (SNS), which have both reached the pre-production stage.

MANUFACTURER:

American Optical Corporation, Fibre Optics Division, Box 1, Southbridge, Massachusetts 01550, USA.

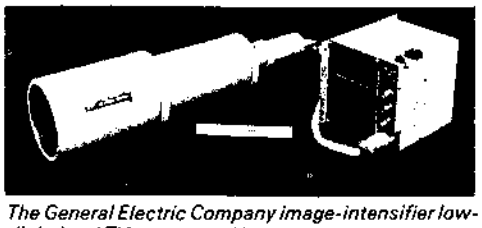
1384.393
GE LOW LIGHT LEVEL TV CAMERA
DESCRIPTION:

This is a lightweight, compact television camera with special applications in airborne surveillance, reconnaissance, weapon delivery and target designation under night conditions. This is possible by use of a vidicon tube preceded by a three-stage image intensifier tube. The power requirement of the camera is 12 W, sufficient for a 500 TV line highlight resolution.

OPERATION:

An automatic target control allows the camera to operate without any adjustment in a wide range of light levels. It is interesting to note that the vidicon tube used in this camera is of hybrid design, with magnetic focussing and electrostatic deflection. By this method virtually any voltage/time waveform can be used for deflection, and the entire spectrum of simple to exotic scanning techniques can be utilised.

DEVELOPMENT:



The General Electric Company image-intensifier low-light level TV camera and its associated electronics unit

Work on the basic camera began in 1966; this was followed in 1967 by the addition of the intensifier stages.

STATUS:
This camera is in current use with the United States Navy and Air Force.

MANUFACTURER:
General Electric Company (USA), Aircraft Equipment Division, Utica, New York, USA.

1641.393
RCA ADS 3000 SERIES TV CAMERAS

DESCRIPTION:
The ASD 3000 range of television cameras for military applications are low light level equipments based on the use of RCA silicon intensifier target tubes. In addition to high performance in near total darkness, these tubes can withstand bright light without damage to a large extent. Four models have been announced for airborne reconnaissance and weapon delivery applications in aircraft and drones. Designations of the four are ASD 3100, ASD 3200, ASD 3300, and ASD 3400. The last of these is the most sensitive, and also incorporates all the necessary circuitry to permit synchronised operation with covert pulsed illumination sources beyond the frequencies visible to the unaided eye. This mode of operation is known as ITV, Illuminated Television.

Ground versions of the RCA cameras are self-contained for tripod mounting, and with all controls on the rear of the case. The airborne configuration is designed for gimbal mounting and with the controls located on a remote control box.

MANUFACTURER:
RCA Aerospace Systems Division, Burlington, Massachusetts, USA.

7007.393
UVR-700 TV TRACKER SYSTEM

DESCRIPTION:
An all-purpose day-night stabilised television tracking system, suitable for such applications as ground target surveillance from an aircraft or helicopter, or accurate angle and rate sensor for weapon delivery.

OPERATION:
The four basic functional elements of the system are: an intensified UVR-700 camera, an electronic video contrast tracker, two-axis gyro stabilised platform, and a display.

The heart of the system is the electronic video contrast tracker. This type of tracker follows the selected target automatically within its field of view, and produces electrical output signals which indicate the position of the target relative to the centre of the field of view. A video gate is generated by the electronics and indicated on the operator's display. When a target is detected, the operator positions the gate over the target on the display using the joystick mounted on the control unit. The system is then switched to the closed loop automatic angle track mode.

In this mode, the signal representing the centroid of the target is processed to determine its position within the gate 60 times a second. The gate is then automatically centred on the centroid signal. Thus the gate tracks the target, and output signals are derived from the gate position within the raster. The output signal, which is proportional to the position of the target relative to the centre of the field of view, is fed into the appropriate gimbal servo which causes the optical line of sight to be centred on the target. The tracker is a two-loop control system which will automatically track the target in both azimuth and elevation.

DEVELOPMENT:
Development began in 1968 as a private venture by General Electric.

MANUFACTURER:
Aircraft Equipment Division of the General Electric Co, French Road, Utica, New York 13503, USA.

1806.353
TISEO-TARGET IDENTIFICATION SYSTEM, ELECTRO-OPTICAL AN/ASX-1

DESCRIPTION:
TISEO is a stabilised airborne camera equipment able to track air and ground targets at ranges beyond unaided visual range. The system comprises a vidicon-tubed television camera with a zoom lens to enable positive visual identification. Two instantaneous fields of view are provided for target recognition and identification, and target acquisition, respectively. The system normally is housed in a tubular shaped housing projecting forward from the leading edge of the aircraft wing.

STATUS:
Fitted to USAF F-4E aircraft and subsequently considered for use with a variety of other types including the F-14, P-3 and helicopters.

MANUFACTURER:
Northrop Corporation, USA.

SIMULATORS AND TRAINERS

BELGIUM

1775.193
SABCAFIT SIMULATORS

DESCRIPTION:

Sabcafit simulators are produced in two versions, Scholafit and Talafit, both being for the training and practice of tank gunner, the former principally at armour schools and the latter for use with qualified tank units as a means of maintaining skills.

Scholafit (School Level Aiming and Firing Trainer), consists of the following main units:

Firing station
Instructor's station
Simulator sub-assembly
Electronic simulation and logic rack

The gunner is installed in a dummy turret containing all controls and instruments normally found in a tank. A standard gunsight is fitted, normally EMES or OIP, depending upon which, the instructor's station is located to the left or right of the gunner's position. The instructor is provided with a sight bore-sighted on the gunner's sight, enabling the former to see exactly what the gunner has in view. The instructor can over-ride the gunner's controls for demonstration or corrective purposes, and he also has the necessary controls for operation of the simulator and variation of the simulated operational parameters. These include lighting, the amount of vibration encountered, and control of targets. Throughout an exercise the gunner's performance is monitored and recorded for subsequent analysis.

Four scenes are incorporated against which exercises can be run, and simulated target size, speed, distance etc can all be varied by the instructor. Fixed or moving targets can be be selected to suit the level of competence attained and either stationary or firing on the move conditions can be simulated. Provision is also made for instruction in the use of tracer.

TALAFIT (Tank Level Aiming and Firing Trainer) has been derived from the Scholafit and is intended for attachment to a tank to enable it to be used for indoor gunnery practice in a hangar. Most of the facilities available with Scholafit are available with the exception of tracer and the system malfunctions which can be introduced into the dummy turret installation of Scholafit. The Talafit is installed on the gun turret of the tank, in front of the gunsight window. The gunner is presented with a battlefield scene with stationary and moving targets which he has to detect, identify and engage.

DEVELOPMENT:

Development was undertaken by Société Anonyme Belge de Constructions Aéronautiques in accordance with directives set out by the Belgian Ministry of Defence.

MANUFACTURER:

Société Anonyme Belge de Constructions Aéronautiques, Chausee de Haecht 1470 – 1130 Bruxelles, Belgium.

CANADA

1735.393
SUBMARINE SIGNAL SIMULATOR

DESCRIPTION:

Developed by CAE Electronics Ltd, the Submarine Signal Simulator (SSS), is an electronic device which generates submarine-like signals, simulating the actual submarine magnetic signature, for injection directly into an aircraft MAD equipment. The SSS can be used either while airborne, on the ground, or in a simulated system trainer.

By means of rotary controls on the front face, the SSS can be made to simulate three different submarines' magnetic moments (from small to nuclear size), aircraft speeds from 50 to 300 knots, and aircraft-to-submarine separations from 500 to 3,000 feet. Each of the above conditions can be simulated for five different representative submarine signal shapes corresponding to the various combinations of aircraft and submarine headings.

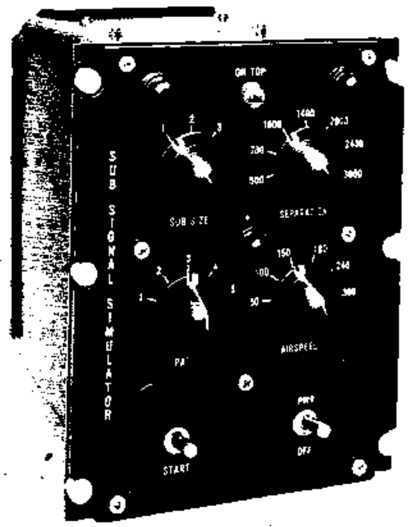
The simulator is simple to operate. Once the various controls have been set to select the desired conditions with respect to separation, airspeed, etc., the simulated signal is then started by means of a toggle switch. When the simulated signal reaches the point where the "aircraft" has passed closest to (or over) the "submarine" an "ON TOP" lamp is illuminated, allowing the operator or (instructor) to determine how "late" he was in recognising the submarine signal.

Since the simulator generates an electrical analogue of the submarine signal, it may be used either in the air with actual background geological and geomagnetic noise or on the ground with simulated background noises. The CAE SSS is compatible with all existing MAD magnetometers.

For realistic MAD operator training, the SSS is usually operated by someone other than the MAD operator (possibly the co-pilot) so that true operator training and performance evaluation may be effected. It is also a very useful tool in evaluating and grading overall MAD performance since it provides a stable signal reference with which detection range capability may be evaluated. The most significant aspect of the equipment is that it eliminates the necessity of tying up a submarine for MAD training purposes.

MANUFACTURER:

CAE Electronics Ltd, PO Box 1800, St Laurent, Montreal 379, PQ, Canada.



Submarine signal simulator for MAD operator training

FRANCE

1520.193
SINTRA-EF SIMULATORS

The SINTRA organisation produces a very wide range of simulation equipment and systems. The following paragraphs contain details of the principal military installations that have been supplied.

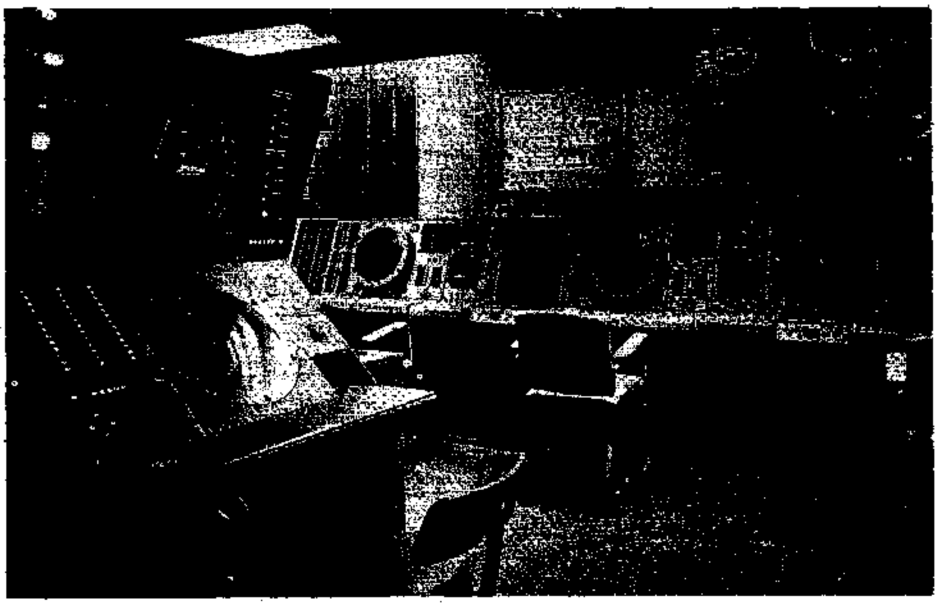
STFG-1

This is a very large system providing for tactical training, tactical and operational research, analysis and utilisation studies of new weapons. It is used by French Navy command teams at the Centre d'Entrainment Synthétique. The STFG-1 simulator has a capacity of 128 vehicles (which can represent any of 16 types) of which 32 are controlled from the simulated 'own ship' cubicles. Each of these has access to a maximum of 16 data sources (radar, sonar, etc), and up to 32 weapon combinations. Exercises are pre-programmed into the control computer by punched tape. The computer automatically simulates the environment for each vessel taking part in an exercise.

SRFG-3

This is a simulator for the training of naval radar operators. It has a capacity of 14 radar targets, three carrier vessels, two surveillance radars, and one height finder radar.

The system consists of a hybrid computer and



Part of a large SINTRA-EF simulator

simulation control unit. A digital central processor controls the targets and detection methods, while repetitive computations are left to specialised peripherals. The simulation is controlled from a set of standardised alpha-numerical control units for 'piloting' the targets, and a graphic display console for the exercise commander.

The simulator drives three (extendable to five) displays, and represents two surveillance/search radars complete with noise, clutter, jamming, fading and IFF, and one height-finding radar. The 14 targets can be increased to 20, and can be aircraft, surface vessels or submarines.

DUFZ-6

This type of simulator is for the training of anti-submarine warfare teams. Surface vessels and submarines are simulated and the system has a target capacity of 13 manoeuvrable vehicles, 16 dummy radar stations, and a full range of sensor data. The Type DUFZ-6 is in service with the French Navy.

RU 503

Simulators of this type are used for the training of air defence radar operators and ground controlled interception personnel. One primary and one secondary radar are simulated, and up to 12 manually-controlled targets can be simulated.

MANUFACTURER:

SINTRA-EF, 26 rue Malakoff, 92600-Asnières, France.

1645.193
LMT SIMULATORS

Le Matériél Telephonique (LMT) has been a supplier of military simulators since 1960, and has produced systems for training the crews of combat and transport aircraft, helicopters, and armoured fighting vehicles. Other simulation activities by this concern include radar land mass simulators, interface equipment for a digital submarine simulator, and a number of specialised research systems. Digital techniques have been employed since the late 1960s.

Aircraft Simulators

The first combat aircraft simulator produced by LMT was for the Mirage IIIC, and this entered French Air Force service in 1962. A total of 24 simulators for various versions of the Mirage have been produced or ordered, eight for use by the French forces, and 16 for export.

Specific Mirage variants covered are: Mirage IIIC, IIIE, IIIR, F1 and 5. Both fixed and trailer-housed mobile versions are produced. For radar-fitted Mirage types, the LMT flight simulators include interception radar facilities, and air-to-ground functions are also provided in some simulators. Earlier Mirage simulators were analogue systems, but for some years digital methods have been used based on the CII 10 020 computer, a French-built version of the SDS Sigma 2 machine.

In the early 1960s LMT supplied the French Fleet Air Arm with a number of Entendard IV flight simulators, these systems additionally having a CCTV visual system for simulating carrier take-off and landing. A Transall C160 digital flight simulator was delivered to the French military in 1969. Four Jaguar simulators are on order for the French services, delivery starting in 1972.

Helicopter Simulators

The fact that digital techniques allow the use of elaborate mathematical models was utilised by LMT in the solution of the special problems associated with the different flight phases of a helicopter, resulting in 1970 in two SA 330 helicopter flight simulators for the French forces. These are installed in air-conditioned semi-trailers and provide for the simulation of helicopter flight, engines, navaids, systems and malfunctions. A high-definition CCTV visual system provides training facilities for the difficult take-off, hover, and landing phases. The computer used is the same as that in most LMT simulators, the CII 10 020.

Instructor's console and pupil driver's cabin of LMT AMX 30 tank simulator

AFV Simulators

LMT has, or is under contract to supply at least 26 land vehicle simulators of various types to French and foreign forces. Of this total, 18 are for export. Vehicles simulated include: the AMX 10, AMX 30, and Leopard main battle tanks, Panhard LAV and Scorpion AFVs. These systems are for driver training and do not incorporate the gunnery aspects of instruction. The main equipment of the tank simulators consists of a replica of the driver's cabin, a CCTV high-definition visual system and terrain model, instructor's console, analogue computer, and ancillary services. The cabin is mounted on a motion system, which with a noise generation system, provides for realism in instruction.

STATUS:

The French armed forces have received or placed orders for a total of 32 LMT simulators; Etendard IV (2), Mirage IIIC (2), Mirage IIIE (3), Mirage IIIR (1), Mirage FI (2), Jaguar (4), SA 330 (2), Transall (1), multi-purpose air navigation trainer (1), AMX 30 (6), AMX 10 (6), Panhard LAV (2). Exports include: Mirage III (8), Mirage 5 (6), Mirage F1 (2), AMX 10 (3), AMX 30 (4), Leopard (5), Scorpion (6), Panhard LAV (4).

MANUFACTURER:

LMT, Division Simulateurs et Systèmes Electronique, 3 Avenue Albert Einstein, 78190-Trappes, France.

1776.193
TANK GUNNERY TRAINER TYPE DX.150

DESCRIPTION:

The DX.150 Tank Gunnery Trainer is a new tank-borne simulator controlled by a digital wired-programme computer. The installation consists of the central computer unit and three optical heads, one for the tank commander, one for the gunner and one for an instructor. The tank commander's and gunner's optical heads are mounted on the tank's normal sighting equipment. A spot of light in each optical head is superimposed on the real landscape, representing the tracer of a fired round. The considerable advantage of the DX.150 over former trainers is that the point of impact with the ground is correctly indicated whenever the target, which may be stationary or moving, is missed, enabling the crew to make realistic fire corrections. The shape of the terrain and target position are loaded in a very simple manner into the computer, which determines if the point of impact is on target or not, and in the latter case calculates the point of impact and whether or not it is masked by terrain features or the target itself. Smoke, flash and sound effects are also simulated. Any unprepared object, such as a vehicle or building, may be used as a target, and gunnery training is not limited to special firing ranges.

STATUS:

In production.

MANUFACTURER:

Givavions Dorand, 5 rue Jean Macé, 92153 Suresnes, France.

SWEDEN

2351.193
BT 16 & BT 17 FIELD SCORERS

These two scorers are designed to give a simple and rapid indication of a hit on a target in field exercises involving the use of anti-tank or similar guns or missiles fired at visual ranges. By using either of these devices the need for observers to enter the target area to record hits is eliminated – thus speeding up the exercise and reducing the risk to range personnel.

BT 16 Flashing Scorer

Of the two, the BT 16 is the simpler, comprising one or more transducers – which are attached to the target and detect the impact – a delaying amplifier, a battery and an indicating light. The battery and amplifier are contained in a strong case which can be stowed in a sheltered position close to the target and can accept inputs from up to three transducers. When the target is hit the indicating lamp is caused to light for one second and is bright enough to be seen clearly by day as well as by night.

Dimensions of the battery/amplifier box are 30 × 17 × 18 cm and the weight, including 12 1.5V batteries, is approximately 7 kg.

BT 17 Smoke Producing Scorer

BT 17 is similar in operating principle to BT 16 but includes provision for the emission of a puff of (red or white) smoke when the target is hit. To produce the smoke the equipment contains a 5-

litre air bottle (200 atmospheres pressure), and a hermetic plastic powder pack. The equipment can be set to produce puffs having durations of 0.5, 1.0 or 1.5 seconds and there is sufficient capacity in a single filling to produce a total puff duration of 60 seconds. Like the BT 16, the BT 17 can accept inputs from up to 3 transducers and it is provided with an output socket for an indicator light which can be used instead of the smoke for night exercises.

Dimensions of the BT 17 equipment container are 23 × 63 × 65 cm and the all-up weight is approximately 30 kgs.

TARGETS:

Targets for use with either equipment need to be made of rigid material so that a clear hit signal is picked up by the transducers. Old vehicles are suitable and provide more realistic simulation than silhouettes. Targets may be fixed or mobile and either equipment may be used in conjunction with the remote-controlled BT1 8S tank target. The sensitivity of the amplifier can be adjusted to suit the type of target and the calibre of the weapon used.

MANUFACTURERS:

Saab-Scania AB, Jönköping, Sweden, who have developed the equipment in co-operation with the Royal Swedish Army Ordnance Administration.

2352.193
BT 19 & BT 19A GUNFIRE SIMULATORS

These two simulators are designed to enhance the realism of field training by simulating the noise of automatic weapons (BT 19) or the noise and muzzle flame of heavier weapons (BT 19A)

BT 19 Machine Gun Simulator

This device uses compressed air to operate a horn which produces a realistic simulation of machine gun fire at a rate of about 500 "rounds" per minute. The unit is compact and portable and can be operated by remote control to produce between 1,200 and 1,500 shots from one filling.

Dimensions (excluding the horn) are 60 × 30 × 30 cm and the all-up weight is approximately 30 kg. Two air bottles (each 5 litres at 200 atmospheres) are used and the control valves are operated by a 12-18V d.c. supply.

Added realism can be achieved by combining this equipment with a remotely operated silhouette target – as can be done by adding the BT 18 Vanishing Target to the system. Both this unit and the BT 19 can be remotely controlled by the BT 22 radio remote control system or by wires.

BT 19A Gunfire Simulator

This is a remote-controlled unit, the purpose of which is to create a realistic simulation of a nozzle-flame and the sound of gunfire. The simulation is achieved by means of electrically-fired pyrotechnic shells.

BT 19A is a light, transportable unit containing a magazine that holds 30 shells, each in its own barrel. The unit also contains the electric firing circuits that enable the shells to be fired one at a time, control being exercised either by direct wire link or by radio.

Dimensions of equipment are 90 × 50 × 28 cm and the all-up weight is approximately 27 kg.

The operating voltage is 12-18V d.c. as for the other units in the SAAB BT series of targets and simulators: the equipment can thus be associated conveniently with such training aids as the BT 18S Tank Target and the BT 16 and BT 17 scorers (**2351.193**). The BT 18S target can be raised or lowered at varying speeds giving duration of from 3 to 10 seconds for raising or lowering: it can thus be used to simulate the gradual appearance or disappearance over the horizon of a moving vehicle. Coupled with the BT 19A simulator, therefore, with its simulation of gunfire and production of a 1-2 metre muzzle-flame the complete installation is capable of a high degree of realism for exercises involving anti-tank weapons.

MANUFACTURER:

Saab-Scania AB, Jönköping, Sweden 1, who have developed the equipments in association with the Royal Swedish Army Ordnance Administration.

1777.193
BT 33 ARTILLERY FIRE CONTROL SIMULATOR

DESCRIPTION:

The BT 33 is an indoor simulator for the training of artillery and mortar fire controllers. It consists of the following main units: projection screen, two terrain view projectors, target projector, two or three burst projectors, and the main control unit.

The terrain view projectors are standard colour slide projectors (6 × 6 cm). One of them shows a view of a terrain area as seen by a fire controller from an observation post, whilst the other simulates the effect of a star shell over the same terrain at night.

Targets appearing in the terrain view can by symbolized in different fashions. Hostile troops under cover, seen at long distance, are practically invisible, and consequently the target then consists simply of a certain area in the terrain picture. Moving target effects (including tanks, or even helicopters) can be projected onto the terrain view by means of the target projector.

Burst projectors are used for simulation of firing into a terrain area or at targets of opportunity. They are capable of projecting different types of burst symbols into the target terrain view, representing ground burst, air burst, shrapnel impact, rising burst cloud, and concealed burst. If the projectile bursts behind a hill, a "B observation" is automatically produced (sound of explosion only). If the hill is not very high, the burst will also become apparent through a cloud of smoke rising from behind the hill. The size of the bursts (which depends on the observation range) and their appearance, possible smoke in case of a concealed burst, and shrapnel hitting the ground in the case of air bursts give the fire controller valuable information on the location of the burst with respect to the target.

The simulator is equipped with a synthetic sound system. Before the burst, the sound of the projectile in its trajectory is heard for a few seconds. The burst explosion is then heard, delayed in accordance with the actual observation range. Both the time and the intensity of the explosion sound vary automatically.

A simulated exercise is under the control of the instructor, who operates the requisite controls on the main control unit. In addition to the operating controls, this contains: an analogue computer for the calculation of simulated projectile trajectories; a core memory of 4096 16-bit words for the target terrain topography; and automatic control units for the burst projectors and the sound system. A magnetic tape is prepared to correspond with each terrain view used, this being necessary to make the appropriate allowances for the effects on fall-of-shot, whether a burst would be visible or not, etc due to the height of the terrain portrayed.

The imaginary trajectory can be regarded as a straight line which, when seen from above, crosses a number of sectors and ends in a burst point. Computation of the burst point requires signals representing the projectile trajectory and the height variation of the terrain in the firing direction, as well as a device for determining when these two signals are equal. Signals containing the terrain height data are obtained from the terrain memory of the simulator, and the trajectory of the projectile is represented by a signal generator with an output signal proportional to the height of the projectile in the imaginary trajectory. The initial height at the time of entering the picture area and the rate of descent are dependent on the artillery piece.

The burst projector is then trained by servo control at the correct burst point in the picture.

In case of a ground burst (i.e. when the signals are equal) the terrain memory will yield information on whether the burst shall be visible or not, or whether it shall be shown above any concealing terrain features.

Air detonation can be produced by means of time fuses or zone fuses. Timed detonation with time fuses can be simulated by using the comparing device to compare the trajectory signal with a constant signal corresponding to a certain timing. Fire with zone fuses can be simulated by comparing the trajectory signal with the terrain signal plus an additional constant signal representing the desired bursting height.

In case of an air burst, the burst point signal is compared with a visual obstruction signal representing the line of sight from the observation point over any intervening concealing terrain features. Should the air burst occur at less than 7 metres below the line of sight, a burst cloud will be released above the concealing terrain, and should the burst occur lower than 7 metres below the line of sight, no visual burst indication will be obtained. The fire controller will receive an audio observation, but whether shrapnel shall be seen or not will depend on information obtained from the terrain memory.

DEVELOPMENT:

Development was undertaken by Saab-Scania's Computer and Electronics Group to meet a requirement formulated in 1967 by the Swedish Army.

STATUS:

Over a year of prototype testing has been completed at the Swedish Artillery Training School and 20 series production models have been ordered by the Swedish Forces Material Department for delivery during 1974. The first export order was placed by Norway.

MANUFACTURER:

Saab-Scania AB, Jönköping, Sweden.

SWITZERLAND

1646.193
FLORETT

DESCRIPTION:

Initially intended for training up to 40 AA gunners, simultaneously, in the engagement of low-flying fast aircraft. A single target aircraft is tracked by a ground radar (type unknown) and this data is fed into two Honeywell 316 computers. The latter are also linked to all the 40 fire positions, and presumably data fed back to the processors includes such things as gun azimuth and elevation and 'firing' data. It is claimed that all 40 guns can engage the target simultaneously and the system will be able to record in virtual real-time the individual performance of each gunner against single target. It is understood that other inputs to the computers include meteorological and appropriate ballistic information.

DEVELOPMENT:

The system was developed for the Swiss Government under a contract worth DM5.7m. More systems are to follow. There is a possibility that the Swiss Government may be joined by other nations in the ensuing programme. Unofficially, larger Honeywell machines will be used in later systems. The Florett system clearly has the potential for development into a ground AA fire control system, although no-one is saying this officially.

MANUFACTURER:
Honeywell GmbH, West Germany.

THE UNITED KINGDOM

7005.193
DIRECT FIRE WEAPON EFFECTS SIMULATOR (SIMFIRE)

DESCRIPTION:

The Simfire equipment, originally designed to operate on tanks and armoured cars, simulates direct fire weapons by means of a laser light projector. It is in use, widely, throughout the world in two roles:

1. As a gunnery trainer, by allowing tank crews to practice their techniques against live targets with far greater realism than is possible with live ammunition against mock targets on a range.
2. As a tactical trainer, by introducing into peacetime training exercises the effects of long-range high accuracy weapon systems. Its forces use all the participants of an exercise to react as if they are under the threat of live attack.

In these two roles its use has brought an increasing awareness of the importance of the skills of the individual tank crews on the success or failure of a simulated battle. One of its most important features has been to identify good from indifferent crews, and to highlight failures in training. Trials with many armies throughout the world have proved, not only that Simfire has brought much needed and long awaited realism to field exercises, but also that at all levels its use generates a new understanding on the part of crews and instructors, of the importance of good training and the need to keep tanks and their gun control equipment in good repair. During peacetime, when severe restrictions are necessarily imposed on the use of live ammunition for training, Simfire is a material help in maintaining crews and their equipment at a high state of combat readiness.

The title Simfire refers to the simulation of direct fire weapons such as tanks and armoured cars. However, other variations have evolved which rely upon the basic idea of laser light projection:

SIMRAY: Developed as an umpires' aid, is a laser ray gun which has both civil and military applications. The British Army intend using the device as an Umpires' Gun with which an umpire can discover whether participants of an exercise are 'cheating' by obstructing the operation of their Simfire equipment. A user of Simray can simulate minefields, and fire from both anti-tank and artillery weapons by knocking out vehicles that stray into danger zones.

SIMKILL: A target Simfire system which can be fitted to mobile or static targets to represent a range layout and provide realistic gunnery training for tank and gun crews without the limitation of range safety areas.

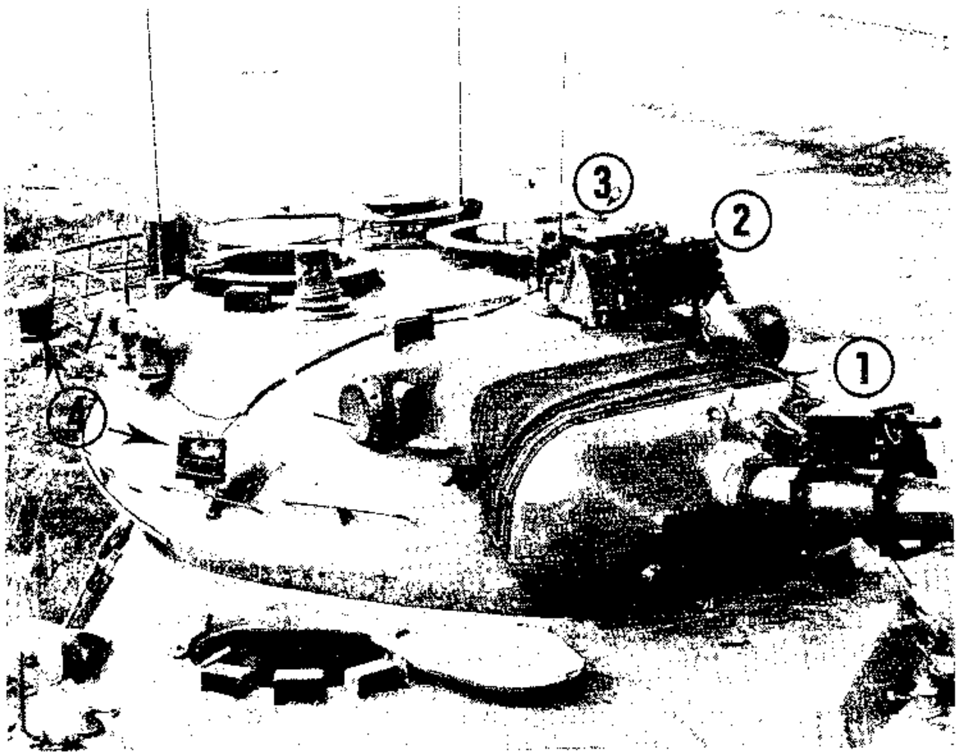
SIMSTRIKE: An air-to-ground attack simulation designed to represent the effect of gun and missile attack by aircraft at ground targets equipped with Simkill.

SIMFLASH: A Flash Generator System linked to the firing switch which provides the visible and audible effects of a gun firing.

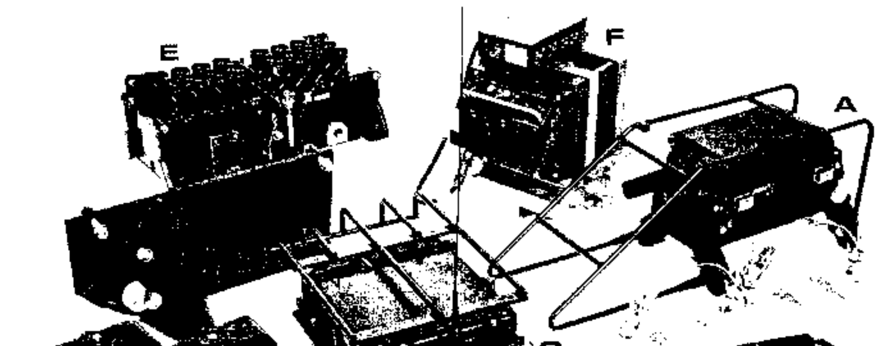
SIMFLAK: A ground-to-air attack simulation designed primarily for helicopter pilot training.

SIMGUN: A rifle version of Simfire under development for the British Army. Associated with the 'firing' equipment will be a target system worn by a man on a webbing harness so that soldiers may be trained to react quickly and accurately to swiftly moving targets within a realistic tactical framework.

The basic Simfire equipment can be mounted on any tank or armoured car in the world including the Scorpion light tank which is having world wide success. The major armies of the Western World have all bought the equipment or are in the process of evaluating it. Tactical exercises have taken on a completely new significance and many



A German Army Leopard tank with Simfire fitted. (1) Laser projector fitted to gun barrel. (2) The flash generator which controls the 'bang, flash and smoke' effects. (3) The radio transmitter/receiver which responds to the Simfire attack signal. (4) Two of the four detectors which pick up the laser attack signal



Complete Simfire equipment for a British Army Chieftain tank:

(A) Laser projector with tree guard.
(B) Smoke pyrotechnic holder—this is ignited once the vehicle has been 'killed'.
(C) Commander's and gunner's eyepieces which indicate the fall of a shot by a series of lights.
(D) Detector's units which gather the laser signal.
(E) Flash generator—this forms the basic part of the SIMFLASH system and controls the "bang, flash and smoke" effects.
(F) Control unit which is mounted internally and enables the crew to select ammunition, range and the correct information for engaging moving targets. It also contains the umpire switches under a sealed flap.
(G) Radio transmitter—receiver which responds to the Simfire attack signal.

theories of modem armoured warfare are given a severe test under very realistic conditions.

Simfire helps to reduce the amount of live ammunition needed to achieve a fully trained crew and thereby significantly reduces training costs. Worthwhile field exercises can be conducted using Simfire on small training areas which are not normally considered suitable for armoured training. The British Army trials report summed up the value they placed on the use of this equipment by stating it to be an essential training aid.

DEVELOPMENT:

The simulator was developed as a private venture project by Solartron and was started early in 1967. Throughout development Solartron worked in close association with the British Ministry of Defence.

MANUFACTURER:

The Solartron Electric Group Limited, Farnborough, Hampshire, England.

Simray, the 'Umpire's Gun'. The control unit is carried on the man's back

1647.193

REDIFON SIMULATORS

The Redifon organisation has produced a large range of simulation systems and equipment for military applications. These generally come within one of three groups, flight simulators, radar simulators, and naval training simulators.

Flight Simulators

Almost 100 military flight simulators have been supplied by Redifon, of which 59 are for use by the UK forces, and 48 for foreign services. Aircraft types simulated for UK users include: VC-10, Nimrod, Buccaneer, Phantom, Lighting (Mks 1, 2, and 3), Comet (2 and 4), Argosy, Meteor, Hunter, Javelin, Gnat, Gannet, Scimitar, Wessex helicopter, Valiant, Vulcan, and Victor. Aircraft types simulated for overseas forces include: Buccaneer, Agusta Bell 204B helicopter, C-130, Canadair CC106, Transall C160, CHSS-2 helicopter, F-5, Aer Macchi MB326, Lightning Mk 53, Sabre, Canberra Mk 58, Hunter, and Saab A35XD.

Initially, analogue computation was employed, but current production employs analogue, hybrid and digital techniques as appropriate to the requirement and cost specification for specific simulator projects. Digital computers used have included the products of several manufacturers, but most of the later Redifon simulators incorporate machines produced by Redifon itself. The majority of the more recent simulators also incorporate multi-axis motion systems of Redifon design and CCTV colour visual systems.

PHANTOM:

This flight simulator provides aircrew with equipment which simulate the entire flight handling characteristics and systems performance of the Phantom aircraft and also the navigation and weapon attack systems with which it is equipped. It is used in support of conversion training and squadron continuation training both by the Royal Navy and Royal Air Force. It is a "full mission" flight simulator in which aircrew can be instructed in, and practise all the roles in which the Phantom aircraft is employed.

The flight simulator is powered by a digital computer and the simulator fuselage consists of complete replicas of the Phantom aircraft cockpits. The simulator fuselage is mounted on a three axis motion system which provides motion cues in roll, pitch and heave axes. An instructor's station is provided which is designed to be operated by two instructors, and their consoles incorporate instrumentation and controls which enable them to set up and monitor simulated exercises, insert faults and malfunctions and control conditions of ambient lighting, visibility and wind strength and direction. Track and approach recorders are also provided.

The simulator is also equipped with a radar land mass attachment which permits realistic simulation of the mapping radar presentation in the navigator's cockpit.

A closed-circuit television camera scanning a three dimensional model presents a picture of the outside scene to the pilot in full colour through projectors on to a screen mounted in front of his cockpit on the simulator fuselage.

Redifon Buccaneer flight simulator, showing motion system and triple projectors and screen for colour visual systems

An airfield model provides the ability to carry out taxying, take-off, circuits, approaches and landings, and through different scaling on two further models low, medium and high level navigation, target identification and navigation attack and weapon delivery techniques can be carried out.

Five Phantom simulators have been manufactured, a Phantom F4K and four Phantom F4M simulators.

BUCCANEER:

Redifon manufactured simulators for the Buccaneer aircraft are "full mission" simulators powered by digital computers and equipped with three axis motion systems. Visual systems for both airfield and tactical operations are provided.

NIMROD:

Four flight simulators for the Nimrod maritime reconnaissance aircraft have also been manufactured for the Royal Air Force. These are digital powered simulators representative of the Nimrod flight deck with three axis motion, and visual systems. They are designed to train the flight crew of the Nimrod and to be coupled to a maritime crew trainer which simulates the essential navigation, search, location and attack equipment with which the tactical compartment of the aircraft is equipped and in which the tactical crew can be trained and practised on the various tactical operating techniques. When coupled, the flight simulator and maritime crew trainer can operate in conjunction with each other, or separately as the training requirements may demand.

Radar and other Military Simulators:

TYPE C8021 SHIPBORNE HELICOPTER AND AIRCRAFT DIRECTION TRAINER:

Radar simulators offer useful savings in training costs, but are inherently large and relatively costly items. Target simulation using an existing radar installation offers most of the facilities of a full radar simulator with appreciable reductions in size and cost. The C8021 system offers training in Aircraft Direction at modest price and in compact form. The trainer is designed for shipboard use and integrates completely into the ship's radar system. It can be installed in any radar-equipped vessel, for training in aircraft direction and vectored attack procedures, without the use of helicopters, aircraft or landing platforms. The trainer produces two target tracks; additional units may be used in parallel to produce further targets as required.

TYPE C846 SUPER-FLEDERMAUS SIMULATOR:

The C846 simulator is a trailer-mounted gunnery training aid for use in front line tactical instruction. In conjunction with the Super Fledermaus gunnery control radar it enables operators to be trained in the acquisition and tracking of attacking target aircraft flying at speeds of up to Mach 2. Complete realism is maintained on the simulated targets, characteristics of the real radar being faithfully reproduced in the echo configurations. The simulated targets are under the control of the instructor, either locally at the simulator equipment, or by remote control from the gun equipment. Four targets (or optionally two targets) are provided, fully controllable in speed, direction turn and climb/descend rates, with the effects of wind simulated. To allow training for the unexpected the targets may be sequenced or 'programmed' to enter the area of observation at preset intervals. Simulated echoes may be mixed directly with echoes from real targets to give added complexity to an exercise. Realistic jamming returns are produced including noise, pulse and window which may, at the instructor's will, be associated with any target. A mass raid of many aircraft flying in close formation is also simulated.

TYPE C880 MARINE RADAR SIMULATOR:

The Redifon C880 Marine Radar Simulator is a multi-purpose navigation and radar trainer which provides facilities for initial training or continuation training of navigation radar and ships' operations room personnel. It is used as a procedure trainer, for radar control of ships, fixed wing aircraft, helicopters and hovercraft; using the basic capabilities of the system it provides training in navigation, radar fixing, plotting and tracking of all kinds of contracts.

The following features are simulated:

1. The coastline in any area is reproduced with high resolution for inshore working in bays, estuaries or channels, and training in map comparison, contact plotting and navigation.
2. Up to eight echoes each of which can be controlled independently to simulate any contact from an aircraft to a navigation buoy.
3. The land indications, because of the variable intensity and shadow facility could also be used to simulate pack-ice and other similar phenomena, convoys, or fishing fleets.

TYPE C8012 DIGITAL MULTI-CRAFT RADAR SIMULATOR:

This system provides facilities necessary to train and examine officers and men in aspects of proper operation of radar, navigation and radar plotting, including the following:

1. Contact plotting of ships, hydrofoils, helicopters, hovercraft and maritime aircraft.
2. Radar fixing from land points.
3. Tracking of targets and relative fixing (contact to contact).
4. Simulation of features such as ice-edge, pack-ice and cloud returns as an optional extra.
5. Recognition of interference patterns from sources such as sea and rain clutter and other radars, also various malfunctions and common design limitations of radar may be demonstrated.

When simulating military exercises, it can be used to train personnel in most tactical procedures including:

1. Vectored attacks.
2. Anti-submarine exercises (Instructor supplying sonar information).
3. Convoy escort and associated procedures.
4. Interceptions.
5. Shadowing operations.
6. Practice attacks, using targets as torpedoes or missiles.

ACTION SPEED TACTICAL TEACHER AND WEAPONS TRAINER TYPES C805 AND C873:

This is a tactical teacher and weapons training complex which can be used to provide complete detailed simulation of most command tactical problems involving the deployment of ships, submarines, aircraft, helicopters and hovercraft. The trainer comprises an auditorium, where the instructional staff can automatically record and control exercise progress, and because of the programming and read-off facilities, it can also be used for comprehensive debriefings. The system also has cubicles, simulating ships, submarines, aircraft, helicopters, etc, and most of the drive systems, indicators, sensors and weapons normally carried. It can be used for all kinds of training from basic to the fully operational.

Depending on user requirements, the complex can be provided incorporating either analogue (C805) or digital (C863) techniques.

ACTION SPEED OPERATIONS TRAINER TYPE C863:

This digital complex combines all the facilities of the Action Speed Tactical Teacher plus additions such as coastline effects, many more targets of different types and larger more versatile convoy sizes. It can be used to train operations staff in all aspects of control and direction, both tactically and strategically.

MANUFACTURER:

Redifon Flight Simulation Ltd, Gatwick Road, Crawley, Sussex, England.

Redifon Radar Simulator Division, Kelvin Way, Crawley, Sussex, England.

1293.193
AVIMO WEAPON SIMULATORS

DESCRIPTION:

A series of simulators for use in the classroom or in the field has been developed in UK by Avimo Ltd. These instruments are for the selection and training of operators for line-of-sight guided weapons. Typical applications for these simulators are in training operators for the Vigilant and Cobra anti-tank infantry guided missiles.

Initial selection and training of missile operators is achieved by use of a classroom machine. Selection is necessary because although any service personnel can be trained to launch and guide a line-of-sight missile some have greater natural aptitude for the task and are consequently cheaper to train.

In the training role the simulator reproduces as accurately as necessary the launch and flight characteristics of the missile which is represented as a spot of light moving against a typical battle scene background. The movement of the light spot is controlled by using the actual missile controller, the output signals of the controller being processed in an analogue unit so that the light spot moves as the actual missile would move under the conditions simulated. A wide range of engagement conditions can be catered for and the realism of the simulation is good. The increasing range of the missile as it flies is represented by the decreasing size of the light spot. Variable sensitivity is available so that simpler control tasks can be set for the initial training phase.

The classroom system consists of three components in addition to the missile controller. These are the screen carrying the landscape which is usually projected from a conventional slide projector; the Spot Projection Unit which contains the optical system and the Analogue Unit which is built into the spot projector in the classroom machines.

Provision is made to change analogue units readily so that different missile characteristics can be accommodated. This is particularly valuable when the user has to select or train operators for a number of different systems.

A wide range of parameters can be simulated and adjusted to give the operator a full range of operational possibilities. These parameters include all variations in launching conditions including launching from a moving vehicle; wind gust effects and missile drift; target range and a variety of missile control systems including the well known velocity and acceleration types.

The field simulators are designed for outdoor training in conditions very closely approximating to actual battle. Live targets can be used. The field equipment is simpler and less sophisticated than the classroom simulator and its primary role is for tactical and refresher training. The equipment is of rugged construction to withstand the environmental conditions.

Two basic units comprise the field simulator system in addition to the standard missile controller. These are a viewing head for the infantry missiles and a rugged analogue unit having electrical characteristics the same as for the classroom machine. The viewing head is necessary to place the simulator light spot in the operator's field of view and normally he views the panorama before him through this unit. An eyepiece is provided for the instructor to monitor the trainee's performance. In use the operator sees his target in the scene in front of him through the viewing head. On firing the missile the spot of light appears superimposed on the scene and he guides this onto the target as if it were a missile. The viewing head can be mounted on vehicles or helicopters if required.

For applications with systems where an optical sight is used, it is usual for the viewing head and the weapon sight to be combined, increasing realism still further.

STATUS:

Classroom and field simulators are in production and in service with the British Army and several other armies.

MANUFACTURER:

Avimo Limited, Taunton, Somerset, England.

1778.193
LINK-MILES SIMULATORS

DESCRIPTION:

Link-Miles is an independent operating Division of the Singer Company (U.K.) Limited, and is closely associated with Singer's Flight Simulation Operations in New York, U.S.A. Prior to its amalgamation with Singer the firm had gained a great deal of military experience, having designed and manufactured flight simulators for the RAF's Belfast and Hercules aircraft. These were followed by full mission simulators for the Sea King helicopter and the Hawker Harrier.

Under its new title, Link-Miles Division was awarded contracts for four full mission simulators for the Anglo-French Jaguar. This contract is one of the biggest military orders placed in recent years. An order for a fifth Jaguar simulator has now been placed. This is a mobile version, the entire complex being contained in a number of road trailers and containers.

The "trailerised" flight simulator is increasingly favoured by military operators, because it can be quickly repositioned to accommodate changes in the strategy of front-line squadron dispersal. Link-Miles has conducted intensive research into this approach and is now able to encapsulate a full mission simulator, including visual and motion systems, instructor's consoles, briefing rooms and workshops. Recent military simulator contracts awarded to Link-Miles Division, include the following:

SEA KING HELICOPTERS:

One for the Royal Navy, now in service, using analogue computation and one for the Royal Australian Navy, using two digital computers, scheduled for delivery in early 1976. The simulator comprises two separate parts, a cockpit section, mounted on a three-axis motion system and a rear crew compartment, each under the control of its own instructor. Full anti-submarine warfare missions are simulated, including operation of the following systems:

1. Navigational doppler
2. Search radar
3. Transponder interrogation radar
4. Submersible sonar transducer
5. Weapons release system

HARRIERS:

Three for the Royal Air Force. The flight simulator is designed to reproduce the flying, handling and systems characteristics of the Hawker Siddeley Harrier aircraft throughout its operational envelope, including the simulation of malfunctions and emergencies. It is intended for conversion training at RAF Operational Conversion Units and for continuation training with operational squadrons.

The flight simulator consists of a detailed replica of the fuselage and cockpit of the Harrier aircraft, mounted upon a four-axis, hydraulically operated motion system. Motion cues in the roll, pitch, sway (lateral translation) and heave (vertical translation) axes are provided in response to operation of the flying controls. The visual system is based on the principle of a closed-circuit television camera scanning a model surface, the resultant picture being projected in natural colour, onto a screen in front of the pilot. Full daylight, dusk and night effects are provided. There are three separate scale models: an airfield area, a low flying area and a weapon delivery area. Transition from one to the other is smooth and natural.

Cockpit instruments and indicators are fully simulated, including the inertial navigation system, weapons system and head-up displays. All performance parameters are calculated by a digital computer complex which accepts inputs from the simulator, solves the flight equations and routes the necessary signals back to the cockpit instruments. Training exercises are controlled from a separate instructor's console which incorporates all monitoring facilities, environment controls (wind, visibility, etc) and switches for inserting faults and malfunctions. Track, approach and weapon attack result recorders are included.

The following pilot-training facilities are provided:

(a) Cockpit familiarisation, checks and drills
(b) Taxying
(c) Take-off (conventional and VTOL/STOL)
(d) Circuit flying
(e) Hovering and transitional flight
(f) Radio-navigation, communications and air traffic control procedures
(g) Emergency drills, procedures and manoeuvres
(h) Navigation, including map reading at low level and operation of the Inertial Navigation/Attack System
(i) Weapon attacks, using all attack modes and all specified weapons
(j) Reconnaissance procedures
(k) Landing (conventional and VTOL/STOL)

Two of these simulators are now in service with the RAF and the third is completed and awaiting delivery.

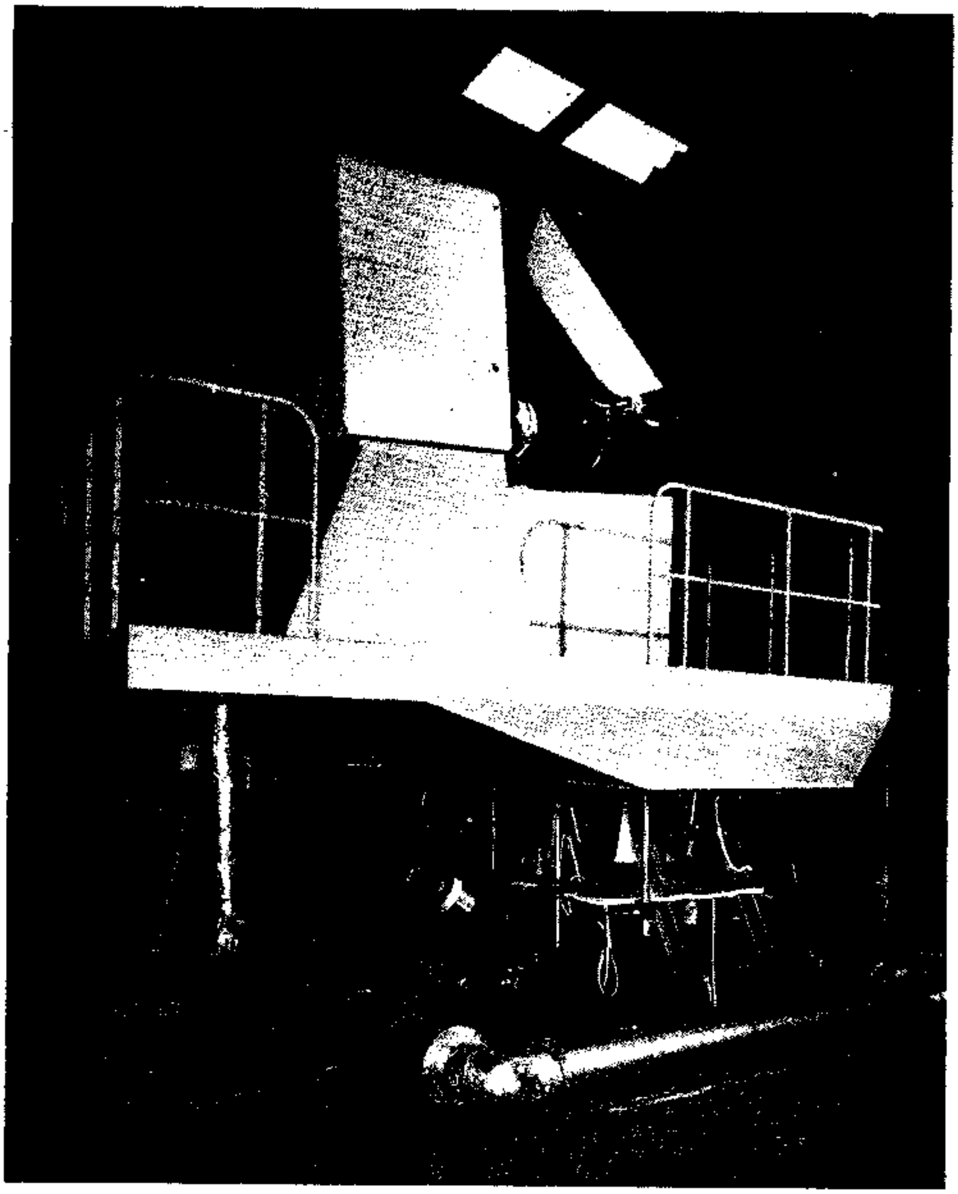
A simulator for the AV8A, the United States Marine Corps version of the Harrier was delivered in late 1973. Designed to meet the special training requirements of the Marine Corps, the simulator is installed in a mobile road trailer, which permits it to be operated at various sites in the USA. The complex incorporates an automated instructor's station, a feature of which is the Performance Assessment Monitor. This enables the instructor to call up various operational procedures, in tabulated form, on a CRT presentation; the computer then assesses the student's performance of the selected procedure against the correct standard and indicates any errors or omissions.

