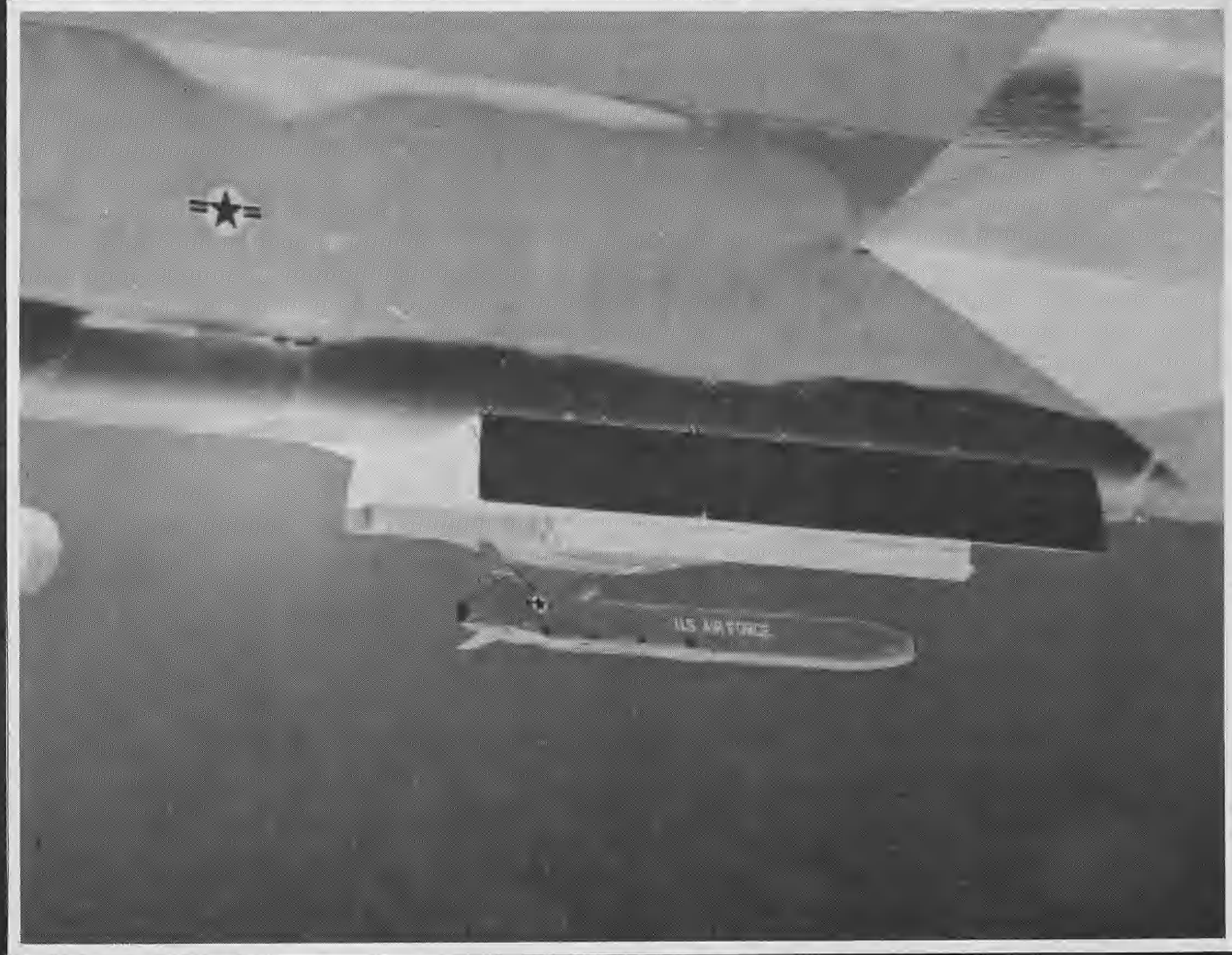
WEEK ENDING 2 AUGUST 1980
FLIGHT INTERNATIONAL

Defence

WORLD MISSILE DIRECTORY



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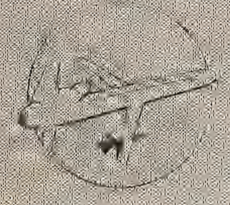

Strategic ballistic 1

China

CSS-1 This single-stage liquid-propellant MRBM is based on the Russian SS-3/SS-4 designs and may have been deployed as early as 1966, the year in which a CSS-1 flew 1,750km carrying a 20-kiloton atomic warhead. The missile is fired from a concrete pad, and between 50 and 90 are thought to have been deployed.

CSS-2 This IRBM entered service in 1970, but only about 20 are thought to be operational.

CSS-3 This limited-range ICBM is reported by some sources to have entered service in 1976. The exact state of its deployment is not clear.

CSS-X-4 A full-range ICBM that may be deployed in the early-1980s.

CSS-N-X Reports in the United States indicate that China may at last be ready to deploy its submarine-launched ballistic missile. One report says that six of the weapons are expected to be deployed this year in a modified *Han*-class nuclear-powered submarine.

France

Aérospatiale Sol-Sol Balistique Stratégique (SSBS) S3 The S3 variant, which has greater range than the S2 deployed since 1971 and incorporates an advanced re-entry system, is replacing the earlier version from this year. The S3 was first launched in December 1976 and development firings were completed in the late summer of 1979. Work on converting the first existing base to take the S3 began in April 1978.

Two squadrons of nine SSBS each are operational in silos spaced between 3km and 8km apart in the Plateau d'Albion, Haute Provence. The 36,000ha Saint-Christol base is operated by the Armée de l'Air 1*er* Groupement des Missiles Stratégiques. Reaction time is about 3min 20sec.

Aérospatiale Mer-Sol Balistique Stratégique (MSBS) M20 The M20 became operational in 1977, replacing the earlier M1 and M2 models, and is now the standard French SLBM equipping five nuclear submarines.

Aérospatiale MSBS M4 The M4, which is almost twice the weight of the M20 and has a greater diameter, is being developed to arm the French Navy's sixth nuclear-powered ballistic-missile submarine, *L'Inflexible*, from 1985. The weapon will then be fitted retrospectively in the existing five vessels. Compatibility trials with a mockup of the M4 in the trials submarine *Gymnote* have begun, but the original development timescale has slipped.

Aérospatiale SSBS-X This mobile ballistic missile, which has also been referred to as the SX, is being studied as a possible successor to both the present SSBS series of silo-launched IRBMs and the Mirage IV strategic bomber. The weapon would be powered by solid-propellant rocket motors and would carry a single 150-kiloton warhead—of the same type as that being developed for the MSBS M4—over a range of nearly 4,000km. The missile would be towed on a five-axle trailer/launcher travelling on normal roads to reduce the likelihood of the force being destroyed by a surprise attack.

United States

Martin LGM-25C Titan II The Titan II is the sole survivor of the force of first-generation ICBMs, which included Titan I and various marks of Atlas. Reaction time is about 1min.
Operator US Air Force (54 missiles in six squadrons of nine each).

Boeing LGM-30F Minuteman II The force of 450 Minuteman IIs will be retained in service even after MX is deployed, since they carry only a single re-entry vehicle and therefore do not infringe the Mirv limits imposed by Salt.

Boeing LGM-30G Minuteman III The Minuteman production line closed at the end of 1978, and the final research-and-development firing took place in March 1980. This test concluded a series of 199 R&D firings (80 Minuteman I, 54 of the II, and 65 of the III) since February 1961. The USAF continues test firings of operational missiles, however, and passed the 400 mark in July 1979. The USAF will deactivate 200 of its Minuteman IIIs as MX deployment builds up in 1986-89, but the other 350 will be retained in service. A wide-ranging improvement programme is being implemented to increase the ability of Minuteman III to survive a Russian attack—a first-strike capability against Minuteman silos may be achieved as early as next year—and to improve the accuracy and yield of part of the force. These measures include hardening the silos by adding 20cm of boron-impregnated concrete to the silo covers, incorporating a new silo suspension system, mounting the associated ground-control electronics on suspended floors to reduce their shock

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vulnerability, and fitting bins on the silo doors to catch debris thrown up by a nearby nuclear detonation. Command-and-control upgrading includes installation (now complete) of the Command Data Buffer System which allows missiles to be retargeted remotely in 30min, and providing up to 200 missiles with the ability to be retargeted from airborne EC-135 command posts following an attack, using a jam-resistant data link. The electronics in Minuteman III are being further hardened against electromagnetic-pulse effects, and part of the force (possibly 300 rounds) is expected to be fitted with the Mk 12A re-entry system for use against hard targets. The Mk 12A, development of which is complete, carries three W-78 warheads with a yield of 330 kilotons each compared with 165 kilotons for those in the Mk 12.
Operator US Air Force (450 Minuteman II, 550 Minuteman III).

Martin Marietta MX Full-scale engineering development of MX to replace part of the Minuteman III force, which will become vulnerable to a Russian first strike within the next few years, was authorised in June 1979. The complete programme is expected to cost $33 billion, although the General Accounting Office is already talking of a total of $56 billion including inflation. Two hundred MXs are due to be based in Nevada and Utah, with the first ten becoming operational in July 1986 and all 200 being in service by 1989. Congress has until September to decide exactly how the missiles will be based; if no decision is reached by then, the in-service date will slip. The racetrack concept favoured earlier has now been replaced by a grid system, in which each MX would be carried aboard a transporter vehicle and loaded into one of 23 hardened shelters running off a central road. Since an attacker would not know which of the 23 shelters was occupied, the weapon would have a much better chance of survival than present silo-based ICBMs.

MX operations will be controlled before an attack from two operational control centres (OCCs) which will be linked to each launcher by a network of buried optical fibres. The OCCs will also have multiple landlines connecting them to the national command authority, together with two-way voice and digital data links to Strategic Air Command and other command posts. After an attack, the MXs will be controlled from airborne launch control centres (ALCCs) using a medium-frequency radio link to each launcher. One ALCC, probably a C-130 Hercules, will be kept on full-time airborne alert and another will be on permanent ground alert.

The first of 20 MX test-flights is due to take place in January 1983 from Vandenberg AFB, with a production decision being taken in July 1983. The missile is intended to carry ten Mk 12A re-entry vehicles, although other candidates are being considered. These include the Amarv (Advanced Manœuvring Re-entry Vehicle) being developed by the Department of Defence's Abres (Advanced Ballistic Re-entry Systems) office. The first of three Amarv flights took place last December.
Operator US Air Force Strategic Air Command (200 missiles planned).

Lockheed UGM-27C Polaris A3 The US Navy's Polaris force is nearing the end of its life—the remaining eight submarines based at Apra Harbour on Guam will be withdrawn between July and September 1981. But Britain is conducting a major improvement programme for its weapons. The project, known as Chevaline, was initiated in 1973 and is nearing completion at a cost of about £1,000 million. Existing rounds will be fitted with a new manœuvrable warhead developed by the Atomic Weapons Research Establishment at Aldermaston and tested in the United States. The warhead will not be a true Mirv, according to UK Secretary of State for Defence Francis Pym, but will "include advanced penetration aids and the ability to manœuvre the payload in space."
Operators US Navy (ten submarines, 16 missiles each), Royal Navy (four submarines, 16 missiles each).

Lockheed UGM-73A Poseidon C3 The US Navy has 31 submarines armed with Poseidon, of which the 12 of the *Benjamin Franklin* class are being converted to take the longer-range Trident missile (see below).
Operator US Navy (31 submarines, being reduced to 19, 16 missiles each).