ANGLO-FRENCH JAGUAR:

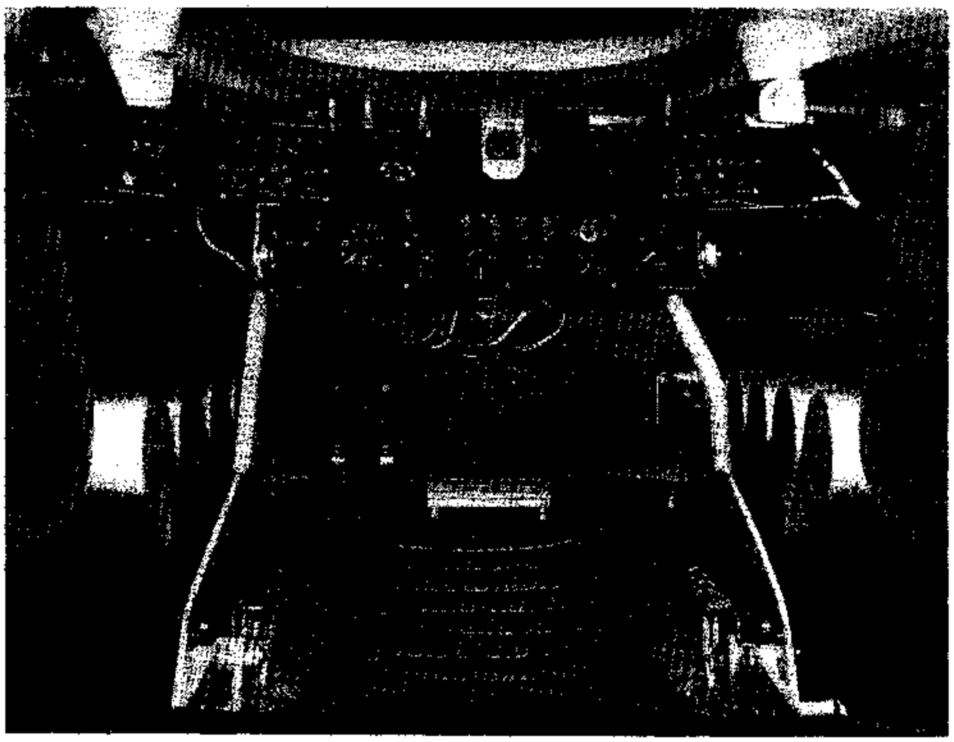
Five for the Royal Air Force. This simulator combines all the mission training facilities described for the Harrier, except that it is mounted on a standard Link-Miles three-axis motion system. The first Jaguar simulator was scheduled for delivery in early 1974, whilst the fifth is scheduled for early 1975. The last of the series is designed to be transported in a number of road trailers, reflecting the current military preference for mobility.

JETSTREAM:

One for the Royal Air Force. This is scheduled for delivery in late 1975. The Jetstream, as supplied to the RAF, is a twin-engined advanced pilot training aircraft. The flight simulator complex, in-



Jaguar Flight Simulator on 3-axis motion system with wide-angle collimated visual display unit



Interior of Chieftain Tank Driving Simulator, designed and manufactured by Link-Miles Division of the Singer Company (U.K.) Ltd cluding the cockpit and motion system, is housed entirely in one trailer, in a similar manner to the fifth Jaguar and the AV8A. Computation is by a PDP 11/45 digital computer, reproducing the flying and handling characteristics of the Jetstream aircraft throughout its operational range. The complex is designed to accommodate the retrospective fit of a visual flight system.

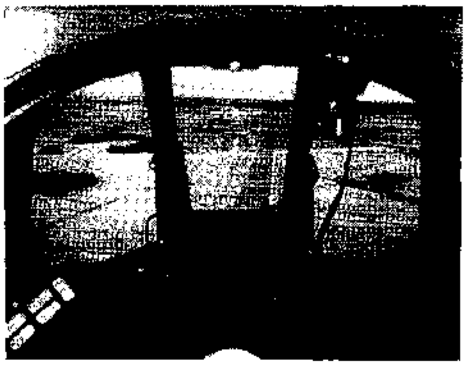
FIGHTING VEHICLE SIMULATORS:

Since the early 1960's, Link-Miles has applied its flight simulator experience to the design and development of driving simulators for specific types of fighting vehicles. The first of these was a Chieftain tank simulator, supplied to the British Army in 1965, which comprised a true facsimile of the driver's compartment fitted with a monochrome closed-circuit television visual system. Computation was by the Link-Miles standard analogue computer, Since 1965 the firm has made rapid progress in this field and is now able to offer driving trainers of any type with 2 or 3-axis motion systems, full colour collimated visual displays and digital computation.

Recent contracts include the following.

Chieftain Tank Mk. III for the British Army, delivered in 1971.

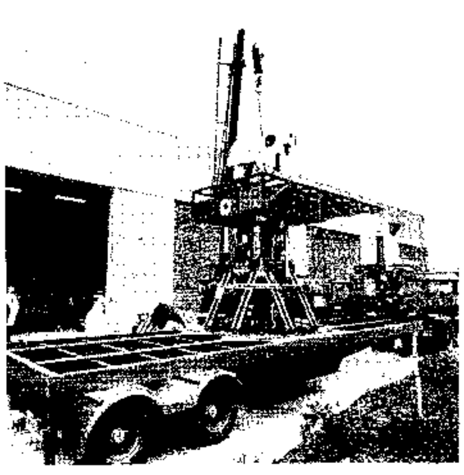
An FV 32 and an FV 433 for the British Army, delivered in 1972.



View through cockpit windscreen of a Jaguar flight simulator. The visual scene is presented via a Link-Miles optical display system which collimates the image to infinity. The Head Up Display is generated by an actual aircraft system and superimposed upon the presentation

Chieftain Tank Mk. III for the Iranian Army, delivered in 1972.

Chieftain Tank Mk. V for the Iranian Army, scheduled for delivery in 1974.



Jaguar Flight Simulator 3-axis motion system in process of installation on trailer chassis

MANUFACTURER:

Link-Miles Division, The Singer Company (UK) Ltd, Churchill Industrial Estate, Lancing, Sussex BN15 8UE, England.

2401.293
FRIGATE ASW COMMAND AND OPERATOR TRAINER

This equipment is designed for training sonar teams in the operation of surface ship sonar sets and to train the ship's command in the tactics employed in the use of sonar and radar data in the co-ordination and direction of anti-submarine weapons.

The equipment can simulate an exercise involving two manned surface ships against an unmanned submarine or one manned surface ship and an unmanned consort against an unmanned submarine.

Attacking ships will respond realistically to the demands of speed and helm and the target submarine will perform realistic manoeuvres under the control of the instructor or under pre-programmed conditions.

Standard naval equipment is fitted in compartments providing working conditions for the trainees similar to those found in normal exercise. Equipment control is exercised by an Argus digital computer and operator actions produce realistic system responses.

TYPICAL SIMULATION:

The degree of complexity of an exercise depends upon the requirements of the team under training. However, the following is typical of the type of exercise which might be mounted.

Two ships are set to patrol a wide sea area in a co-ordinated search for a reported enemy submarine. The submarine is set on a pre-programmed course, or controlled by the instructor. The Command sonar teams and fire control teams of the ships are manned by the trainee crews.

The submarine is first located on a search sonar and the Command alters course to intercept the submarine. The appropriate course is set into the computer at the helmsman's console and the sonar, etc. respond accordingly under computer control. The two ships communicate and co-operate via the RT link, and any of the Weapons Systems are employed.

The success of the attack depends on the accuracy of the final aiming data and appropriate miss-distances are shown on the instructor's tabular displays.

MANUFACTURER:

Ferranti Limited, Military Systems Department, Simonsway, Wythenshawe, Manchester, M22 5LA, England.

2402.393
HELICOPTER ASW CREW TRAINER

The purpose of this equipment is to train anti-submarine warfare helicopter crew members in the use of on board radar and sonar sensor equipments and to give integrated operational training in the techniques of co-ordinated ASW search and attack procedures. The trainer derives all of its own 'movement' parameters from an instructor's console. The complete equipment and each of the three simulated helicopter cabins is therefore capable of being operated independently and 'moved' at will within the three dimensional playing area.

DESCRIPTION:

The trainer can simulate an exercise involving a team of up to three ASW helicopters, four surface consorts (unmanned), and one submarine target (unmanned).

Crew compartments are represented by cubicles fitted with the actual helicopter equipment which is driven by an Argus digital computer. The students are presented with realistic displays and the student actions cause system responses which accurately represent those occurring in practice.

The instructor's console uses a CRT display system for data presentation. Facilities are provided for the instructor to initiate tracks, control target movement, 'fly' the helicopters, inject faults and monitor student actions. Controls are connected to the computer and the displays are computer driven.

Annotated large screen tactical displays are provided under computer control enabling the instructor and observers to readily follow the course of the exercise.

A tape deck is provided to record digital data as an exercise progresses. The complete exercise including vehicle tracks, student actions, etc. can be recorded and the tape can then be subsequently replaced into the system producing a complete picture of the original exercise, enabling detailed debriefing to take place.

MANUFACTURER:

Ferranti Limited, Military Systems Department, Simonsway, Wythenshawe, Manchester, M22 5LA, England.

2449.493
SUBMARINE COMMAND TEAM TRAINER

This equipment is for training attack team personnel and sonar teams in the full use of their equipments and to train the submarine command in the co-ordination and direction of attacks or defensive manoeuvres.

DESCRIPTION:

The equipment can simulate an exercise involving two manned submarines and up to five other unmanned vessels of types which can be selected at the start of an exercise and can be either surface ships or submarines.

Submarines can attack in consort or can oppose each other, or two separate exercises can be conducted simultaneously with the five unmanned vessels shared between the two submarine exercises.

During the course of the exercise, the instructor can control the manoeuvring of the unmanned vessels and can also initiate an attack against the submarines, using torpedoes, mortars and other weapons as appropriate.

The major components of the equipments fitted in the submarines are:

- Underwater telephone system
- Bathythermograph
- Passive sonars
- Active sonars
- Intercept sonar set
- Plotting tables
- Control consoles
- Fire control equipments, including wire-guided torpedo control equipment
- Attack periscopes

Tape recording equipment is provided and can be used either for pre-recording of unmanned vehicle movements, initial conditions etc, or for recording the exercise as it progresses and subsequent replay for debriefing.

TYPICAL SIMULATION:

A submarine is detailed to search and attack a convoy of up to five vessels, which sail on a pre-programmed course or manoeuvre under instructor control. The command, sonar team and fire control team in the submarine are manned by the trainee crews. The submarine's course, depth, etc, are set into the computer at the helmsman's console as required by the command.

The convoy is located on the search sonars of the submarine and the submarine command alters course accordingly. The submarine commander uses the periscope if he wishes, and representative views are presented to him, correctly correlated with the information presented on the sonars.

The periscope data and/or sonar data is fed into the fire control equipment and finally, torpedoes are launched. The success of the attack depends upon the accuracy of the aiming data and the appropriate miss distances are presented to the instructor and any audience on the tabular displays.

MANUFACTURER:
Ferranti Limited, Military Systems Department, Simonsway, Wythenshawe, Manchester, M22 5LA, England.

THE UNITED STATES OF AMERICA

1649.193
TACDEW

DESCRIPTION:
TACDEW (Tactical Advanced Combat Direction and Electronics Warfare) is the largest of the US Navy's computerised command and control training systems. Two of these systems one at each of the Fleet Anti-Air Warfare Training Centres in San Diego, California and Dam Neck, Virginia, provide for synthetic training in a wide range of naval tactics. These include:

1. Anti-aircraft operations
2. Anti-submarine warfare
3. Amphibious operations
4. Strike operations
5. Electronic Warfare
6. Air intercept control
7. Weapons direction
8. Shore bombardment
9. Carrier air traffic control
10. Surface operations

The simulator elements for these may be used separately or in combination within the overall system to provide for simultaneous individual specialist training programmes or for large scale exercises involving most or all of the elements. Replica systems of actual USN operational hardware are provided for the Navy Tactical Data System (NTDS), Airborne Tactical Data System (ATDS) aircraft, non-NTDS ships, the Carrier Controlled Approach System, and a range of ship's systems. Environmental conditions and parameters, such as the performance of ships, aircraft, and their systems, and sea and weather conditions are inserted in the form of computer software.

1734.193
LASER GUNNERY TRAINER

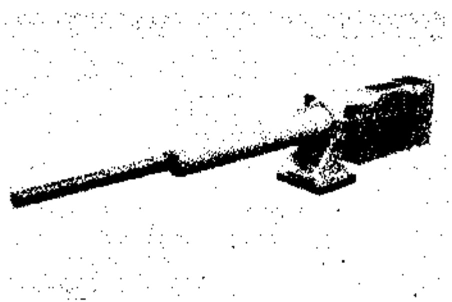
DESCRIPTION:
The Laser Tank Gunnery Trainer has been developed for training tank crews in firing the main tank gun, in lieu of the former method of using a co-axially mounted machine gun to simulate firing of the main armament.

The trainer is a gas laser weapon fire simulator consisting of a plasma tube, sealed collimating optics, controls, and a self contained-power supply. It produces a visible output in both flash and CW modes of operation. Hits are scored by noting reflections from training targets.

DEVELOPMENT:
The Laser Tank Gunnery Trainer was developed and produced under a $275,000 contract from the US Naval Training Devices Centre in 1970.

STATUS:
Quantity deliveries have been made and the equipment is in use by the US Army.

MANUFACTURER:
Kollsman Instrument Company, 575 Underhill Boulevard, Syosset, New York 11791, USA.



The Kollsman Laser Gunnery Trainer is designed to simulate the M73 machine gun in gunnery training

SECTION FOUR—ANALYSIS

2202.114

STRATEGIC SURFACE-TO-SURFACE MISSILES

Entry No.	Country	Name or NATO Code	US Code	Number of Stages	Propellant	Type of Warhead	Single Warhead	Alternative Warheads	Range	Status	Deployment
	1. Intercontinental Ballistic Missiles (ICBM)										
2048.111	China (People's Republic)	–	–	Not known	Liquid	Nuclear	Suggested 3MT	None known	10,000 km	Development and reduced-range testing	10-25 suggested by 1975-76
2826.111	USA	Titan II	LGM-25C	2	Liquid	Nuclear	5MT	None	15,000 km	Obsolescent	54
2715.111	USA	Minuteman I	LGM-30B	3	Solid	Nuclear	1MT	None	10,000 km	Obsolescent	about 100
2716.111	USA	Minuteman II	LGM-30F	3	Solid	Nuclear	1MT	None	11,250 km	Operational	500
2717.111	USA	Minuteman III	LGM-30G	3	Solid	Nuclear	1MT	MIRV 3 x 170KT	11,250 km	Operational	about 400 (balance of 1,000 total)
2982.111	USSR	Saddler	SS-7	2	Storable	Nuclear	5-10MT	None	10,000 km	Obsolescent	about 200
2956.111	USSR	Sasin	SS-8	2	Storable	Nuclear	5-10MT	None	10,000 km	Obsolescent	
2962.111 2978.111 2979.111	USSR	Scarp	SS-9	Probably 3	Liquid	Nuclear	20-25MT	MRV (Mod 4) 3 x 4-5MT	15,000 km	Operational	about 300
2965.111	USSR	Scrag	SS-10	3	Storable	Presumably nuclear	Not known	–	8,000 km	Believed only experimental	–
2984.111 2988.111	USSR	–	SS-11	3	Storable?	Nuclear	1MT	MRV (Mod 3) 3 warheads	10,500 km	Operational	about 1,000
2958.111	USSR	Savage	SS-13	3	Solid	Nuclear	1MT	None known	8,000 km	Operational	about 100

Reference should also be made to entries **2990 - 2993.111** for details of the new experimental Russian missiles SSX-16 - 19

Entry No.	Country	Name or NATO Code	US Code	Number of Stages	Propellant	Type of Warhead	Single Warhead	Alternative Warheads	Range	Status	Deployment
	2. Intermediate-Range Ballistic Missiles (IRBM)										
2049.111	China (People's Republic)	–	–	Not known	Solid	Nuclear	Small	None known	Low IRBM	Operational?	Small
2145.111	France	SSBS S-2	–	2	Solid	Nuclear	150KT	None known	3,000 km	Operational	18
2145.111	France	SSBS S-3	–	2	Solid	Nuclear	1MT	None known	3,000 km	Development	–
2981.111	USSR	Skean	SS-5	1	Liquid	Nuclear	Probably 1MT	None	3,000 km	Operational	About 100
2961.111	USSR	Scapegoat	SS-14	2	Solid	Nuclear	1MT	None known	4,000 km	Operational	Mobile. Numbers unknown
2967.111	USSR	Scrooge	SS-XZ	Not known	Presumably solid	Nuclear	Not known Probably about 1MT	None known	5-6,000 km	Operational	Mobile. Small deployment. Possibly an ICBM
	3. Medium-Range Ballistic Missiles (MRBM)										
2049.111	China (People's Republic)	–	–	Not known	Liquid	Nuclear	Possibly 20KT	None	About 1,500 km	Possibly Operational	About 50
2952.111	USSR	Sandal	SS-4	1	Liquid	HE or nuclear	Possibly 1MT if nuclear	None	About 1,800 km	Obsolescent	About 500

1763.224
TACTICAL SHIPBORNE SURFACE-TO-SURFACE MISSILES

Entry No.	Designation	Dimensions l x d – span (cm)	Wt. (kg)	Warhead	Propulsion	Range	Guidance	Deployment
CANADA								
2035.221	Canadian Sea Sparrow	366 × 20 – 102	200	HE	Solid	25 km (max)	Semi-active radar	Fitted four DDH Class destroyers
FRANCE:								
1156.221	MM 38 Exocet	520 × 35 – 100	700	150-200 kg HE	2-stage solid	38 km	Inertial + active radar	France, Germany Greece, Brazil, Chile, Malaysia, Peru, UK
INTERNATIONAL:								
1336.221	Otomat	438 × 40 – 124	700	210 kg SAP HE	Solid boosters, turbojet cruise	80 km	Autopilot + active radar	Italy, Venezuela, 1 other. Mk II and Téséo versions in development
ISRAEL:								
6019.221	Gabriel	335 × 32 – 138	400	180 kg HE	2-stage solid	22/41 km	Autopilot/ command + I/R or radar	Israel, 2 others poss. inc Singapore
ITALY:								
2240.221	Sea Killer Mk 1	373 × 21 – 86	170	35 kg HE	Solid	10+ km	Beam rider/ radio command	Italy. Used in Marte helicopter anti-ship system
2253.221	Sea Killer Mk 2	470 × 21 – 100	270	70 kg SAP HE	2-stage solid	25 km	Beam rider/ radio command	Iran. Used in Marte helicopter anti-ship system
2242.221	Sea Killer Mk 3	530 × 32 – 109	548	150 kg SAP HE	3-stage solid	45+ km	Autopilot + active radar	Development
NORWAY:								
1339.221	Penguin	300 × 28 – 140	330	120 kg HE	2-stage solid	20 km	Inertial + I/R homing	Norway, 1 other
SWEDEN:								
2366.221	RB 08A	572 × 66 – 301	1215	c 250 kg	2 × solid boosters, turbojet cruise	–	Command/ autopilot + active radar homing	Sweden. Also used for coastal defence
UNITED STATES OF AMERICA:								
2641.221	Harpoon (RGM-84A)	457 × 34 – 83	500	HE/Nuclear	Solid booster, turbojet cruise	110 km	Programmed inertial + radar	Development. Air and sub launched versions
2669.221	Standard SSM	(Formerly Interim Surface-to-Surface Missile. Involves three versions of Standard anti-aircraft missile with semi-active radar, anti-radiation-ARM, and active radar homing heads.)						Development
1758.221	Navy Cruise Missile	Surface launched tactical model of USN Submarine-Launched Cruise Missile (**1759.411**)						Development and study
UNION OF SOVIET SOCIALIST REPUBLICS:								
2968.221	SSN-1 Scrubber	760 × 100 – 460 (Est)	–	HE	Solid booster + internal cruise motor	185 km Max (Est)	Prob. radio command	Obsolescent
1155.221	SSN-2 Styx	625 × 75 – 275 (Est)	–	HE	Solid booster + internal cruise motor	40 km Max	Prob. radio command + I/R or active radar homing	USSR, Algeria, Bulgaria, China, Cuba, Egypt, E.Germany, India, Indonesia, N. Korea, Poland Romania, Syria, Yugoslavia, Poss. Pakistan. China has own production
2976.221	SSN-3 Shaddock	1100 × 86 (Est)	4700	–	Solid boosters + internal cruise motor	840 km Max (Est)	Probably radio command	USSR only
1760.221	SSN-9	–	–	–	Solid	275 km (Max (Est)	–	Fitted to Nanuchka missile boats – 6 launchers each

Entry No.	Designation	Dimensions lxd-span (cm)	Wt (Kg)	Warhead	Propulsion	Range	Guidance	Deployment
1761.221	SSN-10	–	–	–	Solid	55 km (Est)	–	Fitted Kara, Kresta II, and Krivak classes
1762.221	SSN-11	–	–	–	Solid	–	–	Successor to SSN-2 Styx. Fitted Osa II boats and modernised Kildin class destroyers

1756.314
TACTICAL AIR TO SURFACE MISSILES

Entry No.	Designation	Dimensions l x d – span (cm)	Wt. (kg)	Warhead	Propulsion	Range	Guidance	Deployment
FRANCE:								
1170.311	AS.20	259 × 25 – 78	143	30 kg HE	2-stage solid	16 seconds	Radio command	France W. Germany Italy, 2 others
1171.311	AS.30	390 × 34 – 100	520	HE	2-stage solid	10-12 km	Radio command	France, W. Germany Israel, Switzerland, S.Africa, others
1173.311	AS.11	120 × 16 – 50	30	A/T, HE, or frag.	Solid	3000 m	Wire-guided	France and 21 others
1174.311	AS.12	187 × 21 – 65	76	28 kg various	Solid	6-800 m	Wire-guided	French and UK maritime a/c
ITALY:								
1650.311	Airtos	390 × 21 – 86	191	35 kg frag.	Solid	11 km	Active radar	In development
1651.311	Marte	320 × 19 – 79	110	HE	Solid	10 km	Beam-rider, with radio command s/by	In development
GERMANY (FED. REP.):								
1180.311	Kormoran	440 × 34 – 100	580	HE	Solid	20 nm	Inertial cruise, active/passive radar homing	In development
1532.311	Jumbo	–	–	HE, poss nuclear	–	–	TV	In early development
1531.311	Strebo	–	–	Anti-armour and anti-personnel mine dispensing system	–	Area coverage	–	At study stage
INTERNATIONAL:								
1022.311	Martel (AJ 168)	390 × 40 – 120	150	HE	2-stage solid	60 km	Command &	
	(AS 37)	420 × 40 – 120	148	HE	2-stage solid	60 km	TV radiation homing	France and UK
1338.311 1336.221	Otomat	440 × 46 – 119	600	SAP 200 kg	Turbojet	60-80 km	Inertial & active radar homing	At late development stage
JAPAN:								
1653.311	ASM-1	–	–	140 kg HE	–	45 km	–	–
SWEDEN:								
1652.311	Bantam (RB 53)	85 × 11 – 40	7.5	1.9 kg hollow-charge AP	2-stage solid	250-2000 m	Wire-guided	Surface A/T version used by Swedish and Swiss Armies
1190.311	Rb 05A	360 × 30 – 80	305	–	Pre-packed liquid	–	Radio command	Sweden
1189.311	Rb 04E	445 × 50 – 200	600	–	Solid	–	Auto pilot cruise, active/passive radar homing	E version in development for Viggen. C and D versions for Lansen/Draken
UNITED KINGDOM:								
1654.311	Hawkswing	Helicopter version of Swingfire (2450.111) proposed for Lynx helicopter						
2415.311	Helicat	Helicopter version of Seacat (1019.231) proposal						
1530.311	Skua (CL 834)	283 × 20 – 60	210	20 kg	Solid	–	Programmed or command cruise. Semi-active radar homing	In development for RN
UNITED STATES OF AMERICA:								
1280.311	Bullpup A (AGM-12B)	320 × 31 – 95	258	113 kg HE	Pre-packed liquid	11 km	Radio command	NATO
1280.311	Bullpup B (AGM-12C)	407 × 44 – 118	812	454 kg HE	Pre-packed liquid	17 km	Radio command	NATO

Entry No.	Designation	Dimensions l x d – span (cm)	Wt. (kg)	Warhead	Propulsion	Range	Guidance	Deployment
1655.311	Bulldog (AGM-83A)	298 × 31	272	Mk 19 Mod 0	Pre packed liquid, or solid	–	Laser seeking	Pilot production early 1973 for US Marine Corps
1081.311	Condor (AGM-53A)	610 × 64	1134	HE	Solid	60-80 km	TV & command link	In development for USN
1129.311	Walleye I (AGM-62A)	344 × 33 – 116	499	385 kg HE	None – guided bomb		TV homing	USAF, USN
1129.311	Walleye II	404 × 46	1061	709 kg HE	None – guided bomb		TV homing	Production for USN
1102.311	Shrike (AGM-54A)	305 × 20 – 91	177	HE	Solid	12-16 km	Radar radiation homing	USAF, USN
1097.311	Hornet (ZAGM-64A)	198 × 18	57	–	Solid	–	Test-bed for laser and TV homing heads for bombs and Hellfire missile	
1098.311	Maverick (AGM-65A)	246 × 30 – 71	209	59 kg HE	2-stage solid	–	TV homing	USAF
1301.311	Harpoon (ZAGM-84A)	800 × 30 – 100	900	–	–	–	Radar homing	In development for USN
1391.311	Hellfire	Helicopter battlefield missile	–		–	–	Laser homing	In development for US Army
1597.311	HOBO (Homing Bombs)	Add-on guidance packages for Mk 84 (2000 lb) and Mk 118 (3000lb) bombs)					TV homing	US Forces
1534.311	Paveway (Laser Bombs)	Add-on guidance packages for Mk 82 (500lb), Mk 84 (2000lb), Mk 117 (750lb), Mk 118 (3000lb) demolition, and Mk 20 Mod 2 (Rockeye) cluster bombs					Laser homing	US Forces
1123.311	Standard ARM (AGM-78B)	457 × 31	816	–	Dual thrust solid	25 km +	Passive radar homing	–
2831.311	TOW	116 × 15	19	HE shaped charge	Solid	25-2000 km	Wire-guided	–
USSR:								
1148.311	Kennel	850 × 490 span (est)	–	–	Turbojet	Up to 90 km	Beam riding or command cruise. Passive/active radar homing	USSR
1149.311	Kelt	940 × 460 span (est)	–	–	Rocket	Up to 180 km	Prob radar homing	USSR, possibly Indonesia and Egypt

1850.314
AIR TO SURFACE TACTICAL MUNITIONS

Designation	Entry No.	Country	l x d (cm)	Wt (kg)	Applications/Remarks
Free Fall Bombs:					
Mk 1/2	–	UK		245	Various aircraft. Battlefield targets.
Mk 2	–	UK		453	Various aircraft. Battlefield and medium tactical targets
Mk 6	–	UK		453	" " " " " " "
Mk 6*	–	UK		453	" " " " " " "
Mk 7	–	UK		453	" " " " " " "
Mk 7*	–	UK		453	" " " " " " "
Mk 9	–	UK		453	" " " " " " "
Mk 10	–	UK		453	" " " " " " "
Mk 11	–	UK		453	" " " " " " "
Mk 11*	–	UK		453	" " " " " " "
Mk 12*	–	UK		453	" " " " " " "
Mk 13-16	–	UK		453	" " " " " " "
Mk 19	–	UK		453	" " " " " " "
(Note: Most or all of the above types of bomb can be converted for retarded fall by fitting either Mk 3 or 4 Retarder Tail Type 117, or Retarder Tail Type 118. See Entry No **1267.393**)					
M 64	–	USA		227	Various US and NATO aircraft. HE. Can be fitted with British Type 117 or 118 tail.
M 65	–	USA		453	Various US and NATO aircraft. HE. Can be fitted with British Type 117 or 118 tail.
M 117	–	USA		340	Various US and NATO aircraft. HE. Can be fitted with British Type 117 or 118 tail.
Mk 81	–	USA	188 × 23	113	Used on American F-4, F-8. Troop concentrations, transport.
Mk 82	–	USA	222 × 28	227	Used on American A-4, A-6, A-7, F-4, and F-8. Also NATO and other nations.
Mk 83	–	USA	300 × 35	453	Used on American A-4, A-6, A-7, F-4, and F-8. Also NATO and other nations.
Mk 84	–	USA	375 × 33	907	Used on American A-4, A-6, A-7, F-4, and F-8. Also NATO and other nations.
Virgo	**7514.393**	Sweden	158 × 21	123	Used on Lansen, Draken and Viggen. Retarded version also. Fragmentation.
Retarded Bombs:					
Mk 82R	–	USA	222 × 28	227	Used on various US and NATO aircraft. Retarded by 1 m dia balloon tail.
Mk 83R	–	USA	300 × 35	453	Used by US, UK and FRG aircraft
Matra Type 200	**1514.393**	France	– –	2508 400	Used on French and FRG aircraft. Tail parachute retarder.
Virgo	**7514.393**	Sweden	154 × 21	123	Used on Lansen, Draken and Viggen. Free-fall version also.
Type 117	**1267.393**	UK	– –	453	British Type 117 Bomb Retarder Tails Mk 3 or Mk 4 can be fitted to 1000 lb class UK bombs Mk 6 and Mks 9-19, and US Mk 83, M 65, M 117.
Type 118	**1267.393**	UK	– –	--	British Type 118 Bomb Retarder Tails can be fitted to UK Mk 1/2 & US M 64 bombs.

Designation	Entry No.	Country	lxd (cm)	Wt (Kg)	Applications / Remarks
Cluster Bombs and Area Weapons:					
Giboulee	1509.393	France	385 –	490	Bomblet dispenser. 12 or 24 tubes for 60 or 120 0.7 kg anti-personnel or A/T bomblets.
Rockeye Mk 20	1534.311	USA	–	227	Used on A-4, A-6, A-7, F-4, and F 8. About 250 fragmentation bomblets.
BL755	1277.303	UK	244 × 42	272	600 lb Bomb No 1 Mk 1. Used by UK and other NATO countries. About 150 bomblets
Dragon Seed	1512.303	FRG	– –	–	Anti-personnel and anti-tank bomblets.
Pandora	–	FRG	– –	–	Aerial sown anti-armour mines. Dispensed by rockets. Surface dispersing system also
Medusa	–	FRG	– –	–	Aerial sown magnetic, hollow-charge anti-tank mines. Air dropped from containers.
Grasshopper	–	USA	– –	–	Anti-tank mine and aerial dispenser system development programme.
Gator	1849.303	USA	– –	–	Anti-tank and anti-personnel mine dispensing system for US Army, USAF and USN In early development stage
HSM	1848.303	USA	– –	–	Hard Structure Munitions. Development project.
SUU-54B	1534.311	USA	– –	907	Cluster bomb. Also guided version (Pave Storm).
Fuel / Air Explosive Weapons:					
CBU-55B	1847.303	USA	200 × 35	226	Contains 3 separate 45 kg canisters. Used for mine clearance and against pressure-sensitive structures.
CBU-72	1847.303	USA	– –	–	USN development of CBU-55B with retarder parachute.
HSF-1	1847.303	USA	– –	226	FAE bomb development project by USAF
HSF-II	1847.303	USA	– –	900	FAE bomb development project by USAF.
MAD	1847.303	USA	– –	–	USMC helicopter dispensed FAE project.
Guided Bombs:					
Mk 20 (Rockeye)	1534.311	USA	– –	226	Laser homing version of Mk 20 (Rockeye) Cluster bomb with KMU-420/B guidance package.
Mk 82 (Snakeye)	1534.311	USA	– 23	226	Laser homing version of GP Mk 82 bomb. KMU-388B/B guidance package.
Mk 84	1534.311 1597.311	USA	– 33	907	Guided versions of GP Mk 84 bomb. KMU-351A/B laser guidance package, or KMU-353A/B electro-optical guidance package.
M 117	1534.311	USA	– –	340	Laser homing. KMU-342/B guidance package.
M 118E1	1597.311 1534.311	USA	– –	1360	Guided versions of M 118 demolition bomb. KMU-370B/B laser guidance package, or KMU-390/B electro-optical guidance package.
Pave Storm	1534.311	USA	– –	907	Laser guiced version of SUU-54B cluster bomb.
Walleye I	1129.311	USA	344 × 33	499	TV-guided.
Walleye II	1129.311	USA	404 × 46	1061	TV-guided.

1757.334
AIR TO AIR MISSILES

Entry No.	Designation	Dimensions l x d – span (cm)	Wt. (kg)	Warhead	Propulsion	Range	Guidance	Deployment
FRANCE:								
1178.331	R.511	309 × 26 – 100	184	HE	2-stage solid	8-10 km	Semi-active radar	French forces
1176.331	R.530	328 × 26 – 110	195	27 kg HE	Solid	18 km	Radar and I/R versions	Australia, Brazil, France, S. Africa
1349.331	Super 530	–	–	–	–	36 km	Radar	In development
1348.331	R.550 (Magic)	250 × 26 – 65	–	–	Solid	200 m-10 km	I/R	France and three others. In development
GERMANY (FED. REP.):								
1738.331	Viper	270 × 15	80	HE	Solid	–	–	In development for German forces
ISRAEL:								
1659.331	Shafrir	260 – 16	93	HE	Solid	–	I/R	Israel
ITALY:								
1656.331	Aspide	400 × 20	200	35 kg HE	Solid	–	Semi-active radar	In development
JAPAN:								
1187.331	AAM-1	–	–	–	–	–	Prob I/R	Claimed in service 1969 JASDF
1188.331	AAM-2	Successor to AAM-1 –		–	–	–	–	
UNITED KINGDOM:								
1079.331	Firestreak	319 × 22 – 75	136	22.7 kg	Solid	1.2-8 km	I/R	RAF. Superseded by Red Top
1080.331	Red Top	327 × 22 91	160 (est)	31 kg	Solid	12 km+	I/R	In development
1344.331	SRAAM	273 × 17		HE	Solid	–	I/R	for RAF

Entry No.	Designation	Dimensions l x d – span (cm)	Wt. (kg)	Warhead	Propulsion	Range	Guidance	Deployment
UNITED STATES OF AMERICA:								
1302.331	Agile	–	–	–	–	–	I/R	Dogfight missile project.
1657.331	Brazo	–	–	–	–	–	Passive anti-radiation	Ground defence suppression missile project
1303.331	BDM (Bomber Defence Missile)	–	–	–	–	–	–	Project stage
1083.331	Falcon (AIM-4A)	198 × 16 – 51	54.4	HE	Solid	–	Semi-active radar	Up-dated to AIM-4D standard
1084.331	Falcon (AIM-4C)	198 × 16 – 51	54	HE	Solid	–	I/R	In service
1085.331	Falcon (AIM-4D)	198 × 16 – 51	60	HE	Solid	–	I/R	–
1086.331	Falcon (AIM-4E)	218 × 16 – 61	63.5	HE	Solid	–	Semi-active radar	–
1086.331	Falcon (AIM-4F)	218 × 17 – 61	68	HE	Solid	–	Semi-active radar	–
1087.331	Falcon (AIM-4G)	218 × 17 – 61	68	HE	Solid	–	I/R	–
1090.331	Falcon (AIM-47A)	320 × 33 – 84	363	HE or nuclear	Solid	100 nm	Semi-active radar	–
1091.331	Genie (AIR-2A)	274 × 43	370	Nuclear	Solid	10 km	Unguided	–
1099.331	Phoenix (AIM-54A)	396 × 38 – 91	380	–	Solid	110-165 km	Radar homing	In late development
1658.331	Seek Bat (XAIM-97A)	Long-range, high altitude intercept missile based on AGM-78 (Standard)						In development
1103.331	Sidewinder (AIM-9B)	284 × 13 – 61	75	HE	Solid	1100 m	–	–
1104.331	Sidewinder (AIM-9C/D)	284 × 13 – 61	84	HE	Solid	18 km	Semi-active radar (C) I/R (D)	–
1105.331	Sidewinder (AIM-9E)	284 × 13 – 61	–	HE	Solid	–	–	Improved version of AIM-9B
1308.331	Sidewinder (AIM-9G/H/J)	Improved Sidewinder projects			–	–	–	–
1106.331	Sparrow (AIM-7E/F)	365 × 20 – 100	200	30 kg HE	Solid	25 km	Semi-active CW radar	–
USSR:								
1143.331	Alkali	188 × 18 – 58	–	–	Solid	6-8 km	Prob. radar	
1144.331	Anab	360 × 28 – 130	–	–	Solid	8-10 km	–	
1145.331	Ash	330 × 30 – 130	–	–	–	–	Radar and I/R versions	

1195.154
LAND BASED RADAR

Designation	Entry No.	Remarks	Manufacturers
DENMARK			
DR 513	**1576.153**	Artillery radar.	Terma
DR 810	**2286.153**	Ballistic Radar	Radartronic
M/532	**1577.153**	Doppler radar for projectile velocity measurement.	Terma
Pointer	**1573.153**	Portable Independent Terma Radar X-band	"
TSSR	**1574.153**	Terma Splash Spotting Radar.	"
FRANCE			
Adour	**2056.153**	TH.D 1215 automatic multi-mission missile tracking radar, 200 km range on passive target.	Thomson-CSF
Antares	**2060.153**	High precision 3-D S-band monopulse radar with electronic scan, in elevation.	"
Aquitaine II	**2062.153**	Precision missile/satellite tracking monopulse radar. Angular accuracy seven seconds; range accuracy two metres.	"
Arabelle	**2066.153**	Portable transponder.	"
Artois	**2063.153**	(Under development) Missile tracking radar, using electronic scanning techniques, with capacity to track several targets simultaneously.	"
Bearn	**2065.153**	Precision missile/satellite tracking radar with digital range-finder working to an accuracy of three metres in 4,000 km and with an angular accuracy of 20 seconds of arc.	"
Bretagne	**2067.153**	TH.D 1801 tracking radar.	"
Champagne	**2069.153**	Missile tracking radar, using 300 km range on 1 sq. m. passive target and to measure target speed to the nearest 10 cm/sec. Radar will use pulse compression techniques and will have low-noise receiver with 12 metre diameter "cold aerial".	"

Designation	Entry No.	Remarks	Manufacturers
Domino 20	**2073.153**	L-band surveillance radar. Coherent, pulse-doppler; 17 km range; 10° beamwidth; coherent pattern.	Thomson-CSF
Domino 30	**2083.153**	As Domino 20, but 6.5° beamwidth and 30 km maximum range.	,,
Domino 40N	**2084.153**	As Domino 20 but 3° pencil beam and 80 km maximum range.	,,
Eldorado	*2080.151* *2082.153*	X-band tracking radar for light anti-aircraft operations against low-flying targets. Associated with MIRADOR surveillance radar as mobile combination.	,,
ER-116-A	**2157.153**	IFF interrogator.	,,
LDTR	–	C-band scanning radar for special application. Designed to work under high level ECM conditions, it has an exceptionally narrow aerial beam.	,,
LP23 (TRS 2050)	**2100.153**	Long-range L-band surveillance radar.	,,
Matador	**2102.153**	3-D S-band radar (Mobile And Tridimensional Air Defence Operations Radar). Range about 250 km. Electronic elevation scan for accurate height measurement.	,,
Mirador	*2080.151* *2116.153*	Pulse-doppler surveillance and target designation radar. S-band; 18 km range; pencil beam 5.6° wide. Associated with ELDORADO tracking radar for mobile operations for defence against low-flying aircraft.	,,
Mirador II	**2080.151** **2075.131** **2117.153**	Mobile S-band pulse-doppler surveillance radar for defence against low-flying aircraft. Associated with tracking radar (name unknown) in Crotale surface-to-air guided weapons system. Dual, back-to-back, 4° beamwidth aerials. Range 18 km.	,,
Oeil Noir	**2129.153**	L-band pulse-doppler surveillance radar. 10° cosecant pattern beam. Range 15 km. Mounted on AMX-30 tracked AFV with twin 30 mm cannon to form mobile anti-aircraft system.	,,
Olifant	**2131.153**	Lightweight battlefield radar.	,,
Olifant II	**2132.153**	Lightweight man-portable battlefield patrol radar.	,,
Palmier	–	20MW 3-D S-band surveillance radar.	,,
Perceval	**2120.153**	Helicopter recovery radar.	,,
Picador	**2119.153**	Mobile 3-D radar.	,,
Racine	*2136.153*	X-band non-recurrent pulsed Doppler surveillance and target acquisition radar.	LCT
RALF	**2152.153**	Lightweight X-band low altitudes surveillance radar using Racine techniques.	,,
Rapace	**2137.153**	Ku-band AFV-mounted surveillance radar.	EMD
Rasit	*2142.153*	X-band portable medium-range battlefield surveillance radar.	,,
Rasit 72S / Rapière	**2141.153**	X-band battlefield surveillance radar. 20 km range.	LCT
Rasit 72B	**2153.153**	Lightweight version of Rasit 72A.	,,
Rasit 72C	**2154.153**	Short-range (10 km) version of Rasit 72A.	,,
Rasura	**2143.153**	X-band portable or vehicle-mounted battlefield surveillance radar.	Thomson-CSF
Ratac	**1528.153**	Battlefield surveillance. Also produced in USA and West Germany.	LCT
RS 660	–	Secondary radar interrogator using AS 309 aerial which is suitable either for independent operations or for mounting on the primary radar aerial.	Thomson-CSF
TH.D 1012	**2133.153**	Precision Approach Radar.	,,
TH.D 1013	**2098.153**	Light Precision Approach Radar.	,,
TH.D 1021	**2058.153**	Airfield Surveillance Radar.	,,
TH.D 1060	–	L-band medium-range surveillance radar. Transportable and suitable for use as a gap-filler or as surveillance element of GCA system. 200 km range on small targets; digital MTI system; 2-beam aerial.	,,
TH.D 1940	–	Low-cost 3-D surveillance radar with electromechanical elevation sweep. Transportable by cargo aircraft, helicopter or truck.	,,
TH.D 1955	**2155.153**	High-power 3-D S-band monopulse stacked-beam radar for surveillance or GCI. 400 km range capability.	,,
Tiger	**2156.153**	S-band lightweight surveillance radar for the detection of high-flying targets.	,,
TRS 2050	**2100.153**	See LP 23.	,,
TRS 2055	**2104.153**	2 MW Terminal Area surveillance radar. MTI system. Uses aerial type TH.D-284B.	,,
TRS 2060	**2121.153**	Mobile or static S-band surveillance radar.	,,
TRS 2065	**2059.153**	ATC Approach Radar.	,,

Designation	Entry No.	Remarks	Manufacturers
Volex III	2160.153	Medium-range two beam 3-D radar. Fast electromechanical elevation sweep with narrow (2° × 2°) beam gives good elevation measurement accuracy.	Thomson-CSF
–	–	L-band panoramic radar with double beam AT 431HB (9 m × 13 m) aerial; 400 km range; high ECM resistance.	..
–	–	Phased array 3-D radar for air defence and ballistic missile detection. Possible replacement for PALMIER radar	..
–	–	400-600 MHz surveillance radar for special applications. Range better than 1,000 km.	..
GERMANY			
Marder	–	Fire control radar for light anti-aircraft guns. Suitable for vehicle or tank mounting.	AEG-Telefunken
PAR-T4	–	Precision approach radar.	..
SRE-A4	–	10 cm S-band medium-range surveillance radar. 500 kW.	..
SRE-A5	–	Medium-range (60 nm) surveillance radar.	..
SRE-LL1	–	23 cm L-band long-range surveillance radar. Back-to-back 14.5 × 9 m reflectors 2 × 2.25 MW. Range 255 nm.	..
SRE-M2B	–	23 cm L-band long-range surveillance radar. 1MW. Range 245 nm.	..
SRT-2	–	Secondary surveillance radar.	..
–	–	Surveillance radar for anti-aircraft fire control system.	Siemens
INTERNATIONAL			
Zenda	*2198.153*	Project for SP AFV-mounted battlefield radar. Believed to have been abandoned.	EMI and others
ITALY			
Argos RAT-5C	2239.153	Coastal defence radar.	Selenia
Argos RAT-6L	2243.153	Short-range L-band acquisition radar for AA targets. Suitable for mountainous terrain.	..
Argos RAT-7L	2282.153	S-band 450W low-coverage radar.	..
Argos RAT-10S	2237.153	Coastal defence radar.	..
Argos RAT-15	–	10 cm S-band search and surveillance radar. 600 kW	..
Argos RAT-20L	2281.153	L-band long-range surveillance radar.	..
Argos RAT-21C	2280.153	C-band high-power low-altitude surveillance radar	..
Argos 800	–	Coastal defence radar.	..
ATCR-2T	2248.153	High-power L-band civil/military ATC surveillance radar.	..
ATCR-3T	2248.153	Medium-power S-band civil/military ATC surveillance radar.	..
ATCR-4T	2248.153	Medium-power L-band civil/military ATC surveillance radar.	..
Indigo FC Centre (CT40-GM)	2291.153	Missile control system. Italian version of Superfledermaus	Contraves
LPD-20	1529.153	Pulse-doppler search and acquisition radar.	..
MLV-4	–	Doppler infantry portable battlefield surveillance radar.	Selenia
RIS-3E	2244.153	Monopulse skin or beacon tracking radar.	..
RIS-4C/A	2245.153	C-band pulsed tracking radar.	..
RIS-5X	2246.153	Drone tracking radar.	..
Sentinel RQT-9X	2249.153	Portable infantry radar.	..
JAPAN			
NPG-360	2297.153	S-band Airport Surveillance Radar	Nippon Electric
NPG-434	2297.153	High-power ARSR	..
NPG-435	2297.153	Precision approach radar	..
NPG-454	2297.153	GCA system.	..
NPG-460	2297.153	S-band Airport Surveillance Radar.	..
NPG-542	2297.153	IFF/SSR system.	..
NPM-510	2298.153	Mobile 3-D radar electronic elevation scan	..
NETHERLANDS			
L4/5 AA Weapon Control System	–	Weapon control system for use with 40 mm anti-aircraft guns for close air defence. Search and tracking radar aerials on compound mounting which, together with transmitter-receivers computer and displays is mounted on single trailer. Search radar employs FASCAN principle to achieve early detection of very low-flying aircraft.	Signaal
LAR, 8GR200	–	Long-range air surveillance radar for civil or military applications.	..
LDTR		Long dwell time radar.	..
SLAM	1557.153	Signaal Low Air-defence Module.	..
Star, 8GR 550	1556.153	Terminal area radar with single transmitter receiver.	..
Star, 8GR 552	1556.153	Terminal area radar with dual diversity transmitter-receiver.	..