Lockheed UGM-93A Trident I (C4) The Trident long-range SLBM is being deployed aboard 12 submarines of the *Benjamin Franklin* class, which were formerly armed with Poseidon, and will additionally equip the new *Ohio*-class vessels. The first Trident-armed submarine, USS *Francis Scott Key*, began its initial seven-week operational patrol in October 1979 and has since been joined by the *Mraiano G Vallejo*. The first underwater launching from the *Francis Scott Key* was a failure but firings since then have been successful, and the third converted boat—the *Henry L Stimson*—carried out its first Trident firing in March. The USN is spending $3,500 million on converting ex-Poseidon submarines to carry Trident by March 1982, and the weapon is also to be deployed in the specially designed *Ohio* class. At least 13 of this class will be built, each carrying 24 rounds. The first, *Ohio* herself, is undergoing sea trials and the second, *Michigan*, was launched at the end of April. Deliveries to the fleet begin next year.

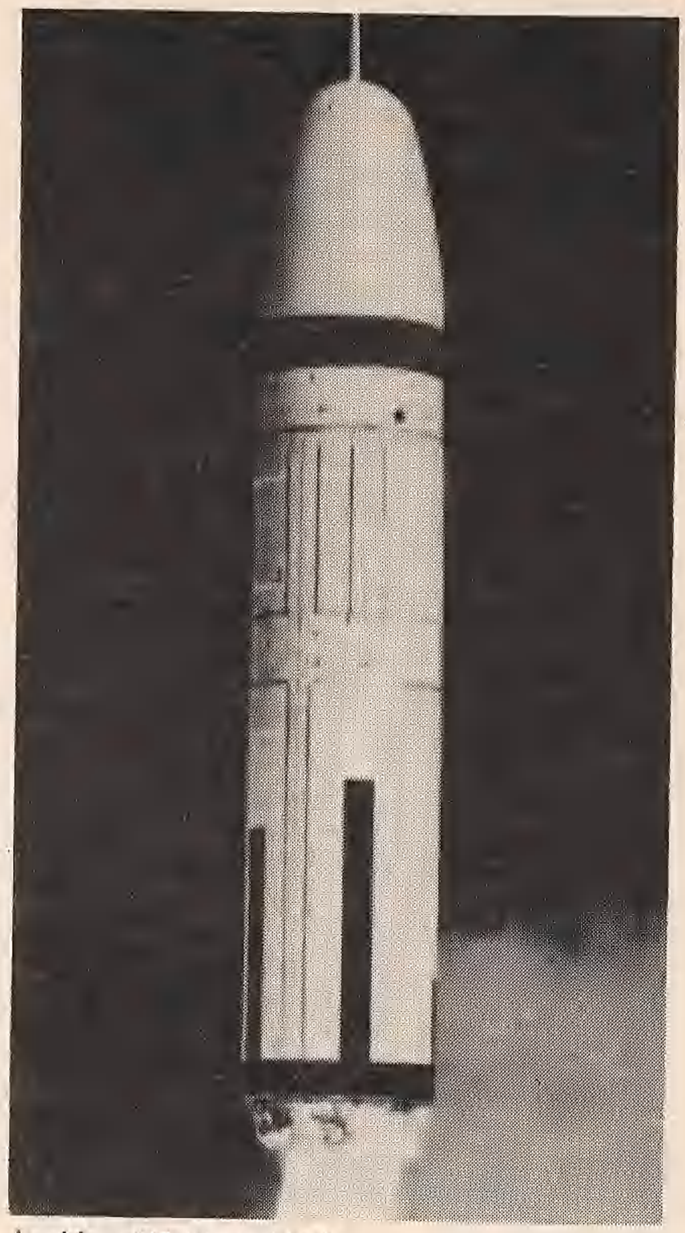
Last October, Lockheed was awarded a $73 million contract for engineering development of the Mk 500 Evader manœuvrable re-entry vehicle as a candidate to equip Trident in place of the present package of seven Mk 4 Mirvs.

Britain has announced that it is to buy Trident I to replace the Polaris SLBM from the early 1990s. Four or five 16-missile boats will be built, costing at least £5,000 million.

Lockheed Trident II (D5) Trident II, which may be developed to enter service after the mid-1980s, would have even longer range than Trident I and would allow SLBM throw weight to be increased. The missile could be fired from the launch tubes being built into Trident submarines, and would have a higher accuracy than Trident I, rivalling that of the Minuteman force.

Soviet Union

SS-14 Scamp/Scapegoat The SS-14 missile (Scapegoat) consists of the upper two stages of SS-13, the weapon being



Lockheed Trident I (C4)

enclosed in a split container during transport on a modified JS III tank chassis. Deployed along the Mongolian/Chinese border. The complete weapon system is known as Scamp.

SS-XZ (SS-15) Scrooge This system is probably a combined transporter/loader for the SS-13 Savage ICBM and not a weapon. An SS-13 without its warhead would fit neatly into the 19m-long storage container carried by the JS III tank chassis. The estimated 60,000kg all-up weight would create high track pressures, giving poor off-the-road mobility.

SS-16 (Russian designation **RS-14**) Some 40 or 50 SS-16s have been deployed in silos to replace SS-13s, and the weapon can also be used in a mobile role.

SS-17 (Russian designation **RS-16**) Both SS-17 and SS-19 are replacing SS-11. About 150 SS-17s have been deployed in SS-11 silos, but the rate of conversion is slower than had been anticipated. SS-17 is cold-launched and has twice the throw weight of its predecessor. Two variants have been identified (most operational rounds are Mod 2).
Mod 1 Entered service in 1975. Carries four Mirvs.
Mod 2 Carries a single re-entry vehicle.

SS-18 (Russian designation **RS-20**) A cold-launched, liquid-propellant missile with about 30 per cent greater throw weight than SS-9. Three hundred and eight SS-18s have been deployed and four variants have been identified.
Mod 1 Carries a single re-entry vehicle. Operational since 1974.
Mod 2 Armed with ten RVs of 600KT each. Entered service in 1976.
Mod 3 Equipped with single RV. Greater range than the other two variants, and more accurate than Mod 1. Deployed since 1976.
Mod 4 Test-flights suggest that the

latest version can carry 14 payloads, perhaps a mixture of warheads and decoys or other penetration aids.