Designation	Entry No.	Remarks	Manufacturers
Stola	–	Target acquisition system for use against very low flying aircraft. Believed to be X-band with back-to-back aerial arrangement. Aerials mounted on telescopic mast which can raise them (apparently) about 10 metres to give good low-angle cover and clear obstructions.	Signaal
Tank Radar	**2302.153**	Integrated radar system for 35 mm AA tank.	,,
VI, SGR 104	–	Height-finding radar.	,,
VI, 8GR 551	–	Automatic height-finding and long-range tracking radar.	,,
–	–	Gap-filling radar.	,,
POLAND			
AVIA B	**2340.153**	23 cm L-band surveillance radar. Two 1.5 MW transmitter/receivers in frequency diversity. Range 240 km.	Industrial Institute of Telecomms, Warsaw
SWEDEN			
Domti	*2354.153*	Mobile coherent C-band pulse doppler search radar for use with AA guns or missiles.	L.M. Ericsson
Ecstra	**2357.153**	X-band coherent search and fire control radar for AA gun or missile systems. Separate search and tracking aerials.	,,
Isidor	**2481.153**	X-band portable intrusion radar.	,,
PE-48/T	**2325.153**	Mobile X-band AA fire control radar.	,,
PE-452/T	**2327.153**	X-band range-only AA fire control radar.	,,
PE-453/T	**2328.153**	Mobile X-band AA fire control radar	,,
Mareld	–	X-band coastal defence radar with closed-circuit TV for visual tracking and 30 km range laser rangefinder (by L.M. Ericsson).	Philips Teleindustri
PS-70/R	**2329.153**	Mobile C-band search radar.	,,
PS-171/R	**2326.153**	Mobile S-band search radar.	,,
Peder II	**2355.153**	Ku-band monopulse fire control tracking radar.	,,
UAR 1021	**2357.153** **2377.151**	X-band combined search and track pulse Doppler radar.	,,
UAR 1022	**2356.153**	Tracking sub-system of the UAR 1021.	,,
9GR 600	**1549.153**	Frequency-agile 200 kW search radar.	,,
SWITZERLAND			
CONAR	**2551.153**	Artillery Radar Fire Control System.	Contraves
Skyguard	**2377.151**	Solid-state successor to the Superfledermaus; uses separate search and tracking radars whose aerials are concentrically mounted on a single pedestal, as with Sea Hunter Shipborne tactical air defence system. Radar is by Ericsson; computer and control circuits by Contraves.	Contraves/Ericsson
Superfledermaus	**2376.151**	Anti-aircraft fire control system incorporating tracking radar by Albiswerk with visual attachment. Equipment uses valve circuits and has an analogue computer. Latest version has MTI addition by Ericsson.	Contraves/Albiswerk/Ericsson
UNITED KINGDOM			
AA No. 3 Mk 7	–	Mobile AA fire control radar. Lock and follow.	AEI
ACR-6	–	Medium-range 10 cm S-band search radar. Similar to CR 787 but with additional display and processing facilities.	Cossor
ACR-7c	–	Mobile short-range X-band surveillance radar.	,,
AR-1	**1140.153**	S-band medium-range surveillance radar. 650 kW. Single or dual transmitter/receivers with frequency diversity. Range 75 nm.	Plessey
AR-5	**2416.153**	L-band long-range surveillance radar. 2 MW. Single or dual transmitter/receivers. Range 200 nm.	,,
AR-15	**2456.153** and **1141.153**	S-band medium-range surveillance radar similar to and superseding AR-1. Available in static (**2456.153**) or mobile (**1141.153**) versions.	,,
CR 21	–	Medium-range 10 cm S-band surveillance radar. Similar to CR 787 but less microwave pre-amplifier.	Cossor
Coastal Artillery Radar	–	3 cm X-band target acquisition and fire control radar for use with several coastal batteries.	Decca
CR 787	–	Medium-range 10 cm S-band surveillance radar.	Cossor
CR 901	–	23 cm L-band long-range high-cover surveillance radar. 2 MW.	,,
CRI 600	–	Microminiature IFF Mk 10 interrogator.	,,
Cymbeline	**1018.153**	Mortar locating radar.	EMI
DASR-1	–	10 cm S-band back-to-back long-range/high-cover surveillance radar. Two 800 kW transmitter/receivers. Range 110 nm.	Plessey formerly Decca

Designation	Entry No.	Remarks	Manufacturers
DASR-3	–	Improved performance version of DASR-1 2.5 MW transmitter/receivers. Range 150 nm.	Plessey formerly Decca
FCE.AA No. 7	–	Anti-aircraft fire control radar for use with guns or missiles at close range.	EMI
Firelight	**2413.153**	Type 86 (which see) target illuminating radar.	Ferranti
Green Archer (FA No. 8 Mk 1)	**2412.153**	Mortar locating radar.	EMI
GS No. 14 Mk 1	**2490.153**	See ZB 298	Marconi
GS No. 18 Mk 1	**2483.153**	Infantry Combat Radar. Successor to ZB 298.	,,
HF 200	**1142.153**	S-band height finder radar. 2.5 MW. 10.6 × 2.4 m aerial.	Plessey
IFF 800	**2410.153**	Solid-state military IFF/SIF secondary surveillance radar developed from SSR.700.	Cossor
LC 150	–	10 cm S-band low cover coastal surveillance radar. 800 kW. (10.6 m aerial.	Decca
Mk 10 IFF/SIF	**2418.153**	IFF Mk 10 (SIF) interrogation and passive and active decoding equipment.	Plessey
Rapier	**2424.183**	Search and target acquisition radar for Rapier AA missile system.	Decca
Rapier	**2439.153**	Tracking Radar (Blindfire) for Rapier AA missile system.	Marconi
S 105	–	3 cm X-band fixed or mobile harbour and coastal surveillance radar. 70 kW.	,,
S 244	-	10 cm S-band height finder radar. 2.5 MW 12.2 × 2.1 m aerial.	,,
S 247/S 266	**2458.153**	Back to back early warning radar. Two 2.25 MW transmitter/receivers, one 10 cm S-band, one 23 cm L band.	,,
S 259	**2480.153**	Air transportable L-band 2 MW tactical radar with limited ground mobility.	,,
S 264		Range of 50 cm L-band long-range surveillance radars.	,,
S 314		10 cm S band coastal defence radar. 800 kW. 8.8 × 3 m aerial. 40 nm range.	,,
S 330	**2463.153**	Land mobile tactical surveillance radar. Uses two low-profile back to back aerials, S band and L-band plus IFF.	,,
S 404	**2463.153**	Land mobile C-band height finder radar.	,,
S 505		3 cm X-band harbour and coast watch radar. 20 kW.	,,
S 600 Series 600	**1168.153**	Modular system of transmitter/receivers, static and mobile aerial heads, displays and processing equipment capable of deployment to produce a wide range of air defence radar systems. The main elements of the S 600 Series are as follows:	,,
Aerial Heads:			
S 1006	–	10 cm S-band static height-finder aerial. 2.4 × 12.1 m cylindrical parabolic reflector with linear slotted feed.	,,
S 1010	–	10 cm S band transportable surveillance aerial. 5.48 × 1.8 m single curvature parabolic reflector. linear feed, frequency diversity capability.	,,
S 1011		10 cm S-band static surveillance aerial. 13.7 × 4.57 m parabolic reflector. Can be used in back-to-back configuration.	,,
S 1012	–	10 cm S band static surveillance aerial. 13.7 × 4.57 m cosecant-squared reflector. Can be used in back-to-back configuration.	,,
S 1013		23 cm L-band static surveillance aerial. 13.7 × 4.57 m parabolic reflector. Can be used in back-to-back configuration.	,,
S 1014		23 cm L-band static surveillance aerial. 13.7 × 4.57 m cosecant-squared reflector. Can be used back-to-back.	,,
S 1015	–	10 cm S-band transportable surveillance aerial. 5.48 × 1.8 m cosecant squared reflector	,,
S 1016	–	23 cm L-band transportable surveillance aerial. 5.48X 1.8 m cosecant squared reflector.	,,
S 1017	–	5.5 cm C-band transportable height finder aerial. 4.27 × 1.3 m double curvature, point fed reflector.	,,
Transmitter/receivers:			
S 2010		1 MW 10 cm S-band transmitter/receiver. Tunable within band.	,,
S 2011	–	2 MW 23 cm L-band transmitter/receiver. Tunable within band.	,,
S 2012	–	2.5 MW 10 cm S-band transmitter/receiver.	,,
S 2013		1 MW 5.5 cm C-band transmitter/receiver.	,,
S 613	**2479.153**	C band mobile/transportable heightfinding radar. 1 MW	,,
S631/S647	**2458.153**	S- and L-band back-to-back 2-plus MW surveillance radars.	,,
S 650	–	50 cm L band surveillance radar. 16 × 3.7 m reflector. 600 kW. 150 160 nm range	,,
S 654	**2459.153**	23 cm L band surveillance radar 11 × 4.6 m reflector. 2 MW, 90 nm range.	,,

Designation	Entry No.	Remarks	Manufacturers
S669	**2462.153**	S-band 2.25 MW 150 nm height-finding radar.	Marconi
S670	–	50 cm L-band surveillance radar 20.7 × 3.7 m reflector. 500 kW. 180 nm range.	"
S841/S842	**2464.153**	"800-series" mobile coastal defence X-band surveillance radars. Type S842 has tunable transmitter.	"
ST850	**2466.153**	"800-series" X-band tracking radar with TV for use with Tigercat AA missile system (**2465.131**).	"
SLA-3C	–	Precision approach radar.	STC
Scorpion (Type 87)	**2428.153**	Target tracking and illuminating radar for Bloodhound II surface-to-air missile system.	Marconi
Shrimp	**2482.153**	J-band battlefield surveillance radar.	Marconi/RRE
Stingray (Type 83)	–	Target acquisition, tracking and illuminating mobile radar for use with Bloodhound I and Thunderbird surface-to-air missiles. Used by UK, Swedish and Australian Forces.	Marconi
Type 13	–	Height finder.	–
Type 80	–	Long-range surveillance radar. Range 200 nm plus. Probably L-band.	Plessey, formerly Decca
Type 82	–	'Volumetric', stacked beam 3-D surveillance radar. Used for tactical control of Bloodhound I surface-to-air missiles.	Marconi, formerly AEI
Type 83	–	Mobile target tracking and illuminating radar for Bloodhound I.	"
Type 84	**2457.153**	High-power L-band surveillance radar.	"
Type 85	**2457.153**	High power stacked beam 3-D surveillance radar similar to AEI 4502. Used in Linesman/Mediator UK air defence/ATC system.	"
Type 86 (Firelight)	**2413.153**	Mobile CW target illuminating radar for Bloodhound II surface-to-air missiles.	Ferranti
Type 87 (Scorpion)	**2428.153**	Target tracking and illuminating radar for Bloodhound II. CW.	Marconi, formerly AEI
Type 200	**1142.153**	S-band height finder radar. 2.5 MW. 10.6 × 2.4 m aerial.	Decca
Type 430	**2420.153**	Airfield radar.	Plessey
ZB 298	**2490.153**	Man-portable non-coherent X-band pulsed doppler battlefield surveillance infantry radar for location of men and vehicles out to 10 km.	Marconi
4502	–	Stacked beam 3-D long range surveillance radar. 10 cm S-band. 12 lobes. Elliptical parabolic reflector. 13.7 × 6.6 m. 4 MW.	Marconi, formerly AEI
40 Series	**2478.153**	Range of 3-D radars developed from 4502.	"
USA			
ADAR	**2506.153**	Advanced design array radar. Electronically steered beam for tracking multiple targets.	Hughes
AN/-	–	US joint service nomenclature for many of the systems listed below uses the AN/- prefix. For convenience this prefix has been omitted. Thus AN/CPN-6 is listed simply as CPN-6.	–
ASR-7	–	S-band surveillance radar giving 100 km range on 3 sq. metre target. All digital signal processor. Frequency diversity and 1 MW transmitter available.	Texas Instruments
AWCS	**2533.181**	Air weapons control system. Code number 412L, otherwise known as QUICKDRAW. Mobile control and warning system.	General Electric
BMEWS	**2525.181**	Ballistic missile early warning system to give warning of ICBM/IRBM attacks on USA/UK. Sites at Thule, Greenland (equipped with FPS-49 and FPS-50); Clear, Alaksa (equipped with FPS-50 and FPS-92); and Fylingdales Moor, UK (equipped with FPS-49) System code 474L.	General Electric, RCA and Western Electric
CPN-18	–	ATC surveillance radar.	Bendix
CPS-5	–	ATC radar.	"
DEW	**2567.181**	Distant early warning system. Code number 413L.	Western Electric
EMS	–	Emergency mission support system. Air transportable, system designed to set up ATC, communications and varied facilities to support operations in areas where such facilities are not available. Code number 842L. Also known as Project FOUR WHEELS. Radars used TPN-14 TPS-35.	Chu Associates, ITT Gilfillan
FAAR	**1526.153**	Forward area alerting radar. Detects very low-flying high-speed aircraft; checks IFF identification; and relays data by VHF link to anti-aircraft sites equipped with Chaparal Redeye or Vulcan. Mobile system with high-mast aerial.	Sanders Associates
FPN-16	–	GCA-radar.	ITT Gilfillan
FPN-34	–	Long-range L-band ATC radar.	Bendix
FPN-36	–	QUAD radar. Tactical GCA system.	ITT Gilfillan

Designation	Entry No.	Remarks	Manufacturers
FPN-47		S-band medium-range ATC radar (ASR-5).	Texas Instruments
FPN-52	–	GCA PAR system based on FPN-16.	ITT Gilfillan
FPQ-6	2508.153 2846.153	MIPIR (Missile Precision Instrumentation Radar) C-band monopulse missile tracking radar. Transportable version is TPQ-18.	RCA
FPS 3, 3A		L band long range radars	Bendix
FPS-5		Long-range radar.	Hazeltine
FPS-6, 6A, 6B	2492.153	S-band long-range heightfinding radars. Superseded by FPS-89. Mobile version is MPS-14.	General Electric
FPS-7, 7A, 7B, 7C, 7D	2526.153	10 MW 3-D search/GCI radar. Cosecant elevation pattern with 7 stacked beams. Search range 500 km. Elevation cover 45 km. MTI. Frequency diversity. Part of SAGE system.	.. ..
FPS-8	2493.153	L-band long-range search radar with MTI. Superseded by FPS-88. Mobile version is MPS-11.	.. ..
FPS-10	–	See FPS-27.	
FPS-14	2527.153	S-band 400 kW medium-range (110 km) search radar used in SAGE system.	Bendix
FPS-16	–	C-band monopulse missile-tracking combined primary/secondary radar. Transportable version is MPS-25.	RCA
FPS-17	–	Long-range early warning radar for missile detection.	General Electric
FPS-18	2527.153	1.2 MW S-band search radar used in SAGE.	Bendix
FPS-19	–	DEW LINE radar.	Raytheon
FPS-20, 20A, 20B	2528.153	Long-range, dual-channel search and GCI radar with MTI, 2 MW, L-band; range 350 km. FPS-20 is used in SAGE, FPS-20A in AWCS and FPS-20B in both. GPS-4 is mobile version.	Bendix
FPS-24	2494.153	Long-range search radar, used in SAGE.	General Electric
FPS-26	–	Long-range heightfinder for SAGE. Possible application as early warning radar for SLBM after modification.	Avco
FPS-27	–	Replacement for FPS-10. Search radar for SAGE.	Westinghouse
FPS-28	–	Search radar for SAGE.	Raytheon
FPS-30	–	Long-range duplex search radar	Bendix
FPS-35	–	Long-range SAGE or ATC surveillance radar.	Sperry
FPS-36	2723.131	Nike-Hercules radar. Others are FPS-56, FPS-61, FPS-69-71, FPS-75-76.	Raytheon
FPS-37	2499.153 2723.131	High-power acquisition radar for Nike-Hercules.	General Electric
FPS-46	–	Long-range electronically steerable array radar (ESAR). See FPS-85.	Bendix
FPS-49	2509.153	Very long-range tracking radar for missile early warning (BMEWS) and satellite tracking (SPADATS).	RCA
FPS-50	2511.153	BMEWS surveillance radar.	General Electric
FPS-56	2723.131	See FPS-36.	
FPS-59	–	Tracking radar.	.. ..
FPS-60	–	SAGE heightfinding radar.	–
FPS-61	2723.131	See FPS-36.	
FPS-63	–	DEW line gap-filler, being modified to FPS-74.	Budd
FPS-64, 65, 66, 67, 67A	–	Search radars for SAGE. FPS-67A is also used in AWCS.	Bendix
FPS-69, 70, 71	2723.131	See FPS-36.	
FPS-74	–	See FPS-63.	
FPS-75, 76	2723.131	See FPS-36	
FPS-78, 79, 80	–	Tracking radars. FPS-79 and FPS-80 are part of SPACETRACK.	General Electric
FPS-85	2546.153	L-band 3-D phase array radar for satellite detection, identification and tracking. Based on FPS-46 and part of SPADATS/SPACETRACK.	Bendix
FPS-88, 89	2512.153 2513.153	Modernised versions of FPS-6, FPS-8.	General Electric
FPS-92	2509.153	BMEWS scanner/tracker radar. Improved version of FPS-49.	RCA
FPS-95	–	Tracking radar.	..
FPS 100	–	Modernised FPS-20.	Bendix
FPS 105(V)	2847.153	C band Range instrumentation radar.	RCA
FPT-5, 7	–	Long-range surveillance and tracking radar transmitters.	Ling Temco Vought
FSS-7	2538.153	Radar surveillance central for SLBM system.	Avco Cincinatti
GPN-6		S-band ATC surveillance radar 150 km range.	LFE
GPS-4		See FPS 20.	
GPS-57A		Surveillance radar.	Bendix
HIPAR	2499.153	High-power acquisition radar for Nike Hercules. See FPS-37.	General Electric

Designation	Entry No.	Remarks	Manufacturers
MPN-1, 11, 13, 14, 15	-	Mobile GCA radars.	ITT Gilfillan
MPQ-4	**2497.153**	Mortar-locating radar.	General Electric
MPQ-10A	**2500.153**	S-band Mortar locating radar	-
MPQ-12, 18	-	S-band 300 km range missile tracking radars.	Reeves
MPQ-25	-	Trailer-mounted radar for Corporal missile system.	ITT Gilfillan
MPQ-29	-	Drone control radar.	Sperry
MPQ-31	-	S-band 4,000 km range 3-D tracking and guidance radar.	Canoga
MPQ-32	-	Field detection and tracking radar.	Sylvania
MPQ-33	**2640.131**	CW illuminator for Hawk missile system. Also MPQ-39.	Raytheon
MPQ-34	**2640.131**	CW target acquisition radar for Hawk.	"
MPQ-25	**2640.131**	Pulse target acquisition radar for Hawk.	"
MPQ-37	**2640.131**	Range radar for Hawk.	"
MPQ-39	**2640.131**	See MPQ-33.	
MPQ-43	**2723.131**	HIPAR mobile high-power acquisition radar for Nike-Hercules.	General Electric
MPQ-49	**1526.153**	See FAAR.	
MPQ-501	-	Mortar locating radar. Used in Canada.	Raytheon
MPS-3, 4	-	Height-finding radars.	"
MPS-4, 4A, 4C	-	Height-finding radars.	Hazeltine
MPS-7	-	Long-range L-band search radar.	Bendix
MPS-9	-	S-band drone and missile control radar. Range 300 km.	Reeves
MPS-11, 11A	**2493.153** **2495.153**	See FPS-8.	
MPS-14	**2942.153** **2496.153**	See FPS-6.	
MPS-16	-	Nodding height-finder for AWCS C-band; 300 km range.	Crosley
MPS-21	-	3-D search radar. See also TPS-34.	Sperry
MPS-23	-	FRESCAN-elevation frequency scanning 3-D search radar.	Hughes
MPS-24	-	See TPS-28.	
MPS-25	-	See FPS-16.	
MPS-30	-	Mobile surveillance radar; trailer-mounted TPS-25.	Hazeltine, FMC
MPS-36	**2514.153**	Missile tracking radar.	"
MSQ-35	-	300 km range X-band tracking radar.	Reeves
MSR	**2791.153** **2798.131**	Missile site radar for Safeguard ABM system. Phased array type. Prototype at Kwajalein test area.	Raytheon
MSW-1	**2723.131**	Acquisition radar for Nike Ajax and Nike-Hercules systems.	-
MTTS	-	Mobile target tracking system for drone tracking.	Epsco
PAR	**2790.153** **2798.131**	Perimeter Acquisition Radar for Safeguard ABM system. Under development.	-
PPS-3	-	Portable surveillance radar.	Sperry
PPS-4	-	Silent Sentry portable forward area surveillance radar.	"
PPS-5	**2540.153**	Transistorised versions of PPS-4.	AIL
PPS-6	-	Portable battlefield surveillance radar.	General Instrument Corp.
PPS-9	-	Portable battlefield surveillance radar.	RCA
PPS-55	-	Portable forward area surveillance radar.	-
RCA 2019 M2	**2783.153**	X-band hand-held tactical radar. System weight 4 kg; T / R weight 1 kg; range 500 metres on 0.5 sq metre target. Resolution 25 metres. Aural output.	RCA
RCA 4019 M2	**2783.153**	X-band hand-held tactical radar. System weight 6.35 kg including accessories; T / R weight 3.6 kg; range 1,500 metres, resolution 25 metres. Aural and / or visual output.	"
SAGE	**2803.181**	Semi-automatic ground environment system for detecting, identifying and tracking aircraft threats to North America and directing weapon interception. Code number 412L.	Western Electric, System Development Corp., Burroughs
SAM-D	**2800.131**	Phased array radar for SAM-D guided missile system now under development.	Raytheon
Site Defence Radar	**2792.153**	Phased-array radar similar in purpose to the MSR but smaller	General Electric
SLBM	-	Sea-launched ballistic missile detection system. Purpose is to detect and identify missile attack on North America and warn NORAD and SAC. Code number 474N.	Avco
Spacetrack	**2825.181**	USAF worldwide detection, identification, tracking and reporting system. Records data on all space objects. Spacetrack is US section of NORAD SPADATS system. Spacetrack code number 496L.	General Electric, Philco-Ford, RCA, Bendix, System Development Corp.
SPADATS	**2825.181**	NORAD space object detection and recording system of which SPACETRACK is a large part.	-
TPN-12	-	ATC GCA.	LFE, Bendix
TPN-14	-	Transportable GCA for EMS.	ITT Gilfillan, RCA

Designation	Entry No.	Remarks	Manufacturers
TPN-17	–	Air transportable landing control central.	IFF
TPN-19	**2537.153**	All-weather transportable tactical ATC radar with S band terminal area surveillance and X-band, dual-mode (search and track) 6 target. PAR. Cassegrain feed aerial.	Raytheon
TPQ-10	**2498.153**	Transportable radar course direction central for control of close support bombing operations.	General Electric
TPQ-14, 15, 16	**2640.131**	Transportable versions of MPQ 33, 34, 35	Raytheon
TPQ-18	**2846.153**	Transportable version of FPQ 6.	RCA
TPQ-19	**2640.131**	Transportable version of MPQ-39.	Raytheon
TPQ-28	–	Omnidirectional mortar-locating radar.	ITT Gilfillan
TPQ-32	**1526.153**	See FAAR.	
TPQ-36	**2848.153**	Electronically-scanning mortar locating radar	Hughes
TPQ-39	**2849.153**	C-band digital instrumentation radar	RCA
TPS-10D	–	X-band height-finder. 220 km range.	..
TPS-21	**2529.153**	Portable X-band battlefield surveillance and reconnaissance radar. Range 9 km. Also TPS-33.	Admiral
TPS-22	–	Tactical early warning radar for AWCS system. Complemented by TPS-27.	Westinghouse
TPS-25, 25A	–	Battlefield surveillance radars.	Hazeltine
TPS-27	*2515.153*	3-D tactical radar for AWCS. Complemented by TPS-22.	Westinghouse
TPS-32	**2516.153**	Automatic 3-D tactical long-range surveillance radar.	ITT
TPS-33	**2515.153**	See TPS-21.	
TPS-34	**2530.153**	3-D (V-beam) tactical long-range early warning radar.	Sperry
TPS-35	–	L-band 500 km surveillance radar for EMS. Modernised version of UPS-1.	RCA
TPS-37	–	Transportable version of MPS-16.	Avco
TPS-43	**2517.153**	Transportable 3-D tactical tracking radar measuring range, altitude and azimuth plus IFF identification ECM-resistant for forward area operation.	Westinghouse
TPS-44	**2518.153**	Transportable tactical surveillance radar.	Cardion Elec.
TPS-48	**2519.153**	Transportable 3-D tactical radar.	Westinghouse
TPS-61	**2520.153**	Tactical surveillance radar.	..
TPX-19, 20, 22	–	Mark X IFF interrogator-responsors.	Raytheon
TPX-42	–	ATC surveillance radar.	Whitaker
TSW-5	–	Tactical approach radar.	RCA
TTQ-28	–	Mortar-locating radar.	ITT Gilfillan
UPS-1	–	Gap-filler radar for AWCS. See also TPS-35.	RCA, Bendix
UPW-1	–	Drone tracking and control radar	Ford, Sperry
UPX-6	–	Mark X IFF interrogator-responsor.	Raytheon
VPS-2, 5	**2547.153** **2844.153** **2850.131**	Vulcan air defence system radar.	Lockheed
U.S.S.R. Military Radars	**2860.153** to **2895.153**	Little information is available concerning these radars. The reader is referred to the entries in the USSR subsection of the Ground Radar section.	–

1332.254
NAVAL RADAR

(Additional details of those radars for which an Entry Number is given will be found in the Naval Radar Section of Section Three of this volume.)

DENMARK			
–	**1575.253**	X-band navigation radar.	Terma
FRANCE			
ELI 4	**1688.253**	Naval IFF interrogator.	LMT
Triton	**1062.253**	C-band 5 cm air and surface surveillance radar. Used with Castor or Pollux in Vega Series. 200 kW.	Thomson-CSF
Castor	**1063.253**	X-band target tracking radar used in some versions of Vega Series fire control systems. 20 kW.	..
Pollux	**1064.253**	X-band target tracking radar used in some versions of Vega Series fire control systems. 200 kW.	..
Pollux II	**1686.253**	Improved version of Pollux.	..

Designation	Entry No.	Remarks	Manufacturers
Calypso II	1240.453	TH.D 1030. X-band submarine radar for surveillance and navigation. 70 kW.	Thomson-CSF
Jupiter	1236.253	TH.D 1077 Long range-surveillance radar. L-band. 2 MW	..
Ramses	1239.253	TH.D 1022. Short-range navigational and surveillance radar. X-band. 35 kW. 60 nm range.	..
Lynx	1238.153	TH.D 1051. Dual radar coastal mine-watching system	..
Saturne	1237.253	TH.D 1041 S-band medium-range air and surface surveillance radar. 1 MW peak.	..
Sea Tiger	1687.253	Surveillance radar.	..
DRBC 32	1894.253	Series of gun fire control radars. A, B, C, D and E versions fitted in verious classes of French ships	–
DBRI 10	1593.253	S-band 3-D air surveillance radar. Robinson scanner.	Thomson-CSF
DRBV 13	1893.253	S-band pulse-doppler air search radar. Multi-mode operation.	–
DRBV 20	1892.253	Long-range metric air surveillance radar. A and C versions in service	–
DRBV 22	1891.253	Search radar. A, C & D versions in service on French and foreign vessels.	–
DRBV 23	1594.253	L-band long-range air search radar.	Thomson-CSF
DRBR 51	1177.231 1890.253	X-band tracker and target illuminator. Three scanners. Part of Masurca surface-to-air missile system.	..
DRBI 23	1177.231 1889.253	Three-dimensional surveillance and target designator radar. L-band 23-cm. Stacked-beam system.	..
INTERNATIONAL			
Ex 77 Mod 0	1578.253	Director radar group for NATO Seasparrow.	NATO Consortium
ITALY			
Argus 5000	–	High-power ship's early warning radar. 5 MW peak power.	Selenia
Orion 250	–	X-band fire control radar. Used in NA9 system. Conical scan. 200 kW.	..
Orion RTN-10X	1368.253	Fire control radar. Used by RN.	..
Orion RTN-16X	1367.253	X-band monopulse fire control radar.	..
RAN-2C	1700.253	C-band dual purpose air and surface surveillance radar.	..
RAN-3L	1364.253	L-band early warning radar. Digital signal processing.	..
RAN-7S	1527.253	10 cm air and surface search radar	..
RAN-10S	1699.253	S-band dual purpose air/sea search radar.	..
RAN-11L/X	1365.253	L- and X-band system for air warning and weapons control on small ships.	..
RAN-13X	1701.253	X-band search radar.	..
RAN-14X	1366.253	X-band low altitude and surface search radar.	
Sea Hunter	1704.253	Search radar.	Contraves
SEA Hunter	1705.253	Tracker radar.	..
SPQ-2D	1703.253	X-band search radar	SMA
NETHERLANDS			
LW.02	1256.253	Long-range L-band air surveillance. 23-cm. 500 kW peak power.	Signaal
–	1257.253	S-band height-finder. Probably naval version of SGR.109.	..
–	1258.253	C- or X-band surface warning radar.	..
M20	1590.253	Small vessel fire control system.	
M40	1591.253	Fire control system.	..
DA.05	1554.253	S-band medium-range air and surface surveillance radar.	..
LW.04	1553.253	L-band long-range air search radar.	..
ZW.06	1555.253	X-band surface search and navigation radar.	..
3D MTTR	1589.253	Three-dimensional multi-target search and tracking radar.	..
SWEDEN			
SUBFAR	1545.453	X-band submarine radar.	Philips
9GR 600	1546.253	X-band. Frequency-agile 200 kW.	..
9LV 200	1547.253	Ku-band monopulse frequency-agile tracking radar	..
UNITED KINGDOM			
AWS-1	1139.253	Naval version of land-based AR-1.	Plessey
AWS-2	1751.253	Improved version of AWS-1.	..
Cossor IFF	1571.253	Naval IFF Mk 10 (SIF) 800 Series, 825, 825M	Cossor
MRS*/GWS 22	1563.253	Seacat and gun fire control radar.	Sperry
PTR 461	1896.253	Shipborne IFF transponder.	..
S604 HN	1895.253	Search radar.	Marconi
S810	1754.253	Surveillance radar	..

Designation	Entry No.	Remarks	Manufacturers
SNG 20	–	Fire control system.	Marconi
SNW 10	–	Metric wavelength early warning radar.	,,
SNW-12	–	Early warning radar. 150 cm. 450 kW. 4.28 × 2.14 m scanner.	,,
SNW-20	–	Early warning radar.	–
ST801	1508.253	Lightweight fire control radar.	Marconi
TM626	–	Small navigational radar.	Decca
Type 262	–	Short-range anti-aircraft fire control radar.	EMI
Type 277	–	Nodding height-finder radar.	–
Type 293	–	Nodding height-finder radar.	–
Type 901	1752.253	Seaslug missile target tracking and guidance radar.	–
Type 909	1559.253	Target tracker and illuminating radar for Sea Dart missile system (GWS 30). 8 ft Cassegrain aerial.	Marconi
Type 910	1562.253	Tracking radar for Seawolf missile.	,,
Type 912	1558.253	RN designation of Selenia RTN-10X	–
Type 944	–	IFF.	–
Type 965	1560.253	Primary search radar.	–
Type 967	1561.253	Compact air surveillance radar. Combined in Sea Wolf system	Marconi
Type 968	1561.253	Surface surveillance radar.	,,
Type 975	1253.253	Lightweight X-band high definition surface warning radar. 50 kW.	Kelvin Hughes
Type 975ZW	1253.253	Mine-hunting version of Type 975. True motion display plus sonar contract working.	,, ,,
Type 978	1254.253	Probably X-band, 3 cm navigational radar. Double-cheese scanner. Successor to Type 974.	Decca
Type 979	–	Similar to 978 but with additional B-scope display.	–
Type 982	–	Aircraft direction radar.	–
Type 983	–	Nodding height-finder radar.	–
Type 984	1041.253	Three-dimensional air surveillance long-range radar.	Marconi
Type 992	1255.253	Long-range surveillance radar. Obsolescent.	EMI
Type 992Q	1753.253	Solid-state general purpose radar.	Marconi
Type 993	–	S-band search radar.	–
Type 1006	1394.253	Successor to Type 975. Solid-state. 305 mm display. Max range 64 nm.	Kelvin Hughes
USA			
RTN-10	1245.253	X-band fire control radar for Sea Sparrow III.	Raytheon.
SPA-72	–	Three-dimensional fixed planar array surveillance radar.	Hughes
SPG-49	1749.253	Guidance radar for Talos and Terrier surface-to-air missiles. Used with SPW-2.	Sperry
SPG-51	1247.253	Tartar missile guidance radar. X-band. Part of Mk 73 FCS.	Raytheon
SPG-55	1748.253	Terrier missile fire control radar. C-band.	Sperry
SPG-56	1750.253	Talos fire control radar. C-band.	,,
SPG-59	–	Typhon missile radar. Performs all functions. Luneberg lens.	Westinghouse
SPQ-5	–	Long-range tracking and guidance radar for Terrier. C-band.	Sperry
SPQ-9	–	Track-while-scan surface fire control radar used in Mk 86 FCS. Housed in 300 cm radome.	–
SPQ-55	–	Terrier tracking and guidance radar.	Sperry
SPQ-60	–	Pulse doppler air target tracking radar used in Mk 86 FCS.	–
SPS-3	–	Surveillance radar.	Sylvania
SPS-4	–	Air and surface surveillance radar.	Raytheon
SPS-5	–	Surface surveillance radar.	,,
SPS-6	1744.253	Search radar.	RCA
SPS-10	1564.253	C-band surface search radar.	Sylvania
SPS-12	1566.253	L-band medium / long-range surveillance radar.	RCA
SPS-17	–	Long-range surveillance radar.	General Electric
SPS-23	–	Height-finder.	,, ,,
SPS-29	–	Air surveillance radar for guided missile destroyers.	Westinghouse
SPS-30	1745.253	Long range height-finder.	General Electric
SPS-32	1250.253	Three-dimensional fixed planar array electronic scanning air and surface search radar.	Hughes Hughes
SPS-33	1251.253	Three-dimensional fixed planar array electronic scanning target tracking radar.	,,
SPS-34	–	Shipborne version of FPS-7 stacked-beam three-dimensional radar.	General Electric

Designation	Entry No.	Remarks	Manufacturers
SPS-37	1565.253	Air search radar.	Westinghouse
SPS-39	1249.253	'Frescan' hybrid three-dimensional air target search radar.	Hughes
SPS-40	1746.253	Air search radar. 'A' version has IFF.	Lockheed
SPS-42	–	Hybrid electronic scanning three-dimensional radar.	Hughes
SPS-43	1747.253	Air search radar.	Westinghouse
SPS-48	1252.253	S-band long-range frequency scanned search and target acquisition radar. Similar to SPS-52.	Gilfillan
SPS-52	1248.253	Rotating planar (hybrid) three-dimensional surveillance radar. Probably S-band.	Gilfillan
SPS-55	1697.253	X-band surface radar radar.	Raytheon
SPS-58	1359.253	L-band air search radar.	Westinghouse
SPW-2	–	Talos guidance radar. Used with SPG-49.	Sperry
SPY-1	1570.253	Multi-function array radar for Aegis system. Electronic scan.	RCA / Raytheon
USSR			
Band Stand	–	Search radar group on Nanuchka missile corvettes. Housed in large radome. Used with SSN-9 surface-to-surface missile.	–
Big Net	1608.253	Long-range air surveillance.	–
Boat Sail	1507.253	Air search radar for submarine pickets.	–
Cylinder Head	1596.253	Gun fire control group on optical director	–
Cross Bird	–	Obsolescent early warning radar.	–
Dead Duck	–	IFF system.	–
Don	–	X-band navigation radar.	–
Drum Tilt	–	X-band fire control. Enclosed scanner.	–
Egg Cup	–	Splash spotting radar mounted on gun turrets.	–
Eye Bowl	–	Missile guidance radars on Krivak class destroyers.	–
Fan Song E	–	Missile control and tracker group for Guideline SAM on Dzerzhinski.	–
Flat Span	1321.353	Long-range air search radar.	–
Hair Net	1607.253	General-purpose search radar.	–
Half Bow	–	X-band torpedo target designation radar.	–
Hawk Screech	1325.253	Gun fire control radar.	–
Headlight	1328.253	Missile fire control group.	–
Head Net A	1318.253	Long-range air surveillance radar.	–
Head Net B	1319.253	Back-to-back installation of two Head Net A for low and high cover.	–
Head Net C	1320.253	Dual V-beam high three-dimensional installation of Head Net A	–
High Lune	1606.253	Nodding height finder.	–
High Pole	–	IFF antenna.	–
High Seive	–	Surface search radar.	–
Horn Spoon	–	Navigation radar.	–
Knife Rest B	–	Long wavelength early warning radar.	–
Long Bow	–	X-band target designation radar for torpedoes or guns.	–
Low Seive	–	Surface search radar.	–
Muff Cob	1611.253	Gun fire director radar.	–
Neptune	–	Navigation radar.	–
Owl Screech	1325.253	Gun fire control radar.	–
Peel Group	1323.253	Missile fire control group for Goa.	–
Plinth Net	1609.253	Medium-range general purpose search radar.	–
Pop Group	1897.253	Fire control radar group for SAN-4 missile system.	–
Post Lamp	–	X-band target designation radar.	–
Pot Drum	1613.253	Short-range surface search radar.	–
Pot Head	1613.253	Short-range surface search radar.	–
Scoop Pair	1324.253	Twin radar group for SSM.	–
Sea Gull	–	P-band long-range air search radar.	–
Skin Head	1614.253	Surface target detection radar for torpedo boats.	–
Ski Pole	–	IFF antenna. On Osa missile boats.	–
Slim Net	1322.253	High definition surface target radar.	–
Snoop Plate	–	Submarine surveillance radar.	–
Snoop Slab	–	Submarine surveillance radar.	–
Snoop Tray	–	Submarine surveillance radar.	–
Square Head	1595.253	IFF interrogator array.	–
Square Tie	1329.353	General purpose search radar.	–
Strut Curve	1331.253	Lightweight search radar.	–
Sun Visor	1326.253	Optical director-mounted gun fire control radar.	–
Top Bow	–	Target acquisition radar for naval guns.	–

Designation	Entry No.	Remarks	Manufacturers
Top Sail	1327.253	Long-range three-dimensional air surveillance radar.	–
Top Trough	1610.253	High-definition surface target radar.	–
Witch Five	–	IFF system.	–

1194.354

AIRBORNE RADAR

(More detailed information for those radars having an Entry Number will be found in Section Three, Airborne Radar.)

FRANCE

Designation	Entry No.	Remarks	Manufacturers
Agave	1672.353	X-band helicopter radar.	Thomson-CSF/EMD
Aida I	–	Boresight ranging radar. Fitted French Navy Etendard IVM. X-band.	Electronique Marcel Dassault
Aida II	1211.353	Improved version of Aida I.	.. .. ..
Antilope	–	All weather strike radar. Ku-band. 4-lobe Cassegrain aerial. Terrain following, mapping, ground attack.	.. .. ..
Antilope II	–	Simplified version of Antilope for light aircraft.	.. .. ..
Cobra	–	Low-level strike and terrain following Experimental system. Some features used in Cyrano III.	Thomson-CSF
Cyrano I bis (RA 536)	1050.353	Monopulse fire control radar. Used in Mirage IIIC. X-band.	..
Cyrano II (RA 537)	1051.353	Monopulse fire control radar. Cassegrain aerial. Used in Mirage IIIE. X-band.	..
Cyrano III (RA 538)	1052.353	There are nine models in this range, which is also known as the Series 30, providing a number of options up to full multi-role capability including air and ground attack and terrain following.	..
Cyrano IV	1396.353	Attack radar, air-air/air-ground Used in Murol system	..
DRAA-2B	–	ASV and navigation radar for Atlantic ASW aircraft.	..
DRAC-25	–	X-band fire control radar used in French Vatour fighters.	..
Madrague	–	Pulse doppler early warning radar.	Electronique Marcel Dassault
NR-A1-3-A	1674.353	Airborne IFF interrogator.	LMT
ORB-31	1793.353	Helicopter and light aircraft X-band ASV, navigation and met radar	Omera-Segid
Oryx	1351.353	Ku-band terrain following and attack radar.	Electronique Marcel Dassault
Rafal	–	X-band coherent sideways looking radar Under development.	Thomson-CSF
RH 370	1395.353	X-band helicopter ASV radar.	..
Saiga	1352.353	Helicopter terrain avoidance radar. Ka-band.	Electronique Marcel Dassault
Saiga II	–	Simplified, lightweight version of Saiga	.. .. ..

INTERNATIONAL

Designation	Entry No.	Remarks	Manufacturers
APS-503	1784.353	Helicopter ASV, search, and navigation radar X-band.	AIL/Litton Canada

SWEDEN

Designation	Entry No.	Remarks	Manufacturers
DAX-100/200 Series	1741.353	Fire control radars.	L.M. Ericsson
PS-03/A	1208.353	X-band AI radar, conical scan Cassegrain aerial. Used in J35B and J35D Swedish Air Force Drakens.	..
PS-01/A	1209.353	Improved version of PS-03/A. Used in J35F Draken.	..
PS-011/A	1209.353	Version of PS-01/A used with S71 N IR search and track set in J35F.	..
PS-37/A	1210.353	X-band. Monopulse. Modes include search, ground ranging, mapping and obstacle avoidance.	..

L M. Ericsson has also produced three models of AI radars for the J32 Lansen aircraft. Airborne radars for export carry designations running LAX-100, LAX-200 etc. X-band and Ku-band sets are produced.

UNITED KINGDOM

Designation	Entry No.	Remarks	Manufacturers
UK AIR	1785.353	UK Airborne Interception Radar. Development for RAF interceptor version of MRCA.	Marconi-Elliott
Airpass I	1031.353	X-band AI radar. Search, tracking and ranging. Used in RAF Lightning interceptors. Produced in four versions. RAF designation AI23.	Ferranti
Airpass II	1033.353	Development of Airpass I with added air-to-ground modes.	..
Airpass III	1032.353	Surface strike radar for Buccaneer aircraft. Multi-mode X-band Cassegrain aerial.	..
AI-18	–	X-band fire control radar for RN Sea Vixen aircraft	GEC (UK)
ARI 5955/5954	1027.353	X-band system for use in ASW helicopters. Enables helicopter to be used as tactical control centre for ASW operation. Secondary radar capability. Fitted RN Sea King's	Ekco Electronics

Designation	Entry No.	Remarks	Manufacturers
ASV-21D	-	Air-to-Surface vessel search radar used in HS 801 Nimrod maritime aircraft.	EMI Electronics
Cossor IFF	**1572.353**	Airborne IFF transponders.	Cossor
E290M	**1028.353**	Combined weather and tactical radar. RCAF.	
LRR	**1035.353**	Lightweight ranging radar. Air and ground ranging. Terrain warning.	Ferranti
P111	-	Coherent pulse multi-mode strike, AI and terrain following radar. Developed for classified project.	Marconi-Elliott
P 391	**1023.353**	Q-band sideways looking recce radar. Used in UK Phantom recce pod. Licensed to Electronique Marcel Dassault. Originally developed for TSR-2 strike aircraft. This company has also produced an X-band SLR which was also intended for the TSR-2.	EMI Electronics
SATF	**1216.353**	Strike and Terrain Following Radar. X-band Multi-mode.	Ferranti
Seaspray	**1342.353**	X-band helicopter ASV radar.	"
Searchwater	**1740.353**	ASV and maritimt eradar.	EMI
AEW	**1740.353**	UK development for airborne Early Warning radar. Announced March 1969, suspended August 1970.	"
USA			
APD-7	-	Sideways looking radar. Used RA-5C.	Westinghouse
APD-8	-	Sideways looking radar for RF-111A.	"
APG-22	-	CW ranging radar. USN.	Raytheon
APG-31	-	Ranging radar. USAF	"
APG-43	-	CW AI radar.	"
APG-59	-	Fire control radar, USN, USAF.	Westinghouse
APG-63	**1765.353**	Multi-mode fire control radar for F-15.	Hughes
APN-59	-	Search and mapping radar.	Sperry
APN-170	**1037.353**	Terrain following radar.	General Dynamics
APQ-55	-	Surveillance mapping radar. US Army.	
APQ-56	-	Sideways looking radar for RB-47E. USAF.	Westinghouse
APQ-67	-	AI radar. USAF.	Raytheon
APQ-72	-	X-band AI radar. Target illuminator for Sparrow III missile. Fitted F-4B.	Westinghouse
APQ-83	-	Fire control radar for Sidewinder missile.	Magnavox.
APQ-86	-	Sideways looking battlefield surveillance radar.	Texas Insts.
APQ-92	**1489.353**	Search radar used in USN A-6A aircraft.	Norden.
APQ-94	-	Fitted in F-8D aircraft.	Magnavox
APQ-97	**7014.353**	Sideways looking radar. US Army	Westinghouse
APQ-100	-	Fire control radar. Used in F-4C.	"
APQ-102A	-	Recce radar. Used by USAF, USMC RF-4Cs. Modified version fitted to some W. German RF-104Gs	Goodyear
APQ-109	-	Fire control radar for F-4D.	Westinghouse
APQ-110	-	Ku-band terrain following and avoidance radar for F-111A. Mounted below APQ-113.	Texas Insts.
APQ-112	**1490.353**	Tracking radar on A-6A. Used with APQ-92 search radar.	Norden
APQ-113	-	Fire control, ground ranging radar for F-111A.	General Electric (US)
APQ-114	-	Airfield radar.	Plessey
APQ-116	-	Fire control radar. Ground ranging, terrain following AI. Used on A-7A.	Texas Insts.
APQ-119	-	Modified version of APQ-113. Limited procurement for F-111 programme.	General Electric (US)
APQ-120	**1310.353**	AI Terrain following radar for F-4E.	Westinghouse
APQ-122	**1487.353**	Dual frequency X- and Ka-band radars for AWADS C-130 aircraft.	Texas Insts.
APQ-124	-	Doppler AI ranging radar. USN.	Magnavox
APQ-125	-	Doppler ranging order for F-8J.	"
APQ-126	-	Used in USN A-7 aircraft.	Texas Insts.
APQ-127	-	Forward looking radar.	Sperry
APQ-128	-	F-111 terrain following radar.	"
APQ-130	-	F-111D attack radar for Mk II avionics.	Autonetics
APQ-136	-	Nose radar for AC-119 Gunship.	Texas Insts.
APQ-137	**1401.353**	Ka-band MTI radar for detection of ground targets.	Emersion
APQ-139	**1486.353**	Ku-band AMTI terrain avoidance / mapping radar. Used in Tropic Moon 3 programme.	Texas Insts.
APQ-140	**1488.353**	Ku-band multi-mode electronic scan radar.	Raytheon
APQ-148	**1567.353**	Ku-band multi-mode radar for A-6E aircraft.	Norden
APQ-152	-	All-weather topographic mapping radar set.	Goodyear

Designation	Entry No.	Remarks	Manufacturers
APQ-153	1675.353	Fire control radar.	Emerson
APS-20	–	Airborne warly warning radar.	
APS-42	–	Navigation and search radar.	Bendix
APS-45	–	Airborne early warning radar.	–
APS-49	–	High scan-rate ASV	Hazeltine
APS-70	–	Airborne early warning radar.	General Electric (US)
APS-73	–	Series of SLARs developed for USAF and flown on C-97, B-58, and C-135 aircraft for test and evaluation of coherent, focused, synthetic aperture side-looking radars.	Goodyear
APS-81	–	Nose radar for B-52.	–
APS-85	–	Sideways looking MTI radar.	Motorola
APS-88A	–	ASV search radar for S-2E Tracker aircraft.	–
APS-91	–	Airborne early warning radar.	–
APS-94	1484.353	Long-range sideways looking radar. X-band.	Motorola
APS-96	1781.353	Airborne early warning radar for E-2A.	General Electric (US)
APS-111	1782.353	Early Warning radar for detection of aircraft targets against surface background. Used in E-2A.	,,
APS-113	–	Lightweight helicopter radar.	,,
APS-115	–	ASV search radar for P-3C ASW aircraft. X-band.	Texas Insts.
APS-116	1485.353	ASV search radar for S-3A ASW aircraft. X-band.	,,
APS-120	1783.353	Airborne Early Warning radar for E-2C aircraft.	Goodyear
APX-83	1569.353	Airborne IFF interrogator for E-2C aircraft.	AIL
ASG-14	–	Fire control radar for nuclear armed F-104A.	Texas Insts.
ASG-15	–	Rear fire control radar for B-52.	Arma
ASG-17	–	Fire control radar. Nuclear weapons.	–
ASG-18	–	Fire control radar for AIM-47A and AIM-54 missiles. Fitted FY-12A.	Hughes
ASG-19	–	Fire control radar for F-105D. (Thunderstick).	General Electric (US)
ASG-25	–	Fire control radar. Non-nuclear arms.	–
ASQ-112	–	MTI radar. USN.	Norden
AWG-9	1100.353	Missile fire control radar system. F-111B.	Hughes
AWG-10	–	AI-terrain avoidance, mapping radar for F-4J. High PRF pulse doppler.	Westinghouse
AWG-11	–	Version of AWG-10 for RN Phantoms.	,,
AWG-12	–	Version of AWG-10 for RAF Phantoms.	,,
UPD-4	1676.353	Side looking radar. Used on USAF RF-4Cs and Japanese RF-4E.	Goodyear
UPD-6	–	Reconnaissance radar for W. German Air Force.	,,
AWACS	1585.353	Airborne early warning radars.	Hughes/Westinghouse
Cobra	1706.353	Fire control radar.	Hughes
ESAIRA	1491.353	Experimental electronic scanned antenna.	,,
MERA	–	Molecular Electronics for Radar Applications. Experimental phase scanning system.	Texas Insts.
NASARR	1568.353	North American search and ranging radar for F-104.	Autonetic/NATO
F15	–	Monopulse. AI, mapping, terrain avoidance, ground ranging Also known as NASARR-North American Search and Ranging Radar.	Texas Insts.
R14	–	AI, mapping, ground ranging. F-105	Autonetics
R-21G	–	Solid-state version of F.15 Italian F-104.	,,
R-45	–	Ku-band. Micromin. Cassegrain aerial. Multi-mode. Believed experimental only.	,,
R-47	–	Ku-band. Micromin. Cassegrain aerial Terrain following.	,,
R-101	–	Ku-band. AI, ground ranging. Intended for Mk 2 F-111 avionics.	,,
RARF	–	Radome, Antenna, RF. Refractive lens phase scanning. Ku-band radar. Experimental.	Emerson
RARF	–	Radome, Antenna, RF. Reflecting len phase scanning. X-band and Ku-band versions under development.	Raytheon
WX Series	1673.353	Fire control radar series.	Westinghouse
USSR			
Look Two	1475.353	X-band bombing and navigation radar.	–
Pull Ball	1476.353	X-band search radar used in Bison aircraft.	–
Scan Fix	1477.353	AI radars for MiG-17 and 19 interceptors.	–
Short Horn	1478.353	Ku-band bombing and navigation radar.	–
Scan Odd	1479.353	X-band AI radar for MiG-19.	–
Scan Three	1480.353	X-band AI radar for Yak-25.	–

Designation	Entry No.	Remarks	Manufacturers
Skip Spin	1481.353	X-band AI radars used in Su-11 and Yak 28.	–
Spin Scan	1482.353	Series of AI radars used in Su-9 and MiG 21	

1521.454

SONAR EQUIPMENT

(More detailed information on those equipments having an Entry Number will be found in Section Three, Sonar and Underwater Equipment.)

Designation	Entry No.	Description	
AUSTRALIA			
Barra	**1791.453**	Project Barra. RAAF/RAN project to develop advanced sonobuoy and airborne detection system	Amalgamated Wireless
Mulloka	**1790.453**	Sonar project for RAN	–
CANADA			
HS-1000	**1636.453**	Lightweight search/attack sonar. Hull mounted and towed versions	Canadian Westinghouse
SQS-505	**1792.453**	Medium search/attack sonar	Canadian Westinghouse
SQS-507 (Helen)	**2038.243**	Lightweight variable-depth towed sonar	Canadian Westinghouse
FRANCE			
Diodon	**1725.253**	Surface vessel sonar	Thomson-CSF
DUBA-3A	*1157.253*	Surface vessel attack sonar	CIT-ALCATEL
DUBM-20A	**1357.253**	Active mine hunting sonar	Thomson-CSF
DUBM-40	**1358.253**	Active mine hunting sonar, towed	Thomson-CSF
DUBV-23D	**1159.253**	Active surface vessel search/attack sonar	CIT-ALCATEL
DUBV-24A	**1217.253**	Low-frequency panoramic search/attack sonar	CIT-ALCATEL
DUBV-43B	**1334.453**	Variable depth towed sonar. Active or passive. Used with DUBV-23	CIT-ALCATEL
DUBY-24C	**1355.453**	Active submarine sonar. Panoramic, sector or tracking modes	Thomson-CSF
DUUA-1	*1161.453*	Submarine sonar. A, B and C versions	CIT-ALCATEL
DUUA-2A	**1634.453**	Simultaneous search and attack sonar for modernised Daphne class submarines	CIT-ALCATEL
DUUX-2	**1162.453**	Passive submarine detection system	CIT-ALCATEL
DUAV-4	**1631.353**	HS-71 helicopter sonar	CIT-ALCATEL
DUAV-18	**1160.353**	Helicopter sonar. Superseded by HS.70	CIT-ALCATEL
HS.70	*1219.353*	Helicopter sonar	CIT-ALCATEL
Pascal	**1633.253**	Surveillance and tracking sonar for small and medium ships	CIT-ALCATEL
Piranha (DUBM 41)	**1726.453**	Submarine sonar	Thomson-CSF
Premo	*1218.253*	Panoramic search/attack sonar	CIT-ALCATEL
SQS-17A	*1158.253*	Panoramic sonar. Superseded by Premo	CIT-ALCATEL
TSM 2400	**1724.253**	Surface vessel sonar	Thomson-CSF
ITALY			
IP64-MD64	**1720.453**	Submarine sonars	USEA
UNITED KINGDOM			
MS26/27	**7002.253**	Lightweight search/attack sonar	Plessey
MS32	**1221.253**	Active panoramic sonar	Plessey
MS35	**1788.453**	Small frigate digital sonar. In development	Plessey
MS70	**1374.253**	Solid-state version of Type 193 mine hunting sonar	Plessey
Project 35	**1788.453**	Advanced fleet escort sonar. In development	Plessey
SADE	**1788.453**	Sensitive Acoustic Detection Equipment. Intruder detection system	Plessey
T17164	**1787.453**	Mark Ic active sonobuoy	Plessey
Type 162M	**1755.453**	Side-looking sonar	Kelvin Hughes
Type 186	–	Submarine sonar	EMI
Type 187	–	Submarine sonar	EMI
Type 193	**1373.253**	Mine hunting sonar of RN Mk 1 system	–
Type 193M	**1374.253**	Solid-state improved version of Type 193 mine hunting sonar	Plessey
Type 195	**1373.253**	Helicopter sonar based on MS 26/27	Plessey
Type 199	**2447.253**	Variable depth towed sonar	EMI
Type 719	–	Submarine sonar	EMI
USA			
AQS-13	**1637.353**	Helicopter sonar	Bendix
BQG 1/4	–	Submarine passive fire control sonars	Sperry/Raytheon
BQQ-1	–	Search and fire control sonars	Raytheon

Designation	Entry No.	Description	Manufacturers
BQQ-2	–	Sonar for Subroc system	Raytheon
BQQ-5	–	Towed sonar	Hughes/GE
BQR-2	–	Submarine passive sonar	Raytheon
BQR-3	–	Submarine passive sonar	Raytheon
BQR-7	–	Passive sonar. Part of BQQ-2 system	Raytheon
BQR-15	–	–	Western Electric
BQR-19	–	Submarine sonar	Raytheon
BQR-21	–	Submarine passive detection and tracking set	Honeywell
BQS-6	–	Active submarine sonar. Part of BQQ-2 system	Raytheon
BQS-8	–	Under-ice navigation sonar	Hazeltine
BQS-13	–	Submarine search sonar. Passive/active	–
BQS-15	–	–	Amtek
SQA-10	–	Variable depth sonar	Litton
SQA-13	–	Variable depth sonar	–
SQA-14	–	'Searchlight' sonar	Raytheon
SQA-16	–	'Searchlight' sonar	Raytheon
SQA-19	–	Variable depth sonar	Litton
SQG-1	–	Anti-submarine attack sonar	Raytheon
SQQ-14	**1789.453**	Mine hunting and classification sonar	GE
SQQ-23	–	Sonar for A/S patrol ships	–
SQR-14	–	Surface sonar	–
SQS-4	–	Short-range active sonar	Sangamo/GE
SQS-23	–	Long-range active sonar	Sangamo
SQS-26	**2636.253**	Bow-mounted, 'bottom bounce' mode sonar to replace SQS-23	Edo/GE
SQS-29/32	–	Surface vessel active sonars. Numbers relate to differing frequencies 'B' models are associated with a variable depth sonar	Sangamo
SQS-35	–	Variable depth towed sonar	–
SQS-36	**2534.253**	Medium-range hull sonar	–
SQS-38	**2534.253**	Medium-range hull sonar	–
SQS-53	–	–	GE
SQS-56	**1807.453**	Lightweight sonar under development for USN PF (Patrol Frigate) ships	Raytheon
SSQ-41	–	Sonobuoy	Magnavox
SSQ-47	–	Sonobuoy	Spartan
SSQ-53	–	Sonobuoy	Spartan
SSQ-62	–	Sonobuoy	Spartan
UQS-2	–	Mine hunting sonar	GE
610	**2580.253**	Long-range hull sonar	Edo
700 Series	**2581.253**	Medium-range. Hull and variable depth versions	Edo

2296.444
TABLE OF TORPEDOES

COUNTRY/DESIGNATION	LAUNCH PLATFORMS	ROLE/TARGETS	MANUFACTURER &c
FRANCE:			
E14	Submarine	Ships, some submarines	DTCN/CIT-ALCATEL
E15	"	" " "	" " "
L3	Ship or submarine	Submarines to 300 m	" " "
L3 Mod 1	" "	" " "	" " "
L4	Aircraft or Malafon	Submarines	DTCN
L5 Mod 1	Surface vessels	"	"
L5 Mod 3	Submarines	"	
R3	Aircraft, helicopters &c	"	"
Z16	Submarines	"	–
–	Light surface craft	Deep submarines	DTCN
GERMANY (FEDERAL REPUBLIC)			
SST 4	Ship or submarine	Ships or submarines near surface	–
Seal	" "	" " "	AEG/Krupp Atlas Elektronik
Sea Serpent	" "	Deep Submarines	" " " "
ITALY:			
G6e	Submarines	Ships or submarines near surface	Whitehead – Moto Fides
G62ef (Kangaroo)	Submarines	Submarines	" " "
A.184	Ships or submarines	Ships or submarines	" " "
A.244	Aircraft or surface vessls	Submarines	" " "
SWEDEN:			
Type 27:2	Submarines	Ships	Centrala Torpedverkstaden
Type 41	Ships or submarines	Ships and submarines	Förenada Fabriksverken
Type 61	Ships or submarines	Ships	" "
–	Helicopters, ships, submarines	Ships and submarines	" "
UNITED KINGDOM:			
Mark 8	Ships or submarines	Ships	UK MoD
Mark 20	Submarines	Submarines and some ships	UK MoD
Mark 20 (Improved)	"	" " "	UK MoD/Vickers
Mark 23	"	" " "	UK MoD/AUWE
Mark 24	"	Submarines	UK MoD
Tigerfish	"	"	Marconi Space and Defence
Mark 31	Aircraft	"	UK MoD
Project 7511	Aircraft, helicopters or surface vessels	"	Marconi Space and Defence
MW30	" "	Practice	Plessey Marine

STATUS	DIAMETER/LENGTH	NOTES	BOOK ENTRY
Service	21-inch × 4.29 m	Passive acoustic homing. Contact and magnetic fuse	1163.441
Service	550 mm × 6.0 m	As E14 but 300 kg charge instead of 200 kg	1164.441
Service	21-inch × 4.32 m	Active acoustic homing. Contact and magnetic fuze. 200 kg charge	1165.441
Service	550 mm × 4.3 m		
Service	21-inch × 3.13 m	Circular search. Active acoustic homing. Contact and acoustic proximity fuse	2096.441
Service	21-inch	Active/passive acoustic homing. Direct attack or programmed search. Torpedo weight 1,000 kg.	2122.441
Service	21-inch	As Mod 1 but torpedo weighs 1,300 kg	
Discontinued	-	Intended as successor to L4 but project discontinued at experimental stage	2144.441 (1973/74)
-	550 mm × 7.2 m	Programmed sinuous attack course. Remote depth control. Magnetic end contact fuse. 300 kg charge	2146.441
Discontinued	400 mm × 2.45 m	Active acoustic homing. Contact or acoustic fuse. Small charge. Project discontinued	2097.441 (1972/73)

Service	21-inch	Wire-guided; acoustic homing. Torpedo sonar linked to shipborne FCS.	2000.441
Service	21-inch	As SST 4. The two torpedoes are believed to be identical	2000.441
-	21-inch	Similar to SST 4 but deep diving	2178.441

Service	21-inch × 6.0 m	Acoustic homing. Cable depth-setting	2001.441
Service	21-inch × 6.2 m	Carries US Mk 44 torpedo (licence-built) Cable depth-setting	2002.441
Development	21-inch × 6.0 m	Wire-guided, automatic acoustic homing successor to G6e	2003.441
Development	324 mm × 2.7 m	Acoustic homing. Shallow water capability. Probable replacement for US Mk 44 in Italian service	2004.441

Service	21-inch	Wire-guided, non-homing	-
Service	400 mm × 2.5 m	Active homing in azimuth and depth. Shallow water capability Impact and proximity fuse. Electric propulsion. All-up weight 250 kg	2323.441
Service	21-inch × 7.0 m	Wire-guided, fast, long-range. 250 kg charge. Peroxide/fuel propulsion	2367.441
Development	400 mm × 2.5 m	Successor to Type 41 with helicopter-launch capability	2323.441

Obsolescent	21-inch	1930s design. Compressed air propulsion, free-running. In RN service certainly to 1973. May still be in service elsewhere	2474.441
Service	21-inch × 4.11 m	Passive sonar homing (depth and azimuth). Electric propulsion. Mechanical course settings. 91 kg charge. 244 m homing depth	-
Production	21-inch × 4.11 m	As standard Mark 20 but with cable-set course angles	2471.441
Discontinued	21-inch	Project abandoned	-
Discontinued	21-inch	Redeveloped as Tigerfish	2472.441
Service	21-inch × 6.46 m	Wire-guided plus active/passive acoustic homing. Impact and proximity fuse. Torpedo computer coupled to submarine FCS. Electric propulsion	2440.441
Discontinued	–	Intended replacement for US-designed Mk 44 Project cancelled in 1972 because delays had invalidated design. US Mk 46 bought as stopgap	2473.441 (1972/73)
Study		New project to replace US Mk 44/46. Successor to Mark 31 development	2448.441
Service		Drill/practice round for training in handling US pattern Mk 44 torpedoes	2491.441

COUNTRY/DESIGNATION	LAUNCH PLATFORMS	ROLE/TARGETS	MANUFACTURER &c
UNITED STATES OF AMERICA:			
Mark 14	Ships or submarines	Ships	–
Mark 16	Ships or submarines	Ships	–
Mark 18	–		Westinghouse
Mark 19	–		"
Mark 21 Mod 0	Aircraft	Ships	"
Mark 22	–		"
Mark 26	–		"
Mark 27 Mod 4	Ships or submarines	Submarines	–
Mark 28	Ships or submarines	Ships	Westinghouse
Mark 37 Mod 0	Ships or submarines	Submarines	"
Mark 37 Mod 1	Primarily submarines	"	"
Mark 37 Mod 2	" "	"	"
Mark 37 Mod 3	Ships or submarines	"	"
Mark 37C	{Ships or submarines} {Primarily submarines}	Ships, submarines and shore targets	Northrop
Mark 43 Mod 1	Aircraft and helicopters	Submarines	–
Mark 43 Mod 2	Helicopters	"	–
Mark 44	Aircraft, surface vessels and ASROC	Submarines	Several in USA also licence-built overseas
Mark 45 (ASTOR)	Submarines	Primarily submarines plus some surface vessels	Westinghouse
Mark 46 Mod 0	Aircraft, helicopters, surface vessels and ASROC	Submarines	Aerojet-General and others
Mark 46 Mod 1	" " "	"	" " " "
CAPTOR	Submerged mine (air-droppable)	"	Goodyear Aerospace
Mark 48 Mod 0	Submarines	"	Westinghouse
Mark 48 Mod 1	"	Ships and submarines	Gould (formerly Clevite)
Mark 48 Mod 2	"	" "	Westinghouse
DEXTOR	–	Very deep nuclear submarines	Honeywell
Freedom Torpedo Mod 0	Ships or submarines	Submarines	Westinghouse
Freedom Torpedo Mod 1	" "	"	"
UNION OF SOVIET SOCIALIST REPUBLICS:			
21-inch Torpedo	Ships or submarines	Ships	State
Airborne Torpedo	Aircraft	Submarines	"
Light Torpedo	Surface vessels	"	"

STATUS	DIAMETER / LENGTH	NOTES	BOOK ENTRY
Obsolescent	21-inch × 5.25 m	1930s design. Free-running. Compressed air propulsion. Weight 1,780 kg. Withdrawn from USN service in 1973 but still in service elsewhere	2813.441
Obsolescent	21-inch × 6.25 m	Fuel / peroxide thermal engine. Weight 2,180 kg. Charge 400 kg. Status as for Mark 14	2814.441
Obsolescent	–	1942. First mass-produced electric torpedo: based on German design. No longer in USN service but may survive elsewhere	2815.441
Discontinued	–	1943. First all-electric torpedo. Development quantity only built	–
Discontinued	–	1943. Acoustic homing. Development quantity only built	–
Discontinued	–	Development quantity only built	–
Discontinued	–	" " " "	–
Obsolescent	19-inch × 3.23 m	Passive acoustic homing. Electric propulsion. Used in USN service as training round prior to Mk 37 introduction but some warshot torpedoes sold elsewhere	2831.441
Probably Obsolete	21-inch × 6.25 m	Passive acoustic homing and pattern running. 2,000 built	2816.441
Service	19-inch × 3.52 m	Active / passive acoustic homing. Electric dual-speed propulsion. Warshot weight 648 kg. Mod 3 is improved version	2817.441
Service	19-inch × 4.09 m	Wire-guided. Electric dual-speed propulsion. Warshot weight 766 kg. Mod 2 is improved version	2818.441
Service	19-inch × 4.09 m	Updated version (minor modifications) of Mod 1	2818.441
Service	19-inch × 3.52 m	Updated version (minor modifications) of Mod 0	2817.441
Service	{19-inch × 3.52 m / 19-inch × 4.09 m}	Improved versions of Mark 37 Mods 2 and 3. Better speed, range and acoustic performance including shallow water capability. Sold to Canada and Netherlands	2830.441
Service	254 mm × 2.35 m	Electric propulsion. Weight 120 kg	2819.441
Obsolete	254 mm	Special helicopter-launched version. Probably generally similar to Mod 1 but now regarded as obsolete	2819.441
Service	324 mm × 2.56 m	Two versions differing slightly in length and both weighing about 233 kg. Active acoustic homing. Electric propulsion. Replaced by Mk 46 in USN service but still in service elsewhere	2820.441
Service	19-inch × 5.76 m	16 km range, deep-diving, wire-guided. Nuclear warhead. Weight about 1,310 kg	2821.441
Service	324 mm × 2.67 m	Deep-diving, high-speed, active / passive acoustic homing. Weight about 258 kg. First US torpedo with solid-fuel propulsion	2822.411
Service	324 mm	As Mod 0 but slightly larger and with liquid mono-propellant (OTTO) motor	2822.441
Production	324 mm	Mk 46 torpedo inserted in a mine casing and released when target detected. Entering service with USN in mid-1975	2541.441
Discontinued	21-inch	AS-only version. Superseded during development by Mod 2	2823.441
Service	21-inch × 5.8 m	Deep-diving (914 m) high-speed (93 km / h) active / passive acoustic homing, wire-guided, long-range (46 km) weapon. Weight about 1,600 kg. Said to be the most complex torpedo ever designed	2823.441
Discontinued	21-inch	Competing against Mod 1 which was selected after comparison at pilot production stage	2823.441
R & D	–	–	2793.441
Production	19-inch × 4.83 m	Private-venture development. Wire-guided, pattern-running, electrically propelled. Contact fuse. Warshot weight 1,237 kg. Charge 295 kg. Range 11 km. Adapts to 21-inch tubes	2618.441
Production	19-inch × 4.83 m	AS Mod 0 but with long-range homing system	2618.441

STATUS	DIAMETER / LENGTH	NOTES	BOOK ENTRY
Service	21-inch	Standard fit for submarines. Alternatives available for surface vessel launching	2995.441
Service	–	–	2996.441
Service	406 mm × 5.0 m approx	Trainable deck launchers	2997.441

1498.094

US ELECTRONIC INTELLIGENCE AND MONITORING EQUIPMENT

Designation	Category	Description	Service	Manufacturer(s)
ALA-5	Analyser	Airborne signal analyser	USAR	–
ALA-6	Analyser	Airborne pulse analyser	USAF	–
ALH-2	Recorder	Airborne ECM recorder	USAF	–
ALM-48	Analyser	Airborne spectrum analyser	USAF	General Electric
ALQ-61	Elint (airborne)	Fitted RA-5C, RF-4C, RF-4B. Receiver system	USN	AIL
ALQ-78	Surveillance	Airborne surveillance system for P-3C	USN	Loral
ALQ-86	Surveillance	Airborne surveillance system. Modified version of ALQ-53. Fitted EA-6A	USN	Bunker Ramo
ALR-5	Receiver	Airborne ECM receiver	USAF	–
ALR-7	Receiver	Airborne panoramic intercept receiver	USAF	Raytheon
ALR-18	Receiver	Airborne ECM receiver	USAF	General Electric
ALR-20	Panoramic receiver	Airborne monitoring and recording system used on B-52 bomber and RB-66 recce aircraft	USAF	
ALR-25	Elint (airborne)	Airborne receiver	USAF	Sanders
ALR-27	Panoramic receiver	Airborne panoramic receiver	USAF	Loral
ALR-28	Receiver	Airborne receiver	–	Loral
ALR-29	Receiver	Airborne receiver	USN	Sanders
ALR-35	Monitoring / recording	Airborne Elint HF and VHF communications monitoring and recording system	USAF	Sanders
ALR-40	Monitoring / recording	Airborne multi-band surveillance and recording system. Fitted EA-3B, 3C, Sea Wing system	USN	Sylvania
APA 74	Analyser	Airborne ECM pulse analyser	USAF	Loral
APM-83	Analyser	Airborne spectrum analyser	USN	Raytheon
APR-14	Receiver	Airborne panoramic reconnaissance receiver	USAF	Raytheon
APR-17	Receiver	Airborne intercept receiver	USAF	Loral
ARR-88	Receiver	Airborne ECM reconnaissance receiver	USAF	–
ASM-13	Analyser	Airborne antenna pattern analyser	USAF	Bendix
ASQ.96	Surveillance	Airborne system for location and classification incorporates Honeywell Alert computer. Fitted EB-66E	USAF	TRW
FLR-3	Receiver	Fixed ECM receiver	USAF	General Electric
FLR-12	Receiver	Fixed ECM receiver system. Part of 466L programme	USAF	ITT
GLH-1	Recorder	Fixed ECM reconnaissance recorder	USAF	–
GLH-9	Recorder	Fixed radar recorder reconnaissance system	USAF	Ampex
GLR-1	Receiver	Fixed passive detection system. Part of 466L programme	USAF	–
GLR-9	Receiver	Panoramic receiver 20 MHz to 4 GHz	–	ACL
MSM-63	Analyser	Ground mobile spectrum analyser system	USAF	Sperry
QRC-213	Surveillance	Airborne reconnaissance and analysis system	USAF	
QRC-259	Panoramic receiver	YIG-tuned airborne Elint receiver system. Fast sweep speed. Fitted KC-135	USAF	Watkins-Johnson
QRC-334	Elint (airborne)	System, with QRC-374 and QRC-385, for detection and location of radiators by time of arrival techniques	USAF	IBM
QRC-374	Elint (airborne)	See QRC-334. Used in Vietnam	USAF	AIL
QRC-385	Elint (airborne)	See QRC-334. Used in Vietnam	USAF	IBM
SLA-2	Surveillance	Ship's intercept and analysis system	USN	–
SLR-2	Receiver	Ship's ECM receiver	USN	–
SLR-12	Receiver	ECM receiver used on destroyers	USN	–
SLR-14	Receiver	ECM receiver used on destroyers	USN	–
WLR-1	Receiver system	Counter measure receivers extensively used on surface ships	USN	–
WLR-6(V)	Recce system	Submarine reconnaissance collection system. Also on some destroyers	USN	Sylvania

1499.094

US ELECTRONIC WARFARE DIRECTION FINDING EQUIPMENT

Designation	Description	Ser	Manufacturer(s)
ALD-2	Airborne direction finder	USN	Avco
ALQ-111	Electronic emitter locator system (EELS) for A-6A	USN	
ALR-17	Intercept receivers used with photo recce systems for identification of radars on photo-maps. Fitted RF-4C	USAF	Electronic Specialty
ALR-31	Radar homing and warning receiver	USAF	Loral
ALR-34	DF system	USAF	Sanders

Designation	Description	Service	Manufacturer(s)
ALR-37	Radiating site target acquisition system	USAF	Sylvania
ALR-39	Improved version of ALR-31 for F-111	USAF	Loral
ALR-41	Improved version of ALR-39. Used in F-111	USAF	Loral
APR-9	Airborne direction finder	USAF	Loral
APR-14	Panoramic reconnaissance receiver	USAF	Raytheon
APR-17	Early warning intercept receiver	USAF	Loral
APR-25	Radar warning crystal video receiver. Gives coarse bearing of threat. Fitted F-100, F-105, RF-4C and others	USAF/Army	Itek
APR-26	Missile launch warning receiver, used with APR-25	USAF/Army	Itek
APR-27	Surface-to-air missile launch warning receiver. Fitted F-4B. USN equivalent of APR-26	USN	Magnavox
APR-30	Radar homing and warning set for A-6A and A-4	USN	Melpar
APR-32	Radar homing and warning system	USN	Magnavox
APR-35	Search and homing receiver. Fitted F-105. For detection and location of HF and low VHF comms.	USAF	Itek
APR-36	Radar warning receiver. Fitted F-4D, F-4E, A-7D. Improved APR-25	USAF	Itek
APR-37	Surface-to-air missile launch warning receiver. Improved APR-26	USAF	Itek
APS-57	X-band search radar intercept set	–	Loral
APS-105	Radar homing and warning set for B-52	USAF	Dalmo-Victor
APS-107	Radar homing and warning system for F-105, F-4D	USAF	Bendix
APS-109	Radar homing and warning system for F-111	USAF	Dalmo-Victor
APS-118	Target identification and acquisition system for use with Standard Anti-Radiation Missile. Monopulse DF	USN	IBM
ASQ-93	Part of THAWS (Tactical Homing and Warning System) for F-14	USN	RCA
FRD-10	Fixed detection finding system. HF band	USN	GTE
SLA-15	Shipborne detection and DF system	USN	Cubic

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US NOISE JAMMERS

Designation	Description	Service	Manufacturer(s)
ALQ-31	Used on A-1, A-4, EA-6A	USN	McDonnell-Douglas
ALQ-55	VHF data link jammers	USN	Sanders
ALQ-59	VHF data link jammer. Fitted B-52, F-105	USAF	Hallicrafters
ALQ-67	Pod-mounted ECM system	Army	Sylvania
ALQ-70	Used on RC-135A	USAF	Raytheon
ALQ-71	Barrage jammer pod containing dual C, S, and L-band transmitters	USAF	Hughes
ALQ-72	X-band jammer pod for use against A1 radars	USAF	Hughes
ALQ-75	Jammer for B-52	USAF	–
ALQ-76	Jamming pod used with ALQ-86 reconnaissance system on EA-6A	USN	Raytheon
ALQ-77	Jammer for B-52	USAF	–
ALQ-80	Used on CV-2, OV-1	Army	Hallicrafters
ALQ-87	Barrage jammer pod with carcinotron source. Used on F-4, F-100, F-101, F-105	USAF	General Electric
ALQ-89	Communications jammer. Used on RA-5C	USN	Sanders
ALQ-91	Part of Thaws (Tactical Homing and Warning System) for F-14. Communications jammer	USN	Sanders/Magnavox
ALQ-92	Communications jammer. Used on EA-6B	USN	Sanders
ALQ-93	Ku-band jammer	USAF	Raytheon
ALQ-98	Integrated ECM system for use against anti-ship missiles. Fitted in helicopters	USN	General Instrument
ALQ-102	Pod mounted version of ALQ-98	USN	General Instrument
ALT-6	Airborne jammer	USAF	General Electric
ALT-7	Airborne jammer	USAF	–
ALT-13/28	Carcinotron source. Fitted B-52	USAF	Hallicrafters
ALT-15/32	Jammer for B-52	USAF	Hallicrafters
ALT-16/31	Barrage jammer. Travelling wave tube source. Fitted B-52	USAF	Hallicrafters
ALT-22	Jammer for B-52	USAF	General Electric
APT-16	Airborne jammer	USAF	Raytheon
SLQ-12	Automatically tuned shipboard jamming system	USN	Scope
SLQ-13	ECM buoy	USN	General Instrument
SLQ-17	Shipboard jamming system for protection against air and missile threats	USN	Hughes
SLQ-19	Shipboard shelter-housed jamming system for destroyers	USN	RCA
SLQ-21	Automatic shipboard jamming system	USN	American Electronic Labs
SLT-5	Shipboard jammer	USN	Raytheon
SLQ-8	Shipboard jammer transmitter. Version of ALT-27	USN	Litton

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US DECEPTION JAMMERS

Designation	Description	Service	Manufacturer(s)
ALQ-41	X-band track breaker. Fitted A-6A	USN	Sanders
ALQ-49	Track breaker used on A-3, A-4, RA-5C, RF-101. A-6A	USN	Sanders
ALQ-51	S-band deception jammers. Also provides some radar warning. Track breaker. Used on A-3, A-4, RA-5C, RF-101	USN / USAF	Sanders
ALQ-53	Track breaker. Used on EA-6A	USN	Loral
ALQ-58	Radar deception jammer	USAF	Litton
ALQ-63	Radar deception jammer	USAF	Litton
ALQ-81	Track breaker, pod-mounted with ALQ-83	USN	Sanders
ALQ-83	Track breaker, pod-mounted with ALQ-81	USN	Sanders
ALQ-94	Multi-band system X, C, and S-bands. Used F-111	USAF	Sanders
ALQ-99	Integrated ECM set. Fitted EA-6B. Incorporates IBM 4-pi computer. Raytheon transmitters	USN	AIL (prime)
ALQ-100	Multiband track breaker. Fitted A-6, A-7, A-4, and F-14. C and S-bands	USN	Sanders
ALQ-101	Combined noise and repeater jammer. Travelling wave tube source. Fitted F-4, RF-4C	USAF	Westinghouse
SLQ-13	ECM buoy	USN	General Instrument
ULQ-5	Guidance interference jammer. Shipboard. Deception repeater	USN	RCA / General Instrument
ULQ-6	Guidance interference jammer. Shipboard. Deception repeater	USN	RCA / General Instrument

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US CHAFF DISPENSER EQUIPMENT

Designation	Description	Service	Manufacturer(s)
ADR-8A	Chaff rocket carried by B-52. Fired from ALE-25 pod	USAF	Revere Copper & Brass
ALE-1	Electro-mechanical metal foil cutter / dispenser. Fitted B-47, B-52, B-66	USAF	Various
ALE-2	Electro-mechanical metal foil cutter / dispenser. Used on RB-57, T-33, F-100 and NATO aircraft	USAF / NATO	Various
ALE-16	Pneumatic dispenser	–	General Dynamics
ALE-18	Pneumatic dispenser	USN	Prime Co / Piqua Eng
ALE-24	Electro-mechanical dispenser for B-52G and H	USAF	Lundy
ALE-25	Rocket pod for ADR-8A chaff rocket launch from B-52	USAF	Boeing
ALE-27	Re-packaged version of ALE-24	USAF	Lundy
ALE-28	Pneumatic dispenser for F-111	USAF	General Dynamics
ALE-29	Pyrotechnic dispenser. 60 tube capacity	USN / USMC	Tracor / Electrospace
ALE-30	Dispenser for A-6A	–	Lundy
ALE-32	Electro-mechanical dispenser fitted EA-6A. Pod-mounted	USN	Lundy
ALE-33	Electro-mechanical dispenser for BQM-34 drone	–	Lundy
ALE-35	Pyrotechnic dispenser for F-4. Larger capacity than ALE-29	USN / USMC	–
ALE-36	Dispenser pod	USAF	–

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MILITARY COMPUTERS

Designation	I/O Channels	Main Memory	Memory Cycle Time (μ sec)	Wt (Kg)	Word length (bits)	Instruction Set	General	Manufacturer
FRANCE								
IP 08C	–	8k / 16k	1	17.5	18	–	Airborne / mobile	IBM, France
Camille	–	8k	4	89.3	16	–	GP stored program	IBM, France
AE-51	8	8k	–	15	24	–	Drum memory	SAGEM
EMD Type A	30	2k	4	15	12	–	Missile guidance computer	Dassault
EMD Type B	119	4k / 8k	2	12	24	–	Airborne	Dassault
CNM-1	16-24	4k / 8k	2.4	12	16	–	GP Mobile	Dassault
CNM-2		4k-32k	2	–	16 / 32	256	Airborne	SAGEM
UTD	Up to 64	1k-16k	0.25 / 0.9	1	16 / 32	–	Universal modular. MOS or bipolar IC store	SAGEM
IRIS 55M	24	512 k bytes	1.2	–	1 / 2 / 4 k bytes	80	Large ship-board or land-based central processor	CII
IRIS 35M	8 (multiplex)	256 k bytes	1.6	50	–	58	Mobile. Land and sea applications	CII
IRIS 15M	4	8k-32k	–	–	18	86	Compact mobile modular computer	CII
CS 2	–	1k	–	3	16	18	Mobile	LCT
825P	–	4k	–	12	24	30	Mobile	LCT
BCH	–	8k-32k	–	80	16	50	Hybrid. Mobile. Fire control and similar applications	Thomson-CSF

Designation	1/0 Channels	Main Memory	Memory Cycle Time (μ sec)	Wt (Kg)	Word length	Instruction Set	General	Manufacturers
1050	–	4k	5	17	24	100	Mobile	Thomson-CSF
ISRAEL								
ISAC-77		1k-16k	1.5	–	24	–	Airborne	MBT Israel Aircraft Industries Ltd
ITALY								
CDG-3032	–	Up to 131k	700 n sec	–	–	–	Large-scale GP. Shipboard or land-based	Selenia
NETHERLANDS								
SMR		8k-64k	1	310	24	60	Large-scale GP. Shipboard or land-based	Signaal
NORWAY								
SM-3M		4k-64k	0.8	67	16/32	92	Land- and sea-mobile versions	Kongsberg
SM-4M		4k-64k	1.2	60	16/32	92	Land- and sea-mobile versions	Kongsberg
SWEDEN								
CK-37		8k	–	45	13/26	48	Airborne and mobile GP machine	Saab-Scania
Censor 908	–	16 k bytes	–	–	4 bytes	–		SRT
Censor 932	–	4k-128k	1	–	32	80	Air defence computer	SRT
UNITED KINGDOM								
F1600	–	8k-64k	2	–	24	–		Ferranti
FM1600	64	16k-262k	–	–	24	–	Modular IC multi-purpose computer	Ferranti
FM1600B	22	4k-64k	1 or 650 n sec	18	24	–	Widely used in naval FCS, ADA, and other applications	Ferranti
FM1600D	16+	8k	1	5.5	24/48	325	Multi-role, air, sea or land mobile	Ferranti
FM1600E	112+	4k/8k	700 n sec	11	24/48	430	High-power GP processor for land, sea or airborne use	Ferranti
Myriad III	–	16k-262k	0.7/1.6	–	24	–	Modular multi-purpose central processor	Marconi
12/12	–	4k	2	5-11	12/24	–	Multi-purpose airborne	Marconi
920M	–	8k-32k	2	15	18	60	Airborne	GEC
920C	–	8k-131k	1	25	18	67		Marconi
920 ATC	8	16k-131k	1.1	16	18	67	Airborne	Sperry, UK
1412	256	4k-32k	2.5	7	12	47	Mobile, multi-purpose	Marconi
UNITED STATES OF AMERICA								
D26J	–	1k-16k	6	6	27	32	Missile guidance and navigation	Rockwell
D37B	–	7k	78	15	27	56	GP missile guidance	Rockwell
D200	18	4k-32k	4	3	24	35	Navigation computer	Rockwell
Verdan	137 (Mk II)	1.6k	–	37	26	–	DDA navigation computer	Rockwell
BR-1018M	Up to 512	8k-132k	–	2	18	52	GP Mobile	Bunker Ramo
D84	–	4k-64k	2	45	–	–	GP	Burroughs
Alpha Series	Variable	16k+	1	8	32/36	179	Multi-purpose	CDC
CP-16A	–	4k-64k	1.2	8	16	45	Aerospace computer	GE
CP-32A	16	4k/8k	1	17	32	70	Aerospace computer	GE
Alert	64	4k-32k	1	17	24	53	Mobile, multi-purpose	Honeywell
H 4400	–	–	–	–	–	–	Large, modular central processor	Hughes
HCM-205	–	8k-16k	–	6	18	–	Airborne central processor	Hughes
L-304	64	4k-131k	1.6/1.8	15	32	62	GP Mobile	Litton
L-305	64	4k-131k	1.6/1.8	18	32	62	GP Mobile	Litton
L-306	64	4k-131k	1.6/1.8	21	32	62	GP Mobile	Litton
L-3040	64	4k-131k	1.6/1.8	17	32	500	GP Mobile	Litton
L-3050	64	4k-131k	1.6/1.8	20	32	500	GP Mobile	Litton
L-3060	64	4k-131k	1.6/1.8	23	32	500	GP Mobile	Litton
NDC-1051	–	2k-8k	2	13	24	38		Northrop
NDC-1060	32	4k-16k	2	17	28	42	Airborne GP	Northrop
NDC-1070	–	8k-65k	2	16	16/32	87	Mobile GP	Northrop
SKC-2000	69	4k-131k	1.2	9	16/24	99	Multi-purpose aerospace computer	Kearfott
SKC-3000	–	6k	–	–	16/20	–	GP navigation computer.	Kearfott
SKC-20	–	4k-16k	4	11	10	32	Navigation and weapons delivery	Kearfott
SKC-33	32	3.4k	–	–	25	–	Missile guidance computer	Kearfott
ASN-24(V)	–	4k	–	50	25	8	Navigation computer	Kearfott
ASP	–	4k-65k	66 nsec	317	16	24	Advanced Signal Processor	Sylvania
UYK-7	16+	16k-212k	1.5	239	32	142	Multi-purpose ship-borne central processor	Univac
Type 1230	32	2 × 16k	2	952	30	63	GP	Univac
Type 1832	–	–	–	172	–	–	GP multi-purpose	Univac

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NATO DESIGNATIONS OF SOVIET SYSTEMS AND EQUIPMENT

Alkali	Air-to-air missile
Anab	Air-to-air missile
Ash	Air-to-air missile
Atoll	Air-to-air missile
Awl	Air-to-air missile
Backfire	Tupolev VG bomber
Back Net	Early warning and GCI radar
Badger	Tu-16 bomber / reconnaissance aircraft
Band Stand	Naval radar for SSN-9 missile
Barlock	P-50 Twin scanner land-mobile early warning and GCI radar
Bear	Tu-20 bomber aircraft
Big Bar A	Early warning and GCI radar
Big Mesh	Early warning and GCI radar
Big Net	Naval surveillance radar
Bison	Mya-4 bomber-reconnaissance aircraft
Blinder	Tu-22 bomber aircraft
Boat Sail	Submarine radar
Brewer	Yak-28 attack aircraft
Candid	Il-76 transport aircraft
Careless	Tu-154 transport aircraft
Cat	An-10 transport aircraft
Charger	Tu-144 supersonic transport
Classic	Il-62 transport aircraft
Cleat	Tu-114 transport aircraft
Clod	An-14 general purpose aircraft
Cock	An-22 transport aircraft
Codling	Yak-40 transport aircraft
Coke	An-24 / 26 transport aircraft
Colt	An-2 general purpose aircraft
Cookpot	Tu-124 transport aircraft
Coot	Il-18 transport aircraft
Cross Bird	Naval early warning radar
Cross Slot	Ground radar
Crusty	Tu-134 transport aircraft
Cub	An-12 transport aircraft
Cuff	Be-30 transport aircraft
Curl	An-26 transport aircraft
Cylinder Head	Ship's gun fire director radar
Dead Duck	Naval IFF
Doghouse	Phased-array missile and space tracking radar
Don	Naval navigation radar
Drum Tilt	AA fire control radar
Dumbo	VHF early warning and search radar
Egg Cup	Ship's splash spotting radar
Eye Bowl	Naval missile guidance radar
Faithless	Mikoyan STOL fighter aircraft
Fan Song A	S-band tracking radar
Fan Song B	Target tracking radar
Fan Song E	C-band target tracking radar
Fan Song Series	Range of electro-mechanically scanned target tracking radars
Fiddler	Tu-28 strike aircraft
Firebar	Yak-28P all-weather fighter aircraft
Fire Can	Land-mobile S-band AA fire control radar
Fire Wheel	AA fire control radar
Fishbed	MiG-21 interceptor aircraft
Fishpot	Su-9 interceptor aircraft
Fitter	Su-7 interceptor aircraft
Flagon-A	Su-11 all-weather fighter aircraft
Flagon-B	Sukhoi STOL fighter
Flap Wheel	AA fire control radar
Flashlight	Yak-25 all-weather interceptor
Flat Face	P-15. Land mobile target acquisition radar
Flat Spin	Naval air search radar
Long Track	Search and acquisition radar
Look Two	Bombing and navigation radar
Flogger	Mikoyan variable-geometry fighter (MiG-23)
Foil Two	Ground based IFF
Foxbat	MiG-25 interceptor aircraft
Freehand	Experimental VTOL aircraft
Frog-1	Surface-to-surface missile
Frog-2, 3, 4, and 5	Surface-to-surface missiles
Frog-7	Surface-to-surface missile
Gage	Ground target acquisition radar
Gainful	Surface-to-air missile
Galosh	Surface-to-air missile
Ganef	Surface-to-air missile
Goa	Surface-to-air missile
Goblet	San-3 naval missile
Grail	Man-portable AA missile
Griffon	Surface-to-air missile
Guideline	Surface-to-air missile
Guild	Surface-to-air missile
Gun Dish	AA fire control radar
Hair Net	Naval search radar
Half Bow	Naval target designation radar
Harke	Mi-10 helicopter
Hawk Screech	Naval fire control radar
Headlight	Naval fire control radar
Head Net	Naval surveillance radar
Hen Egg	Ballistic missile early-warning radar
Hen House	Ballistic missile early-warning radar
Hen Nest	Ballistic missile early-warning radar
High Lune	Ship's nodding height-finder
High Pole	Ship's IFF
High Sieve	Naval search radar
Hip	Mi-8 helicopter
Homer	Mi-12 helicopter
Hoodlum	Ka-26 helicopter
Hook	Mi-6 helicopter
Hormone	Ka-25 helicopter
Horn Spoon	Ship's navigation radar
Hound	Mi-4 helicopter
Kangaroo	Air-to-surface missile
Kelt	Air-to-surface missile
Kennel	Air-to-surface missile
Kipper	Air-to-surface missile
Kitchen	Air-to-surface missile
Knife Rest A, B, C	P-10 Series. VHF truck-mounted early warning radars
Long Bow	Naval target designation radar
Plinth Net	Target acquisition radar
Pop Group	Naval radar for SAN-4 missile
Post Lamp	Naval target designation radar
Pot Drum	Naval fire control radar
Pot Head	Submarine surface search radar
Puff Ball	Airborne X-band search radar
Rock Cake	Height finder radar
Rod Mat	Ground-based IFF
Sagger	Anti-tank missile
Salish	Coastal Defence Missile
Samlet	Surface-to-surface version of Kennel missile
Sandal / Shyster	Surface-to-surface missile
Sasin	ICBM
Savage	ICBM
Sawfly	Submarine-launched ballistic missile
Scaleboard	Surface-to-surface missile
Scamp	IRBM
Scan Fix	AI radar
Scan Odd	AI radar
Scan Three	X-band AI radar
Scapegoat	IRBM
Scarp	ICBM
Scoop Pair	Naval target acquisition radars
Score Board	Ground-based IFF
Scrag	ICBM
Scrooge	IRBM
Scrubber	Naval anti-shipping missile
Scud A and B	Surface-to-surface missiles
Sea Gull	Long-range naval search radar
Sea Net	Naval search radar
Serb	Submarine-launched ballistic missile
Shaddock	Naval surface-to-surface missile
Sheet Bend	Naval search radar
Sheet Curve	Naval search radar
Short Horn	Ku-Band bombing and navigation radar
Side Net	Height finder radar
Skean	IRBM
Skin Head	Target acquisition radar for torpedo boats
Ski Pole	Ship's IFF
Skip Spin	X-band AI radar
Slim Net	Naval search radar
Snapper	Anti-tank missile
Snoop Plate	Submarine surveillance radar
Snoop Slab	Submarine surface search radar
Snoop Tray	Submarine surveillance radar
Spin Scan	AI radar
Sponge Cake	Height finder radar
Spoon Rest A	P-12 VHF early warning radar
Square Head	Naval IFF
Square Tie	Target acquisition radar
Squint Eye	Surveillance radar
Stone Cake	Height finder radar
Stop Light	Broad-band passive radar
Strut Curve	Naval search radar
Styx	Naval anti-shipping missile
Swatter	Anti-tank missile
Token	Early warning GCI radar
Top Bow	Naval radar
Top Sail	Naval long-range search radar
Top Trough	Naval surface target radar
Track Dish	Ground tracking radar
Wasp Head	Ship's fire control radar
Watch Dog	Submarine passive radar
Whiff	AA fire control radar
Witch Five	Naval IFF
Witch Series	IFF ground radars
Yo Yo	Target tracking radar

COMPARATIVE MILITARY STRENGTHS

Introduction

The following pages have been compiled to show diagrammatically the relative strengths of most of the armed forces of the world. Because of the enormous disparity between the armies, navies and air forces of the "superpowers" and those of smaller countries, certain special techniques have been used to present the information available in a consistent manner: these are described below and the reader is advised to familiarise himself with them before attempting to interpret the diagrams.

Sizes of Armed Forces

The armed forces of each country have been divided into four groups, denoted by four rectangles, which are (from top to bottom) Army, Navy, Air Force and a miscellaneous group comprising reserves, militia, gendarmerie and other para-military forces. The imprecise nature of this fourth group is regretted, but there is such a wide variety of forces appropriate to this classification that sub-classification within the compass of this survey is virtually impossible. Where separate figures for marines are known they have been added to the naval strength.

The four rectangles denote the numbers of personnel in each classification. To encompass the wide range of variation of these numbers, however, the areas of the rectangles have been made proportional, not to the numbers of personnel, but to the square roots of those numbers. The vertical dimensions of the rectangles are constant for each classification, so that if, say, the "army" rectangle for one country is three times as wide as that for another country this indicates that the army of the first country has a numerical strength nine times as great as that of the other country. Although the relationship has been chosen largely for convenience of presentation, however, it has also some practical validity; because after taking command structure and lines of communication into account the front line combatant strength of a military unit is probably more nearly proportional to the square root of its numerical strength than to the numerical strength itself.

The vertical dimensions of the rectangles have been chosen in such a way that if a country's armed forces are all of average size, or all some multiple of that average size, the four rectangles will all be of the same width. It is thus possible to see at a glance whether any country has a disproportionately large army or a disproportionately small navy and so forth.

Additional information

Superimposed upon some of the rectangles are various horizontal bars. These denote selected characteristics of the armed forces such as numbers of tanks, size of the submarine fleet, numbers of combat aircraft and so forth. The purpose of these bars is to indicate, in a general way, the degree of sophistication of the various forces; and in determining their lengths, processes of calculation have been used that are broadly similar to those used in determining the widths of the basic rectangles. For tanks and aircraft, for example, the lengths are simply proportional to the square roots of the numbers involved: the surface fighting vessels and submarines the lengths have been chosen proportional to the tonnages: for naval missiles both the number of launchers and the numbers of missile-armed vessels have been taken into account.

It must be stressed that comparisons between lengths of bars can be made only between one country and another and not between one parameter and another: it is not possible to determine, for example, the relative numbers of tanks and aircraft of one country by comparing the appropriate bar lengths.

Nuclear Weapons

No attempt has been made to indicate nuclear weapon power in these diagrams. The main reasons, for this are lack of precise information on the one hand and the ready availability of published estimates on the other. The estimates of gun and missile fire power therefore, relate only to "conventional" warheads.

Army Parameters

Tank strength

Missile fire-power

Gun fire-power

Naval/Air Force Parameters

Naval Maritime Aircraft

Navy Parameters

Surface fighting tonnage

Submarine tonnage

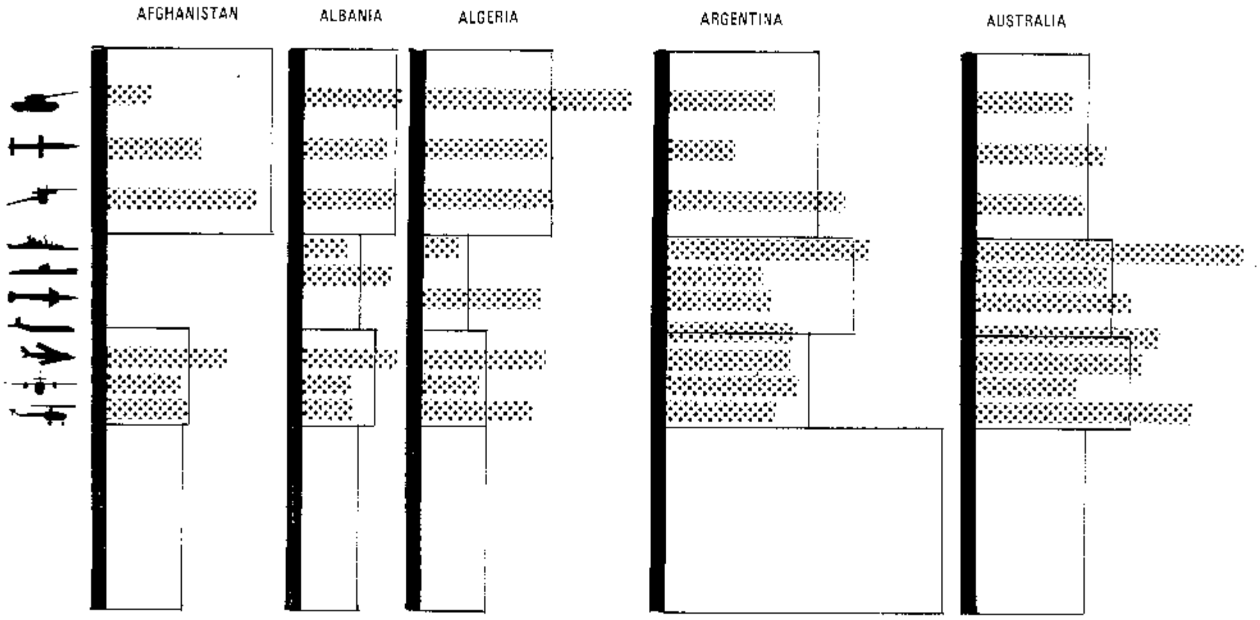
Missile fire-power

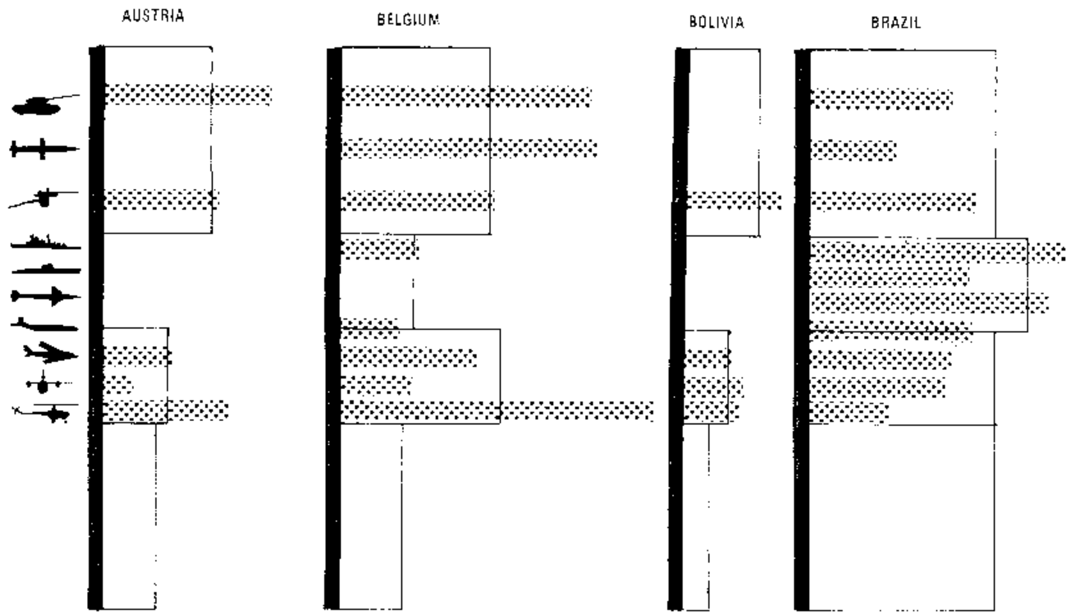
Air Force Parameters

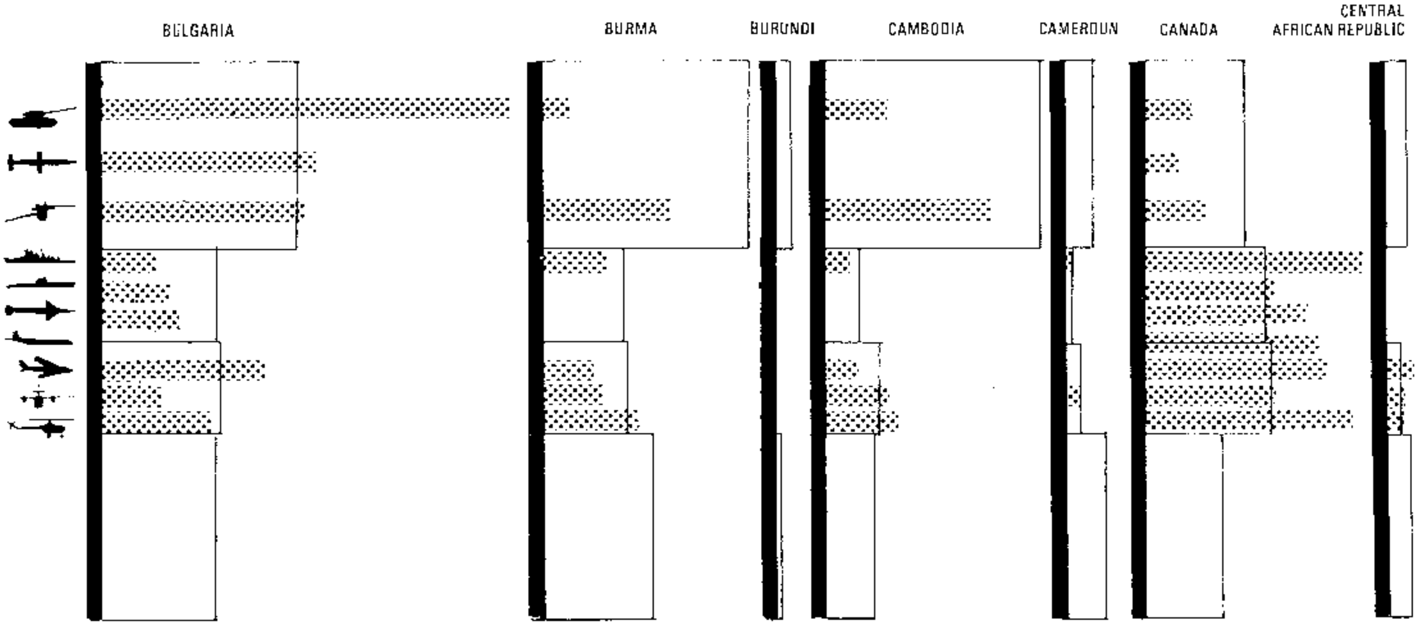
Combat Aircraft

Transport Aircraft

Helicopters



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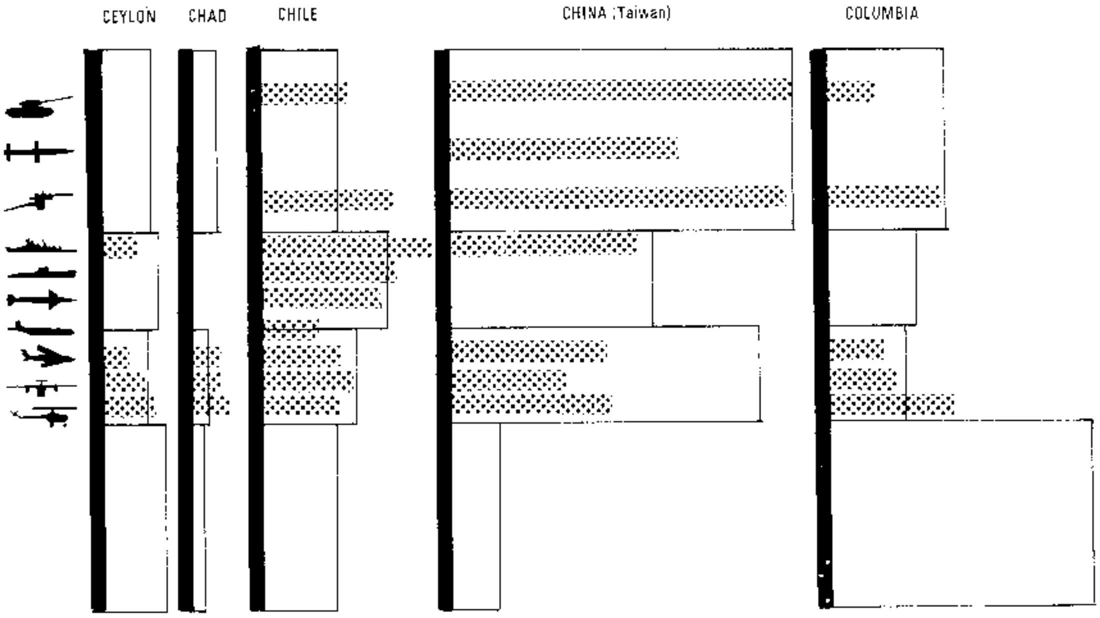
BURMA
BURUNDI
CAMBODIA
CAMEROUN
CANADA
CENTRAL AFRICAN REPUBLIC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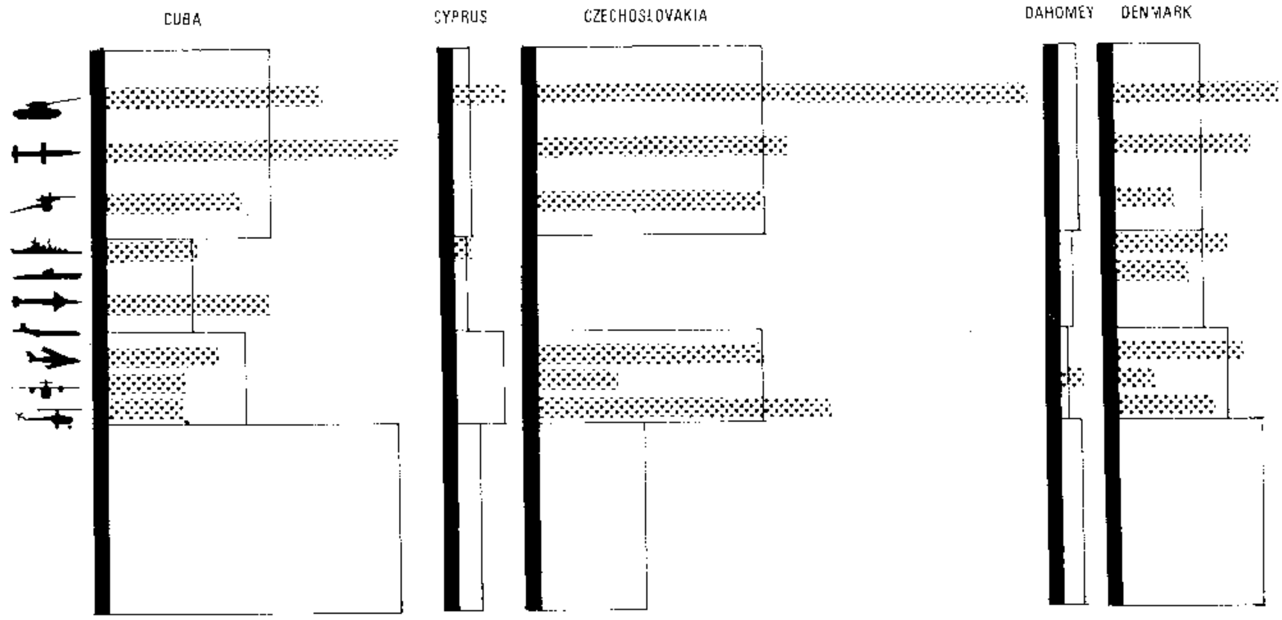
CHAD
CHILE
CHINA (Taiwan)
COLUMBIA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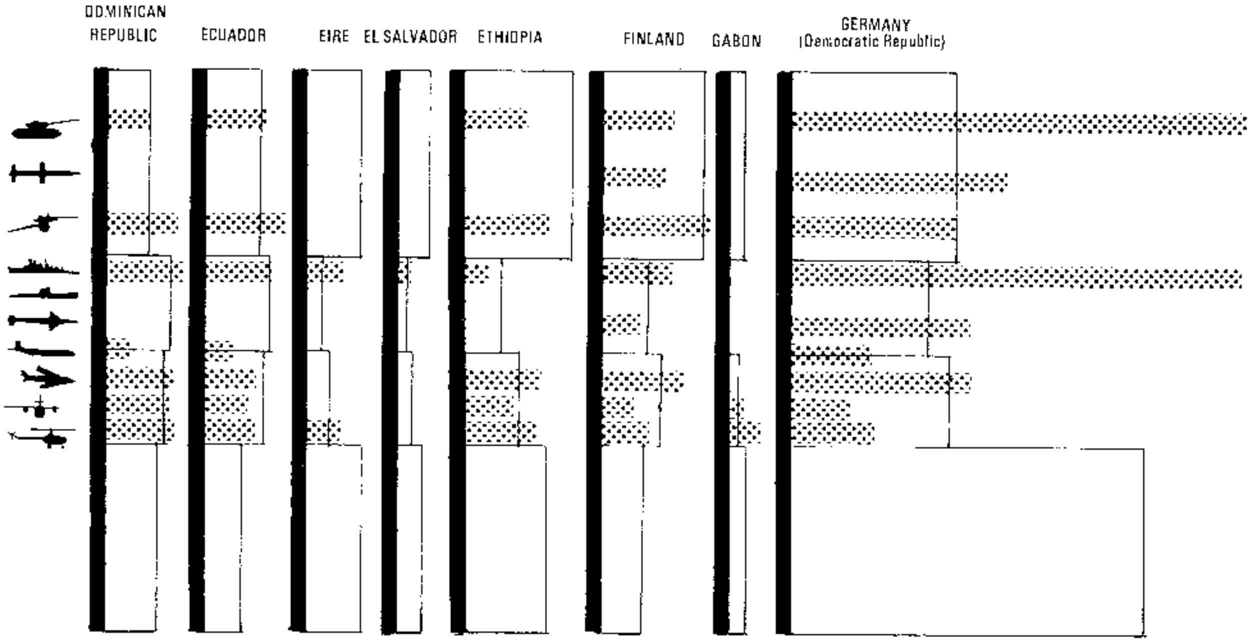
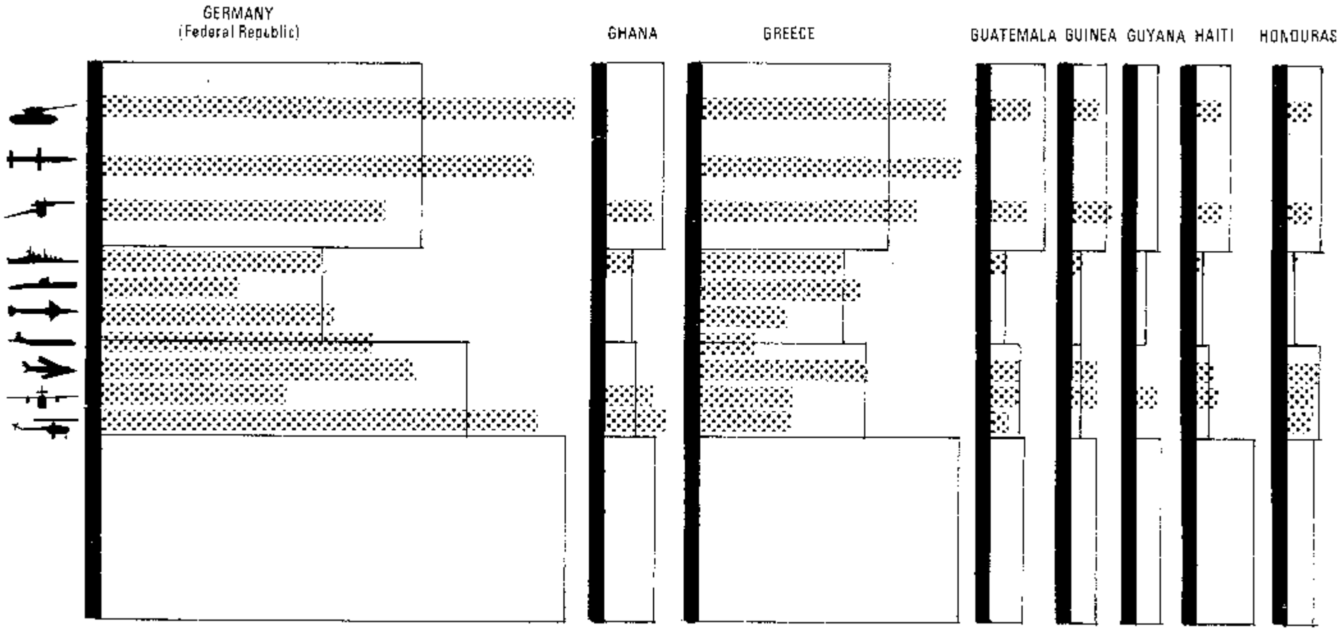
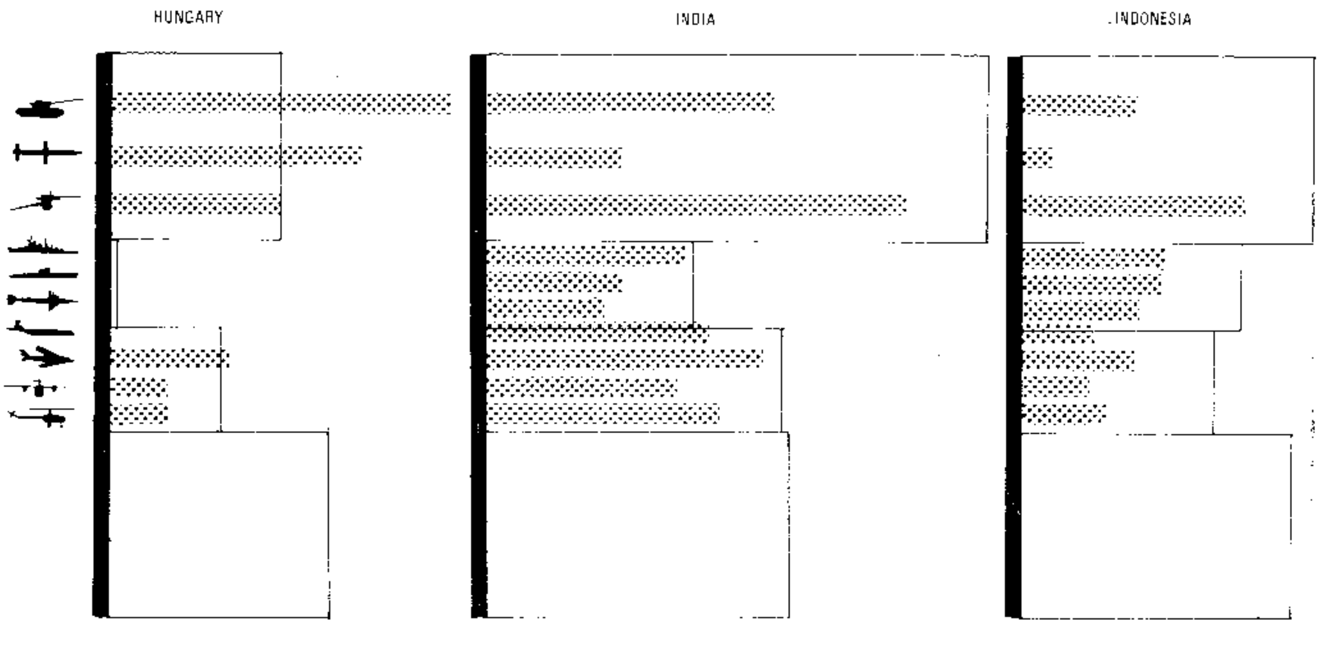
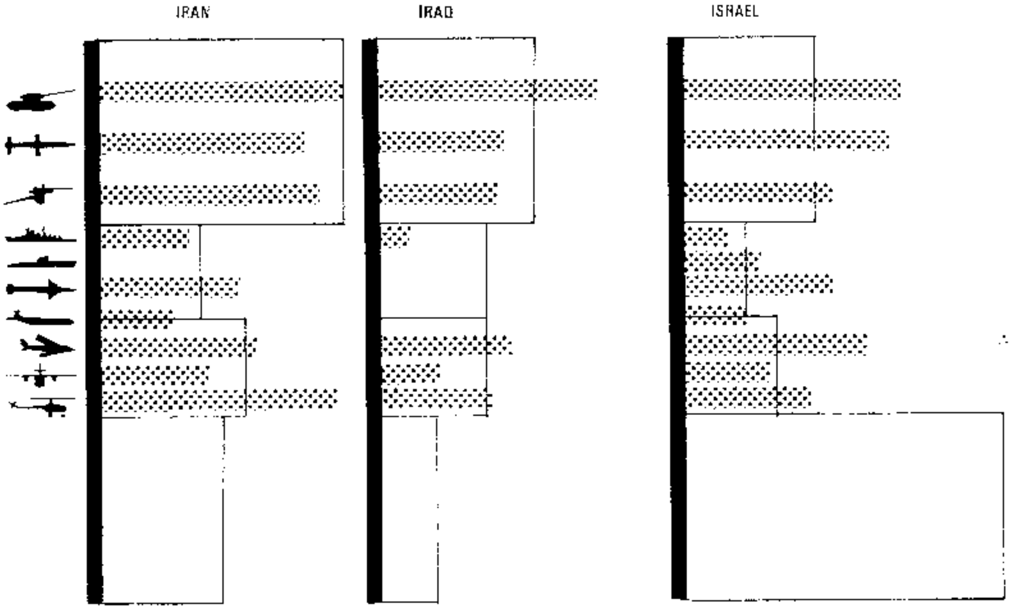
CYPRUS
CZECHOSLOVAKIA
DAHOMEY
DENMARK