SS-19 (Russian designation **RS-18**) An SS-11 replacement. More than 200 have been deployed, carrying six Mirvs of 550KT yield each. A Mod 2 variant carrying a single RV has also been tested. The SS-19 is thought to be the most effective Soviet ICBM.

SS-20 Being deployed to replace the older IRBM/MRBM force. SS-20, which comprises the first two stages of SS-16, is launched from a tracked vehicle which can quickly be reloaded; the new weapon can thus deliver about three times as many warheads as the force which it is replacing. SS-20's CEP is about 750m when fired from its mobile launcher at pre-surveyed sites, and the initial deployment is expected to total 300-400 launchers plus reloads. SS-20 carries three Mirvs of about 150KT each. About 120 have been deployed in the western USSR and others are reported to be targeted on Japan.

SS-22 This mobile battlefield missile is being deployed as a replacement for the SS-12 Scaleboard and has a range of less than 800km.

SS-X-? Four fifth-generation ICBMs are under development for service in the mid-1980s. At least one of these is reported to use solid propellant, while others may be modified versions of existing weapons. Flight trials of one or more of these missiles could begin this year.

SS-N-5 Serb Serb is now considered obsolescent, but remains in service with the Soviet Navy on six or seven Hotel II submarines. Removal of launch tubes from these vessels began early in 1978.

SS-N-6 Sawfly This missile has been operational in Yankee nuclear submarines since late 1967, this class of vessel being the first in the Russian fleet to carry the launch tubes within the main hull rather than in the conning tower (sail). Thirty-four Yankees and about a thousand SS-N-6s have been produced. SS-N-6 is expected to be replaced by SS-N-17.

SS-N-8 Until the arrival into service of this formidable weapon, the Soviet SLBM force seemed destined always to be inferior to its US counterpart. If SS-N-6 was virtually a Soviet Polaris, SS-N-8 completely eclipses Poseidon and gives Delta-class SSBNs a missile with a longer range even than Trident. Stellar-inertial guidance gives a CEP of about 400m—similar to that of Minuteman, but not small enough to make the SS-N-8 an effective counter-force weapon. Two variants have been reported and a third may exist.
Mod 1 Carries a single re-entry vehicle with a 1·2MT warhead.
Mod 2 Carries three MRVs of unknown yield.
Mod 3? Has been tested with three Mirvs.

SS-N-8 is carried by 15 Delta 1 and 4 Delta II-class submarines, the former hold 12 rounds, the latter 16.

SS-N-17 The first Russian SLBM to use solid propellant, SS-N-17 is being developed to replace SS-N-6s in the 34 Yankee-class submarines, one is already being operated as a trials vessel carrying 12 rounds. Multiple re-entry vehicles can be carried.

SS-N-18 (Russian designation **RSM-50**) This long-range liquid-propellant SLBM was first test-fired in the spring of 1977 and became operational in the winter of 1977-78. It has a range of more than 7,400km, improved guidance and has been deployed in two versions, carrying three and seven Mirvs, and a third variant with a single warhead. SS-N-18 arms the 16-round Delta III class; six of the nine vessels observed to date are thought to be operational. Some sources report that the weapon will be retrofitted to earlier Deltas and may arm the latest Typhoon-class SSBNs. Little is known about the latter vessels and none is in service. Missile capacity has been estimated at 20 or even 24 rounds.

SS-N-X A solid-propellant SLBM to succeed the SS-N-18 is under development and is expected to be deployed aboard the 24-round *Typhoon* class of submarine. The new missile is larger than SS-N-18 and has a greater throw weight.

Strategic non-ballistic 2

France

Advanced air-launched missile Air-breathing weapons are being considered as possible successors to the present generation of French strategic missiles. Other contenders include the SSBS-X/SX mobile IRBM or a further development of MSBS beyond the M4 variant. France could develop powerplants for either subsonic or supersonic cruise missiles from engines already available, and en-route navigation and targeting maps for such weapons could be provided by the projected Samro military observation satellite. Any French cruise-missile development could possibly be carried out collaboratively with other European countries, and such developments come within the scope of studies being carried out by Niag (Nato Industrial Advisory Group) Subgroup 12.

United Kingdom

British cruise missile British Aerospace and other companies are, like their counterparts in France and Germany, carrying out low-key studies of possible cruise missiles based on existing technology.

United States

Boeing AGM-69A Sram The Short-Range Attack Missile will remain in service as a complement to the Air-Launched Cruise Missile, and Boeing has proposed development of a longer-range version known as Sram-L—either as an adjunct to the present force or as an alternative to Asalm. Sram-L could also incorporate alternative guidance packages.
Operator US Air Force Strategic Air Command (17 wings of B-52G/Hs—12 missiles on underwing pylons and eight on a rotating launcher in the belly; two wings of FB-111As—two rounds under each wing and two in the bomb bay).

Boeing AGM-86B ALCM-B The AGM-86B was selected in March as the US Air Force's Air-Launched Cruise Missile in preference to the General Dynamics Tomahawk, following a fly-off involving ten rounds of each design. Boeing won mainly because it has developed better guidance software than was available

Ground-launched cruise missile transporter/erector

for Tomahawk, and the AGM-86B also has improved terrain-following performance over hilly country and promises to be easier to maintain in the field. Present plans call for 3,418 rounds to be built, with 225 of these being constructed in the first year (Fiscal 1980) and 480 each in the second and third. Production is scheduled to build up rapidly to the maximum rate of 40 missiles a month, with the last rolling off the line in Fiscal 1989 (although production may be completed by 1986 under an accelerated programme). The ALCM will be carried by all Strategic Air Command B-52G bombers, some 150 of which remain operational. The first aircraft will be fitted with its interim load of 12 ALCMs at Griffiss AFB, New York, in September 1981 and the first squadron of 14 aircraft will become operational in December 1982. Later modifications will enable the B-52s to carry up to eight ALCMs—or a combination of that missile and Sram or Asalm—on a rotary launcher in the internal weapons bay, in addition to the six under each wing, giving a maximum load of 20 rounds.