DOMINICAN REPUBLIC
ECUADOR
EIRE
EL SALVADOR
ETHIOPIA
FINLAND
GABON
GERMANY (Democratic Republic)


GERMANY (Federal Republic)
GHANA
GREECE
GUATEMALA
GUINEA
GUYANA
HAITI
HONDURAS


HUNGARY
INDIA
INDONESIA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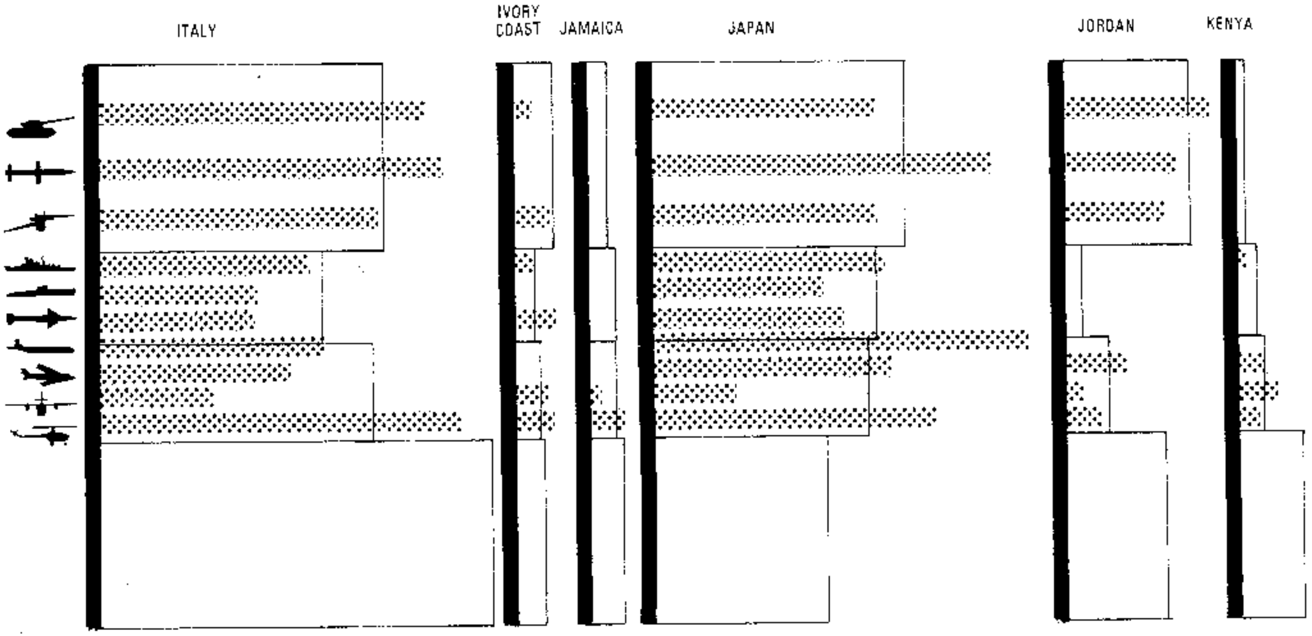
IRAQ
ISRAEL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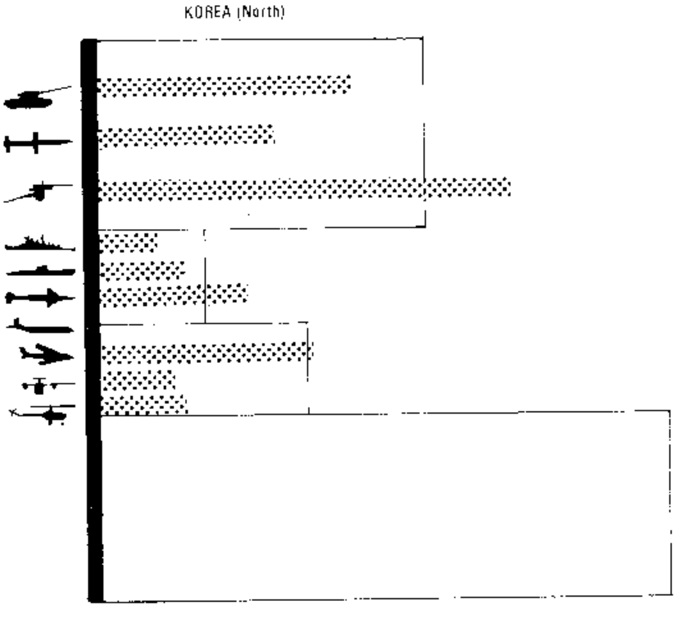
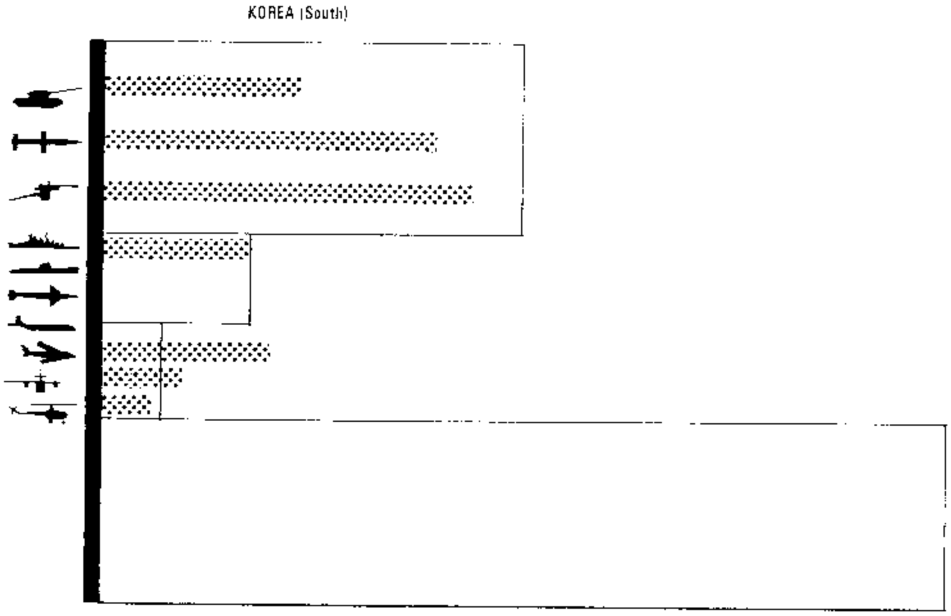
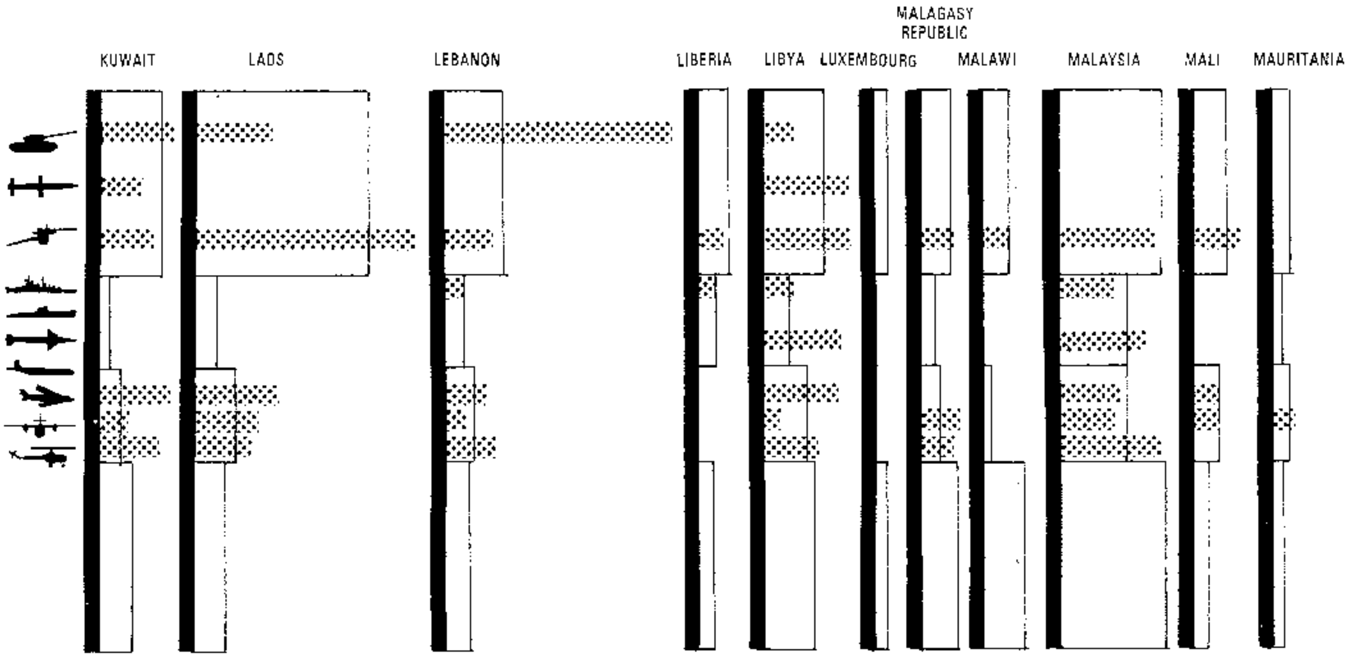
IVORY COAST
JAMAICA
JAPAN
JORDAN
KENYA


KOREA (North)


KOREA (South)


KUWAIT
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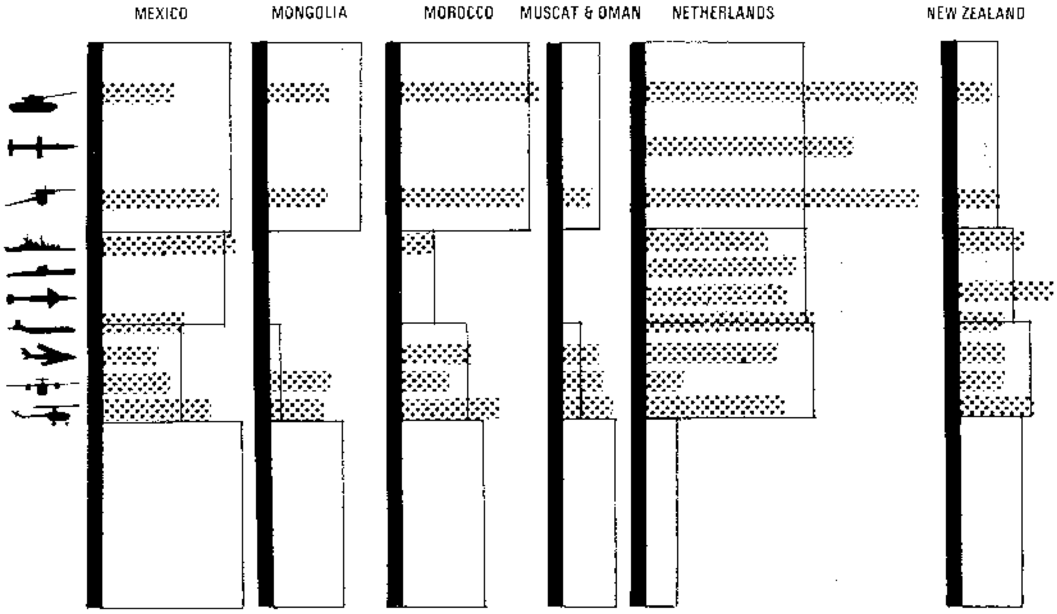
LIBYA
LUXEMBOURG
MALAGASY REPUBLIC
MALAWI
MALAYSIA
MALI
MAURITANIA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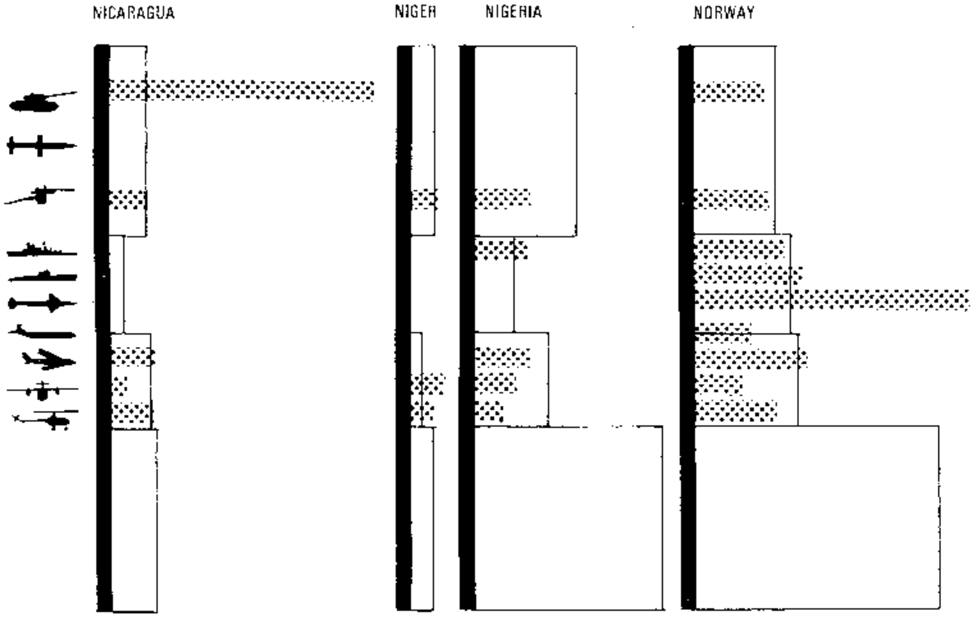
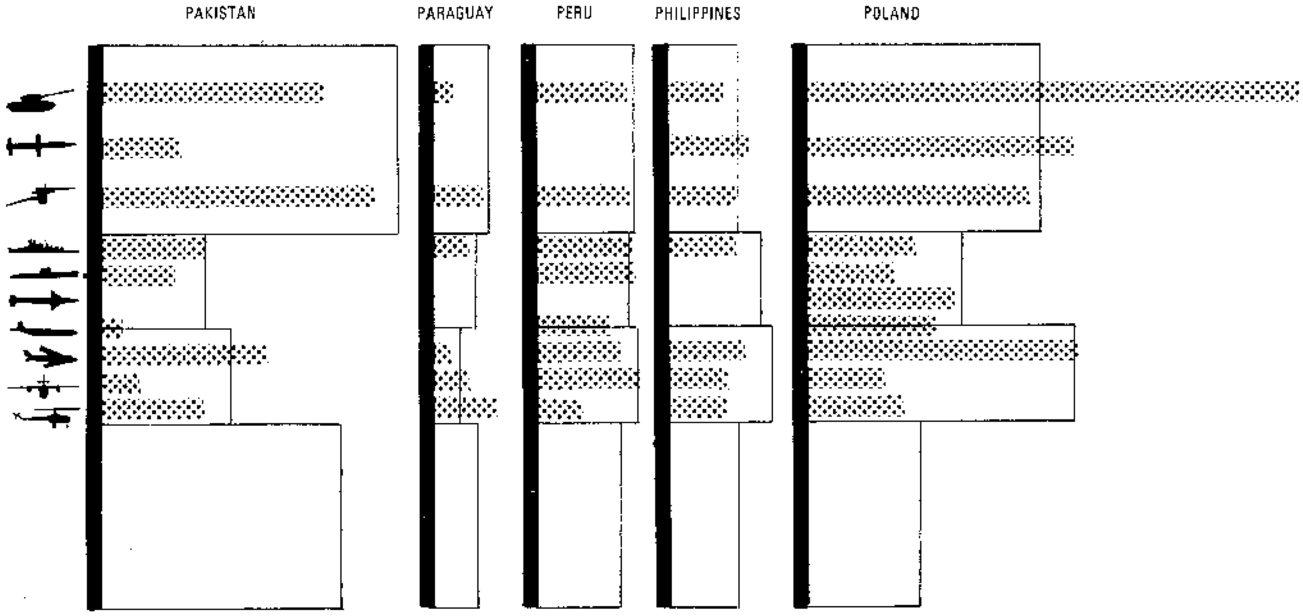
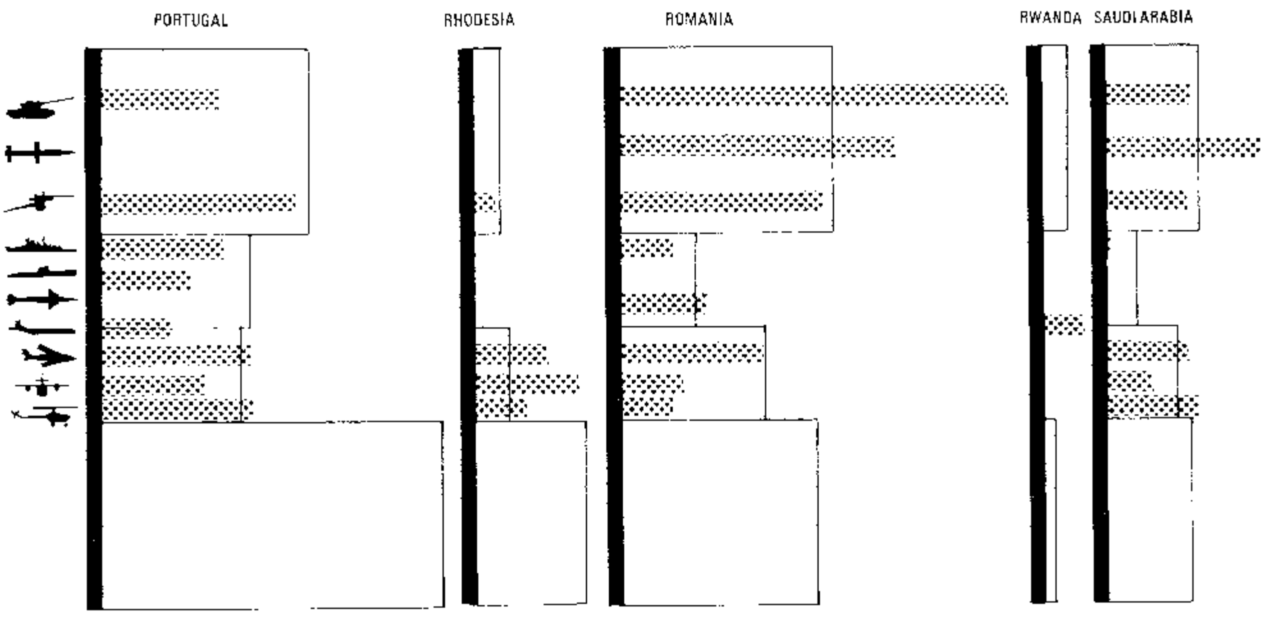
MONGOLIA
MOROCCO
MUSCAT & OMAN
NETHERLANDS
NEW ZEALAND


NICARAGUA
NIGER
NIGERIA
NORWAY


PAKISTAN
PARAGUAY
PERU
PHILIPPINES
POLAND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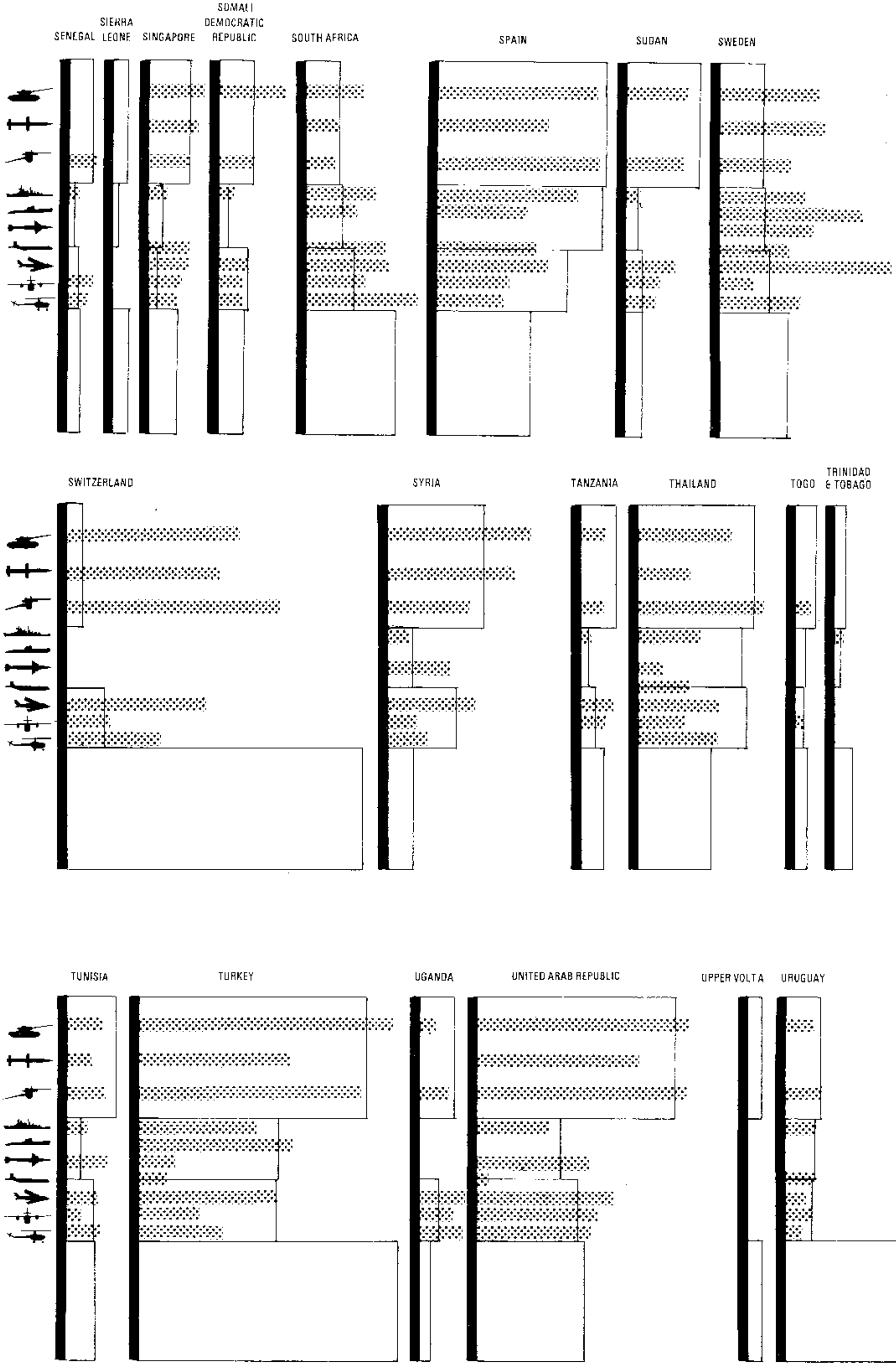
ROMANIA
RWANDA
SAUDI ARABIA


SENEGAL
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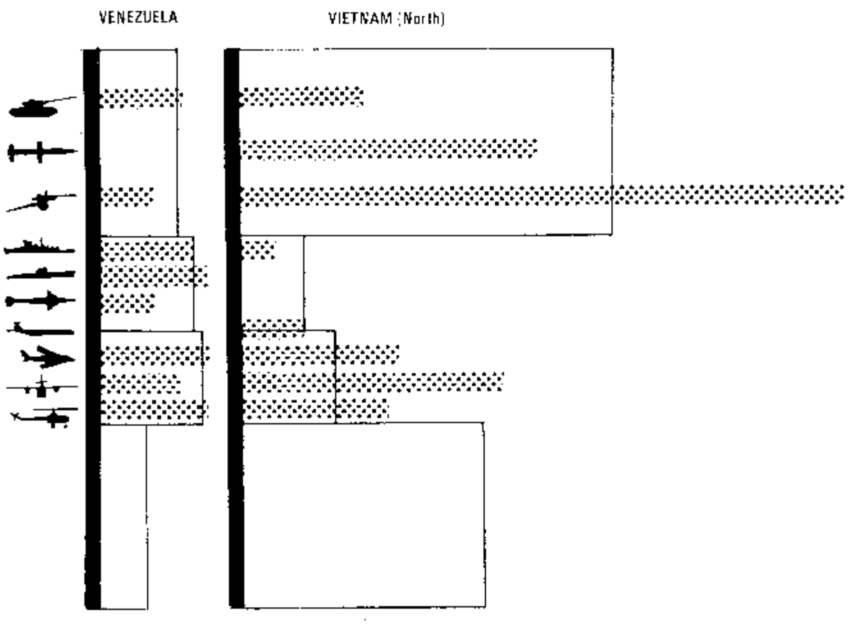
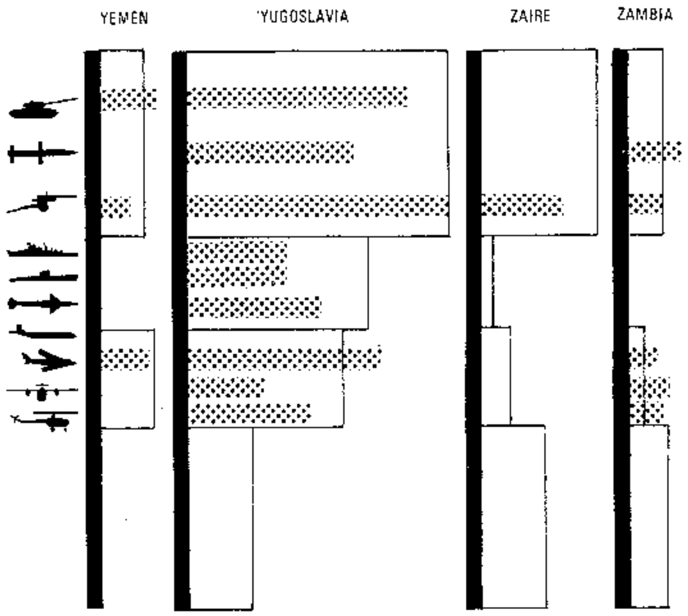
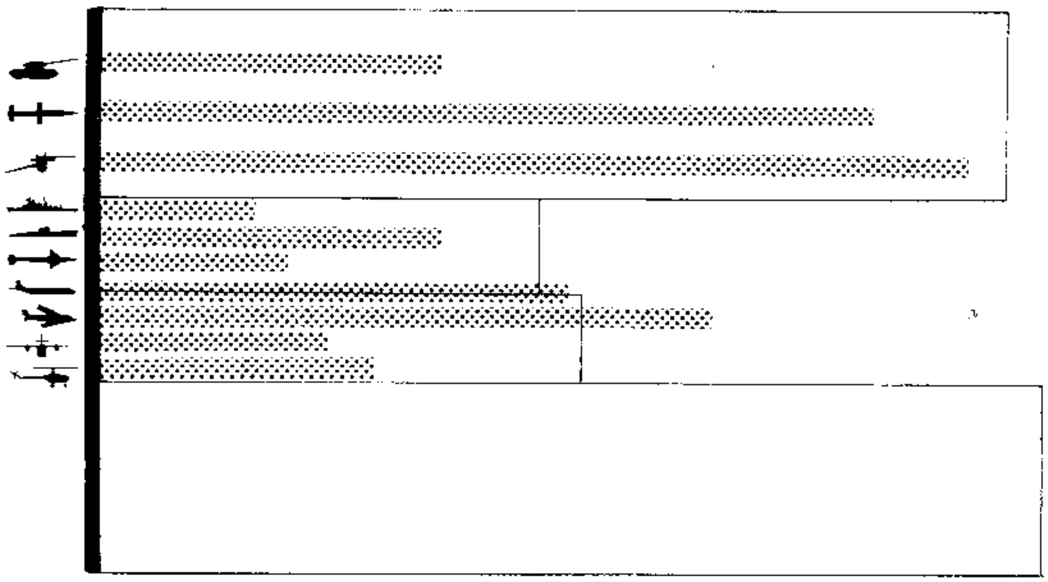
SINGAPORE
SOMALI DEMOCRATIC REPUBLIC
SOUTH AFRICA
SPAIN
SUDAN
SWEDEN
SWITZERLAND
SYRIA
TANZANIA
THAILAND
TOGO
TRINIDAD & TOBAGO
TUNISIA
TURKEY
UGANDA
UNITED ARAB REPUBLIC
UPPER VOLTA
URUGUAY


VENEZUELA
VIETNAM (North)
VIETNAM (South)

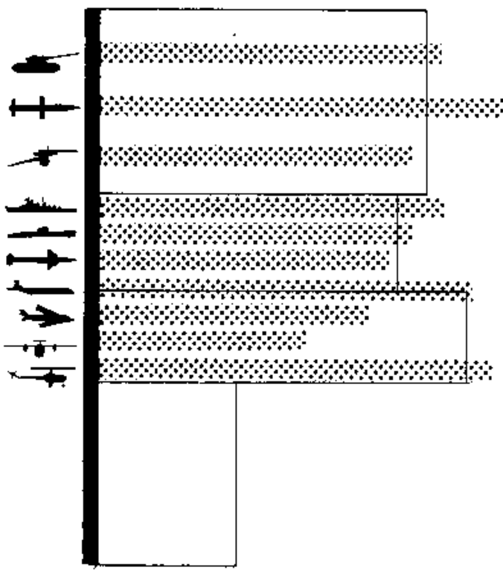

YEMEN
YUGOSLAVIA
ZAIRE
ZAMBIA

COMPARATIVE MILITARY STRENGTHS
NUCLEAR POWERS

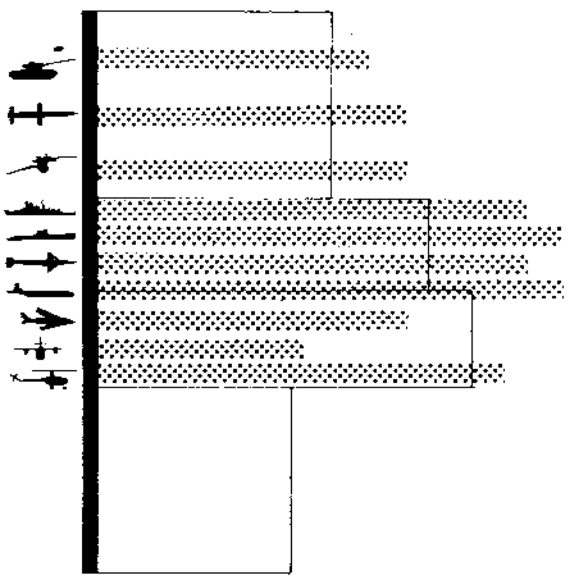
CHINA (Peoples Republic)

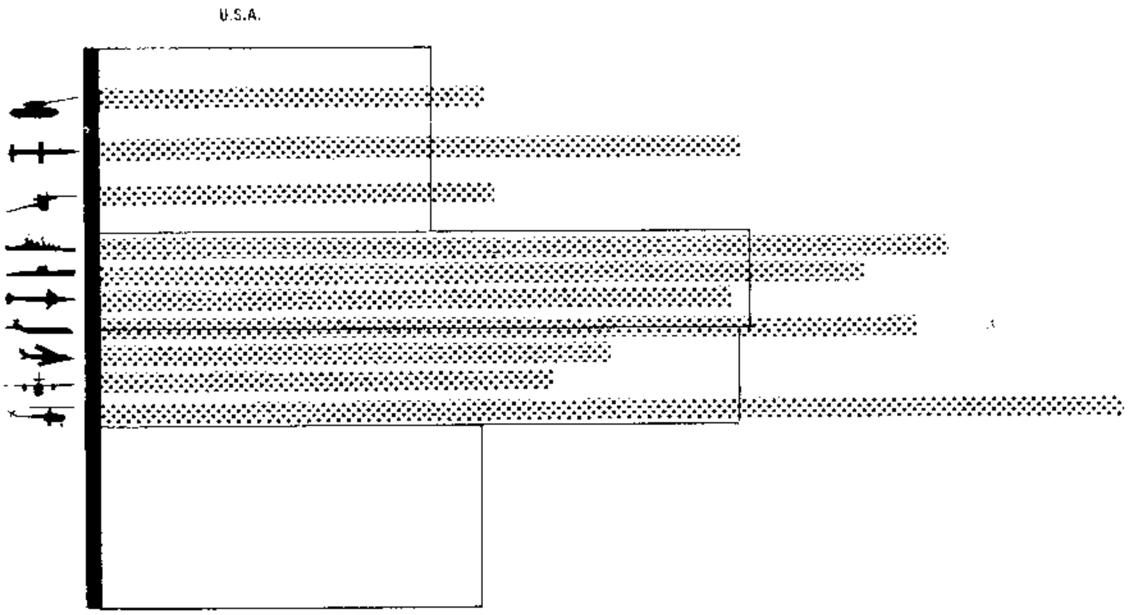


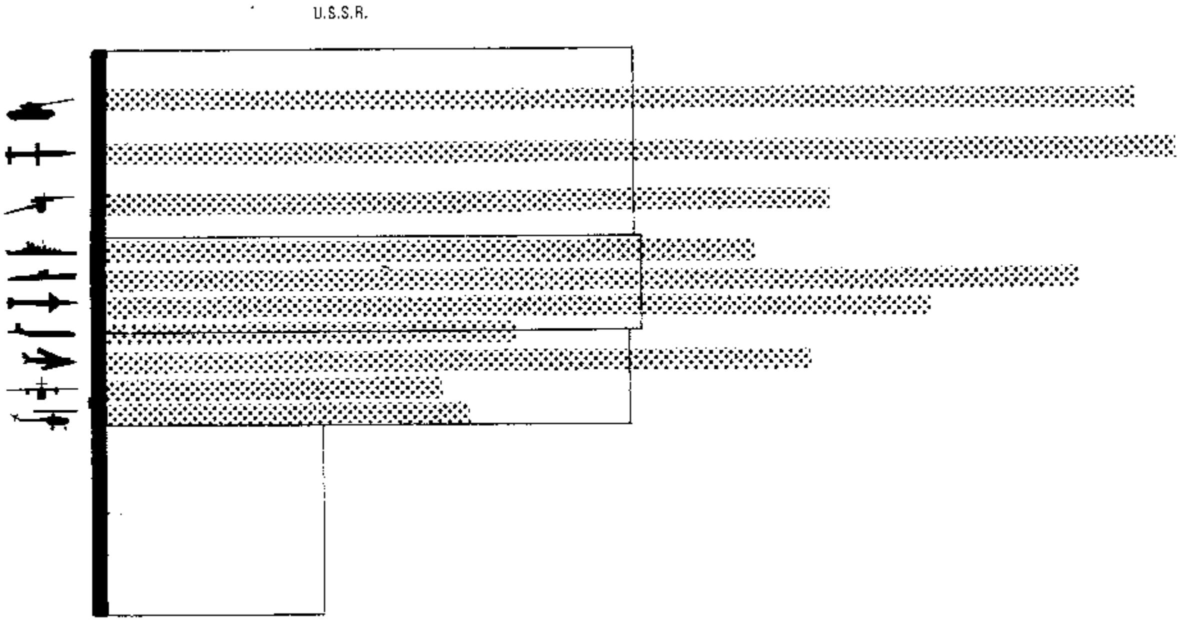
FRANCE



U.K.







To accommodate the equipment inventories of the two 'super-powers', the charts on this page are scaled down by one-third.

NUMERICAL LIST OF ENTRIES

Entry Number	Subject	Book Section	Country
1001.281	AWCLS – All-Weather Carrier Landing System	1970-71	
1002.283	SPN-41 Carrier Approach & Landing System	1970-71	
1003.283	SPN-42 Carrier Automatic Landing System	1970-71	
1005.183	TRN-28 Land-Based Version of SPN-41	1970-71	
1006.181	TILS Tactical Instrument Landing System	1970-71	
1007.161	TSQ-82 Photo Interpretation System	1970-71	
1008.393	XM-76 Sighting System		USA
1009.393	Type AF 120 Gyro-Stabilised Sight		UK
1010.351	AN/USQ-28 Geodetic Mapping & Survey System	1970-71	
1011.453	UDACS-1 Underwater Detection & Classification System	1970-71	
1012.393	ISIS Weapon Aiming System		UK
1013.341	HS801 Nimrod MR 1 ASW Aircraft	1969-70	
1014.373	DS 5500 Tactical Display System	1970-71	
1015.341	P-3 Orion ASW Aircraft	1969-70	
1016.341	Breguet 1150 Atlantic ASW Aircraft	1969-70	
1018.153	Cymbeline Mortar Locating Radar		UK
1019.231	Seacat Shipborne Surface to Air Missile		UK
1020.281	NA 9 Ship's Fire Control System		Italy
1021.293	Marconi 323 Series Military TV		UK
1022.311	Martel AS.37 / AJ.168 Air to Surface MISSILE		UK
1023.353	EMI Sideways Looking Recce Radar Type P391		UK
1024.353	Type 195 Helicopter Sonar		UK
1025.273	Outfit JYA Automatic Surface Plotter	1970-71	
1026.341	SH-3D Sea King ASW Helicopter	1969-70	
1027.353	ARI 5955 / ARI 5954 Helicopter Tactical Radar		UK
1028.353	E290M Combined Weather & Tactical Radar		UK
1029.393	Ekco Missile MD 1 Systems	1970-71	
1030.231	Talos Shipborne Surface-to-Air Missile		USA
1031.353	Airpass I		UK
1032.353	Airpass III		UK
1033.353	Airpass II		UK
1035.353	Ferranti Lightweight Ranging & Terrain Warning Radar	1971-72	
1036.383	FE 541 Inertial Nav/Attack System	1970-71	
1037.353	AN/APN-170 Terrain Following Radar		USA
1038.183	Chieftain Tank Gun Control Equipment		UK
1039.393	NV-100 Low Light Level TV Camera System	1973-74	
1040.261	ADA Action Data Automation System, HMS Eagle	1972-73	
1041.253	Type 984 Naval Air Surveillance Radar		UK
1042.263	Ferranti Poseidon Computer	1970-71	
1043.261	ADA Mk 1		UK
1044.261	ADA WS Mk II Action Data Automation System		UK
1045.263	Ferranti FM 1600 Digital Computer	1970-71	
1046.263	Ferranti F1600 Digital Computer	1970-71	
1047.263	Ferranti FM1600B Digital Computer	1970-71	
1048.191	Action Speed Tactical Trainer (ASTT)	1970-71	
1049.281	Gun System Automation (GSA4/GWS24)	1971-72	
1050.353	Cyrano I bis Fire Control Radar	1972-73	
1051.353	Cyrano II Airborne Attack Radar		France
1052.353	Cyrano III Forward Looking Radar		France
1053.281	Vega Series Ships Fire Control System		France
1054.281	Vega-Castor Fire Control System	1973-74	
1055.281	Vega-Pollux Fire Control System	1973-74	
1056.281	Vega-Pollux PC Fire Control System	1973-74	
1057.281	Vega-Pollux PCE Fire Control System	1973-74	
1058.281	Vega-Pollux PCET Fire Control System	1973-74	
1059.281	Vega-Triton BF Fire Control System	1970-71	
1060.281	Vega-Triton E Fire Control System	1973-74	
1061.281	Vega-Triton T Fire Control System	1973-74	
1062.253	Triton Surveillance Radar		France
1063.253	Castor Tracker Radar		France
1064.253	Pollux Tracker Radar		France
1065.373	Tactical Display, ASW		France
1067.453	Sonobuoys Types DSTA3 & DSTV 2K		France
1068.353	Omera-Segid Reconnaissance Cameras	1970-71	
1069.363	Sagem AE 51 Digital Computer	1970-71	
1070.353	Cyclope Airborne I/R Recce System		France
1071.363	LCT 825 Digital Computer	1970-71	
1072.363	LCT CS2 Digital Computer	1970-71	
1073.393	SFENA 12B Miss-Distance Acoustic Detector	1970-71	
1074.393	Type 295 Missile Fire Simulator	1972-73	
1075.163	TIV 1050 Digital Computer	1970-71	
1076.383	Twin-Gyro Platform Type 250	1970-71	
1077.191	Sintra Simulators	1970-71	
1078.311	Blue Steel Stand-off Bomb		UK
1079.331	Firestreak Air to Air Missile		UK
1080.331	Red Top Air to Air Missile		UK
1081.311	Condor (AGM-53A) Air to Surface Tactical Missile		USA
1082.331	Falcon Air to Air Missile Series	1973-74	
1083.331	Falcon (AIM-4A) Air to Air Missile		USA
1084.331	Falcon (AIM-4C) Air to Air Missile		USA
1085.331	Falcon (AIM-4D) Air to Air Missile		USA
1086.331	Super Falcon (AIM-4E & F) Air to Air Missile		USA
1087.331	Super Falcon (AIM-4G) Air to Air Missile		USA
1088.331	Falcon (AIM-4H) Air to Air Missile	1972-73	
1089.331	Falcon (AIM-26A & AIM-26B) Air to Air Missile		USA
1090.331	Falcon (AIM-47A) Air to Air Missile		USA
1091.331	Genie (AIR-2A) Air to Air Missile		USA
1092.311	HART/ZAP Air to Surface Missile		USA
1093.311	Hound Dog (AGM-28A & B) Air to Ground Missile		USA
1094.383	KS-120/KS-140 Astro Tracking Sub-System	1970-71	
1095.311	Blue Eye (XAGM-79A) Air to Surface Missile	1972-73	
1096.311	Viper (XAGM-80A) Air to Surface Missile	1971-72	
1097.311	Hornet (ZAGM-64A) Air to Surface Missile		USA
1098.311	Maverick (ZAGM-65A) Air to Surface Missile		USA
1099.331	Phoenix (AIM-54A) Air to Air Missile		USA
1100.353	AN/AWG-9 Airborne Missile Control System		USA
1101.391	Quail (ADM-2C) Decoy Missile		USA
1102.311	Shrike (AGM-54A) Air to Surface Missile		USA
1103.331	Sidewinder 1A (AIM-9B) Air to Air Missile		USA
1104.331	Sidewinder 1C (AIM-9C & D) Air to Air Missile		USA
1105.331	Sidewinder (AIM-9E) Air to Air Missile		USA
1106.331	Sparrow III (AIM-7) Air to Air Missile		USA
1107.311	SRAM (AGM-69A) Short Range Attack Missile		USA
1108.303	M5 Aircraft Armament System		USA
1109.303	XM8 Armament Subsystem		USA
1110.303	M16 Armament Subsystem		USA
1111.303	XM18E1 Armament Pod		USA
1112.303	M21 Aircraft Armament System		USA
1113.303	M23 Armament Subsystem		USA
1114.303	M24 Armament Subsystem		USA
1115.303	XM27E1 Armament Subsystem		USA
1116.303	XM28 Armament System		USA
1117.303	XM28E1 Armament Subsystem		USA
1118.303	XM35 Armament Subsystem		USA
1119.303	XM156 Armament Mount		USA
1120.303	XM140 Automatic Gun		USA
1121.303	XM93/XM94 Armament Subsystem		USA
1122.231	Standard (RIM-66A & RIM-67A) Surface to Air Missile		USA
1123.311	Standard ARM (AGM-78B) Anti Radiation Missile		USA
1124.193	AN/VGS-3 (XM23E2) Laser Range Finder		USA
1125.161	FADAC System		USA
1126.193	M43 Periscope		USA
1127.373	Specto Head Up Display	1970-71	
1128.441	Subroc (UUM-44A) Anti Submarine Missile		USA
1129.311	Walleye (AGM-62A) Air to Surface Missile		USA

1130.411	Polaris A 2 (UGM-27B) Fleet Ballistic Missile	USA
1131.411	Polaris A-3 (UGM 27C) Fleet Ballistic Missile	USA
1132.414	US Navy FBM Submarines	USA
1133.411	Poseidon C-3 (UGM-73A) Fleet Ballistic Missile	USA
1134.411	MSBS Submarine Launched Ballistic Missile	France
1135.173	*Plessey Mk 7 Tabular Viewing Unit*	*1970-71*
1136.173	*Type PSD 100 Synthetic Display Drive*	*1970-71*
1137.173	*Plessey Mk 5 Radar Displays*	*1970-71*
1138.173	*Plessey Mk 8 Modular Display System*	*1970-71*
1139.253	*Plessey AWS-1 Naval Radar*	*1972-73*
1140.153	Plessey AR-1 Radar	UK
1141.153	Plessey AR-15 Mobile Surveillance Radar	UK
1142.153	Plessey Type HF-200 Height Finder Radar	UK
1143.331	Alkali Air to Air Missile	USSR
1144.331	Anab Air to Air Missile	USSR
1145.331	Ash Air to Air Missile	USSR
1146.331	Atoll Air to Air Missile	USSR
1147.311	Kangaroo Air to Surface Missile	USSR
1148.311	Kennel Air to Surface Missile	USSR
1149.311	Kelt Air to Surface Missile	USSR
1150.311	Kipper Air to Surface Missile	USSR
1151.311	Kitchen Air to Surface Missile	USSR
1152.411	Sark Submarine Launched Ballistic Missile	USSR
1153.411	Serb Submarine Launched Ballistic Missile	USSR
1154.411	Sawfly Submarine Launched Ballistic Missile	USSR
1155.221	Styx Shipborne Surface to Surface Missile	USSR
1156.221	MM38 Exocet Surface to Surface Missile	France
1157.253	*DUBA-3A Surface Vessel Sonar*	*1973-74*
1158.253	*SQS-17A Surface Vessel Sonar*	*1973-74*
1159.253	DUBV-23 Sonar (Sub-assemblies DAT & LVA)	France
1160.353	*DUAV-1B Helicopter Sonar*	*1970-71*
1161.453	*DUUA 1A/B/C Submarine Sonar*	*1973-74*
1162.453	DUUX-2A/B/C Passive Sonar	France
1163.441	E14 Acoustic Torpedo	France
1164.441	E15 Acoustic Torpedo	France
1165.441	L3 Acoustic Torpedo	France
1166.421	Z16 Torpedo	France
1167.453	*MF65 & MF65-P1 Hydrophones*	*1970-71*
1168.153	Marconi S600 Series Radars	UK
1169.173	*Marconi Photographic Positive/Negative Viewer*	*1970-71*
1170.311	AS 20 Air to Surface Missile	France
1171.311	AS.30 Air to Surface Missile	France
1172.311	*AS.30L Air to Surface Missile*	*1972-73*
1173.311	AS.11 Air to Surface Missile	France
1174.311	AS.12 Air to Surface Missile	France
1175.221	SS.12M Surface to Surface Missile	France
1176.331	R.530 Air to Air Missile	France
1177.231	Masurca Surface to Air Missile System	France
1178.331	R.511 Air to Air Missile	France
1179.241	Malafon Surface to Sub-Surface Missile	France
1180.321	Kormoran Air to Surface Anti-Shipping Missile	W Germany
1181.181	NADGE-NATO Air Defence Ground Environment	NATO
1182.303	Mk 4 Mod 0 Gun Pod	USA
1183.303	Mk 11 Mod 5 20 mm Gun	USA
1184.231	*Murene/Mureca Surface to Air Missile System*	*1973-74*
1185.311	Hellcat Air to Surface Missile	UK
1186.331	*Taildog Air to Air Missile*	*1970-71*
1187.331	Mitsubishi AAM-1 Air to Air Missile	Japan
1188.331	Mitsubishi AAM-2 Air to Air Missile	Japan
1189.321	Robot Rb 04 Air to Surface Missile	Sweden
1190.311	Rb 05A Air to Surface Missiles	Sweden
1191.004	*US Missile Names and Designations*	*1973-74*
1192.004	*US Rocket & Missile Designation System*	*1971 72*
1194.354	Table of Airborne Radar Equipment	International
1195.154	Table of Ground Radar Equipment	International
1196.393	Ferranti Laser Ranger & Marked Target Indicator	UK
1197.373	*Unihedd Multi Mode Display*	*1970 71*
1198.153	*MV.21 Series Instantaneous Frequency Measuring Receivers*	*1972-73*
1199.353	Hawker Siddeley Dynamics Type 201 Infra-Red Linescan	UK
1200.331	*AIM-82A Short Range Air-to-Air Missile*	*1972 73*
1201.183	*Omega Navigation System*	*1970-71*
1202.283	*AN/SRN-12 Omega Navigation Receiver*	*1970-71*
1203.193	Harrier Flight Simulator	UK
1204.351	*UK Airborne Early Warning System*	*1970-71*
1205.373	*Elliott Head Down Display*	*1970-71*
1206.373	*Elliott Head Up Displays*	*1970-71*
1207.293	Shorts Target Designation Sight	UK
1208.353	UAP 12 Series Airborne Attack Radars	Sweden
1209.353	UAP 13 Séries Airborne Attack Radars	Sweden
1210.353	UAP 1011 (PS-37/A) Airborne Attack Radar	Sweden
1211.353	Aida II Fire Control Radar	France
1212.373	*AJ37 Viggen Head-Up and Head-Down Display System*	*1970-71*
1213.253	UAL 10102 Marine Laser Range Finder	Sweden
1214.193	*SFENA LPCB II Bomb Scoring Equipment*	*1970-71*
1215.193	*SFENA Type 14 Miss Distance Indicator*	*1970-71*
1216.335	Ferranti Strike & Terrain Following Radar	UK
1217.253	Sonar DUBV-24A	France
1218.253	*Alcatel Premo Search & Attack Sonar*	*1973-74*
1219.353	*HS-70 Helicopter Sonar*	*1973-74*
1220.391	Scad Decoy Missile	USA
1221.253	MS 32 Sonar	UK
1222.453	*XBT Expendable Bathythermograph*	*1970-71*
1223.263	Plessey Accustic Ray Trace Indicator	UK
1224.353	PTR 820 Airborne IFF	UK
1225.393	*Model 800B-7 Miss Distance Indicator*	*1970-71*
1226.393	*Digidops Miss Distance Indicator*	*1970-71*
1227.393	*Model 800B-4 Miss Distance Indicator*	*1970-71*
1228.393	*Hayes TA-8 Towbee Targets*	*1970-71*
1229.393	*Hayes TJT-1 Towed Target*	*1970-71*
1230.393	*Hayes Target AZC-1*	*1970-71*
1231.383	Saab TVT-300 Automatic TV-Tracker	Sweden
1232.281	Alcatel DLT-L-4C Torpedo Launch Control System	France
1233.481	TIOS Tactical Information Organisation System	UK
1234.261	ADAWS 4 Action Data Automation Weapon System	UK
1235.261	ADAWS 5 Action Data Automation Weapon System	UK
1236.253	Jupiter (TH.D 1077) naval radar	France
1237.253	Saturne (TH.D 1041) naval radar	France
1238.153	*Lynx (TH.D 1051) Mine Watch Radar*	*1972-73*
1239.253	*Ramses (TH.D 1022) Naval Radar*	*1972-73*
1240.453	Calypso II (TH.D 1030) Submarine Radar	France
1241.281	Gun Fire Control System Mk 86	USA
1242.281	MRS3/GWS22 Fire Control System	UK
1243.281	*Argo 10 Fire Control System*	*1971-72*
1244.281	DLB-1 Anti-Submarine Weapon Control System	France
1245.253	Raytheon RTN-10 Fire Control Radar	USA
1246.331	Awl Air to Air Missile	USSR
1247.253	SPG-51 Radar	USA
1248.253	SPS-52 Radar	USA
1249.253	SPS-39 (Frescan) Radar	USA
1250.253	SPS-32 (Scanfar) Radar	USA
1251.253	SPS-33 (Scanfar) Radar	USA
1252.253	SPS-48 Air Surveillance Radar	USA
1253.253	RN Type 975 Radar	UK
1254.253	RN Type 978 Radar	UK
1255.253	*RN Type 992 Radar*	*1973-74*
1256.253	LW.02 Naval Radar	Netherlands
1257.253	Signaal Naval Height-Finder Radar	Netherlands
1258.253	Signaal Surface Warning & Navigation Radar	Netherlands
1259.281	M20 Series Fire Control Systems	Netherlands
1260.281	Gun Fire Control System Mk 87	USA
1261.281	M40 Series Fire Control Systems	Netherlands
1262.283	*Sagem LH C Electromagnetic Log*	*1970-71*
1263.303	SURA 80 mm Aircraft Rocket	Switzerland
1264.393	ML Lightweight Low-Drag Twin Store Carrier	UK