Mating the ALCM with the B-52G will extend that aircraft's operational life by at least ten years, and the early introduction of the missile will allow the bomber force to shoulder a greater proportion of the Triad responsibilities until the MX ballistic missile enters service in 1986. A series of up to 19 ALCM development flights in the follow-on test and evaluation programme began late in May and will last until March 1981. These trials will involve launchings under a wide variety of aircraft conditions and will expand the bank of navigation data available. Areas to be further investigated include making landfall after flights over the sea, cruising up and down valleys, and accumulating further experience of handling and maintenance. The last eight of these missions are expected to be integration flights for the B-52 Offensive Avionics System (OAS)/ALCM system for which Boeing Wichita is responsible. The OAS is designed to correct reliability problems with the B-52's navigation and bombing equipment, and to increase overall weapon-system effectiveness as well as providing a launch platform for ALCM.

B-52s carrying ALCMs will provide coverage of about 85 per cent of the US list of strategic targets in the Soviet Union; the missiles are expected to be launched at least 370km from the Warsaw Pact's borders. The inertial guidance system, which drifts about 900m/hr, is updated by the McDonnell Douglas Tercom (terrain-contour matching) program for the Litton 4516C computer. Up to 20 maps of areas en route to the target can be stored, these being compared with returns from the missile's radar altimeter; when a perfect match is found the error in the flightpath is computed and corrections are applied. Further updating may be provided in the terminal phase by a Smac (Scene-Matching Area Correlator), which compares stored and sensed images of the target area for last-minute adjustments. Cruise-missile accuracy is independent of flight time or distance travelled, since Tercom corrects any inertial errors; CEP (circular error probable) at any range is at least 100m, and may be nearer 30m.

Operator US Air Force (more than 4,000 missiles to equip some 150 B-52Gs).

Asalm test vehicle on an A-7D

General Dynamics BGM-109 Tomahawk The same basic GD cruise missile exists in a number of guises for use against land targets and ships following launching from submarines, surface ships, ground launchers and aircraft. Tomahawk lost the competition to select an Air-Launched Cruise Missile for Strategic Air Command—see entry for Boeing AGM-86B ALCM—but remains under development for other strategic and tactical roles.

The strategic version of Tomahawk, the Sea-Launched Cruise Missile (SLCM), will be launched from submarines and surface ships to deliver a nuclear warhead against land targets. General Dynamics is continuing flight-testing of the submarine-launched SLCM, with a total of 17 missions due to have been completed by the end of this year. This stage is scheduled to be followed by four flights comprising the US Navy's technical evaluation, with a 12-flight operational evaluation taking place throughout the rest of 1981. Completion of these trials would prepare the weapon for a production go-ahead, but the USN has no plans at present to proceed with this stage.

The same basic missile can also perform the strategic land-attack role when launched from surface ships, and contractor-organised trials involving five flights will last until next spring. These are to be followed by three missions during the Navy's test and evaluation, with a further six flights forming that Service's operational evaluation lasting from mid-1981 to mid-1982. A production decision could then be taken in late-1982.

Advanced Strategic Air-Launched Missile Asalm is designed to improve the survivability and effectiveness of bombers and cruise missiles by suppressing enemy defences—the Soviet Union Airborne Warning And Control System (Suawacs), airfields and surface-to-air missile sites—and by attacking defended targets that cannot be destroyed with Srams launched from B-52s. A team led by Martin Marietta has been conducting trials of a propulsion test vehicle (PTV) designed to demonstrate engine technology that could be applied to Asalm; the first flight took place from an A-7D in October 1979, and the seventh and final test was completed in May. Subcontractors to Martin are Marquardt (ramjet propulsion), Garrett AiResearch Manufacturing (secondary power), Litton Guidance & Control (inertial navigation), Hughes (guidance) and Hercules (rocket propulsion). Another team led by McDonnell Douglas and including United Technologies (ramjet propulsion) and Raytheon (guidance) has also been conducting Asalm work.

The next stage of development is the subsystem demonstration validation programme (SDVP), emphasising air-to-air guidance and reduction of the vehicle's radar cross-section. Captive flight trials of competitive air-to-air guidance packages are planned for Fiscal 1983, and Asalm could enter service in the late 1980s. The missile will cruise at Mach 4-5 over a range of some 370km, following a variety of trajectories and using high-g terminal manœuvring. Mid-course guidance will be inertial, and alternative terminal seekers will be available: active radar against air targets, and passive anti-radiation in the air-to-surface role. Both conventional and nuclear warheads will probably also be available.

Advanced cruise missiles The USAF's Advanced Cruise Missile Technology (ACMT) programme is intended to pave the way for a successor to the ALCM to be deployed some time between 1987 and 1991. Development has begun of advanced turbofan engines with emphasis on reduced fuel consumption and higher performance, and further work is being carried out on reducing radar signatures and improving avionics. The four companies that have been working on engine/fuel technology are to be reduced to two, and a further two contractors will demonstrate component technology associated with materials, low radar and infra-red signatures, improved avionics for guidance, better manœuvrability and threat avoidance, and the ability to retarget, resist ECM and automatic route planning.

Tactical, ballistic 3

China

Battlefield-support missiles Frog-type weapons carrying nuclear warheads are reported to have been deployed in large numbers near the Sino-Soviet border.