1265.393	ML Carrier Bomb Light Stores No 100	UK
1266.393	Miles Weapon Release System – EMRU No 20	UK
1267.393	British Bomb Retarding System	UK
1268.303	Minigun Pod Type SUU 11B/A	USA
1269.303	Aircraft Gun Type 304 RK	Switzerland
1270.303	Vulcan 20 mm Aircraft Gun & Linkless Feed System	USA
1271.303	30 mm Aircraft Gun DEFA Type 552	France
1272.303	Hispano 20 mm Tactical Air Armament	Switzerland
1273.303	30 mm Aircraft Gun DEFA Type 553	France
1274.303	68 mm SNEB Rocket	France
1275.303	Aircraft Gun 20 mm M.621 Model F1	France
1276.273	*TTF/TTG Tactical Plotting Table*	*1970-71*
1277.303	Cluster Bomb Type 600 lb No 1 Mk 1	UK
1278.393	*Matra 18 x 68 mm Rocket Launchers Types 150 & 155*	*1970-71*
1279.393	*Matra Expendable Launcher Type 116*	*1970-71*
1280.311	Bullpup (AGM-12) Air to Surface Tactical Missile	USA
1280.393	ML Ejector Release Unit No 122 Mk 2	UK
1281.303	Matra 30 mm Gun Pods	France
1282.393	ML Bomb Carrier Universal Two Store	UK
1283.393	*Stores Rack AW1 Models 11-005-001 and 11-006-001*	*1970-71*
1284.303	5.56 mm Minigun	USA
1285.303	XM 188 30 mm Three-Barrel Aircraft Gun	USA
1286.303	XM 197 20 mm Three-Barrel Aircraft Gun	USA
1287.303	Vulcan Gun Pods SUU 16/A & 23/A	USA
1288.303	20/30 mm Flexible Weapon System	USA
1289.283	*Sagem CG-J Gyro Compass*	*1970-71*
1290.283	*Sagem VG-C Vertical Gyro*	*1970-71*
1291.463	*Alcatel Sound Field Plotter*	*1972-73*
1292.261	Alcatel Anti-Submarine Action Data System	France
1293.193	Avimo Weapon simulators	UK
1294.383	*SRAM (AGM-69A) Guidance and Control Unit KT76*	*1970-71*
1295.383	*AN/ASN-90 Inertial Measuring Set*	*1970-71*
1296.383	*AN/APN-190(V) Doppler & Signal Converter*	*1970-71*
1297.383	*AN/APN-185 Doppler*	*1970-71*
1298.383	*ASN-57 & ASN-58 Gyro-compassing Altitude Reference System*	*1970-71*
1299.383	*AN/ASN-100 GAVRS*	*1970-71*
1300.383	*Orion Doppler/Inertial Systems APN-187/ASN-84*	*1970-71*
1301.321	Harpoon Anti-Shipping Missile	USA
1302.331	Agile Air-to-Air Missile	USA
1303.331	*Bomber Defence Missile*	*1973-74*
1304.351	AWACS – Airborne Warning & Control System	USA
1305.351	Moss Soviet Early Warning Aircraft	USSR
1306.283	*Arma Brown Heading Reference System*	*1970-71*
1307.231	SAMID-Ship Anti-Missile Integrated Defence	USA
1308.331	Sidewinder (AIM-9G/H) Missile	USA
1309.481	Submarine Torpedo Fire Control System DLT-S-4E	France
1310.353	AN/APQ-120 Fire Control Radar	USA
1311.353	AN/APS-119 (XN-1) Airborne Surface Search Radar	USA
1312.383	*Jaguar Nav/Attack System*	*1970-71*
1313.353	*AHV/6 Radio Altimeter*	*1970-71*
1314.163	*Sperry 1412 Digital Processor*	*1970-71*
1315.363	*Sagem MS-A-200 Airborne Disc Memory*	*1970-71*
1316.383	*Sagem NS1 Inertial Navigator*	*1970-71*
1317.373	Thomson-CSF Series 120-190 Attack Sights	France
1318.253	Strand Naval Radar	USSR
1319.253	Aldwych Naval Radar	USSR
1320.253	Kingsway Naval Radar	USSR
1321.253	Holborn Naval Radar	USSR
1322.253	Haymarket Naval Radar	USSR
1323.253	Piccadilly Fire Control Radars	USSR
1324.253	Cornhill Naval Radars	USSR
1325.253	Cheapside Fire Control Radar	USSR
1326.253	Barbican Fire Control Radar	USSR
1327.253	Knightsbridge 3-D Radar	USSR
1328.253	Millbank Radar Group	USSR
1329.253	Aldgate Naval Radar	USSR
1330.253	Bankside Fire Control Radar	USSR
1331.253	Minories Search Radar	USSR
1332.254	Naval Radar Table	
1333.091	Electronic Warfare Systems, Note	–
1334.453	DUBV-43 Variable Depth Sonar	France
1335.273	Operations Summary Group	USA
1336.221	Otomat Anti-Ship Missile	International
1337.121	Otomat Anti-Ship Missile	International
1338.321	Otomat Anti-Ship Missile	International
1339.221	Penguin Anti-Ship Missile	Norway
1340.293	Look-Out Aiming Sight Mk 1	UK
1341.253	Decca RDL Series Radar Detection Systems	UK
1342.253	Ferranti Seaspray Helicopter ASV Radar	UK
1343.321	*HLM– Helicopter Launched Missile*	*1972-73*
1344.331	SRAAM-100 Air-to-Air Missile	UK
1345.391	GUFO Tactical Reconnaissance System	Italy
1346.353	Type 401 Infra-Red Linescan	UK
1347.353	*Type 601 Infra-Red Linescan*	*1971-72*
1348.331	R550 Magic Air-to-Air Missile	France
1349.331	Super 530 Air-to-Air Missile	France
1350.321	*Albatros Anti-Ship Missile*	*1973-74*
1351.353	Oryx Attack Radar	France
1352.353	Saiga Helicopter Radar	France
1353.231	Hirondelle Air Defence System	France
1354.393	*LT 102 Laser Range-Finder*	*1972-73*
1355.453	*DUBY-24 Sonar*	*1972-73*
1356.453	Thomson-CSF Passive Sonar	France
1357.253	DUBM-20A Mine Hunting Sonar	France
1358.253	DUBM-40X Mine Hunting Sonar	France
1359.253	SPS-58 Naval Radar	USA
1360.173	Radar Display Console IP-17-A	France
1361.273	Sintra Marine Display Unit	France
1362.273	CT-EE Display Unit	France
1363.261	Commodore AIO System	UK
1364.253	RAN-3L Naval Radar	Italy
1365.253	RAN-11 L/X Naval Radar System	Italy
1366.253	*RAN-14X Naval Radar*	*1972-73*
1367.253	Orion RTN-16X Naval Radar	Italy
1368.253	Orion RTN-10X Naval Radar	Italy
1369.173	ATAC Display Equipment	France
1370.273	PLAD Automatic Data Plotter	France
1371.393	EMI Miniature Moonlight Television	UK
1372.063	AIL Type 707 Spectrum Analyser	USA
1373.253	RN Mine Hunting System (Acoustic) Mk 1	UK
1374.253	MS 70 Mine Hunting System	UK
1375.481	M8 Submarine Torpedo Fire Control System	Netherlands
1376.393	LME Airborne Laser Range-Finder	Sweden
1377.393	TA 101 & TAY 18 Airborne Laser Range-Finders	France
1378.091	Elint Equipment	–
1379.091	EW Direction Finders	–
1380.091	EW Antennas	–
1381.053	L-3/A – WJ-1140 Microwave Direction Finding System	USA
1382.063	WJ-1007 Microwave Collection System	USA
1383.363	ASQ-91 Weapon Release Computer Set	Canada
1384.393	GE Low Light Level TV Camera	USA
1385.173	Sintra Colour Display Console	France
1386.363	ASQ-501 Magnetic Anomaly Detector	Canada
1387.393	*AMPC for Magnetic Anomaly Detectors*	*1973-74*
1388.393	ASA-65 9-Term Compensator	Canada
1389.353	DHAX-1 Magnetic Anomaly Detector	France
1390.353	DHAX-3 Magnetic Anomaly Detector	France
1391.311	Hellfire Tactical Air-to-Surface Missile	USA
1392.351	147 Series Reconnaissance Drones	USA
1393.351	154 Firefly Reconnaissance Drones	USA
1394.253	RN Type 1006 Radar	UK
1395.353	*RH370 Helicopter Radar*	*1972-73*
1396.353	Cyrano IV Attack Radar	France
1397.151	Igloo White Surveillance System	USA
1398.302	LAMPS Helicopter	USA
1399.302	*INFANT–UH-1M Iroquois Helicopter*	*1973-74*
1400.302	*SMASH – SE Asia Multiple Sensor Armament System Helicopter*	*1973-74*
1401.353	APQ-137 Airborne Radar	USA
1402.302	Orion P-3 Aircraft	USA

1403.302	S-3A ASW Aircraft	USA
1404.302	Hawkeye E-2 AEW Aircraft	USA
1405.302	Mohawk OV-1 Reconnaissance Aircraft	USA
1406.302	Mirage Milan Aircraft	France
1407.302	Tomcat F-14A Aircraft	USA
1408.302	Phantom II F-4E	USA
1409.302	RB-57A Aircraft	USA
1410.302	RA-5C Aircraft	USA
1411.302	SR-71 Reconnaissaince Aircraft	USA
1412.302	Kiowa OH-58A Helicopter	USA
1413.302	*Blackhawk S-67 Helicopter*	*1973-74*
1414.302	Skyhawk A-4M Aircraft	USA
1415.063	*UYK-501 Computer*	*1972-73*
1416.063	*IP 08C Computer*	*1973-74*
1417.063	*Camille Computer*	*1973-74*
1418.063	*AE-51 Computer*	*1973-74*
1419.063	*EMD Type A Computer*	*1973-74*
1420.063	*EMD Type B Computer*	*1973-74*
1421.063	*CNM-1 Computer*	*1973-74*
1422.063	*Iris 55M Computer*	*1973-74*
1423.063	*Iris 35M Computer*	*1973-74*
1424.063	*Type SMR Computer*	*1973-74*
1425.063	*Type SM-3 Computer*	*1973-74*
1426.063	*CK-37 Computer*	*1973-74*
1427.063	*Censor 908 Computer*	*1973-74*
1428.063	*Censor 932 Computer*	*1973-74*
1429.063	*Argus 400 Computer*	*1971-72*
1430.063	*FM 1200 Computer*	*1971-72*
1431.063	*F 1600 Computer*	*1973-74*
1432.063	*FM 1600 Computer*	*1973-74*
1433.063	*FM 1600B Computer*	*1973-74*
1434.063	*FM 1600C Computer*	*1973-74*
1435.063	*FM 1600D Computer*	*1973-74*
1436.063	*Poseidon Computer*	*1973-74*
1437.063	*Myriad II Computer*	*1973-74*
1438.063	*Myriad III Computer*	*1973-74*
1439.063	*AA6701 Computer*	*1973-74*
1440.063	*920 M Computer*	*1972-73*
1441.063	*MCS 920M Computer*	*1973-74*
1442.062	*920C Computer*	*1973-74*
1443.063	*Type 1412 Computer*	*1973-74*
1444.063	*D26J Computer*	*1973-74*
1445.063	*D37B Computer*	*1973-74*
1446.063	*D200 Computer*	*1973-74*
1447.063	*Verdan Computer*	*1973-74*
1448.063	*BR-1018 Computer*	*1973-74*
1449.063	*D84 Computer*	*1973-74*
1450.063	*Alpha Series Computers*	*1973-74*
1451.063	*Alert Computer*	*1973-74*
1452.063	*H4400 Computer*	*1973-74*
1453.063	*HCM-205 Computer*	*1973-74*
1454.063	*L-300 & L-3000 Series Computers*	*1973-74*
1455.063	*NDC-1051 Computer*	*1973-74*
1456.063	*NDC-1060 Computer*	*1973-74*
1457.063	*NDC-1070 Computer*	*1973-74*
1458.063	*SKC-2000 Computer*	*1973-74*
1459.063	*GPK-10 Computer*	*1972-73*
1460.063	*GPK-20 Computer*	*1973-74*
1461.063	*GPK-33 Computer*	*1973-74*
1462.063	*Micro-Minac Computer*	*1972-73*
1463.063	*ASN-24(V) Computer*	*1973-74*
1464.063	*ASN-25(G) Computer*	*1973-74*
1465.063	*L90 Series Computers*	*1972-73*
1466.063	*ASP Computers*	*1973-74*
1467.063	*UYK-7 Computer*	*1973-74*
1468.063	*Type 1230 Computer*	*1973-74*
1469.063	*Type 1832 Computer*	*1973-74*
1470.063	*CNM-2 Computer*	*1973-74*
1471.063	*LCT 825P Computer*	*1973-74*
1472.063	*LCT CS2 Computer*	*1973-74*
1473.063	*TIV 1050 Computer*	*1973-74*
1474.451	MSS (Moored Sea Surveillance) System	USA
1475.353	Look Two Airborne Radar	USSR
1476.353	Puff Ball Airborne Radar	USSR
1477.353	Scan Fix Airborne Radar	USSR
1478.353	Short Horn Airborne Radar	USSR
1479.353	Scan Odd Airborne Radar	USSR
1480.353	Scan Three Airborne Radar	USSR
1481.353	Skip Spin Airborne Radar	USSR
1482.353	Spin Scan Airborne Radar	USSR
1483.363	Sensor Data Processing System	Canada
1484.353	APS-94 Sideways Looking Radar	USA
1485.353	APS-116 Airborne Radar	USA
1486.353	APQ-139 Airborne Radar	USA
1487.353	APQ-122 Airborne Radar	USA
1488.353	APQ-140 Airborne Radar	USA
1489.353	APQ-92 Airborne Radar	USA
1490.353	APQ-112 Airborne Radar	USA
1491.353	*Esaira Airborne Radar*	*1972-73*
1492.091	Active Electronic Counter-Measures	–
1493.261	US Naval Tactical Data System	USA
1494.161	Marine Tactical Data System	USA
1495.281	*Vega-Pollux SC Fire Control System*	*1973-74*
1496.281	WSA-4 Fire Control System	UK
1497.091	Passive Electronic Counter-Measures	–
1498.094	US Electronic Intelligence & Monitoring Equipment, Table	USA
1499.094	US Electronic Warfare Direction Finding Equipment, Table	USA
1500.094	US Noise Jammers, Table	USA
1501.094	US Deception Jammers, Table	USA
1502.094	US Chaff Dispenser Equipment, Table	USA
1503.351	*Joint Services In-Flight Data Transmission System (JIFDATS)*	*1973-74*
1504.351	Compass Reconnaissance Programmes	USA
1505.094	NATO Designations of Soviet Systems & Equipment	USSR
1506.351	*Reconnaissance Satellites*	*1971-72*
1507.253	Boat Sail Submarine Radar	USSR
1508.253	ST 801 Naval Tracking Radar	UK
1509.303	Giboulee Dispenser	France
1510.303	Hotchkiss Brandt 100 mm Aircraft Rocket	France
1511.393	Matra Unguided Aircraft Rocket Launchers	France
1512.303	Streuwaffen	Germany (Federal Republic)
1513.303	135 mm Bofors Air-to-Ground Rocket System	Sweden
1514.393	Matra Type 200 Bomb Retarding System	France
1515.393	ML Lightweight Twin Store Carrier (High Strength)	UK
1516.393	ML ERU No 123 (MACE)	UK
1517.393	ML Light Four-Store Carrier	UK
1518.393	Thomson-CSF R Series Gunsights	France
1519.393	AGAT Air-to-Surface Weapon Aiming System	France
1520.193	Sintra-EF Simultaors	France
1521.454	Sonar Equipment, Table	International
1522.261	SENIT Tactical Data Handling Systems	France
1523.391	Turana Target Drone	Australia
1524.261	WSA-400 Series Naval Weapon Control Systems	UK
1525.263	SP1-03 Sound Ray Path Analyser	Netherlands
1526.153	Forward Area Alerting Radar TPQ-32 / MPQ-49	USA
1527.253	RAN-7S Naval Radar	Italy
1528.153	RATAC Battlefield Radar	France
1529.153	LPD-20 Search Radar	Italy
1530.321	CL 834 Helicopter Air-to-Surface Missile	UK
1531.311	Strebo Air-to-Surface Area Weapons	W Germany
1532.311	Jumbo Air-to-Surface Missile	W Germany
1533.311	Paveway Air-to-Ground Weapon Delivery Systems	USA
1534.311	Paveway I Laser Guided Bombs	USA
1535.331	South African Air-to-Air Missile	S Africa
1536.351	*KAD Reconnaissance Drone*	*1973-74*
1537.351	Dornier Aerodyne	W Germany
1538.351	L450F Reconnaissance Drone	USA
1539.351	Beech QU-22B Bonanza Drone	USA
1540.391	SPT-B Selectable Performance Target Ballistic (BATS)	USA
1541.281	TORCI Torpedo Fire Control System	Sweden
1542.281	9 LV 200 Fire Control System	Sweden
1543.281	Seafire Weapon Control System	Sweden
1544.481	9 TCI 210 Submarine Torpedo Fire Control System	Sweden
1545.453	SUBFAR Submarine Radar	Sweden
1546.253	9 GR 600 Radar Transmitter / Receiver	Sweden
1547.253	9 LV 200 Tracking Radar	Sweden
1548.181	9 KA 400 Coastal Artillery Fire Control System	Sweden
1549.153	9 GR 600 Radar	Sweden

1550.281	Argo NA 10 Fire Control Systems	Italy
1551.281	Albatros Air Defence System	Italy
1552.281	Sea Hunter-4 Fire Control System	Italy / Switzerland
1553.253	LW.04 Naval Air Surveillance Radar	Netherlands
1554.253	DA.05 Naval Surveillance Radar	Netherlands
1555.253	ZW.06 Surface Search and Navigation Radar	Netherlands
1556.153	STAR – Signaal Terminal Area Radar	Netherlands
1557.153	SLAM – Signaal Low Air Defence Module	Netherlands
1558.253	RN Type 912 Radar	Italy
1559.253	RN Type 909 Radar	UK
1560.253	RN Type 965 Radar	UK
1561.253	RN Types 967 and 968 Radars	UK
1562.253	RN Type 910 Radar	UK
1563.253	MRS3 / GWS22 Fire Control Radar	UK
1564.253	SPS-10 Radar	USA
1565.253	SPS-37 Radar	USA
1566.253	SPS-12 Radar	USA
1567.353	APQ-148 Multi-Mode Radar	USA
1568.353	NASARR Airborne Radar	USA
1569.353	APX-82 Airborne IFF Interrogator	USA
1570.253	SPY-1 Multi-Function Array Radar	USA
1571.253	Cossor Naval IFF	UK
1572.353	Cossor Airborne IFF Transponders	UK
1573.153	Pointer – Portable Independent Terma Radar	Denmark
1574.153	Terma Splash Spotting Radar	Denmark
1575.253	Terma Navigation Radar	Denmark
1576.153	DR 513 Ballistic Radar	Denmark
1577.153	M/532 Doppler Radar	Denmark
1578.253	EX 77 Mod 0 Director Group	International
1579.302	HS 1182 Strike/Trainer Aircraft	UK
1580.302	Alpha Jet	France / W Germany
1581.302	Panavia 200 MRCA	UK / Italy / W Germany
1582.302	B-1 Strategic Bomber	USA
1583.302	105 G Aircraft	Sweden
1584.261	Guided Missile Fire Control System EX 91	International
1585.353	AWACS Radar	USA
1586.302	MFI-17 Army Co-op/Trainer Aircraft	Sweden
1587.302	WG-13 Lynx Helicopter	UK/France
1588.302	SA.330 Puma Helicopter	UK/France
1589.253	Signaal 3D Multi-Target Tracking Radar	Netherlands
1590.253	Signaal M20 Series Fire Control Radar	Netherlands
1591.253	Signaal M40 Series Fire Control Radar	Netherlands
1592.303	Emerson Tactical Armament Turrets (TAT)	USA
1593.253	DRBI 10 Three-dimensional Radar	France
1594.253	DRBV 23 Naval Surveillance Radar	France
1595.253	Square Head Naval Radar	USSR
1596.253	Cylinder Head Fire Control Radar	USSR
1597.311	Smart Bombs	USA
1598.393	Alkan Type 65 Bomb Rack Adapter	France
1599.393	Alkan Type PM3 Bomb Rack	France
1600.393	Alkan Stores Ejectors	France
1601.393	HASA Rocket Rack Launcher	Spain
1602.393	*HASA Honeycomb Rocket Launchers*	*1973-74*
1603.393	HASA AH 039220 Universal Pylon	Spain
1604.393	ML Carrier Bomb Light Stores No. 200	UK
1605.253	Fansong E Naval Radar	USSR
1606.253	High Lune Height-Finder Radar	USSR
1607.253	Hair Net Naval Radar	USSR
1608.253	Big Net Search Radar	USSR
1609.253	Plinth Net Search Radar	USSR
1610.253	Top Trough Surveillance Radar	USSR
1611.253	Muff Cob Fire Control Radar	USSR
1612.253	Pot Drum Naval Radar	USSR
1613.253	Pot Head Naval Radar	USSR
1614.253	Skin Head Naval Radar	USSR
1615.063	*Teledyne 20000 Series Computers*	*1973-74*
1616.063	*Teledyne TDY-300/TDY-310 Computers*	*1973-74*
1617.063	*RCA 195 Military Computer*	*1973-74*
1618.063	*RCA 215 Military Computer*	*1973-74*
1619.163	FLER-H Tank Fire Control Computer	Sweden / W Germany
1620.281	*SATIN A Fire Control System*	*1973-74*
1621.281	*SATIN B Fire Control System*	*1973-74*
1622.281	Sea Killer Integration Kit	Italy

1623.351	*Military Satellites*	*1972-73*
1624.351	American Satellite Programmes	USA
1625.351	Cosmos Series Soviet Satellites	USSR
1626.163	Falke and Marder Computers	W Germany
1627.063	Uni-Comp Signal Analysis Systems	USA
1628.153	UAL 11201 Tank Laser and UAL 11501 Artillery Laser	Sweden / Yugoslavia
1629.393	BT9R Bombing System	Sweden
1630.393	Honeywell Helmet Sight	USA
1631.353	HS-71 / DUAV-4 Helicopter Sonar	France
1632.253	Active Buoy System Type DSAA-4	France
1633.253	Pascal Sonar	France
1634.453	DUUA-2A Sonar	France
1635.453	Bathythermograph Recorder RO-308 / SSQ-36	USA
1636.453	HS-1000 Series Sonar	Canada
1637.353	ASQ-13 Helicopter Sonar	USA
1638.353	Linescan Type 210 Series	UK
1639.353	*RCA Laser-TV System*	*1973-74*
1640.353	*Dornier Reconnaissance Pod*	*1973-74*
1641.393	RCA ASD 3000 Series TV Cameras	USA
1642.393	Thomson-CSF Low Light Television	France
1643.091	American Electronic Warfare Projects	USA
1644.091	Soviet Electronic Warfare	USSR
1645.193	LMT Simulators	France
1646.193	Florett AA Gunnery Training System	Switzerland
1647.193	Redifon Simulators	UK
1648.193	Sea King Flight Simulator	UK
1649.193	TACDEW – Tactical Advanced Combat Direction and Electronic Warfare Simulator	USA
1650.321	Airtos Air to Surface Anti-ship Missile	Italy
1651.321	Marte Helicopter Anti-ship Missile System	Italy
1652.311	Bantam (Rb 53) Airborne Anti-tank Missile	Sweden
1653.311	ASM-1 Air to Surface Missile	Japan
1654.311	Hawkswing Helicopter Anti-tank Missile	UK
1655.311	Bulldog (AGM-83A) Air to Surface Missile	USA
1656.331	Aspide Multirole Missile	Italy
1657.331	Brazo Air to Air Missile	USA
1658.331	Seek Bat (XAIM-97A) Air to Air Missile	USA
1659.331	Shafrir (Dragonfly) Air to Air Missile	Israel
1660.351	Short Skyspy Surveillance Drone	UK
1661.261	ASWDS – Anti-Submarine Warfare Data System	Netherlands
1662.481	SINBADS – Submarine Integrated Battle and Data System'	Netherlands
1663.261	CIDIS – Combat Information Display System	Netherlands
1664.281	SEWACO – Sensor, Weapon and Command System	Netherlands
1665.261	Niteroi Class AIO	Brazil / UK
1666.261	Gun Director Mk 35 Mod 0	USA
1667.302	SF 37 and SH 37 Viggen Reconnaissance Aircraft	Sweden
1668.302	SA.341 Gazelle Helicopter	France / UK
1669.302	F-15A Eagle Aircraft	USA
1670.302	A-10A Close Support Aircraft	USA
1671.302	AX-2 (IA-58) Attack Aircraft	Argentina
1672.353	Agave Airborne Radar	France
1673.353	Westinghouse WX Series Fire Control Radars	USA
1674.353	NR-AI-3A-Airborne IFF Interrogator	France
1675.353	AN/APQ-153 Fire Control Radar	USA
1676.353	AN/UPD-4 Side-looking Radar System	USA
1677.303	*GAU-7/A Aircraft Gun System*	*1973-74*
1678.303	GPU-2/A 20 mm Lightweight Gun Pod	USA
1679.393	ML Triple Store Carrier	UK
1680.393	Miles Free Fall MACE	UK
1681.393	Miles Lightweight Stores Carrier	UK
1682.393	Alkan ASW Aircraft Armament Equipment	France
1683.393	Alkan Cartridge Launchers	France
1684.393	*Saab Ejector Release Unit ULM-1*	*1973-74*
1685.393	Saab Bomb Lock ULM-3	Sweden
1686.253	*Pollux II Tracker Radar*	*1973-74*
1687.253	Sea Tiger Surveillance Radar	France
1688.253	ELI 4 IFF Interrogator	France

1689.363	*12/12 Airborne Computers*	*1973-74*
1690.063	*Selenia CDG-3032 Computer*	*1973-74*
1691.063	*T-VT BCH Computer*	*1973-74*
1692.063	*UTD Computer*	*1973-74*
1693.063	*CP-16A Computer*	*1973-74*
1694.063	*CP-32A Computer*	*1973-74*
1695.063	*SKC-3000 General Purpose Computer*	*1973-74*
1696.393	2in ARF/8 M2 Rocket	Italy
1697.253	SPS-55 Naval Radar	USA
1698.063	*ISAC-77 Computer*	*1973-74*
1699.253	RAN-10S Naval Radar	Italy
1700.253	RAN-2C Naval Radar	Italy
1701.253	RAN-13X Naval Radar	Italy
1702.253	3RM Series Radar	Italy
1703.253	SPQ-2D Naval Radar	Italy
1704.253	Sea Hunter Search Radar	Italy
1705.253	Sea Hunter Tracking Radar	Italy
1706.353	Hughes Cobra Radar	USA
1707.253	SUSIE ECM Receiver System	UK
1708.353	Orpheus Aerial Reconnaissance System	Netherlands
1709.353	IRLS-5 Infra-red Linescan	Netherlands
1710.353	TA-7M2 Aerial Camera	Netherlands
1711.353	TA-8M2 Aerial Camera	Netherlands
1712.153	Plessey HF Monitoring and DF System	UK
1713.253	*SR-1-A Radar Search Receiver*	*1973-74*
1714.253	Model 100 Naval DF Set	Canada
1715.253	MM/SPR-A Naval Radar Intercept System	Italy
1716.053	WJ-1240 Receiving System	USA
1717.053	AN/GLR-9 Receiving System	USA
1718.053	ND210 and ND260 Monitoring Equipment	W Germany
1719.263	Sonar Coverage Computer	France
1720.453	IP64-MD64 Sonars	Italy
1721.453	BI68 Sonobuoy	Italy
1722.353	Falco Submarine Locating System	Italy
1723.453	Servomeccanismi Sonobuoy Equipment	Italy
1724.253	TSM 2400 Sonar	France
1725.253	Diodon Sonar	France
1726.453	Piranha Sonar: DUBM 41	France
1727.153	Driver's Periscope Type BM8005	W Germany
1728.453	*AN/VQX-1 Underwater Damage Assessment TV system*	*1973-74*
1729.453	*TC-125-SIT Low Light-level TV Camera*	*1973-74*
1730.393	RGS 2 Aircraft Sight	Sweden
1731.393	Type 664 HUD-WAS	UK
1732.153	Type LAR Laser Rangefinder	Netherlands
1733.153	Type LAT Tank Laser Rangefinder	Netherlands
1734.193	Laser Gunnery Trainer	USA
1735.393	Submarine Signal Simulator	Canada
1736.393	TAV-38 Laser Rangefinder	France
1737.193	APX M.396 Stabilised Sight	France
1738.331	Viper Air to Air Missile	W Germany
1739.461	DLT-D-3A Submarine Torpedo Fire Control System	France
1740.353	EMI Searchwater Airborne Radar	UK
1741.353	DAX-100/200 Series Airborne Radar	Sweden
1742.193	Ferranti Laser Target Marker and Ranger	UK
1743.263	SARIE - Semi-automatic Radar Identification Equipment	UK
1744.253	SPS-6 Radar	USA
1745.253	SPS-30 Radar	USA
1746.253	SPS-40 Radar	USA
1747.253	SPS-43 Radar	USA
1748.253	SPG-55 Radar	USA
1749.253	SPG-49 Radar	USA
1750.253	SPG-56 Radar	USA
1751.253	AWS-2 Naval Radar	UK
1752.253	RN Type 901 Radar	UK
1753.253	RN Type 992Q Radar	UK
1754.253	S 810 Naval Surveillance Radar	UK
1755.453	Type 162M Sonar	UK
1756.314	Tactical Air to Surface Missiles (Table)	International
1757.334	Air to Air Missiles (Table)	International
1758.211	US Navy Cruise Missile	USA
1759.411	SLCM - Submarine-Launched Cruise Missile	USA
1760.221	SSN-9 Shipborne Surface to Surface Missile	USSR
1761.211	SSN-10 Shipborne Surface-to-Surface Missile	USSR
1762.221	SSN-11 Shipborne Surface-to-Surface Missile	USSR
1763.224	Table of Shipborne Surface-to-Surface Missiles	-
1764.231	Naval Blowpipe Missile System	UK
1765.353	APG-63 Airborne Radar	USA
1766.311	ALCM - Air-Launched Cruise Missile	USA
1767.311	AMX - Airborne Missile 'X'	USA
1768.311	Close Air Support Weapon System (Laser Maverick)	USA
1769.311	HARM - High Speed Anti-Radiation Missile	USA
1770.321	Air Launched Exocet (AM.38 & AM.39)	France
1771.311	HOT Air-to-Surface Missile	France/W Germany
1772.311	American Air-to-Surface Improvement Programme	USA
1773.311	SAGMI - Surface Attack Guided Missile	USA
1774.331	UK Sparrow Air-to-Air Missile (XJ 521)	UK
1775.193	Sabcafit Simulators	Belgium
1776.193	Tank Gunnery Trainer Type DX.150	France
1777.193	BT 33 Artillery Fire Control Simulator	Sweden
1778.193	Link Miles Simulators	UK
1779.281	Vega Tactical Information Unit Type I	France
1780.281	Vega Tactical Information Unit Type II	France
1781.353	APS-96 Airborne Radar	USA
1782.353	APS-111 (XN-1) Airborne Radar	USA
1783.353	APS 120 Airborne Radar	USA
1784.353	APS-503 Airborne Radar	Canada/USA
1785.353	UK Airborne Interception Radar	UK
1786.453	PAP 104 Mine Disposal Weapon	France
1787.453	Mk 1C Active Sonobuoy T17164	UK
1788.453	Plessey Underwater Programme	UK
1789.453	SSQ-14 Sonar	USA
1790.453	Mulloka Sonar	Australia
1791.453	Project Barra	Australia
1792.453	SQS-505 Sonar	Canada
1793.353	ORB-31 Airborne Radar	France
1794.353	Type AF530 Gyro-Stabilised Sight	UK
1795.393	TAV 19 Helicopter Laser Rangefinder	France
1796.193	APX M401 Optical Sight and Rangefinder	France
1797.193	APX M409 Optical Sight and Rangefinder	France
1798.193	IPY 43 Portable Laser Target Marker	France
1799.293	TMV 26 Naval Laser Rangefinder	France
1800.193	Type HV7 × 200AT Night Sight	Netherlands
1801.193	Type TP1MS Night Periscope	Netherlands
1802.193	RZ 502 Thermal Imaging Equipment	W Germany
1803.193	VVS-1 Tank Laser System	USA
1804.193	LP3 Laser Rangefinder	Norway
1805.393	MRCA Head-Up Display	UK
1806.353	TISEO - Target Identification System, Electro-optical, AN/ASX-1	USA
1807.453	SQS-56 Sonar	USA
1808.391	Halbran Target Missile	France
1809.351	Argus Reconnaissance System	France/W Germany
1810.391	Dornier Aerial Target System (DATS)	W Germany
1811.391	AEL Falcon Drone	UK
1812.391	LAST - Low-Altitude Supersonic Target (XBQM-8)	USA
1813.391	Beech Model 1092	USA
1814.391	Beech Model 1089 VSTT	USA
1815.391	Beech Model 1070 HAST	USA
1816.351	Model 235 (YQM-98A) Compass Cope R Drone	USA
1817.351	Compass Cope B Drone (YQM-94A)	USA
1818.311	Model 234 (BGM-34A/B) Ground Attack Drones	USA
1819.391	PQM-102 Target Drone	USA
1820.351	PRAOD - Remotely-Piloted Aerial Observation Designation System	USA
1821.391	Kaman RPV & Drone Programmes	USA
1822.391	Northrop NV-123 VSTT	USA
1823.281	Italian Navy Multi-Purpose Rocket Control System (ULCAR)	Italy
1824.281	AGIS Combat Information System	W Germany
1825.281	SATIR Action Information System	W Germany
1826.481	CICAS - Computer Integrated Command & Attack System	UK
1827.481	TCS 9 Torpedo Control System	UK
1828.261	Marconi/Sperry Lightweight Gunfire Control System	UK

1829.281	Marconi Weapons Control Systems	UK
1830.281	ADAWS 6 Action Data Automation Weapon System	UK
1831.281	Mine Counter-Measures CAAIS	UK
1832.261	Gun Fire Control System Mk 37	USA
1833.261	Gun Fire Control System Mk 68	USA
1834.281	Aegis Command and Control System	USA
1835.281	Fire Control System Mk 92	USA
1836.303	XM 30 Aircraft Armament Subsystem	USA
1837.303	XM 41 Armament Subsystem	USA
1838.303	XM 59 Armament Subsystem	USA
1839.303	CASA Type 06.070 Rocket Launcher	Spain
1840.303	CASA Type 18.037 Rocket Launcher	Spain
1841.303	CASA Type 18.070 Rocket Launcher	Spain
1842.303	CASA Type 54.037 Rocket Launcher	Spain
1843.303	Lanco RC-06-100	Spain
1844.393	EMRU No. 22	UK
1845.393	Westland / Frazer-Nash High Strength MACE	UK
1846.303	XM230 30 mm Chain Gun	USA
1847.303	Fuel / Air Explosive Weapons	USA
1848.303	HSM – Hard Structure Munitions	USA
1849.303	Gator Anti-tank Weapon	USA
1850.314	Table of Air-to-Surface Tactical Munitions	–
1851.302	MiG-23 Flogger Aircraft	USSR
1852.302	Backfire Variable Geometry Bomber Aircraft	USSR
1853.302	Hind Helicopter	USSR
1854.302	Shackleton AEW Mk 2 Aircraft	UK
1855.302	Il-38 May Maritime Patrol Aircraft	USSR
1856.064	Table of Military Computers	–
1857.253	SR-1-A Radar Search Receiver	Norway
1858.253	VR-30 Series Radar Search Receivers	Norway
1859.253	VR-1-B / C Radar Search Receivers	Norway
1860.253	VR-2 Portable Radar Search Receiver	Norway
1861.053	Sylvania EW Antennas	USA
1862.353	ALR-47 Radar Homing and Warning System	USA
1863.363	DSA-20 Digital Signal Analyser	USA
1864.353	Jaguar Reconnaissance Pod	UK
1865.353	Vinten Reconnaissance Pods	UK
1866.353	Vinten Airborne Cameras	UK
1867.173	Vinten Photo-Interpretation Equipment	UK
1868.163	Patricia Reconnaissance Data Processing System	France
1869.173	RCA Laser Beam Image Reproducers	USA
1870.173	RCA Laser Radar Recorder	USA
1871.353	RBV Camera System	USA
1872.153	R-200 Instantaneous Frequency Measuring Receiver	USA
1873.153	Model R-1437 Receiver	USA
1874.153	RD-280 Receiver and Display	USA
1875.153	R-281 Search Receiver	USA
1876.053	HWR-2 Radar Warning Receiver	UK
1877.253	EMI Signal Selection and Pulse Analysis Equipment	UK
1878.353	F126 Reconnaissance Camera	UK
1879.353	F135 Reconnaissance Camera	UK
1880.353	Fairchild Panoramic Cameras	USA
1881.353	F-639 Medium / High Altitude Mapping Camera	USA
1882.353	Minipan Camera and Mount	USA
1883.363	Pave Spike Video Film Recorder	USA
1884.391	Condor and Super Condor Target Drones	Italy
1885.391	Petrel Target Drone	UK
1886.153	BRT / MXB Series Broadband Receiving Equipment	USA
1887.153	FAIRS Elint System	USA
1888.153	Model 3600 Microwave Receiving System	USA
1889.253	DRBI 23 Naval Radar	France
1890.253	DRBR 51 Naval Radar	France
1891.253	DRBV 22 Naval Radar	France
1892.253	DRBV 20 Naval Radar	France
1893.253	DRBV 13 Naval Radar	France
1894.253	DRBC 32 Naval Radar	France
1895.253	S604 HN Naval Radar	UK
1896.253	PTR461 Shipborne IFF Transponder	UK
1897.253	Pop Group Fire Control Radar	USSR
1898.351	US Navy Ocean Surveillance Programme	USA
1899.351	Pave Strike Programmes	USA
1900.253	Other Soviet Naval Radars	USSR

1901.053	Rohde & Schwarz Direction Finding Equipment	W Germany
1902.053	EZF / EZFU Radio Reconnaissance & Monitoring System	W Germany
1903.053	ND210 & ND260 Radio Monitoring Equipments	W Germany
1904.393	ALE-37 Chaff Dispenser	USA
1905.393	ALE-39 ECM Dispenser	USA
1906.393	ALE-40 Chaff Dispenser	USA
1907.393	ALQ-87 ECM Pod	USA
1908.393	ALQ-99 ECM Equipment	USA
1909.393	ALQ-100 ECM Equipment	USA
1910.393	ALQ-101 ECM Pods	USA
1911.393	ALQ-119 ECM Pod	USA
1912.393	ALQ-123 Infra-Red Counter-Measures	USA
1913.126	ALQ-126 ECM Equipment	USA
1914.393	ALQ-130 ECM Equipment	USA
1915.393	ALQ-131 ECM Pod	USA
1916.393	ALQ-133 Elint Equipment	USA
1917.353	ALR-45 ECM Equipment	USA
1918.353	ALR-50 ECM Equipment	USA
1919.353	ALR-52 ECM Receiver	USA
1920.281	DARDO Short-range Defence System	Italy
2000.441	SST4 Wire-guided Torpedo	Germany
2001.441	Submarine-launched Torpedo Type G6e	Italy
2002.441	Submarine-launched Torpedo Type G62ef	Italy
2003.441	Submarine- or Surface-launched Torpedo Type A-184	Italy
2004.441	Surface- or Air-launched Torpedo Type A-244	Italy
2005.102	Main Battle Tank Leopard (Italy)	Italy
2006.102	Modified M-47 Tank (Italian)	Italy
2007.102	*Wheeled Armoured Vehicles (Italian)*	*1973-74*
2008.102	*Chinese Armoured Personnel Carriers*	*1973-74*
2009.102	Israeli Armoured Fighting Vehicles	Israel
2010.111	Chinese MRBM	China
2011.102	Patton / Centurion Tank	Israel
2012.103	Albanian Army Ordnance	Albania
2013.103	45 mm Anti-tank Gun M-57	Albania
2014.103	76 mm SP Anti-tank Gun SU-76	Albania
2015.102	Austrian Medium Tank	Austria
2016.181	Hubcap	Australia
2017.391	Jindivik Drone	Australia
2018.241	Anti-Submarine Mortar System	Australia
2019.153	Chinese Military Radar	China
2020.351	Epervier Surveillance Drone	Belgium
2021.163	Tank Fire Control System	Belgium
2022.103	105 mm Field Howitzer 18 / 40	Austria
2023.103	106 mm Recoilless Rifle M40A1 (Towed)	Austria
2024.103	RM-130 Artillery Rocket Launcher	Czechoslovakia
2025.111	Anti-Tank Weapon System	Brazil
2026.103	Artillery Rockets	Brazil
2027.203	Shipborne Bombardment Rocket R-115	Brazil
2028.102	Brazilian Armoured Vehicles	Brazil
2029.103	Twin 30 mm Anti-aircraft Cannon M-53 / 59	Czechoslovakia
2030.103	Spanish Ordnance	Spain
2031.103	105 mm Light Howitzer	Spain
2032.103	75 mm Light Field Gun	Spain
2033.103	Artillery Rockets	Spain
2034.351	Canadair AN / USD / 501 Drone	Canada
2035.221	Canadian Sea Sparrow Missile System	Canada
2036.231	Canadian Sea Sparrow Missile System	Canada
2037.103	122 mm Field Gun M-60	Finland
2038.243	Helen Sonar	Canada
2039.103	105 mm Light Field Howitzer M-61 / 37	Finland
2040.183	*Land Navigation Systems LNS 101 & 102*	*1970-71*
2041.103	95 mm Recoilless Anti-tank Gun M-58	Finland
2042.103	Finnish Army Mortars	Finland
2043.103	55 mm Recoilless Anti-tank Grenade Launcher M-55	Finland
2044.103	154 mm Artillery Rocket System BR 51 GS	Italy
2045.103	Austrian Ordnance	Austria
2046.261	CCS-280 Command & Control Systems	Canada
2047.263	Underwater Combat System 27	Canada
2048.111	Chinese ICBM	China

2049.111	Chinese IRBM	China
2050.131	Note on Chinese Surface-to-Air Weapons	China
2051.411	Note on Chinese Subsurface-to-surface weapons	China
2052.181	Chinese Air Defences	China
2053.153	*Telsa Radars*	*1972-73*
2054.111	*Ballistic Rockets (Egypt)*	*1972-73*
2055.103	ACL-STRIM Rocket System	France
2056.153	*Adour Tracking Radar*	*1973-74*
2057.241	Anti-Submarine Weapon System	France
2058.153	*Airfield Surveillance Radar TH.D 1021*	*1972-73*
2059.153	ATC Approach Radar TRS 2065	France
2060.153	Antares Tracking Radar	France
2061.183	*Automatic Gyro Compass CDN 10 & 20*	*1970-71*
2062.153	Aquitaine II Tracking Radar	France
2063.153	Artois Tracking Radar	France
2064.153	*Automatic Tracking Radar TH.D 1213*	*1972-73*
2065.153	Béarn Tracking Radar	France
2066.153	Arabelle Portable Transponder	France
2067.153	Bretagne Tracking Radar TH.D 1801	France
2068.103	ACL/APX 80 Light Collective Anti-tank Weapons	France
2069.153	Champagne Tracking Radar	France
2070.453	Acoustic Range	France
2071.111	ACRA Anti-tank Weapon System	France
2072.453	*DG Ranges*	*1970-71*
2073.153	*Domino Surveillance Radar*	*1972-73*
2074.131	Crotale anti-Aircraft Missile System	France
2075.293	Degaussing Equipment	France
2076.393	*CTB 2530 Target Towing System*	*1970-71*
2077.393	*ECA 57 Glider Target*	*1970-71*
2078.393	*ECA 58 Towed Target*	*1970-71*
2079.491	*ED 28 Exercise Mine*	*1969-70*
2080.151	Eldorado-Mirador Fire Control System	France
2081.111	Entac Anti-tank Missile	France
2082.153	*Eldorado Fire Control Radar TH.D 1229*	*1973-74*
2083.153	Domino 30 Radar	France
2084.153	Domino 40 Radar	France
2085.103	ARPAC 68 mm Anti-tank Rocket Launcher	France
2086.103	120 mm Mortar M-65	France
2087.103	120 mm Heavy Mortar AM-50	France
2088.103	120 mm Light Mortar M-60	France
2089.103	120 mm Rifled Mortar	France
2090.103	SARPAC 68 mm Anti-tank Rocket Launcher	France
2091.103	*MAS Type A Individual Anti-tank Weapon*	*1973-74*
2092.453	Harbour Protection Equipment	France
2093.193	IR Aiming Telescope OB-17-A	France
2094.193	IR Binocular Aiming Telescope OB-23-A	France
2095.111	Harpon Battlefield Missile	France
2096.441	L4 Airborne Acoustic Torpedo	France
2097.441	*Light Acoustic Torpedo*	*1972-73*
2098.153	Light Precision Approach Radar TH.D.1013	France
2099.193	IR Periscope OB-11-A	France
2100.153	Long-range Radar LP 23	France
2101.193	Rangefinder M292	France
2102.153	Matador 3-D Radar TRS 2210	France
2103.193	Binocular Telescope M267 and Prism Head M270	France
2104.153	Medium Range Radar TA 23 (TRS 2055)	France
2105.193	Telescope-Periscope M112	France
2106.151	Midas Air Defence System	France
2107.193	Aiming Telescope M262	France
2108.193	IR Aiming Telescope (M267 Modified)	France
2109.193	IR Day/Night Driving Periscope	France
2110.131	Javelot Surface-to-Air Weapon System	France
2111.231	Naval Crotale Surface-to-Air Weapon System	France
2112.491	*MCC 23C War Mine*	*1969-70*
2113.491	*MCT 15 War Mine*	*1969-70*
2114.231	Catulle Surface-to-Air Weapon System	France
2115.181	Ministrida Air Defence System	France
2116.153	*Mirador Radar*	*1973-74*
2117.153	Mirador II	France
2118.121	Exocet Coastal Defence Weapon	France
2119.153	Picador/Mobile 3-D Radar	France
2120.153	Perceval Helicopter Recovery Radar	France
2121.153	ATC Approach Radar TRS 2060	France
2122.231	Hirondelle Surface-to-Air Weapon System	France
2123.351	Nord 510 Flying Platform	France
2124.391	*Nord C 30 Drone*	*1973-74*
2125.391	Nord CT 20 Drone	France
2126.391	*Nord CT 41 Drone*	*1972-73*
2127.351	Nord R20 Drone	France
2128.441	L5 Multi-purpose Torpedo	France
2129.153	Oeil Noir Anti-Aircraft Radar	France
2130.111	Pluton Battlefield Support Missile	France
2131.153	Olifant Radar	France
2132.153	Olifant II Radar	France
2133.153	Precision Approach Radar TH.D 1012	France
2134.103	RAP 14 Artillery Rocket System	France
2135.203	RAP 14 Naval Weapon System	France
2136.153	*Racine Non-recurrent Pulsed Doppler Radar*	*1973-74*
2137.153	Rapace AFV Surveillance Radar	France
2138.131	SP 30 mm Twin-Gun AA Weapon System	France
2139.111	SS 11 Battlefield Missile	France
2140.111	SS 12 Battlefield Missile	France
2141.153	Rasit 72A/Rapière Battlefield Surveillance Radar	France
2142.153	*Rasit Battlefield Surveillance Radar*	*1973-74*
2143.153	Rasura Battlefield Surveillance Radar	France
2144.441	*R3 Experimental Lightweight Torpedo*	*1973-74*
2145.111	SSBS Medium-range Ballistic Missile	France
2146.441	Z16 Submarine-launched Torpedo	France
2147.103	105 mm Tank Gun D1504	France
2148.103	Tank Turret Type FL-12	France
2149.103	Tank Turret Type FL-10	France
2150.103	20 mm AA Turret TG-521-F1	France
2151.103	60 mm Vehicle Mortar (60-MC-A1)	France
2152.153	RALF Low-altitude Acquisition Radar	France
2153.153	Rasit 72-B Battlefield Surveillance Radar	France
2154.153	Rasit 72-C Battlefield Surveillance Radar	France
2155.153	Three-Dimensional Radar TH.D 1955	France
2156.153	Tiger Radar TRS 2100	France
2157.153	Ground-based IFF Interrogator	France
2158.102	Panhard New Generation AFVs	France
2159.193	Rangefinder M.208 for AMX-30 Tank	France
2160.153	Volex III Surveillance Radar TH.D 1945	France
2161.181	Strida Air Defence System	France
2162.283	Optical Fire Control and Target Designation Equipment	France
2163.111	SSBS Intermediate Range Ballistic Missile Type S-3	France
2164.131	M3-VDA AA Gun System	France
2166.181	DACTA ATC & Air Defence System	Brazil
2167.181	Air Defence System – Chile	Chile
2168.103	130 mm Field Gun	China (P.R.)
2169.103	76 mm Light Field Gun Type 54	China (P.R.)
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2170.103	75 mm Recoilless Rifles Types 52 & 56	China (P.R.)
2172.103	37 mm Light Anti-aircraft Gun Type 55	China (P.R.)
2173.103	82 mm Mortar Type 53	China (P.R.)
2174.103	90 mm Mortar Type 97	China (P.R.)
2175.103	120 mm Mortar Type 53/55	China (P.R.)
2176.103	160 mm Mortar Type 60	China (P.R.)
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2178.441	Seeschlange (Sea Serpent) Torpedo	Germany (F.R.)
2179.103	155 & 105 mm Field Howitzers	Germany
2180.103	90 mm SP Anti-tank Gun	Germany
2181.111	Cobra 2000 Anti-tank Missile	Germany
2182.131	20 mm Twin-Gun Anti-Aircraft System	Germany
2183.351	Dornier DO 32K Kiebitz Drone	Germany
2184.103	Armbrust-300 Infantry Anti-Tank Weapon	Germany
2185.193	*Passive Night Viewing Unit NYX 2002*	*1973-74*
2186.153	IR Gunsight Type BM 8001	Germany
2187.153	IR Gunsight Type BM 8004	Germany