France

Aérospatiale Pluton Very similar to Lance in method of operation. The missile can carry alternative warheads; the AN51, which contains the same MR50 nuclear charge of 25KT as the AN52 bomb carried by Armée de l'Air Mirage IIIs and Jaguars, and which is planned for the Aéronavale's Super Etendards; or a 15KT warhead. The former is for use against troop and equipment concentrations in rear areas, while the latter can be fitted when the target is in close proximity to friendly forces. Air or ground burst can be selected and CEP is 150-300m.
Operator French Army (five regiments, each with six launchers—the 3rd at Mailly; 15th [Suippes]; 60th [Laon-Couvron]; 74th [Belfort]; 32nd [Haguenau]).

Super Pluton The French Army is studying a Pluton successor with double the range—240km—combined with greater accuracy and interchangeable warheads, giving the choice of a nuclear payload or terminally guided submunitions to destroy tanks. The weapon could enter service around 1990.

Israel

Battlefield missiles Despite persistent reports that Israel has developed a long-range tactical missile with a nuclear warhead, there is still no evidence that such a weapon exists.

Several reports have described a short-range bombardment rocket designated Ze'ev (Wolf). Two different range/payload combinations have been mentioned—160kg at 1km and 70kg at 4·5km.

South Korea

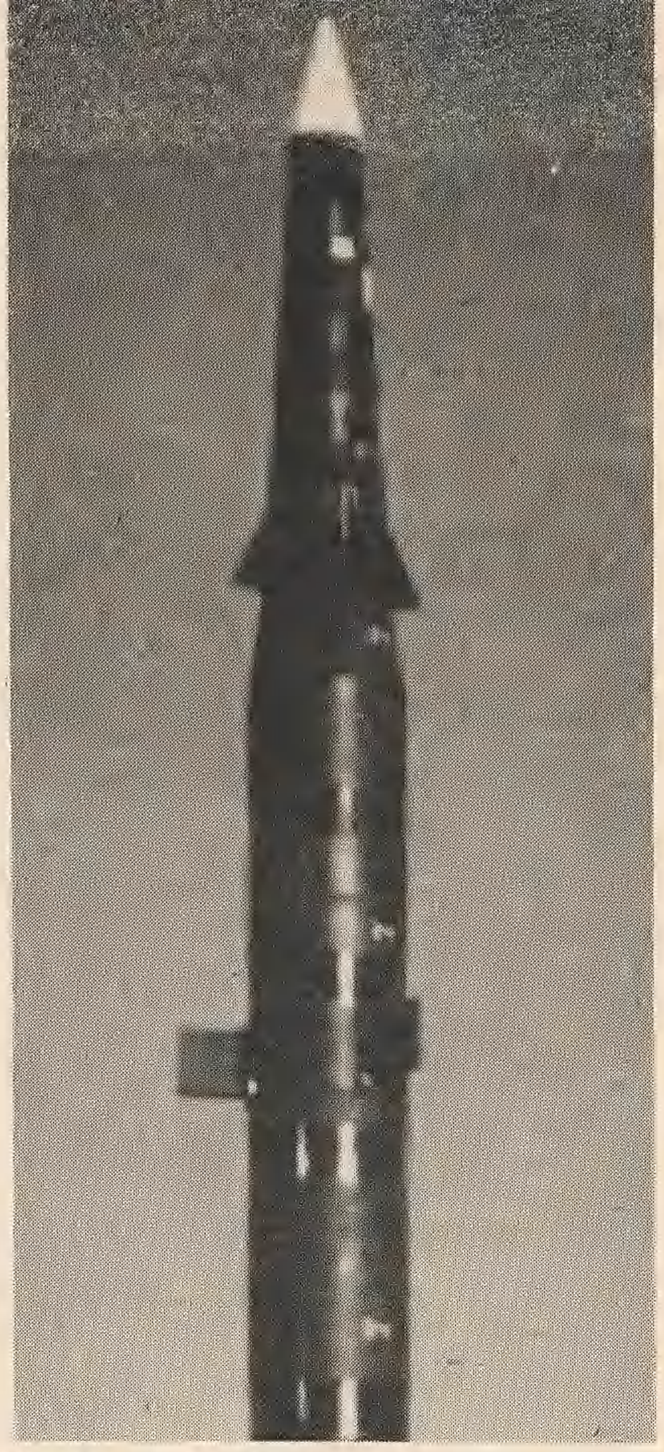
In September 1978 South Korea test-fired a two-stage surface-to-surface missile with a range of 100-160km. Mass production and deployment are to begin in the near future. The weapon seems to be a modification of the US Nike Hercules surface-to-air missile.

Taiwan

Hsiung Feng This short-range tactical missile—locally developed and manufactured, claims Taiwan—is identical externally with the Israeli Gabriel anti-ship missile (see Section 6). It remains open to conjecture whether the weapon has been modified for the surface-to-surface role.

United States

Martin Marietta MGM-31 Pershing II Pershing II, which will be more accurate than the present Ia model and will have more than twice its range, is in full-scale development under a $360 million contract and is scheduled to replace the 108 Pershing Ias based in Germany. Twenty-eight rounds are to be fired during full-scale development and the missile is due to become operational in 1984. Pershing II carries a new terminally guided re-entry vehicle with Goodyear Radag (radar area guidance) to compare live radar returns from the target with stored images of the area. Control signals are then generated to manœuvre the warhead, resulting in an accuracy that is independent of range. The increase in accuracy afforded by Radag allows low-yield nuclear warheads to be used, thus increasing the number of target types that can be attacked with Pershing II. The far greater maximum range extends the weapon's depth of engagement. Other improvements include a reduction in support equipment and personnel, improved reaction time and better survivability. Earth-penetrator warheads being developed for Pershing II will allow the missile to be used against underground command centres at depths of up to 30m.
Operators (Pershing Ia) US 7th Army (four battalions), Luftwaffe (two wings of four nine-missile squadrons each).



Martin Marietta Pershing II

Vought MGM-52C Lance Production of Lance will end in October, although the missile could form the basis of Assault Breaker or the Corps Support Weapon System (CSWS) being developed as a Lance successor (see entries).
Operators US Army (eight battalions), Israeli Defence Forces Artillery Corps (130 missiles), Italian Army (one brigade), German Army (four battalions, 26 launchers, 175 missiles), British Army (No 50 Missile Regiment with four batteries—Nos 15, 19, 36 and 51—operating three launchers each), Belgian Army (five launchers), Dutch Army (1st Army Corps).

Vought General Support Rocket System In May Vought was selected in preference to Boeing as prime contractor for the MLRS artillery rocket and has received an initial award worth $115 million for some 300 rounds and ten vehicle systems to undergo further trials and development. The US Army is expected to buy a total of more than 360,000 rockets and 200-plus vehicle systems, with three European countries —Germany, France and Britain—buying a further 200 or so vehicles and perhaps 250,000 rounds; the European countries signed a memorandum of understanding a year ago and are now discussing how best to procure the system. MLRS may enter service with the US Army as early as 1982, and the programme for the US Services alone is expected to be worth $3,800 million.

MLRS is a battlefield artillery system using a tracked self-propelled launcher that can fire 12 rockets to a range of greater than 30km. The system is designed to complement cannon artillery, especially against surging forces, by attacking targets such as tube artillery and rocket counter-batteries, air-defence concentrations, lorries, light armour, personnel carriers, and supporting troops and supplies. Each MLRS launcher can destroy an artillery battery or equivalent target with one load of 12 rockets.

Phase 1 MLRS rockets will each carry more than 600 M42 submunitions with about the same destructive power as a hand grenade and containing a shaped charge able to penetrate light armour. Phase 2, led by Germany, will use the German AT-2 anti-tank mine. Phase 3, still in the planning stage, will incorporate a number of improvements including various submunitions and alternative forms of guidance.

The Self-Propelled Launcher Loader, using the same chassis and running gear as the US Army's new Infantry Fighting Vehicle, can fire individual rounds or launch them in ripples of up to 12 rockets in less than a minute.

Corps Support Weapon System The US Army has begun studies of a CSWS to replace Lance in both the nuclear and conventional roles. The weapon would have a smaller CEP, better survivability and higher rate of fire than Lance. CSWS could well incorporate Assault Breaker (see below) as one of its elements.

Assault Breaker Assault Breaker is intended as the anti-armour element of the Corps Support Weapon System and is designed to destroy second-echelon forces at a range of some 150km. Submunitions—either terminally guided submissiles (TGSMs) or "smart bomblets"—will be delivered into the general target area by a solid-propellant carrier rocket using a mid-course guidance link from an aircraft equipped with an X-band sideways-looking airborne radar for target location. The submunitions are then dispensed and home independently on to their targets.

Martin Marietta was awarded a $16

million contract in February to act as integration contractor for a 15-flight technology-demonstration programme using the same number of T-16 booster vehicles, for which Martin received a $32·2 million contract in December 1979. In addition to supplying the boosters, Martin will manufacture dispensers, integrate submunitions and demonstrate the complete Assault Breaker system. The T-16 is a modified version of the Patriot surface-to-air missile.

As part of the same technology-demonstration programme, Vought will supply six T-22 boosters based on the Lance battlefield-support missile. The T-22 has already been fired three times, between August 1979 and March 1980, as part of the Army's related SIG-D (Simplified Inertial Guidance Demonstration) programme designed to lead on to development of the Corps Support Weapon System. The T-22s used in SIG-D were Lances with the normal liquid-propellant rocket motor replaced by an Atlantic Research solid rocket. Further changes included the addition of four fixed cruciform wings and the use of rear elevons for steering instead of thrust-vector control valves. The main change, however, was the use for the first time in a ballistic missile of a Honeywell H-700 strapdown laser-gyro inertial-guidance system. The H-700, combined with an Army-developed digital autopilot, allowed the T-22 to achieve an accuracy of some 25m after a flight of 65km. Under the $8·7 million follow-on contract signed last October, Vought will now supply a further six T-22s using an improved solid-propellant motor. The company will also supply a dispensing system for the submunitions, and the missiles will be able to accept mid-course guidance commands from the airborne radar.

General Dynamics has been awarded a $21 million contract to supply 126 terminally guided submissiles—84 with infra-red seekers and 42 dummies for dispersion tests—for use in support of the Assault Breaker technology-demonstration programme. Each missile can carry just over 20 of the TGSMs, which weigh some 11kg each and carry a 10cm-diameter shaped-charge warhead. The Assault Breaker delivery rocket will be launched on to a ballistic trajectory from either a ground platform or an aircraft, with mid-course guidance information provided over a data link from an aircraft carrying a Pave Mover radar. Flight trials of the two contenders for this part of the programme are due to begin in the next few months; Hughes, and a team comprising Norden and Grumman, are each building prototype Pave Mover radars for testing in F-111s. Once guided into a "basket" at a height of 3,000m to 4,500m above the target, the carrier rocket would dispense the TGSMs to home on to individual targets. As an alternative to the TGSMs, Assault Breaker could carry a larger number of smart bomblets weighing 1·2kg to 2·2kg each. These would carry simple and inexpensive infra-red seekers, allowing them to home on to non-armoured targets and destroy them with a warhead weighing only some 0·5kg. The Avco Skeet smartlet and a Martin Marietta/Honeywell design are candidates for this role. A third possibility is fitting TGSMs with millimetre-wave seekers as an alternative to IR heads, giving better performance in bad weather.

A system review of Assault Breaker as a whole is planned for mid-1981, and the extreme urgency for a weapon to counter the Warsaw Pact's build-up of armour could lead to the weapon being fielded as early as 1985. A total of some 2,000 Assault Breakers is likely.