2188.111	Mamba Portable Anti-tank Weapon System	Germany
2189.102	FUG (OT-65) Armoured Personnel Carrier	Hungary
2190.103	105 mm Light Field Howitzers M-18/18M/39	Germany
2191.103	New High-performance Guns	Germany
2192.103	155 mm SP Howitzer M-109G	Germany
2193.103	155 mm SP Howitzer M-109 Modified	Italy
2194.103	RS 80 Artillery Rocket System	International
2195.103	155 mm Towed Howitzer FH 70	International
2196.103	155 mm SP Howitzer SP 70	International
2197.103	110 mm Tank Gun L 10	International
2198.153	*Zenda Battlefield Radar Project*	*1973-74*
2199.221	*Ship Martel Surface-to-Surface Missile*	*1972-73*
2200.111	Introduction – Strategic Surface-to-Surface Missiles	International
2201.004	*Table of Principal Missiles*	*1970-71*
2202.114	Table of Strategic Surface-to-surface Missiles	International
2203.114	*Table of Anti-Tank Missiles*	*1971-72*
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2210.334	*Table of Air-to-Air Missiles*	*1971-72*
2211.181	ADGE (IPG) Air Defence System	International
2212.111	HOT Anti-Tank Missile	International
2213.131	Helip Hawk Improvement	International
2214.111	*Atlas Anti-Tank Missile*	*1972-73*
2215.111	Milan Anti-Tank Missile	International
2216.231	*Seacat-Bofors Gun Launcher*	*1972-73*
2217.231	Marine Roland II Shipborne Surface-to-Air Weapon System	International
2218.131	Roland Mobile AA Weapon System	International
2219.421	Submarine-Launched Exocet	International
2220.414	*Table of Subsurface-to-Surface Missiles*	
2221.411	Introduction – Subsurface-to-Surface Weapons	International
2222.444	*Table of Subsurface-to-Subsurface Missiles*	*1971-72*
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2227.111	*Anti-Tank Weapon (Italy)*	*1972-73*
2228.231	Albatros Sea-to-Air Missile System	Italy
2229.281	*ARGO Naval Gun and Guided Missile Control Systems*	*1971-72*
2230.281	Autonomous Naval Fire Control System	Italy
2231.111	*Artillery Rockets (Italy)*	*1972-73*
2232.111	*Battlefield Support Weapons*	*1973-74*
2233.181	Indigo Integration Kit	Italy
2234.283	Gun Remote Control Equipment	Italy
2235.131	Indigo Mobile AA Weapon System	Italy
2236.391	Meteor Drones	Italy
2237.153	Argos RAT 10S Coastal Surveillance Radar	Italy
2238.111	Mosquito Anti-Tank Missile	Italy
2239.153	*Argos RAT-5c Coastal Defence Radar*	*1972-73*
2240.221	Nettuno (Sea Killer Mk 1)	Italy
2241.221	Sea Killer Missile Systems	Italy
2242.221	Sea Killer Mk 3 Shipborne Surface-to-Surface Missile	Italy
2243.153	RAT-6L Short-range Low Altitude Coverage Radar	Italy
2244.153	RIS-3E Monopulse Tracking Radar	Italy
2245.153	RIS-4C/A Tracking Radar	Italy
2246.153	RIS-5X Drone Tracking Radar	Italy
2247.293	Albatros Missile Launcher	Italy
2248.153	Selenia Civil/Military ATC Radars	Italy
2249.153	Sentinel RQT-9X Portable Infantry Radar	Italy
2250.181	Spada Short/Medium Range Air Defence System	Italy
2251.111	Sparviero Anti-Tank Missile	Italy
2252.103	Attila Mk II Rocket	Italy
2253.221	Vulcano (Sea Killer Mk 2)	Italy
2254.181	BADGE Air Defence System	Japan
2255.111	Artillery Rockets (Japan)	Japan
2256.181	Second Generation Air Defence System	Japan
2257.103	Folgove Anti-Tank Weapon	Italy
2258.203	Breda Compact Twin 40 mm Naval Mounting	Italy
2259.203	*Twin 40 mm Bofors Mountings*	*1973-74*
2260.203	*Single 40 mm Bofors Mountings*	*1973-74*
2261.203	Twin 35 mm Anti-Aircraft Gun Mounting	Italy
2262.111	KAM-3D Anti-Tank Missile	Japan
2263.111	KAM-9 Anti-Tank Missile	Japan
2264.391	*KAQ-5 Drone*	*1972-73*
2265.103	Triple 20 mm Anti-Aircraft Cannon M-55	Yugoslavia
2266.103	130 mm Rocket Launcher M-66	Yugoslavia
2267.103	105 mm Field Howitzer M-56	Yugoslavia
2268.103	76.2 mm Mountain Gun M-48 B1	Yugoslavia
2269.103	82 mm Recoilless Anti-Tank Gun M-60	Yugoslavia
2270.103	120 mm Heavy Mortar UBM-52	Yugoslavia
2271.103	81 mm Medium Mortar M-68	Yugoslavia
2272.103	81 mm Medium Mortar M-38	Yugoslavia
2273.103	60 mm Mortar M-57	Yugoslavia
2274.103	88 mm Coastal Defence Gun (Flak 36)	Yugoslavia
2275.103	75 mm Anti-Tank Gun M-40	Yugoslavia
2276.103	Yugoslav Ordnance	Yugoslavia
2277.103	44 mm Recoilless Anti-Tank Grenade Launcher M-57	Yugoslavia
2278.203	Combined Chaff/Illuminating Rocket Launcher	Italy
2279.203	SCLAR Multi-purpose Naval Rocket System	Italy
2280.153	RAT-21C Low-Altitude Surveillance Radar	Italy
2281.153	RAT-20L Long-Range Surveillance Radar	Italy
2282.153	RAT-7S Low Coverage Radar	Italy
2283.111	Introduction – Tactical Surface-to-Surface Weapons	–
2284.111	Introduction – Anti-Tank/Assault Weapons	–
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2286.153	DR 810 Ballistic Radar	Denmark
2287.131	Indian Surface-to-Air Missile	India
2288.111	Battlefield Support Missile (1973)	Egypt
2289.111	Indian Anti-Tank Missiles	India
2290.131	Introduction – Land-Mobile Surface-to-Air Weapons	–
2291.153	Indigo Fire Control Centre (CT-40-GM)	Italy
2292.131	MIFLA Surface-to-Air Weapon System	International
2293.241	Introduction – Anti-Submarine Weapons	–
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2297.153	Air Traffic Control Radars	Japan
2298.153	Mobile Three-Dimensional Radar NPM-10	Japan
2299.203	Norwegian Naval Guns	Norway
2300.151	L4/5 Weapon Control System	Netherlands
2301.151	Flycatcher (VL4/41) AA Weapon Control System	Netherlands
2302.153	Integrated Radar System for 35 mm AA Tank	Netherlands
2203.203	Single 3-inch (76 mm) 50-calibre Gun Mounting Mk 34	Spain
2304.203	40 mm L/70 Light Anti-Aircraft Gun	Spain
2305.103	57 mm Recoilless Rifle	China (P.R.)
2306.103	152 mm Howitzer M-18/46	Czechoslovakia
2307.103	105 mm Howitzer M-18/49	Czechoslovakia
2308.103	100 mm Field Anti-Tank Gun M-1955	Czechoslovakia
2309.103	85 mm Field Gun M-52	Czechoslovakia
2310.103	82 mm Recoilless Anti-Tank Rifle	Czechoslovakia
2311.103	57 mm Anti-Aircraft Gun	Czechoslovakia
2312.103	155 mm M-68 Gun Howitzer	Israel
2313.103	81 mm Tampella Mortar Type C	Israel

2314.103	60 mm Tampella Mortar	Israel
2315.103	81 mm Tampella Mortar	Israel
2316.103	120 mm Light Tampella Mortar	Israel
2317.103	120 mm Tampella Mortar	Israel
2318.103	160 mm Tampella Mortar	Israel
2319.103	155 mm M-68 Self-Propelled Gun Howitzer (L-33)	Israel
2321.181	South African Air Defences	South Afric:
2322.181	Combat Grande Air Defence System	Spain
2323.441	Torpedo Type 41	Sweden
2324.153	Anti-Aircraft Fire Control Systems	Sweden
2325.153	PE-48/T AA Fire Control Radar	Sweden
2326.153	PS-171/R AA Search Radar	Sweden
2327.153	PE-452/T AA Fire Control Radar	Sweden
2328.153	PE-453/T AA Fire Control Radar	Sweden
2329.153	C-Band Search Radar Type PS 70/R	Sweden
2330.103	89 mm Anti-Tank Rocket Launcher M-65	Spain
2331.103	155 mm Medium Howitzer	Sweden
2332.103	155 mm Brigade Gun 77	Sweden
2333.103	90 mm Recoilless Anti-Tank Rifle	Sweden
2334.103	105 mm Light Field Howitzer M/40	Sweden
2335.103	105 mm Light Field Howitzer 4140	Sweden
2336.103	57 mm Anti-Aircraft Gun M54	Sweden
2337.103	40 mm Anti-Aircraft Gun L/60	Sweden
2338.103	20 mm Anti-Aircraft Cannon M40-70	Sweden
2339.103	75 mm Coastal Defence Gun	Sweden
2340.153	Polish Radar	Poland
2341.131	Cactus Anti-Aircraft Missile System	South Africa
2342.103	34 mm Anti-Aircraft Gun M-38	Switzerland
2343.103	105 mm Tank Gun L74	Sweden
2344.163	Field Artillery Fire Control Equipment GFA 101	Sweden
2345,163	Field Artillery Computer Equipment SAAB ACE-30	Sweden
2346.163	Tank Fire Control Equipment Bofors Types S and C	Sweden
2347.193	Tank Laser Rangefinder	Sweden
2348.131	RBS 70 Anti-Aircraft Missile System	Sweden
2349.131	Bofors 40 mm Anti-Aircraft System 75	Sweden
2350.181	AVISTA Aircraft Tracking and Data Recording System	Sweden
2351.193	BT16 & BT17 Field Scorers	Sweden
2352.193	BT19 & BT19A Gunfire Simulators	Sweden
2353.153	L-Band Search Radar	Sweden
2354.153	*DOMTI C-band Search Radar*	*1973-74*
2355.153	Peder II Coherent-on-Receive Fire Control Radar	Sweden
2356.153	UAR 1022 Track Only Radar	Sweden
2357.153	UAR 1021 Combined Search & Track Pulse Doppler Radar	Sweden
2358.181	STRIL-60 Air Defence System	Sweden
2359.153	UAL 11105 Laser Rangefinder	Sweden
2360.203	40 mm L/70 Automatic Gun Mounting	Sweden
2361.203	57 mm L/70 Automatic Gun Mounting	Sweden
2362.203	Single 3-inch Automatic Gun Mounting	Sweden
2363.111	Bantam Anti-Tank Missile	Sweden
2364.203	*Shipborne 120 mm L/46 Automatic Gun in Turret*	*1969-70*
2365.203	*Single 120 mm L/50 Automatic Gun Mounting*	*1972-73*
2366.221	RB08A Shipborne Surface-to-Surface Missile	Sweden
2367.441	Torpedo TP 61	Sweden
2368.203	Shipborne 2-Tube Anti-Submarine Rocket Launcher	Sweden
2369.203	Shipborne 4-Tube Anti-Submarine Rocket Launcher	Sweden
2370.131	AA Tank System	Switzerland
2371.231	*Combined Sea Indigo/Sea Killer Mk 2 Weapon System*	*1972-73*
2372.121	RB08 Coastal Defence Weapon	Sweden
2373.181	Florida Air Defence Command and Control System	Switzerland
2374.131	Anti-Aircraft Field System Type 2 ZLa/353 Mk	Switzerland
2375.131	*MICON Surface-to-Air Missile*	*1972-73*
2376.151	Superfledermaus AA Fire Control System	Switzerland
2377.151	Skyguard AA Fire Control System	Switzerland
2378.151	BOFI Anti-Aircraft Fire Control System	Sweden
2379.103	30 mm Automatic Cannon Type 831 SLM	Switzerland
2380.103	30 mm Anti-Aircraft Mounting Type 661	Switzerland
2381.103	20 mm Automatic Cannon Type 804	Switzerland
2382.103	20 mm Automatic Cannon Type 820 S/L	Switzerland
2383.103	Single 20 mm Mounting Type 639-B	Switzerland
2384.103	Twin 20 mm Mounting Type 666	Switzerland
2385.103	Triple 20 mm Mounting Type 665	Switzerland
2386.103	DIRA 8 mm Rockets	Switzerland
2387.103	105 mm Light Howitzer M-46	Switzerland
2388.103	105 mm Machine Gun M-35	Switzerland
2389.103	150 mm Medium Howitzer M-42	Switzerland
2390.411	Note on UK Sub-Surface-to-Surface Weapons	UK
2391.103	81 mm Medium Mortars Mw 33 & Mw72	Switzerland
2392.103	120 mm Heavy Mortar Mw41	Switzerland
2393.103	90 mm Anti-Tank Guns M-50/57	Switzerland
2394.103	93 mm Portable Anti-Tank Rocket Launcher M-58	Switzerland
2395.203	Twin 30 mm Naval Mounting	Switzerland
2396.203	20 mm Naval Mounting Type A41/804	Switzerland
2397.203	20 mm Naval Mounting Type GAM/204GK	Switzerland
2398.203	140 mm Rocket Launcher	Switzerland
2399.183	Tank Fire Control System	Sweden
2400.153	AMETS Artillery Meteorological System	UK
2401.293	Frigate ASW Command & Operator Trainer	UK
2402.193	Helicopter ASW Crew Trainer	UK
2403.193	AFV No 52 Gunner's Sight	UK
2404.193	AFV No 68 Commander's Sight	UK
2405.193	Passive Night Driving Periscope for Chieftain Tank	UK
2406.131	Bloodhound 2 Surface-to-Air Missile	UK
2407.131	Falcon SP 30 mm AA Weapon System	UK
2408.221	*Blowpipe Shipborne Surface-to-Surface Application*	*1972-73*
2409.131	Blowpipe Portable Anti-Aircraft Missile	UK
2410.153	Cossor IFF Ground Equipment	UK
2411.393	*Equipment Recovery Beacon*	*1969-70*
2412.153	Green Archer Mortar Locating Radar	UK
2413.153	Firelight Target Illuminating Radar	UK
2414.193	*Fighting Vehicle Driving Simulator*	*1970-71*
2415.163	*FACE – Field Artillery Computer Equipment*	*1973-74*
2416.153	Plessey AR-5 Air Defence Radar	UK
2417.181	Hubcap Air Defence System	UK
2418.153	Plessey IFF Mk 10 (SIF) Interrogation & Decoding Equipment	UK
2419.253	Plessey Naval IFF Mk 10 (SIF)	UK
2420.153	Plessey 430 Airfield Radar	UK
2421.181	Nomad Air Defence System	UK
2422.153	IRIS Infra-Red Intruder System	UK
2423.183	*Rapier Command Guidance Equipment*	*1970-71*
2424.131	Rapier Mobile Anti-Aircraft Missile System	UK
2425.153	Rapier Search & Acquisition Radars	UK
2426.181	Marconi Tactical Air Defence Systems	UK
2427.393	*Rushton Towed Target*	*1970-71*
2428.153	Scorpion Target Illuminating Radar	UK
2429.181	Marconi Static Air Defence Systems	UK
2430.193	Lightweight AFV Cupola No 16	UK
2431.193	AFV Cupola No 22	UK
2432.193	LF2 Laser Rangefinder for Chieftain Tank	UK
2433.193	IR Binocular Sights CU-10 and CU-13	UK
2434.193	Long-Range Viewer CU-15	UK
2435.153	Muzzle Velocity Measuring Equipment	UK
2436.193	MEL IR Sights for Tanks	UK
2437.153	AIDA – Automatic Intruder Detection Alarm	

2438.193	*Gun Control & Stabilisation System EC215*	*1973-74*
2439.153	Rapier Tracking Radar	UK
2440.441	Torpedo Tigerfish	UK
2441.421	Underwater-to-Surface Guided Weapon System	UK
2442.231	Seawolf Shipborne Ship-to-Air Missile	UK
2443.181	Linesman Air Defence System	UK
2444.181	UK Air Defence System	UK
2445.311	Hellcat Air-to-Surface Missile	UK
2446.231	SLAM Close-Range AA Missile System	UK
2447.253	Sonar Type 199	UK
2448.441	Torpedo Project 7511	UK
2449.493	Submarine Command Team Trainer	UK
2450.111	Swingfire Anti-Tank Missile	UK
2451.103	105 mm Tank Guns L7A1, L7A2	UK
2452.103	105 mm Tank Guns L7A3	UK
2453.103	120 Tank Gun L11A3	UK
2454.103	Single 20 mm Pedestal Mounting Type A41B for Land Rover	UK
2455.103	40 mm Light Anti-Aircraft Gun	UK
2456.153	Plessey AR-15 Surveillance Radar	UK
2457.153	Marconi High-Power Static Radars (3-D)	UK
2458.153	Marconi High-Power Static Surveillance Radars (Linear Feeds)	UK
2459.153	Marconi L-band Surveillance Radar Type S654	UK
2460.131	Thunderbird 2 Surface-to-Air Missile	UK
2461.181	Thunderbird 22 Air Defence System	UK
2462.153	Marconi Long-Range Height-finding Radar Type 669	UK
2463.153	Marconi Mobile and Transportable Tactical Control Radars	UK
2464.153	Marconi 800 Series Radars	UK
2465.131	Tigercat Close-Range Air Defence Missile	UK
2466.153	ST850 Tigercat Radar	UK
2467.183	*Gun Control System EC570*	*1973-74*
2468.183	Power Traverse System for Light Fighting Vehicles	UK
2469.183	Weapon Stabilisation System	UK
2470.153	Tobias Intruder Alarm System	UK
2471.441	Torpedo Mark 20 (Improved)	UK
2473.441	*Torpedo Mark 31*	*1971-72*
2475.111	Vigilant Anti-Tank Missile	UK
2476.103	Mobat Recoilless Anti-Tank Gun	UK
2477.103	Wombat Recoilless Anti-Tank Gun	UK
2478.153	Marconi 40-Series Volumetric Radars	UK
2479.153	Marconi S-613 Heightfinding Radar	UK
2480.153	Marconi Transportable Tactical Radar Type S-259	UK
2481.153	Isidor Portable Intrusion Radar	Sweden
2482.153	Marconi / RRE Shrimp Battlefield Surveillance Radar	UK
2483.153	Infantry Combat Radar GS No 18 Mk 1	UK
2484.153	Plessey AR-3D Three-Dimensional Air Defence Radar	UK
2485.103	3-inch Mortar	UK
2486.103	17-pounder Anti-tank Gun	UK
2487.103	6-pounder Anti-tank Gun	UK
2489.103	3.7-inch Anti-Aircraft Gun	UK
2490.153	ZB 298 Short-Range Ground Surveillance Radar	UK
2491.441	Drill and Practice Torpedo MW 30 (Mk 44)	UK
2492.153	AN / FPS-6 Heightfinding Radar	USA
2493.153	AN / FPS-8 Search Radar	USA
2494.153	AN / FPS-24 Search Radar	USA
2495.153	AN / MPS-11 and AN / MPS-11A Search Radars	USA
2496.153	AN / MPS-14 Heightfinding Radar	USA
2497.153	AN / MPQ-4 Mortar Locating Radar	USA
2498.153	AN / TPQ-10 Radar Course Directing Control	USA
2499.153	HIPAR – High-Power Acquisition Radar	USA
2500.153	AN / MPQ-10A Mortar Locating Radar	USA
2501.393	*A/A 37U-15 Tow System*	*1970-71*
2502.393	*Acoustiscore Scoring System*	*1970-71*
2503.393	*Acoustiscore*	*1970-71*
2504.191	*Acoustiscore Type DA2*	*1970-71*
2505.193	*Acoustiscore Type DA3*	*1970-71*
2506.153	ADAR Advanced Design Array Radar	USA
2507.231	AEGIS Shipborne Surface-to-Air Weapon System	USA
2508.153	AN / FPQ-6 (Modified) Monopulse Tracking Radar	USA
2509.153	AN / FPS-49 Early Warning & Tracking Radar	USA
2510.163	*AN / GPA-122 Coder-Decoder Group (IFF)*	*1970-71*
2511.153	AN / FPS-50 Early Warning Radar	USA
2512.153	AN / FPS-88 Surveillance Radar	USA
2513.153	AN / FPS-89 Heightfinding Radar	USA
2514.153	AN / MPS-36 Missile Tracking Radar	USA
2515.153	*AN / TPS-27 3-D Tactical Radar*	*1973-74*
2516.153	AN / TPS-32 Automatic 3-D Tactical Surveillance Radar	USA
2517.153	AN / TPS-43 Tactical 3-D Radar	USA
2518.153	AN / TPS-44 Tactical Surveillance Radar (ALERT)	USA
2519.153	AN / TPS-48 3-D Tactical Radar	USA
2520.153	AN / TPS-61 Tactical Surveillance Radar	USA
2521.391	Beech Cardinal Drone	USA
2522.391	Beech Model 1019 Drone	USA
2523.391	*Beech Sandpiper Drone*	*1972-73*
2524.391	*Beech Stiletto Drone*	*1973-74*
2525.181	Ballistic Missile Early Warning System (BMEWS)	USA
2526.153	AN / FPS-7 3-D Search & GCI Radar	USA
2527.153	AN / FPS-14 & AN / FPS-18 Medium-Range Search Raders	USA
2528.153	AN / FPS-20 – AN / FPS-100 Family of Long-Range Search & GCI Radars	USA
2529.153	AN / TPS-21 & AN / TPS-23 Pulse Doppler Battlefield Radars	USA
2530.153	AN / TPS-34 Transportable Air Defence Radar	USA
2531.131	*Bomarc B Long-Range Air Defence Weapon*	*1972-73*
2532.391	*Bomarc Target Drone*	*1972-73*
2533.181	Air Weapons Control System (AWCS, Quickdraw)	USA
2534.253	AN / SQS-36 & AN / SQS-38 Medium-Range Hull-mounted Scanning Sonars	USA
2535.153	AN / TPX-42 IFF / ATCRBS Ground Equipment	USA
2536.253	AN / SQS-26 Sonar	USA
2537.153	AN / TPN-19 Landing Control Central	USA
2538.153	AN / FSS-7 SLBM Detection and Warning Radar	USA
2539.103	*DICORAP Directional Controlled Rocket-Assisted Projectile*	*1972-73*
2540.153	AN / PPS-5 Battlefield Surveillance Radar	USA
2541.441	Captor Encapsulated Torpedo	USA
2542.131	Chaparral Anti-Aircraft Missile System	USA
2543.231	Close-in Weapon System Vulcan / Phalanx	USA
2544.131	GLADS Low-Altitude Defence System	USA
2545.293	Missile Launcher / Canister	USA
2546.153	AN / FPS-85 Long-Range Phased-Array Radar	USA
2547.153	AN / VPS-2 Ranging Radar	USA
2548.183	All-Electric Stabilised Gun Drive	USA
2549.183	Hydromechanical Transmission	USA
2550.341	*DASH (Anti-Submarine Drone System)*	*1973-74*
2551.153	CONAR Artillery Radar Fire Control System	Switzerland
2552.441	Torpedo Mark 8	UK
2553.203	Shipborne Bombardment Rocket FB-R127	Brazil
2554.203	Single 40 mm Naval Mounting Type 564	Italy
2555.203	Single 40 mm Naval Mounting Type 107	Italy
2556.203	Twin 40 mm Naval Mounting Type 64	Italy
2557.203	Breda / Bofors Naval Mountings	Italy
2558.203	Twin 40 mm Naval Mounting Type 106	Italy
2559.203	Single 30 mm Mounting Type CAS 62	France
2560.393	*D-100A / 1 Radop Scorer*	*1970-71*
2561.103	75 mm Recoilless Rifle M-20	USA
2562.393	*DF-4MFC Towed Target*	*1970-71*
2563.393	*DF-6MFC Towed Target*	*1970-71*
2564.393	*DF-14 Towed Target*	*1970-71*

2565.391	*DH2C Target Drone*	*1972-73*
2566.351	*Surveillance Drone System*	*1972-73*
2567.181	Distant Early Warning System (Dew Line)	USA
2568.393	*DL-45 Tow Target Launcher*	*1970-71*
2569.393	*DL-14 Tow Target Launcher*	*1970-71*
2571.103	Rocket-Assisted Projectiles	Finland
2572.103	155 mm GCT/Leopard SP Gun	Germany (F.R.)
2573.111	Dragon Anti-Tank Missile	USA
2574.131	Advanced Ballistic Missile Defence	USA
2575.131	Homing Intercept Target (HIT) Warhead	USA
2576.393	*DX-4A Tow Reel*	*1970-71*
2577.393	*DX-6A Supersonic Tow Reel*	*1970-71*
2578.393	*DXL-6B Tow Target Weapon Training System*	*1970-71*
2579.393	*DXL-6G Towed Target Weapon Training System*	*1970-71*
2580.253	Edo Model 610 Long-Range Hull-Mounted Scanning Sonar	USA
2581.253	Edo Model 700 Series Sonars	USA
2582.103	105 mm Howitzer M-50	France
2583.103	20 mm Gun M621 for vehicle or naval mounting	France
2585.103	106 mm SP Recoilless Rifle Type 60	Japan
2586.103	South African Ordnance	South Africa
2587.103	90 mm Tank Gun, Bofors KV90 S73	Sweden
2588.103	106 mm Recoilless Rifle M40A2	USA
2589.103	Introduction – Portable Unguided Anti-Tank Weapons	–
2591.103	Panzerfaust Leicht – Portable Anti-Tank Weapon	Germany (F.R.)
2593.103	Wolf Battlefield Missile	Israel
2594.103	Bora Artillery Rocket	Italy
2595.103	Mira Artillery Rocket	Italy
2596.183	Gun Control & Stabilisation Systems GCE 576 & GCE 581	UK
2597.183	Power Traverse Systems for Light Fighting Vehicles	UK
2598.183	SABCA Tank Fire Control System	Belgium
2599.103	105 mm Mortar ECIA Model L	Spain
2600.103	120 mm Mortars ECIA Models L & SL	Spain
2601.103	81 mm Mortars ECIA Models L & LI	Spain
2602.103	60 mm Mortar ECIA Model L	Spain
2603.103	40 mm Breda/Bofors LAA Field Mountings	Italy
2604.153	Isidor Muzzle Velocity Meter	Sweden
2610.351	*Fairchild Hiller Bikini Surveillance Drone*	*1972-73*
2615.391	Firebee Drone	USA
2616.391	Firebee II Drone	USA
2617.351	*Firebee (Reconnaissance) Drone*	*1970-71*
2618.441	Freedom Torpedo	USA
2631.283	*Gun Director Mk 37*	*1969-70*
2632.281	Gun & Guided Missile Director Mk 73	USA
2633.281	Gun Fire Control System Mk 56	USA
2634.281	Gun & Guided Missile Fire Control System Mk 74	USA
2636.353	*Gunfire Warning and Detection Equipment*	*1969-70*
2638.391	Gyrodyne QH-50D Drone Helicopter	USA
2639.131	Hardsite ABM System	USA
2640.131	Hawk Surface-to-Air Weapon System	USA
2641.221	Harpoon Shipborne Surface-to-Surface Missile	USA
2652.103	Honest John Battlefield Support Missile	USA
2668.193	Integrated Night Observation System	USA
2669.221	Interim Surface-to-Surface Missile	USA
2670.111	Janus Project – Dual Role Strategic Missile	USA
2682.111	Lance Surface-to-Surface Missile	USA
2683.111	Lance-derived Experimental Battlefield Missile	USA
2684.131	*Land Sparrow Mobile AA Weapon System*	*1973-74*
2685.131	*Laser-aided ABM Missile*	*1972-73*
2690.111	*Little John Surface-to-Surface Missile*	*1970-71*
2694.391	*Locat Target Missile*	*1972-73*
2702.111	*Mace B Surface-to-Surface Missile*	*1970-71*
2707.111	Triad Strategic Deterrence Combination	USA
2708.111	Ballistic Missile Re-entry Vehicles	USA
2709.111	ABRES – Advanced Ballistic Re-entry Systems	USA
2710.111	Minuteman ICBM	USA
2711.383	*Minuteman II Guidance & Control Equipment*	*1970-71*
2712.111	*Minuteman Rebasing*	*1972-73*
2713.293	Missile Launcher R-202	USA
2714.293	Missile Launcher R-204	USA
2715.111	Minuteman I Intercontinental Ballistic Missile	USA
2716.111	Minuteman II Intercontinental Ballistic Missile	USA
2717.111	Minuteman III Intercontinental Ballistic Missile	USA
2718.111	Missile-X Intercontinental Ballistic Missile	USA
2719.111	MARV (Manoeuvrable Re-entry Vehicle) Systems	USA
2720.111	Minuteman IV Intercontinental Ballistic Missile	USA
2721.111	*Nemesis Project – Strategic Missile*	*1972-73*
2722.411	*Nemesis Project (Sub-surface)*	*1970-71*
2723.131	Nike Hercules Surface-to-Air Missile	USA
2724.153	Night Observation Device – Long-range NODLR	USA
2725.103	Miniature Nuclear Warheads	USA
2730.391	*Northrop MQM-33 Drone*	*1973-74*
2731.351	*Northrop MQM-57 Drone*	*1973-74*
2732.391	*Northrop NV-105 Chukar*	*1973-74*
2733.391	*Northrop RP-76 Drone*	*1973-74*
2734.391	*Northrop RP-76-4 Drone*	*1973-74*
2740.183	NWL Weapon Stabilisation System	USA
2750.181	Over-the-horizon (OTH) Radar System	USA
2763.103	Ontos 106 mm SP Recoilless Rifle	USA
2764.111	*Pershing 1 Battlefield Support Missile*	*1973-74*
2765.111	Pershing 1A Battlefield Support Missile	USA
2766.153	PERSID-4A Intruder Alarm System	USA
2770.231	Point Defence Missile System	USA
2780.391	*Radop Weapon Training System*	*1970-71*
2781.193	*Raytector Radar Monitor*	*1969-70*
2782.111	Ranger Project – Strategic Missiles	USA
2783.153	RCA Portable Battlefield Radars	USA
2784.131	Redeye Portable Anti-Aircraft Missile	USA
2789.391	Roadrunner Drone	USA
2790.153	Safeguard Perimeter Acquisition Radar	USA
2791.153	Safeguard Missile Site Radar	USA
2792.153	Site Defence Radar	USA
2793.441	New Torpedo Projects	USA
2794.131	*SABMIS Anti-Ballistic Missile System*	*1972-73*
2795.103	SMAWT Anti-Tank Rocket Launcher	USA
2796.193	Stabilised Armament Station	USA
2797.421	Submarine-Launched Harpoon Missile	USA
2798.131	Safeguard Anti-Ballistic Missile System	USA
2799.131	*Safesam Anti-Ballistic Missile System*	*1972-73*
2800.131	SAM-D Surface-to-Air Weapon System	USA
2801.181	SAFOC Semi-Automated Flight Operations Centre	USA
2802.483	*SD-510 Inertial Guidance System*	*1970-71*
2803.181	SAGE (Semi-Automatic Ground Environment) Air Defence System	USA
2804.111	Sergeant Battlefield Support Missile	USA
2805.131	Stinger Portable Anti-Aircraft Missile	USA
2806.131	Site Defence of Minuteman (SDM)	USA
2807.131	Sprint II Anti-Missile Missile	USA
2808.221	*Standard Arm – Surface-to-Surface Application*	*1972-73*
2809.111	Shillelagh Close Support Missile	USA
2810.181	SLBM Detection System – 474N	USA
2811.131	Spartan Anti-Missile Missile	USA
2812.131	Sprint Anti-Missile Missile	USA
2813.441	Torpedo Mark 14	USA
2814.441	Torpedo Mark 16	USA
2815.441	Torpedo Mark 18	USA
2816.441	Torpedo Mark 28	USA
2817.441	Torpedo Mark 37 (Mods 0 & 2)	USA
2818.441	Torpedo Mark 37 (Mods 1 & 2)	USA
2819.441	Torpedo Mark 43	USA
2820.441	Torpedo Mark 44	USA
2821.441	Torpedo Mark 45 (ASTOR)	USA
2822.441	Torpedo Mark 46	USA
2823.441	Torpedo Mark 48	USA
2824.181	Tactical Air Control System (TACS)	USA
2825.181	Spacetrack	USA
2826.111	Titan II ICBM	USA

2827.163	TACFIRE – Tactical Fire Control System	USA
2828.193	Stabilised Gun Control System	USA
2829.193	Add-on Weapon Stabilisation System	USA
2830.111	TOW Anti-Tank Missile	USA
2830.441	Torpedo Mark 37 Conversion (Torpedo 37C)	USA
2831.311	Tow (Air-Surface Role)	USA
2831.441	Torpedo Mark 27	USA
2832.103	90 mm Tank Gun M-41	USA
2833.103	152 mm Tank Gun XM-162	USA
2834.103	Rocket-Assisted Projectiles (RAP)	USA
2835.181	TSQ-73 Air Defence System	USA
2836.203	20 mm Three-barrel Deck Mount	USA
2837.111	Rocket-Assisted Guided Projectiles	USA
2838.111	Terminally-guided Sub-missile	USA
2839.111	Pave Pepper Re-entry Project	USA
2840.411	Trident Undersea Long-Range Missile System (formerly ULMS)	USA
2841.131	Alternate Stinger	USA
2842.131	SHORADS / LOFADS Air Defence Missile System	USA
2843.131	AVADS – Automatic Vulcan Air Defence System	USA
2844.153	AVADS Fire Control Radar	USA
2845.221	US Naval Surface-to-Surface Missiles	USA
2846.153	AN/FPQ-6 and AN/TPQ-18 Precision Instrumentation Radars	USA
2847.153	AN/FPS-105(V) Range Instrumentation Radar	USA
2848.153	AN/TPQ-36 Mortar Locating Radar	USA
2849.153	AN/TPQ-39 Digital Instrumentation Radar	USA
2850.131	Vulcan Mobile Air Defence System	USA
2851.203	20 mm Vulcan Gun (naval application)	USA
2852.111	*Vulcan ICBM Project*	*1972-73*
2853.102	XM-1 Main Battle Tank	USA
2854.103	105 mm Tank Gun M-68	USA
2855.103	90 mm Tank Gun M-36	USA
2856.103	20 mm Cannon M-197 Pintle Mounted	USA
2857.103	AN/FPQ-13 Tracking Radar	USA
2859.103	30 mm Chain Gun	USA
2860.153	Back Net GCI Radar	USSR
2861.153	Barlock CGI Radar	USSR
2862.153	Big Bar A GCI Radar	USSR
2863.153	Big Mesh GCI Radar	USSR
2864.153	Doghouse ABM Radar	USSR
2865.203	Twin 85 mm AA Gun Mounting	USSR
2866.153	Fan Song Missile Control Radars	USSR
2867.153	Fan Song B Missile Control Radar	USSR
2868.153	Fan Song E Missile Control Radar	USSR
2869.203	Twin 57 mm Automatic AA Gun Mounting	USSR
2870.203	Twin 37 mm AA Gun Mountings	USSR
2871.153	Fire Can Fire Control Radar	USSR
2872.153	Fire Wheel Fire Control Radar	USSR
2873.153	Flap Wheel Fire Control Radar	USSR
2874.153	Flat Face Target Acquisition Radar	USSR
2875.153	Gage Acquisition Radar	USSR
2876.153	Gun Dish Fire Control Radar	USSR
2877.153	Hen Series Early Warning Radars	USSR
2878.153	Heightfinding Radars	USSR
2879.153	Hen House ABM Radar	USSR
2880.153	Knife Rest A Early Warning Radar	USSR
2881.153	Knife Rest B & C Early Warning Radars	USSR
2882.102	JS III Main Battle Tank	USSR
2883.203	Single 37 mm AA Gun Mounting	USSR
2884.153	Low Blow Tracking & Missile Control Radar	USSR
2885.153	Straight Flush Fire Control Radar	USSR
2886.103	152 mm Gun Howitzer M-37	USSR
2887.103	37 mm Anti-Aircraft Gun M38/39	USSR
2888.103	100 mm SP Anti-Tank Gun SU-100	USSR
2889.153	Spoon Rest A Early Warning Radar	USSR
2891.153	Squint Eye Acquisition Radar	USSR
2892.153	Token Early Warning & GCI Radar	USSR
2893.153	Whiff Fire Control Radar	USSR
2894.103	122 mm Gun M-37	USSR
2895.153	Yo-Yo Missile Control Radar	USSR
2896.203	Twin 30 mm AA Gun Mounting	USSR
2897.203	Twin 25 mm AA Gun Mounting	USSR
2898.203	Twin MG Mountings	USSR
2899.181	Russian Air Defence Systems	USSR
2900.111	Introduction – USSR Surface-to-Surface Missiles	USSR
2901.203	140 mm Rocket Launcher	USSR
2902.203	250 mm Anti-Submarine Rocket Launcher	USSR
2903.203	300 mm Anti-Submarine Rocket Launchers	USSR
2920.103	FROG 1 Battlefield Support Missile	USSR
2921.103	FROG 2 Battlefield Support Missile	USSR
2922.103	FROG 3 Battlefield Support Missile	USSR
2923.103	FROG 4 Battlefield Support Missile	USSR
2924.103	FROG 5 Battlefield Support Missile	USSR
2925.111	FROG 7 Guided Battlefield Support Missile	USSR
2926.103	FROG 7 Battlefield Support Missile	USSR
2927.103	180 mm Field Gun	USSR
2928.103	76 mm Recoilless Rifle SPG-9	USSR
2929.103	160 mm Heavy Mortar M-1943	USSR
2930.131	Gainful Surface-to-Air Missile	USSR
2931.103	160 mm Heavy Mortar M-1953	USSR
2932.131	Galosh ABM Missile	USSR
2933.131	Improved Galosh Anti-Ballistic Missile Missile	USSR
2934.131	Ganef Surface-to-Air Missile	USSR
2935.131	New ABM Missile	USSR
2936.153	Pat Hand Fire Control Radar	USSR
2937.153	Long Track Surveillance Radar	USSR
2938.131	Goa Surface-to-Air Missile	USSR
2939.231	Goa Shipborne Surface-to-Air Missile	USSR
2940.131	Griffon Long-Range Air Defence Weapon	USSR
2941.131	Grail Man-Portable Anti-Aircraft Missile	USSR
2942.131	Guideline Medium-Range Surface-to-Air Missile	USSR
2943.231	Guideline Shipborne Surface-to-Air Missile	USSR
2944.131	Guild Surface-to-Air Missile	USSR
2945.181	Moscow Air Defences	USSR
2946.411	Russian Submarine-Launched Ballistic Missiles	USSR
2947.231	Goblet Shipborne Surface-to-Air Missile	USSR
2948.131	*Russian Anti-Ballistic Missile Systems*	*1973-74*
2949.221	Russian Naval Surface-to-Surface Missile	USSR
2950.111	Sagger Anti-Tank Missile	USSR
2951.111	Samlet Coastal Defence Weapon	USSR
2952.111	Sandal MRBM (SS-4)	USSR
2953.121	Salish Cruise Missile	USSR
2954.231	SAN-4 Shipborne Surface-to-Air Missile	USSR
2955.203	SAN-4 Unguided Missile System	USSR
2956.111	Sasin ICBM (SS-8)	USSR
2958.111	Savage ICBM (SS-11 or SS-13)	USSR
2959.111	Scaleboard Battlefield Support Missile	USSR
2960.111	Scamp Mobile Strategic Missile (SS-14)	USSR
2961.111	Scapegoat IRBM (SS-14)	USSR
2962.111	Scarp ICBM (SS-9)	USSR
2963.111	*New Strategic Missile*	*1973-74*
2964.131	SA-9/10 Surface-to-Air Missile Systems	USSR
2965.111	Scrag ICBM (SS-10)	USSR
2966.103	100 mm Tank Gun D10TG	USSR
2967.111	Scrooge Mobile Strategic Weapon System (SS-XZ)	USSR
2968.221	Scrubber Shipborne Surface-to-Surface Missile	USSR
2969.111	Scud A Battlefield Support Missile	USSR
2970.111	Scud B Battlefield Support Missile	USSR
2971.111	Scud C Battlefield Support Missile	USSR
2972.103	115 mm Type 62 Tank Gun	USSR
2973.203	Close-in Weapon System	USSR
2974.153	Score Board IFF Radar	USSR
2975.221	Shaddock Mobile Cruise Missile	USSR
2976.221	Shaddock Type Shipborne Surface-to-Surface Missile	USSR
2977.111	Shyster MRBM	USSR
2978.111	SS-9 Mod 3 ICBM	USSR
2979.111	SS-9 Mod 4 ICBM	USSR
2980.111	Cold-Launched Ballistic Missiles	USSR
2981.111	Skean MRBM (SS-5)	USSR
2982.111	SS-7 (Saddler) ICBM	USSR
2983.111	Snapper Anti-Tank Missile	USSR
2984.111	SS-11 Mod 1 ICBM	USSR
2985.111	Swatter Anti-Tank Missile	USSR
2986.221	Strela Shipborne Surface-to-Surface Missile	USSR

2987.411	SSN-7 Submarine-launched Cruise Missile	USSR
2988.111	SS11 Mod 3 ICBM	USSR
2989.181	Tallinn Air Defence System	USSR
2990.111	SSX-16 ICBM	USSR
2991.111	SSX-17 ICBM	USSR
2992.111	SSX-18 ICBM	USSR
2993.111	SSX-19 ICBM	USSR
2994.221	Unmanned Russian Shipborne Surface-to-Surface Missiles	USSR
2995.441	533 mm Torpedo	USSR
2996.441	Airborne Torpedo	USSR
2997.441	Light Torpedo	USSR
2998.103	155 mm SP Medium Howitzer M-109U	Switzerland
2999.181	Iranian Air Defence System	Iran
5001.102	Saracen Armoured Personnel Carrier	UK
5002.102	Ferret Scout Car Mks 1 & 2	UK
5003.102	STRV 103 (S Tank) Main Battle Tank	UK
5004.102	Centurion Main Battle Tank	UK
5005.102	Saladin Armoured Car	UK
5006.102	Chieftain Main Battle Tank	UK
5007.102	FV432 Armoured Personnel Carrier	UK
5008.102	SPZ 12-3 (HS-30) Armoured Personnel Carrier	W Germany
5009.102	AMX 10 Amphibious Infantry Combat Vehicle	France
5010.102	AMX-VTP M-56 Armoured Personnel Carrier	France
5011.102	DAF YP408 Armoured Personnel Carrier	Netherlands
5012.102	*Hotchkiss-Rive Light Fighting Unit*	*1972-73*
5013.102	Marder-Schutzenpanzer APC	W Germany
5014.102	Rakete M-1966 GW Launcher	W Germany
5015.102	Leopard Main Battle Tank	W Germany
5016.102	M113 Armoured Personnel Carrier	USA
5017.102	Shorland Armoured Car	UK
5018.102	AMX 30 Main Battle Tank	France
5019.102	Kanone JPZ 4-5 Self-Propelled Anti-Tank Gun	W Germany
5020.102	AMX 13 Light Tank	France
5021.102	AML 245 Armoured Car	France
5022.102	VTT-AML Armoured Personnel Carrier	France
5023.102	Pbv 302 Armoured Personnel Carrier	Sweden
5024.102	M60 Main Battle Tank	USA
5025.102	M60 A1 E2 Main Battle Tank	USA
5026.102	Type 60 Armoured Personnel Carrier	Japan
5027.102	Type 61 Main Battle Tank	Japan
5028.102	*MBT-70 Main Battle Tank (W Germany)*	*1971-72*
5029.102	*MBT 70 Main Battle Tank (USA)*	*1972-73*
5030.102	M551 Sheridan Light Tank	USA
5031.102	Pz 61 Main Battle Tank	Switzerland
5032.102	Panzerjaeger 'K' Self-Propelled Anti-Tank Gun	Austria
5033.102	V-100 Commando Armoured Personnel Carrier	USA
5034.102	BTR-60 Armoured Personnel Carrier	USSR
5035.102	BTR 50P Armoured Personnel Carrier	USSR
5936.102	BRDM-2 Reconnaissance Car	USSR
5037.102	BRDM-1 Reconnaissance Car	USSR
5038.102	PT 76 Light Amphibious Tank	USSR
5040.102	Scorpion Light Tank	UK
5041.102	Vijayanta (Victorious) Main Battle Tank	India
5042.102	T59 Main Battle Tank	USSR
5043.102	M113CR Command & Reconnaissance Carrier	USA
5044.102	M114 Command & Reconnaissance Carrier	USA
5045.102	Tornado Mechanised Infantry Combat Vehicle	Switzerland
5046.102	M47 Main Battle Tank	USA
5047.102	T62 Main Battle Tank	USSR
5048.102	T.10 Heavy Tank	USSR
5049.102	T54/T55 Main Battle Tanks	USSR
5050.102	ASU 57 Assault Gun	USSR
5051.102	ASU 58 Assault Gun	USSR
5052.102	M60A1 (Italian) Main Battle Tank	Italy
5054.102	BMP-76 PB Armoured Personnel Carrier	USSR
5055.102	XM 756 (MICV) Armoured Personnel Carrier	USA
5056.102	M48 Main Battle Tank	USA
5057.102	Vickers Main Battle Tank	UK
5058.102	FN4 RM62 Light Armoured Car	Belgium
5059.102	Berliet VXB Armoured Personnel Carrier	France
5060.102	*Bussing 8-wheeled Armoured Car*	*1972-73*
5061.102	M4 'Super Sherman' (T1-67) Medium Tank	Israel
5062.102	Sabra (or Tsabar) Main Battle Tank	Israel
5063.102	1 Kv 91 Light Tank	Sweden
5064.102	Fox Armoured Car	UK
5065.102	Ferret Mk 5 Missile Launch Vehicle	UK
5066.102	Armoured Car V200 Commando	USA
5067.102	M 132 A1 Flame Thrower	USA
5068.102	M577 A1 Command Post Vehicle	USA
5069.102	M106 A1, M 125 A1 Mortar Carriers	USA
5070.102	XM 800 Armoured Reconnaissance Scout Vehicle	USA
5071.102	LVTP7 Tracked Landing Vehicle	USA
5072.102	M 113 and Variants Armoured Personnel Carriers	Italy
5073.102	ST-B Main Battle Tank	Japan
5074.102	OT 64 Armoured Personnel Carrier	Czechoslovakia
5075.102	Saurer Schintzenpanzer SPzG 4K3F	Austria
5076.102	Main Battle Tank Pz 68	Switzerland
5077.102	Puma Amphibious Personnel Carrier	Switzerland
5078.102	V-150 Commando Armoured Personnel Carrier	USA
5079.102	*SWAT Armed Personnel Carrier*	*1972-73*
5080.102	*Riverine Utility Craft (RUC)*	*1973-74*
5081.102	*Chinese Light Tanks*	*1973-74*
5082.102	Armoured Personnel Carrier BTR-152	USSR
5100.102	Cutia-Vete TIAI	Brazil
5101.102	EE-9 Cascavel	Brazil
5102.102	EE-11 Urutu	Brazil
5103.102	T-60 Light Tank	China (P.R.)
5104.102	T-62 Tank	China (P.R.)
5105.102	T-63 Tank	China (P.R.)
5106.102	Type 55 APC	China (P.R.)
5107.102	Type 56 APC	China (P.R.)
5108.102	M-1967 or M-1970 APC	China (P.R.)
5109.102	OT-62 APC	Czechoslovakia
5110.102	AMX-10RC	France
5111.102	Saviem VAB	France
5112.102	T-70 MBT	USSR
5113.102	M-1970 Light Tank	USSR
5114.102	Leopard 2 MBT	Germany (F.R.)
5115.102	Spähpanzer 2	Germany (F.R.)
5116.102	UR 416 APC	Germany (F.R.)
5117.102	AT 104 APC	UK
5118.102	Infantry Armoured Fighting Vehicle	Italy
5119.102	Fiat 6616 Armoured Car	Italy
5120.102	Armoured Infantry Fighting Vehicle	USA
5121.102	Fiat 6614 APC	Italy
5122.102	Israeli Centurion	Israel
5123.102	Israeli T-54 and T-55	Israel
5124.102	Type 73 APC	Japan
5125.102	Lockheed XM-800 ARSV	USA
5126.102	FMBT-80	International
5501.103	105/14 Model 56 Pack Howitzer	Italy
5502.103	British 25-Pounder Gun	UK
5503.103	105 mm SP Gun Abbot	UK
5504.103	Rarden 30 Automatic Gun	UK
5505.103	105 mm Light Gun	UK
5506.103	115 mm Gun M2	UK
5508.103	155 mm SP Howitzer M109	USA
5509.103	105 mm SP Howitzer M108	USA
5510.103	155 mm Howitzer M123	USA
5511.103	105 mm Howitzer M2A1	USA
5512.103	Lightweight 105 mm Howitzer M102	USA
5513.103	Soviet Ordnance, Note	USSR
5514.103	57 mm AA Gun S-60	USSR
5515.103	57 mm Anti-Tank Gun M.1943 (ZIS-2)	USSR
5516.103	76 mm Divisional Gun M.1942 (ZIS-3)	USSR
5517.103	85 mm Anti-Tank Gun D-48 85 mm Anti-Tank Gun M-44	USSR
5518.103	100 mm Anti-Tank Gun M.1944	USSR
5519.103	122 mm Gun D-74	USSR
5520.103	122 mm Howitzer M.1938	USSR
5521.103	152 mm Gun-Howitzer M37 (ML-20)	USSR
5522.203	Twin 30 mm Gun Mounting A32	UK
5523.103	8-Inch SP Howitzer M110	USA
5524.103	175 mm Gun M107	USA
5525.103	*280 mm Gun M66*	*1972-73*

5526.103	Anti-Aircraft SP Gun, Twin 40 mm M42	USA
5527.103	155 mm SP Automatic Gun L/50 (VK 155 L/50)	Sweden
5528.103	40 mm Automatic Gun L/70	Sweden
5529.103	Communist China, Ordnance, Note	China
5530.103	*Ex-Japanese 70 mm Howitzer Type 22*	*1969-70*
5531.103	75 mm Mountain Gun Type 94 (ex-Japanese)	China
5532.203	Single 76/62 MMI Gun Mounting	Italy
5533.203	Single 76/62 Compact Gun Mounting	Italy
5534.203	Single 127/54 Gun Mounting	Italy
5535.203	Twin 35 mm OE/OTO Gun Mounting	Italy
5536.103	155 mm SP Howitzer Mk F3	France
5537.103	105 mm SP Howitzer AMX 105A	France
5538.103	105 mm SP Howitzer AMX 105B	France
5539.103	SP Twin 30 mm AA Guns AMX DCA 30	France
5540.103	203 mm Gun-Howitzer M55	USSR
5541.103	Tracked Vehicle for 155 mm Howitzer	France
5542.103	105 mm Tank Gun	France
5543.103	90 mm AFV Gun	France
5544.103	SAMM S.530 Turret	France
5545.103	Oerlikon-Contraves 35 mm AA Vehicle on Leopard Chassis	Switzerland
5546.103	BL 5.5-in Gun	UK
5547.103	M61 A1 Gun on Vulcan XM 163	USA
5548.131	ZSU-23-4 AA SP Vehicle	USSR
5549.103	8-in Howitzer M.115	USA
5550.103	155 mm SP Howitzer M.44	USA
5551.103	105 mm SP Howitzer M.52	USA
5552.103	105 mm Light Gun	France
5553.103	Attila Rocket	Italy
5554.103	130 mm Field Gun	USSR
5555.103	Artillery Rockets	USSR
5556.103	105 mm Howitzer with Auxiliary Propulsion (Major-Minor Wheels)	USA
5557.103	Carl Gustav Recoilless Anti-Tank Rifle	Sweden
5558.103	Miniman Recoilless Anti-Tank Weapon	Sweden
5559.103	81 mm Light Mortar	France
5560.103	60 mm Light Mortar	France
5561.103	60 mm Commando Mortar	France
5562.103	60 mm CS Mortar	France
5563.103	81 mm Medium Mortar	UK
5564.103	81 mm Mortar M-29	USA
5565.103	107 mm Mortar M-30	USA
5566.103	82 mm Medium Mortars	USSR
5567.103	120 mm Heavy Mortars	USSR
5568.103	160 mm Heavy Mortar	USSR
5569.103	240 mm Heavy Mortar	USSR
5570.103	155 mm SP Howitzer M109A1	USA
5571.103	155 mm Lightweight Howitzer	USA
5572.103	105 mm Field Artillery Direct Support Weapon System XM204	USA
5573.103	8-inch SP Howitzer M110E2	USA
5574.103	155 GTC SP Gun	France
5575.103	German Artillery – General	W Germany
5576.103	105 mm Light Field Howitzer	W Germany
5577.103	LARS 110 mm Artillery Rocket Launcher	W Germany
5578.103	130 mm AA Gun M-55	USSR
5579.103	100 mm AA Gun M-49	USSR
5580.103	85 mm AA Gun M-44	USSR
5581.103	23 mm AA Cannon	USSR
5582.103	Quad-Mounted 14.5 mm AA Machine Gun ZPV-4	USSR
5583.103	Recoilless Anti-Tank Guns	USSR
5584.103	Recoilless Anti-Tank Guns	USA
5585.103	Artillery Rockets	USA
5586.103	Oerlikon 25 mm AA Gun Turret	Switzerland
5587.103	20 mm AA Gun Type 10 iLa/STG	Switzerland
5588.103	*Czechoslovakian Ordnance*	*1973-74*
5589.103	20 mm Gun M621	France
5590.103	Samurai Artillery Rocket	Italy
5591.103	Light Anti-Tank Grenade Launcher PZF-44	W Germany
5592.103	Light Anti-Tank Weapon (LAW) M 72	USA
5593.103	90 mm Anti-Tank Rifle M-67	USA
5594.103	3.5-inch Rocket Launcher M20 A1	USA
5595.103	100 mm Anti-Tank Rocket Launcher	Belgium
5596.103	Recoilless Anti-Tank Rifle M-18A	USA
5597.103	Anti-Tank Grenade Launchers RPG-2 and RPG-7	USSR
5598.103	Anti-Tank Grenade Launcher P-27	Czechoslovakia
5599.103	20 mm Gun M693	France
5600.103	20 mm Rapid-Fire Gun Mk 20 Rh202	W Germany
6001.241	Asroc (RUR-5A) Anti-Submarine Missile	USA
6002.241	Ikara Anti-Submarine Missile	Australia/UK
6003.231	Seaslug Shipborne Surface-to-Air Missile	UK
6004.231	Sea Dart Shipborne Surface-to-Air Missile	UK
6005.231	Terrier Shipborne Surface-to-Air Missile	USA
6006.231	Tartar Shipborne Surface-to-Air Missile	USA
6007.241	Squid Anti-Submarine Mortar System	USA
6008.241	Limbo Anti-Submarine Mortar System	UK
6009.231	STAAG Mk 2 & 3 Stabilised Tachymetric Anti-Aircraft Gun System	UK
6010.203	Single 4.5-inch Mk 5 Gun Mounting	UK
6011.203	Single 4.5-inch Mk 8 Gun Mounting	UK
6012.203	Twin 4.5-inch Mk 6 Gun Mounting	UK
6013.203	Single 40 mm Bofors Mk 7 Gun Mounting	UK
6014.203	Twin 4-inch Mk 19 Gun Mounting	UK
6015.203	Twin 40 mm Bofors Mk 5 Gun Mounting	UK
6016.203	Twin 3-inch Mk 6 Gun Mounting	UK
6017.203	Twin 6-inch Gun Mounting Mk 26	UK
6018.481	Submarine Control System	UK
6019.221	Gabriel Surface-to-Surface Missile	Israel
6021.241	Type 375 Shipborne Anti-Submarine Missile System	Sweden
6022.241	Terne III Surface-to-Subsurface Missile	Norway
6023.203	Triple 16-inch Gun Mounting	USA
6024.203	Triple 8-inch Mk 15 Gun Mounting	USA
6025.203	Triple 6-inch Mk 16 Gun Mounting	USA
6026.203	Twin 5-inch 38 calibre Gun Mounting	USA
6027.203	Single 5-inch 54 calibre Mk 42 Gun Mounting	USA
6028.203	Single 5-inch 54 calibre Gun Mounting Mk 42 (Lightweight Mod 9)	USA
6029.203	Single 5-inch 54 calibre Mk 45 Lightweight Gun Mounting	USA
6030.203	3-inch 50 calibre Gun Mountings Mks 27, 33 and 34	USA
6031.203	40 mm AA Gun Mountings	USA
6032.203	20 mm Rapid Fire Gun	USA
6033.203	0.50 calibre Machine Gun	USA
6034.203	20 mm Gun Mount Mk 56	USA
6035.203	SAMM/HS 30 mm Gun Mount Type TM 1-30	France
6036.203	Twin 35 mm AA Gun Type GDM-A	Switzerland
6037.203	Triple 180 mm Gun Mounting	USSR
6038.203	Triple 152 mm Gun Mounting	USSR
6039.203	Twin 130 mm Gun Mounting	USSR
6040.203	Twin 130 mm Dual-Purpose Gun Mounting	USSR
6041.203	Single 100 mm Dual-Purpose Gun Mounting	USSR
6042.203	Twin 100 mm Dual-Purpose Gun Mounting	USSR
6043.203	Single 85 mm Dual-Purpose Gun Mounting	USSR
6044.203	Twin 76 or 85 mm Dual-Purpose Gun Mounting	USSR
6045.203	Single 57 mm Dual-Purpose Gun Mounting	USSR
6046.203	Twin 57 mm AA Gun Mounting	USSR
6047.203	Quadruple 57 mm AA Gun Mounting	USSR
6048.203	Quadruple 45 mm AA Gun Mounting	USSR
6049.203	*Light Anti-Aircraft Guns (USSR)*	*1972-73*
6050.203	Single 5-inch Dual Purpose Gun Mounting	Argentina
6051.203	Twin 4.5-inch Gun Mounting	Australia
6052.203	Single 3-inch Dual-Purpose Gun Mounting	Brazil
6053.203	Twin 3-inch AA Gun Mounting	Canada
6054.203	Single 5-inch Dual-Purpose Gun Mounting	Chile

ADDENDA

ADDENDA

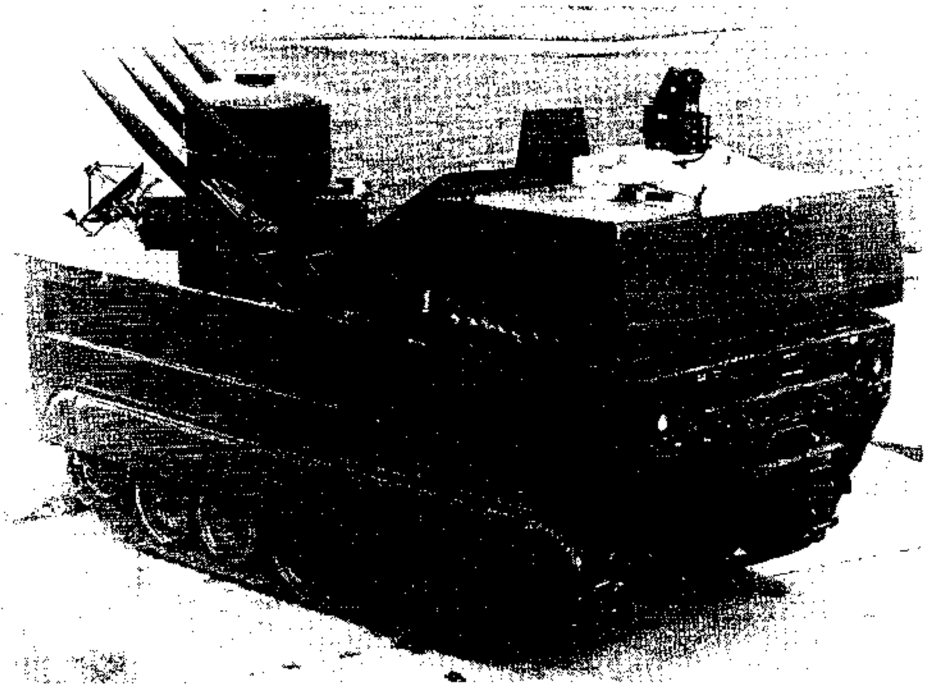
MISSILES

The following notes are a brief record of the most significant developments in the missile sector of defence equipment since the main body of this volume was consigned to the press. The information contained in these notes in most cases is supplementary to more extensive descriptions which appear in one or more entries in the appropriate sections of the book.

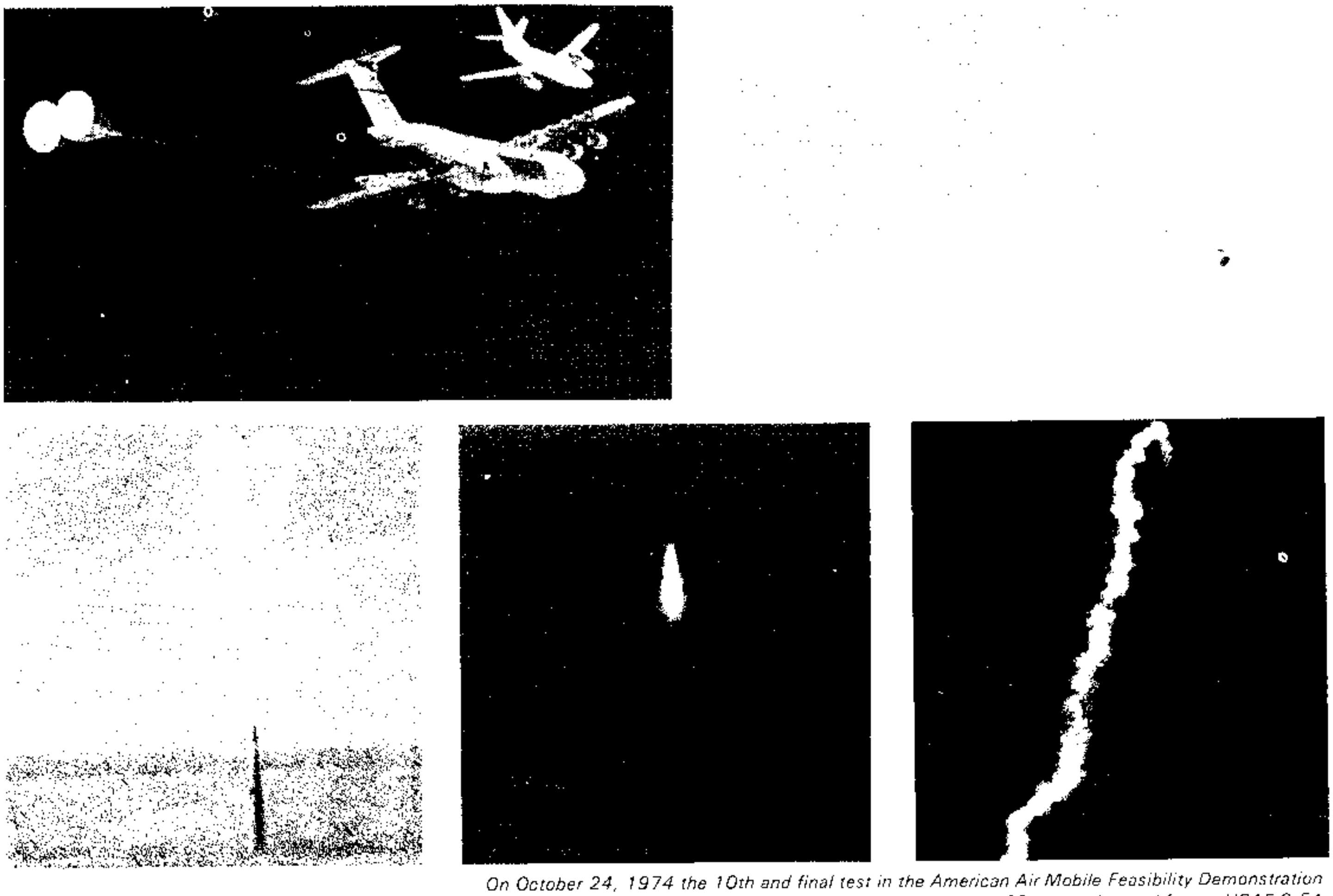
Rapier: In addition to British Forces, this low-level anti-aircraft missile system is on order for at least four foreign countries: Iran, Oman, Abu Dhabi, and an African state which has not been named but is thought to be Zambia. In September 1974 it was revealed that an agreement covering the joint development of the Rapier system, mounted on one of the M.113 family of tracked vehicles, had been concluded by BAC and the Iranian Department of Defence.

Magic: The R.550 Magic, air-to-air dogfight missile has been ordered by six countries in addition to the French Navy and Air Force, according to Matra.

Gabriel: Although Israeli sources have not named any of the foreign purchasers of the Gabriel anti-ship missile, it was reported in late 1974 that South Africa is among the customers for the weapon.



Rapier mounted on an M548 cargo carrier, a member of the US Army M113 family of tracked vehicles



On October 24, 1974 the 10th and final test in the American Air Mobile Feasibility Demonstration programme was successfully completed, when a Minuteman I ICBM was dropped from a USAF C-5A transport aircraft at the Western Test Range off California. The above sequence of five photographs shows (1) the Minuteman being extracted from the aircraft by drogue parachutes, (2) separation of the missile from its cradle, (3) the Minuteman I in stabilised descent beneath its own parachutes, (4) accelerating vertically, and (5) falling into the Pacific Ocean. A first stage motor burn of about 30 seconds only was programmed, of which 10 seconds was at full thrust. This took the Minuteman from an altitude of 8,000 feet at ignition to over 20,000 ft at cut-off.

The air-mobile ICBM is one of several concepts under study in the USA under the overall MX programme. More information appears in Entries Nos. **1767.311, 2707.111, 2718.111**, *in Section One of this volume. The Oct. 24 test had been preceded by two releases of inert Minuteman I missiles from a C 5A, and by seven drops of concrete slabs of varying masses, to establish the feasibility of deploying such large loads safely from the C 5A. The first eight drops (seven concrete, one Minuteman) were carried out at the National Parachute Test Range at El Centro, California, and the remaining two at the Western Test Range*

RS-80: In December 1974 the British Minister of Defence, Mr. Roy Mason, stated that the UK would withdraw from this programme. This was one of a number of measures proposed as part of a plan to reduce UK defence expenditure over the next decade.

Roland: In January 1975, Hughes Aircraft Company, as the US licensee for the German/French Roland system, was awarded a contract valued at

£47.1 million to develop this anti-aircraft missile system for US Army use. Hughes and Boeing will be jointly concerned with US production of Roland.

Dual-Mode Condor: Deletion of funding by the US Congress resulted in termination of Rockwell International's contract for a dual-mode (TV/radar) seeker for the Condor air-to-surface missile. The dual-mode seeker adds an active radar capability to the Condor's existing television guidance to permit night and all-weather operations. The development was being undertaken for US Naval Air Systems Command.

Maverick: The USAF revealed in late 1974 that testing of a new version of the Maverick air-to-surface missile had started. Designated AGM-65B, the Scene Magnification Maverick has improved optics to permit target acquisition at greater ranges. These are supplied by the Perkin-Elmer Corporation and Pacific Optical Company. A series of eight flights are planned, extending into 1975. If successful, at least 2,000 Mavericks of the 17,000 on order at October 1974 would be delivered in the Scene Magnification version.

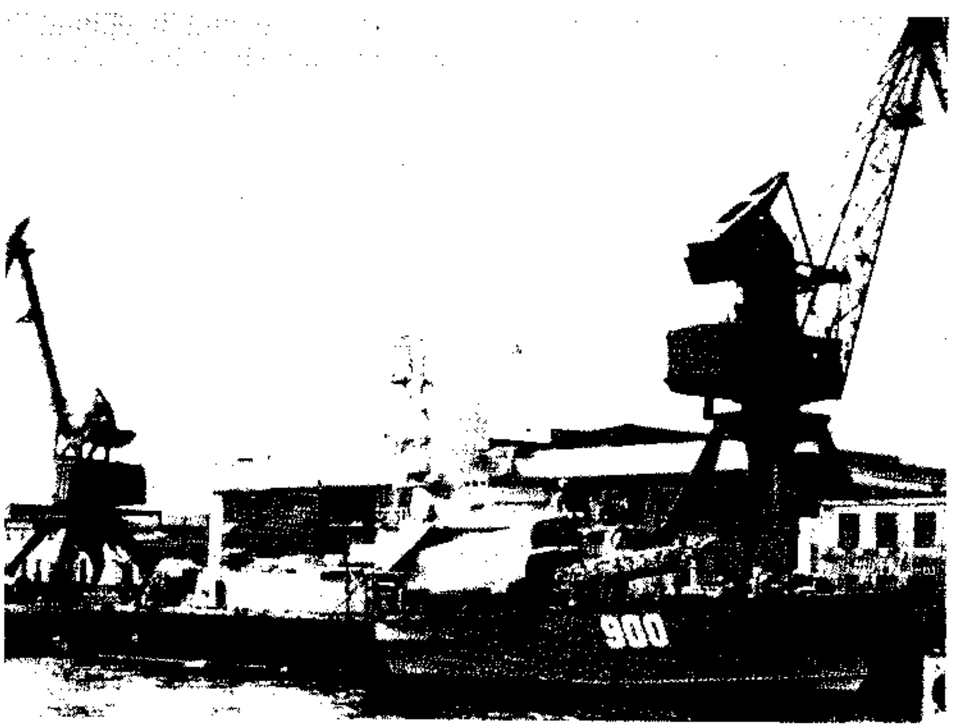
Brazo: The US Navy announced the second of a series of test firings of the Brazo air-to-air anti-radiation missile in October 1974. Launched from a USAF F-4D Phantom, the Brazo destroyed a BQM-34A target drone, in the first long-range test of the missile. The attack was made from head-on and was a "look-down" intercept.

DME-Lance: A version of Lance to enable Distance Measuring Equipment (DME) guidance techniques to be used to enhance accuracy is under study by the US Army and LTV Aerospace. Four canard vanes controlled by modified HOBO guided bomb actuators would be employed to steer the warhead. A master station, relay station, and target position are all located within a common co-ordinate system. The DME stations make continuous precision measurements of the Lance missile position throughout flight. The master station computes cross-range and down-range deviations from constant radius path through target position. Guidance commands are sent from the master station to the missile to adjust its trajectory to intercept the target.

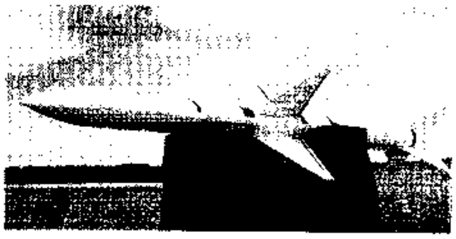
Laser-Pershing: The first test firings by the US Army of Pershing surface-to-surface missiles, with a new laser unit for guidance system alignment, took place in October 1974 at the White Sands Missile Range. The laser is part of a new Automatic Reference System which provides automatic alignment of the missile on the firing azimuth without reference to pre-surveyed points. The ARS combines the laser in an automatic optical link, and a precision north-seeking gyro for initial orientation of the Pershing's inertial guidance platform and "aims" the missile immediately prior to erection and lift-off. Also evaluated was a Sequential Launch Adapter developed by Martin which enables a Pershing commander to count down and launch up to three missiles with a single programmer test station without disconnecting and reconnecting cables between each launch, as was previously necessary.

LVRJ: The USN Low Volume RamJet propulsion system test vehicle made its first free flight on December 2, 1974. It was launched from a USN A-7 attack aircraft over the Pacific Missile Range. The first separation test had taken place in June 1974 at the China Lake, California test facility.

The LVRJ is being developed as a potential propulsion system for new generation high performance missiles, this work being carried out by LTV Aerospace Corporation of Dallas under contract to the Naval Air Systems Command. It combines an integral rocket/ramjet engine in a single motor case. Boosted to high speed by the solid propellant rocket, it then uses the empty motor case as a combustion chamber to burn ramjet fuel for long-

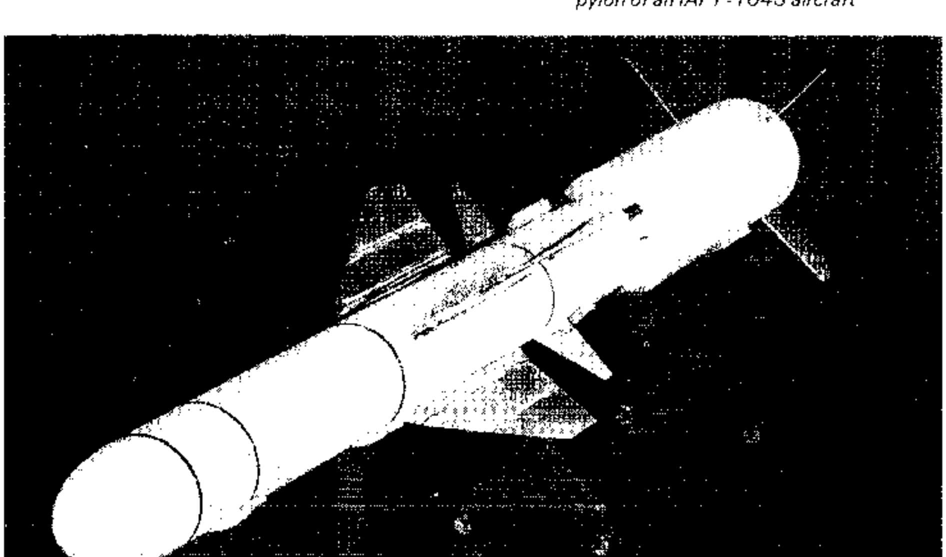


Soviet "Nanutchka"-class missile boat receiving attention in a Russian naval base. Details which can be discerned include the SAN-4 missile launcher on the foredeck and the associated Pop Group radar assembly. Loading cradles for the vessel's surface-to-surface missiles are also in evidence



First picture to show the configuration of the XJ521, or UK Sparrow, which is at the advanced development and initial production stage by Hawker Siddeley Dynamics

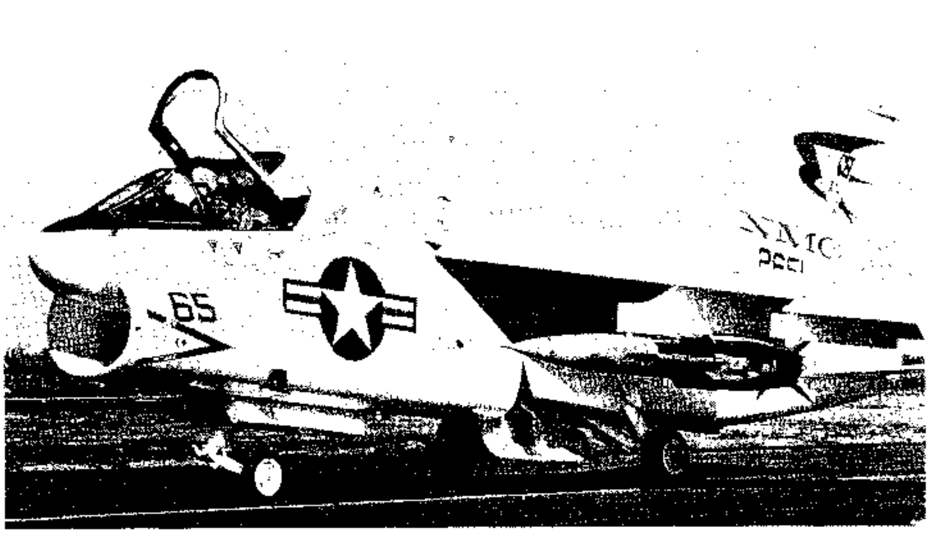
Flight trials of the Italian Aspide-1A multi-role missile began in 1974. It is seen here on the wing pylon of an IAF F-104S aircraft



The USGW, Underwater to-Surface Guided Weapon, under development by Hawker Siddeley Dynamics. It is derived from the Anglo-French Martel air-to-surface tactical weapon. USGW is embarked, stowed, loaded and discharged as if it were a torpedo er duration flight. Once the vehicle reaches ramjet takeover speed with the solid booster, port covers are blown in from four intakes at the rear of the vehicle allowing ram air to enter and mix with fuel to support combustion.

In the December 1974 flight the 13.7 m × 38 cm diameter LVRJ was released at about 4,000 metres and a speed of 965 km/h. Accelerated by the rocket motor for approximately five seconds, the LVRJ then changed to ramjet propulsion for a distance of over 56 km, reaching speeds in excess of Mach 2.0. Test officials said that while the system is capable of considerably higher speeds and range, performance was intentionally limited for the initial flight.

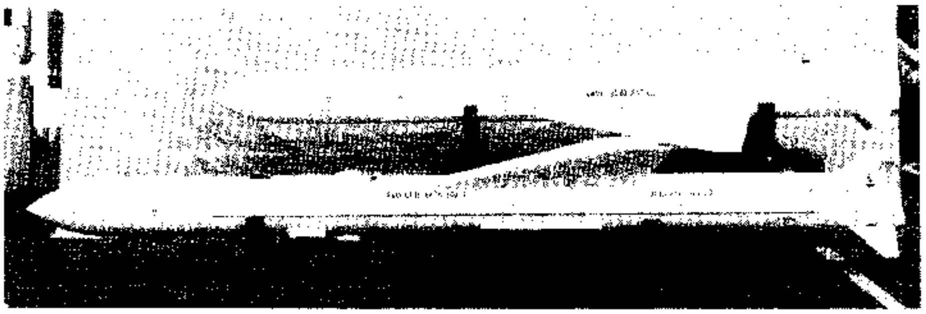
No attempt was made to recover the test vehicle, and this test flight was the first in a series of six which is expected to extend into 1976. Flight test was conducted by the US Naval Missile Centre; the rocket booster was designed and loaded by the Naval Weapons Centre at China Lake; the combustion chamber was fabricated by the Naval Ordnance Plant at Louisville, Ky; and the ram burner/fuel control system was provided by United Aircraft Research Laboratory at East Hartford, Conn.



The USN Low Volume RamJet (LVRJ) test vehicle mounted on an A-7 Corsair II prior to its first flight in December 1974

Exocet: The highly successful Exocet anti-ship missile programme has been expanded appreciably since the main body of this volume was sent to press. In addition to the air-launched versions already described, the Exocet family of weapons now includes two new surface-launched models, and a submarine-launched version is under some consideration in France. Another significant development is a much more compact and lighter, tubular, launcher-container which offers either increased missile fire-power for larger vessels, or the possibility of deploying Exocet on lighter craft than was previously possible.

The complete range of Exocet models is now as follows:



This picture of the AM 39 and MM 38 versions of the Exocet side by side shows the difference in size and in the wing and tail surfaces

MM 38: This is the original surface-to-surface anti-ship weapon and is described in some detail in Entry No. **1158-221.** At the end of 1974 orders for more than 700 examples of this version had been secured from eleven navies: France, UK, West Germany, Argentina, Brazil, Chile, Ecuador, Greece, Malaysia, Peru, and an un-named NATO nation believed to be Turkey.

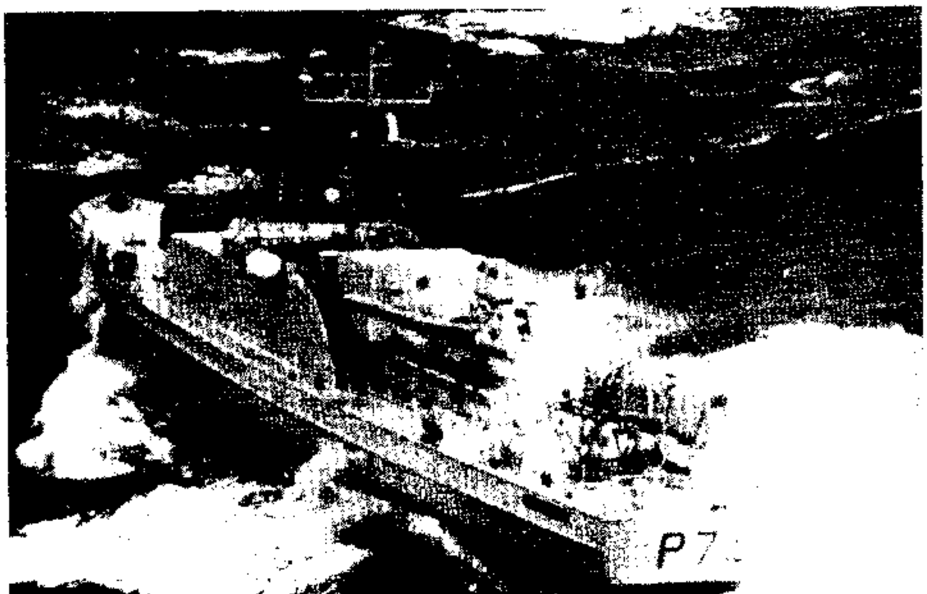
AM 38: This designation refers to the original air-launched version, intended principally for helicopter operations, and was virtually the same missile as the MM 38. This model has been superseded by the AM 39.

AM 39: This version is described (with the AM 38) in Entry No **1770.321** in Section One of this edition of Jane's Weapon Systems; the following notes are concerned with information since that entry was compiled. The AM 39 is lighter and has smaller dimensions than the MM 38, as shown in the following table:-

	MM 38	AM 39
Weight:	735	650 (kg)
Length:	5.212	4.69 (m)
Diameter:	35	35 (cm)
Span:	104	100 (cm)

Other significant differences are a slightly altered wing planform and a modified Electronic Marcel Dassault ADAC homing head on the AM 39, and variations in the propulsion arrangements. The latter give the AM 39 a booster burning time of 2 seconds with a sustainer time of between 130 and 150 seconds, which compares with the MM 38's 2.4 seconds and 120 seconds. Depending upon launch conditions (height and airspeed) the AM 39 range is between 52 & 70 km.

MM 39: This is a shipborne derivative of the AM 39. Dimensions, weight and propulsion arrangements are the same, but folding wings to enable the missile to be accommodated in the new type of glass-fibre launcher-containers are employed instead of the conventional wings of the AM 39. The dimensions of the new container, which is of tubular configuration, are such that four can be accommodated in the same volume as that required for a single conventional MM 38 metal housing. Range of the MM 39 is quoted as 50 km, as against the standard MM 38 range of 42 km.



Launch of an MM 38 Exocet from a fast patrol craft in a lively sea

MM 40: The MM 40 version of Exocet has the same weight and dimensions as the MM 38 model and the same launcher-container is employed. However, the later motor technology is used to give a boost phase of 2.4 seconds followed by a sustainer burn time of 220 seconds. The longer cruise phase – about 100 seconds over that of the MM 38 – is sufficient to extend maximum range, surface-to-surface, to about 70 km. For over-horizon operations at such ranges, the co-operative use of helicopters is envisaged. This version of Exocet is reported to be under development on behalf of an unspecified South American Navy.

SM 39: The folding wing and container/capsule technology involved in the MM 39 Exocet is seen as a step towards the evolution of a submarine launched version. Such a possible development is said to be under consideration.

The AM 39, MM 39, and MM 40 versions of Exocet are all expected to be ready for service before the end of 1977. The MM 40 is proposed for use as a coastal defence weapon in addition to its use in the ship-to-ship role, and a mobile version of the MM 38 for coastal defence has also been developed.

Soviet Strategic Missiles: In the course of 1974 the pace of Soviet strategic missile development was maintained at a high rate, and this was sustained until the final weeks of the year. The following notes are intended to supplement the entries for individual Soviet weapons in this category that appear in Section One of this volume.

SSN-8: Two of these long-range Submarine-Launched Ballistic Missiles were launched on October 3, 1974 from what are thought to have been Soviet "Delta"-class submarines positioned in the Barents Sea. Re-entry was in the Pacific Ocean, representing a range of some 4,300 nautical miles. Single re entry vehicles apparently were carried by each SSN-8.

SS-X-16: Two ICBMs, believed to be solid-fuelled SS-X-16s, were launched from an un-named site in the Soviet Union and re-entered in the Pacific Ocean on December 12, 1974. Single re-entry body payloads were carried.

SS-X-17: Test firings of the SS-X-17 ICBM from the Tyuratam launch site were made on October 21 and 23, 1974. In both cases re-entry was in the Pacific Ocean in an area north of Midway Island, a distance of more than 5,000 nautical miles. Multiple re-entry vehicles, believed to be four in number, were carried on each flight. American sources claim that the re-entry vehicles are large compared with US types.

SS-X-18: In January 1975 the US Secretary of Defence, Dr James Schlesinger, reported to Congress that there was "confirmed evidence" that the new SS-(X)-18 ICBM was being deployed in the Soviet Union. Dr Malcolm R. Currie, US Director of Defence Research and Engineering stated in November 1974 that, "The new SS-18 has been flown with a single large re-entry vehicle but also with eight RVs that not only are larger than those on the SS-19 but also are quite accurate. We have information suggesting the possibility of a quarter-mile CEP although I personally feel that that may be somewhat overstated. Obviously, however, the SS-18 could make an excellent hard-target killer if fully deployed."

SS-19: In his January 1975 report to Congress, Dr. Schlesinger said there were "indications" that the SS-19 was being deployed by the USSR. Dr. Currie (Nov 1974) had previously stated, "We know that the SS-19 can carry six fully MIRVed re-entry vehicles. That's twice as many, each twice as big, as the Minuteman III provides."

French Strategic Missiles

SSBS: The decision to deploy a third unit of nine SSBS (Sol-Sol Balistique-Stratégique) missiles in the Plateau d'Albion has been suspended for reasons of economy, it was announced in December 1974 by the French Ministry of Defence.

French MIRV: At the opening ceremony of the 11th Session du Centre des Haute Etudes de l'Armement (CHEAR) in October 1974 it was stated that in the course of the next decade Multiple Independently targeted Re-entry Vehicle (MIRV) capability will be provided for the French Forces nuclear arm.

IMPROVED POINT DEFENCE/TARGET ACQUISITION SYSTEM

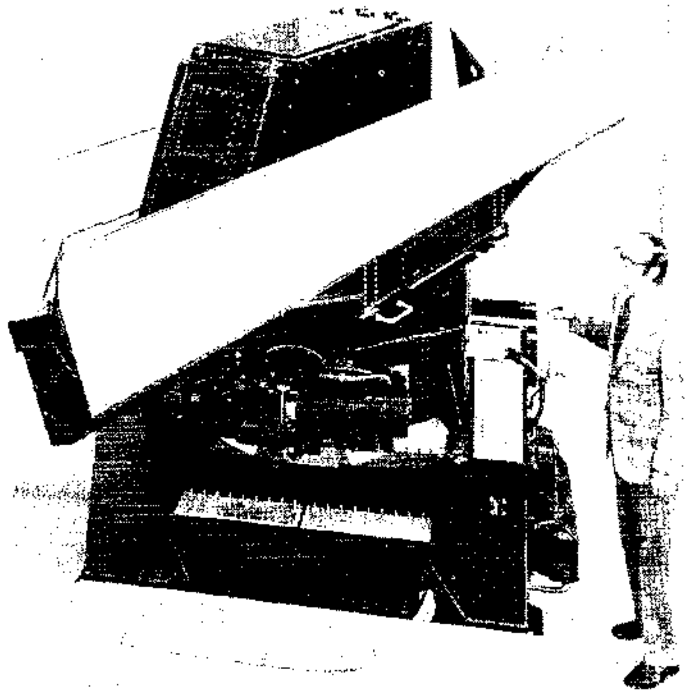
GENERAL:

Shore testing of a combined radar and infra-red target tracking system for use in ships' anti-aircraft and anti-missile defence systems was successfully carried out by Hughes Aircraft in late 1974. Air target data from radar and infra-red sensor are correlated by the integrated system which is designated IPD/TAS (Improved Point Defence/Target Acquisition System). Combined with the NATO Seasparrow weapon system it will be employed in the USN Improved Point Defence Surface Missile System which is intended to provide ships with a quick reaction, short-range air defence capability. The IPD/TAS is the outcome of $30-million R & D contract awarded by the US Naval Ordnance Systems Command.

The infra-red sub-system provides a passive means of obtaining azimuth and elevation bearing data on targets, while the high data rate, wide-band radar gives target range and closing speed. The sensors are mounted on a single stabilised mount and a rotation rate of 30 RPM is reported. Coverage in elevation is 75 degrees.

Five versions of IPD/TAS are being developed, the first being the integrated IR/radar model with computer, data displays and associated equipment. The remaining four are single sensor derivatives providing for automatic and manual versions of the IR or radar sensor types. Manual versions do not have a computer and different displays are used.

US Navy Operational Evaluation of all five on board USS *Downs* is planned to take place during 1975



The combined radar/infra-red sensor assembly developed by Hughes for the US Navy's Improved Point Defence/Target Acquisition System

MSI-70U SUBMARINE FIRE CONTROL SYSTEM

Royal Norwegian Navy submarines of the "Kobben" class are now equipped with a new tactical data processor and weapon control system, the MSI-70U produced by A/S Kongsberg Vapenfabrikk. There are 15 submarines of the "Kobben" class and all are expected to be fitted with the MSI-70U by the end of 1975.

Based on a Kongsberg SM 3 general purpose digital computer, the system has as its main functions, target tracking, torpedo guidance, and the presentation of the tactical situation on a tactical display. The tracking and guidance problems are solved automatically and/or interactively (man/computer), with the MSI-70U computer working as a data bank in the interactive mode. In addition to these main functions, there are a number of supplementary facilities provided by the system. These include:

Computation and display of sound path data.

Display markers for attack and navigational purposes.

Simulator programmes for crew training.

Recording of all data necessary for a complete reconstruction and analysis of an attack.

Maximum utilisation of every target observation is obtained by means of an advanced tracking process and appropriate data presentation, and the tracking system can use data from all available sensors at any time and in any sequence. Each sensor contributes to the solution according to its accuracy, and the overall reliability of the target solution is indicated on the target tracking display.

To permit the submarine to operate and attack employing passive sensors only, the system is so designed with this mode of operation (ie. passive) as the normal one. It may also be noted that in the passive mode the MSI 70U system automatically will establish tracks on targets which are changing course and speed. Special features for early warning of target manoeuvres are incorporated and new target data can be established with minimum delay after the manoeuvre.

The tracking and display systems are combined with a flexible torpedo salvo control, making it possible to engage targets which had hitherto

The console of the Norwegian MSI-70U submarine fire control system been considered beyond range or otherwise impossible. Any combination of automatic and manual guidance is possible and change of target may be performed instantly and at any time, including when the torpedoes are running.

The MSI-70U operating console is designed for two-man operation, but can be manned by one crew-member only. It is provided with the displays and controls necessary for complete control of the system. Within the console are the interface equipment, power supply modules, and the SM-3 computer. Modular construction permits it to be taken aboard via standard hatchways.

DEVELOPMENT:

Development was undertaken by Kongsberg in co-operation with the Norwegian Defence Establishment (NDRE), following an extensive evaluation of the fighting potential of the "Kobben" class submarine carried out in the mid-1960's by the RNoN and NDRE. The development contract was awarded in 1969, a prototype equipment being delivered and installed for sea trials a year later. These lasted for almost a year and production specifications were laid down in 1971. The first operational system was delivered in late 1972. Since then production has been at an approximate rate of one set per month.

MANUFACTURER:

A/S Kongsberg Vapenfabrikk, Postbox 25 N-3601, Kongsberg, Norway.

9AU-300 FIRE CONTROL SYSTEM

DESCRIPTION:

The 9AU 300 is a shipborne fire control system for surface vessels operating in the anti-submarine role. The system is built around a general purpose digital computer with CPU, store and input/output units. The ASW plot contains one PPI, an alpha-numeric display, officers' and operators' panels. The same computer and display techniques are employed as those of the Philips 9LV 200 series of naval weapon control systems (Entry No. **1542.281**).

The main tactical functions of the system are:-

(1) Search and target tracking in association with the ship's sonar system.

(2) Presentation of sound path propagation on a sound path indicator presentation, integrated with the ASW plot (ie. on the same CRT display as the PPI).

(3) Continuous presentation of the combat situation.

(4) Evaluation of target data and prediction of future target position.

(5) Calculation of control signals for an A/S rocket launcher.

(6) Calculation of collision course and dead run, and setting of top and bottom search levels for A/S homing torpedoes.

(7) Calculation of own ship's course and time to fire charges for depth charge attack.

The last two facilities are options, and the 9AU 300 system is designed for control of the Bofors 375 mm twin A/S rocket system with all available types of A/S rockets including Erika and Nelli. Any type of A/S homing torpedo can be accommodated if this option is specified.

Sonar is the principal sensor and various models of different manufacture may be employed. Other inputs to the system are the ship's gyro reference system, and the ship's log.

No other details are available at the time of printing.

MANUFACTURER:

Philips Teleindustri AB, Fack, S-175 20 Järfälla 1, Sweden.

KALLE FIRE CONTROL SYSTEM

DESCRIPTION:

Kalle is an electro-optical fire control system for light anti-aircraft guns. It provides facilities for tracking air targets with an automatic TV tracker and a laser range-finder. For the aiming of two AA guns, the predicted motion of the target and gun ballistics are computed. Gun control and aiming signals are transmitted via a simple two-wire data link to two guns.

No other firm details have been obtained, beyond the information that additional sensor options include a FLIR tracker (Forward Looking Infra-Red) and a LLLTV (Low Light-Level Television) camera.

MANUFACTURER:

Philips Teleindustri AB, Fack, S-175 20 Järfälla 1, Sweden.

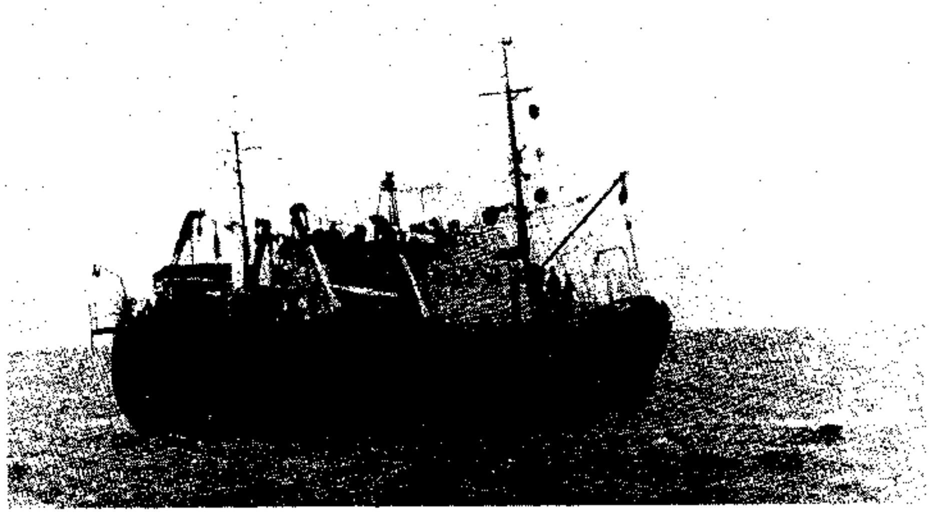
SC 74 ASW CONTAINER WEAPON SYSTEM

GENERAL:

The SC 74 is a containerised anti-submarine weapon system devised by CIT-Alcatel to enable merchant ships or naval vessels, otherwise not equipped for ASW, to be simply and quickly equipped with A/S detection and short and medium range weapons. The system is also suitable for installation on wharves or similar waterside locations to provide protection for harbours etc.

Three containers comprise the complete system: (1) Detection, (2) Weapon, and (3) Power Supply.

The first of these includes all the equipment necessary to use the DUAV4/HS71 helicopter sonar, (Entry No. **1631.353**) the transducer head of which is deployed from the container by means of a folding crane jib mounted on top. The winch for raising and lowering the transducer is housed in the detection container, as is the transducer during transit. The HS71 sonar and signal processing equipment permit detection in a back scattering medium in shallow water and under unfavourable propagation conditions. The transducer unit can be lowered to depths of 130 metres, and use of the optional SCC01 sonar coverage computer assists in determining optimum sonar depth. A single operator mans the detection container and provides target range, azimuth and radial speed data by telephone to the operator in the weapon container.



A Soviet "trawler" at work in the English Channel. The Zvezda has a multiplicity of antennas and there are submersed sensors suspended from davits at the bow and stern of the vessel, possibly for underwater monitoring of sonar signals

This is equipped with an L3 torpedo and launch tube, (Entry No. **1165.441**) and the necessary electronics and control panels for operation of this weapon on the basis of data supplied by the detection container operator. It is not necessary to train the torpedo launch tube as the L3 torpedo is provided with means for directing toward the target under gyro command. Subsequent guidance is by means of the torpedo's active homing head.

FRENCH NAVAL OPTO-ELECTRONIC SYSTEMS

GENERAL:

For the French Navy opto-electronic systems are seen as providing valuable assistance to the present systems for detection, tracking, guidance, display and thermal imaging, and DTCN (the Technical Department for Naval Construction) is energetically continuing R & D along several lines. These include the use of lasers for telemetry, guidance, aiming, illumination and communications; passive infra-red for guidance, tracking, detection, thermal imaging and surveillance. Light intensification and low light-level television techniques are being studied, as are the uses of thermal imaging for surveillance, target designation and guidance.

Laser programmes in progress for DTCN consist of one rangefinder for naval guns, and two projects concerned with laser tracking and guidance.

TAON:

TAON (Télémétrie d'Artillerie Optronique pour Navire) is a laser rangefinder for ships. It is designed as a compact and low data rate unit for installation on all old and new rangefinding turrets to provide accurate range information which can be used directly by the gunnery control computer under the supervision of a single operator at the gun fire control console. A fleet compatible prototype of this laser range-finder has been built by Compagnie Générale d'Electricité to STCAN specifications. TAON equipment is designed for TTAC remote aiming turrets. Its main functions are ranging on shore targets and low speed targets afloat. Range-finding is possible between 1.5 and 16 km to an accuracy of plus or minus 5 metres. Beamwidth is one milliradian, pulse rate 30 pulses/min. The equipment weighs about 40 kg.

LIDAR:

LIDAR (Light Detection And Ranging), or laser radar, is being sponsored by DTCN as a tentative development. With French Naval Headquarters, the STCAN has laid down the main characteristics of a fleet-compatible model for assisting the tracking radar of a 100 mm weapon system and has entrusted Thomson-CSF with the task of building a prototype.

The system will consist of a laser transmitter coupled to a suitable antenna (and possibly a transmission sweep system), and a receiving antenna, receiver, analysis system, with perhaps a detector and processor. This will provide deflection measurement data on a target together with its range, and speed if required. Purpose of the system is the acquisition and tracking of attacking missiles at low elevations within a range of 10 km.

With radar assistance, the field of acquisition is 1.5 milliradian × 20 or 30 mrd; the tracking range 1.5 mrd × 1.5 mrd; sampling time 80 or 60 ms; and operating wavelength 1.06 micron.

IRDAR:

DTCN is already considering a LIDAR using a 10.6 micron (ie. infra-red laser) source and a heterodyne or homodyne receiver. This would be a pulse doppler laser radar operating in the infra-red. Although the source and receiver are still at the design stage, DTCN expects that the advantages of such a system will be considerable.

Passive infra-red developments pursued by DTCN include the VAMPIR system for surveillance and detection, PIRANA for guidance and tracking, and ADMAR for missile guidance.

VAMPIR:

The designation VAMPIR derives from the French for Infra-red Panoramic Air-Sea Surveillance – Veille Air Mer Panoramique Infra-Rouge. It is a low field and low altitude panoramic detection system intended for the detection of anti-ship missiles at ranges of 10 km or more, even during radar silence. The stabilised, rotating head weighs about 50 kg.

DTCN is sponsoring development work undertaken by SAT (Société Anonyme de Télécommunications) of a VAMPIR system and a feasibility model has been tested.

PIRANA:

The PIRANA (Pointeur Infra-Rouge pour l'Artillerie Navale) is an infra-red aiming unit for naval guns, designed by STCAN and constructed by SAT. The dimensions specified permitted simple mounting on existing French Navy gun fire control radars. Its function is to permit these radars to continue tracking at low elevation angles when sea clutter might otherwise obscure the target. This also allows for continued tracking in the face of ECM or under radar silence. The field of view is about one degree, operating wavelength four microns, and the tracking range against a head-on aircraft target is quoted as more than 10 km.

ADMAR:

ADMAR (Auto-Directeur Marine) is a compact infra-red detection system capable of tracking ship targets. The existence of two versions has been revealed: ADMAR I, which gives target elevation and azimuth data, and measures 15 × 15 × 15 cm. ADMAR II, which provides single axis data only and measures 10 × 10 × 10 cm. Initial tests at Toulon have indicated that vessels are susceptible to IR tracking, and IR homing for low-level anti-ship missiles show considerable promise.

Low light-level television (LLLTV) is being studied by DTCN for a variety of naval applications associated with weapon control functions.

CONDOR:

CONDOR is the French acronym for radar target designation optronic night camera, and its function is to replace turret operators, to enable a target to be designated and identified, and enable a laser to be laid on. In addition, and in the context of comprehensive integration with the radar, it can provide sighting facilities or automatic tracking in the event of radar failure, radar silence, or loss of track at low elevation due to sea clutter and/or ECM.

The DTCN has developed two LLLTV systems for evaluation, a Super-Esicon built by Thomson-CSF to study integration in radar gunnery control, and an ISIT camera built by SEREL.

In addition to these lines of research, DTCN is studying potential applications for light amplification and image intensification techniques such as night surveillance from ships and commando operations. In order to increase the capabilities of conventional submarine periscopes, STCAN is designing and developing a new periscope head permitting night vision and possibly laser range finding.

Thermal imaging by infra-red has appreciable potential, especially where hot-spots and temperature contrasts can be expected, and there is considerable interest in this area of opto-electronics also. DTCN has designed, and had constructed by TRT, a thermal imaging camera operating at 4 and 10 microns to measure the IR 'signatures' of vessels with a view to counter-measures and identification. This equipment has a 35 deg × 11 deg field of view, picture rate of 25 frames/sec, thermal resolution of 0.2 deg C, and is steerable between 5 and 45 degrees in elevation and 90 degrees in azimuth.

CLIO-BS OTOMAT FIRE CONTROL SYSTEM

GENERAL:

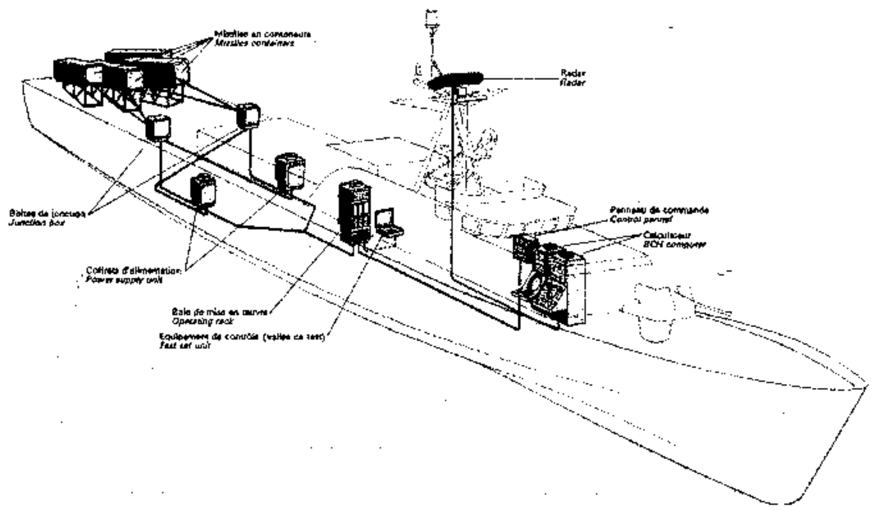
Under the designation CLIO-BS (Conduite de Lancement Intégrée Otomat – Bâtiments de Surface) an integrated fire control system for surface ships fitted with the Otomat surface-to-surface missile was disclosed at the 4th French Exposition Navale which took place at Le Bourget in October 1974.

The system provides for pre-launch preparation and automatic firing of Otomat under the control of a single operator. The firing sequence requires only a 30-second interval from the instant of putting the system to the "ready" status. The integrated fire control for Otomat is compatible with existing target designation systems.

The installation comprises seven units:-

(1) Control Panel
(2) BCH computer
(3) Operating rack
(4) Missile start power supply
(5) Missile general power supply
(6) Junction box
(7) Test set.

There is also a missile container which serves for both quayside storage and as an on-board launcher-housing.



Schematic diagram of the CLIO-BS Otomat fire control system

The control panel is specifically for launch control of the Otomat and provides for the operation of up to four missile launchers. The panel houses all necessary manual controls, signal lamps etc., and a safety arming key for preparing the system. The BCH computer provides each missile with local attitude and orientation data prior to launch, calculates the course heading and time of flight, determines if a given target is within the Otomat's launch/range field, and also computes the firing 'window'.

The operating rack contains the necessary sequencing circuitry and relays for the correct start-up and launch operations of the missiles. It also provides for appropriate read-out and indication of the various stages of the sequence as an aid to monitoring operation or fault-finding.

The two power supplies provide the high current 27-volt DC power for start-up of the Otomat's turbojet motor, and a lower current supply (also 27-volt DC) for the various missile systems. The latter is used for such purposes as gyro run-up, electronics etc., prior to activation of the Otomat internal power supplies.

Either one or two junction boxes will be installed, each capable of linking two Otomats with the CLIO-BS. They provide for the transmission of all data originating in the system to the missiles, and also serve as the link between the umbilical cables and the permanent installed wiring of the system. The test set acts as a 'fifth missile' to permit a check-out of the complete system.

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