GLCM Tomahawk is planned to be used in several tactical roles and forms the weapon element of the Ground-Launched Cruise Missile which is on the borderline between strategic and tactical operations. Nato has agreed to deploy 464 GLCMs and 108 Pershing IIs in Europe as theatre nuclear weapons (TNWs) to counter the USSR's SS-20s and to augment the capability provided by F-111s and Vulcans. A GLCM flight consists of 16 Tomahawk missiles, four transporter/erector launchers and two launch-control centres. One flight will remain on quick-reaction alert on each main operating base during peacetime, and the flights would disperse away from their bases in periods of increased tension. Present plans call for 160 GLCMs to be based in Britain, 112 in Italy, 96 in Germany and 32 each in Belgium and Holland; the last-named country has until the end of next year to take a final decision on whether to proceed with its involvement. GLCM will enter service in December 1983, the date having slipped from May of that year because of delays in authorising the Nato plan.

Vought T-22 test vehicle

Vought multiple-launch rocket system

Soviet Union

Frog 7 The two-stage Frog 7 carries a 1,000lb warhead over a range of about 55km; the range can be adjusted by means of speed brakes.
Operators USSR, Bulgaria (33 launchers), Czechoslovakia (33 launchers), Egypt (at least 50 launchers), East Germany, Hungary (18 launchers), Iraq, North Korea (20 launchers), Poland, Romania (30 launchers), Syria (at least 30 launchers).

SS-1C (Scud B) A single-stage battlefield-support weapon carried by a MAZ-543 eight-wheeled vehicle. A nuclear or high-explosive warhead can be fitted.
Operators USSR (18 launchers per front), Bulgaria, Czechoslovakia, Egypt (two regiments, 20-24 launchers), East Germany, Hungary, Iraq, Poland, Romania, Syria (30-36 launchers), Libya.

SS-21 The Soviet Army is introducing a new guided battlefield-support missile to supplement and replace Frogs. This 120km-range weapon is now deployed by Soviet divisions in East Germany, and is equivalent to the US Lance.

SS-23 This new ballistic missile has been reported but not yet confirmed. Sources which claim it to be an SS-12 Scaleboard replacement are probably confusing it with the longer-range SS-22 (see Section 3). SS-23 may be a 200km-range weapon intended to replace Scud B.

Air-to-ground 4

Argentina

Argentine ASM The Argentinian Armed Forces Scientific and Technical Research Centre (Citefa) has completed eight prototype rounds of an air-to-surface missile to arm naval aircraft and helicopters, and is to construct 50 pre-production weapons for evaluation.

Brazil

Avibras MAS-1 Carcara Avibras-Industria Aerospacial has developed this television-guided ASM for the Brazilian Army. The project was launched in 1973, but its present status is not known.

France

Aérospatiale ASMP Aérospatiale was authorised in March 1979 to begin development of the ASMP (Air-Sol Moyenne Portée) medium-range air-to-surface missile to arm Mirage 2000s and Mirage IVs and possibly other aircraft such as Jaguar. Test firings may begin next year, and service entry could be as early as 1985—although the Electronique Marcel Dassault Antilope 5 terrain-following and ground-mapping radar that will be used to feed ASMP with targeting information is not scheduled to be operational until 1986. ASMP will be powered by an Aérospatiale/Onera liquid-fuelled ramjet, the intakes of which form small lifting surfaces, and will presumably use inertial mid-course guidance; the incorporation of a nuclear warhead probably renders terminal guidance unnecessary, at least in the initial version. The missile's maximum range will be at least 75km.

Aérospatiale AS.30L Following production of 3,900 standard AS.30 missiles for six countries, Aérospatiale is now developing a laser-guided version to arm French Air Force Jaguars from the end of 1981; The last 30 of the FAF's 200 Jaguars will be equipped to operate AS.30L. AS.30L closely resembles its predecessor but carries a Thomson-CSF Ariel laser seeker in the nose, replacing the radio-command method of guidance in the original variant, and is fitted with a new electronics pack to provide stabilisation in roll.

AS.30L homes on to radiation generated by a Cilas ITAY-71 illuminator and reflected by the target. The illuminator is installed in a Thomson-CSF/Martin Marietta Atlis 2 (airborne tracking laser illumination system) pod, which has been undergoing flight trials for the past five years. Atlis 2, which is smaller and lighter than the prototype Atlis 1s, incorporates an automatic television tracker which allows single-seat aircraft to find and attack hardened targets accurately. Atlis 2, which will also be used to designate targets for laser-guided bombs (see entry) and possibly Thomson-Brandt 100mm rockets, is additionally expected to equip the Mirage 2000.

Aérospatiale/MBB AS.2L A laser-guided air-to-surface development of the Euro-

Thomson-CSF Atlis 2 laser designator pod

missile Roland (see Section 8), known as AS.2L (Air-Sol Léger Laser), is being studied. The weapon would use a laser seeker based on the Thomson-CSF Ariel (see AS.30L entry) and would be operated in conjunction with the Atlis illuminator pod.

French laser-guided bombs Guided bombs for use with the Atlis 2 laser illuminator pod (see AS.30L entry) are being studied by both SAMP and a team comprising Thomson-CSF and Matra. The former company's work centres on a 1,000kg BL4 bomb fitted with a Rockwell laser seeker, while the latter consortium's effort is directed at a range of SAMP bombs of 250kg upwards fitted with Eblis, a derivative of the Ariel seeker. Trials have begun of Eblis fitted to Matra 1,000kg bombs. Laser-guided bombs fitted with Eblis, together with control electronics and folding tail-mounted fins for steering, can be launched at stand-off ranges of 2-8km depending on the attack profile being flown.

International

McDonnell Douglas/MBB stand-off missile The United States and Germany have discussed possible joint development of a long-range, fire-and-forget missile which could be launched at low level to soften up heavily defended targets, such as air bases, before an attack by manned aircraft. The weapon is not under active development at present.

Sweden

Saab B83 This lightweight infra-red-homing missile was originally proposed to arm the B3LA light attack/trainer and would have obtained target-designation data from the aircraft forward-looking infra-red (Flir) system. Further development depends on the availability of a suitable launch platform.

United Kingdom

Hunting Engineering VJ291 The VJ291 cluster bomb has been selected to meet Air Staff Target 1227 in preference to Sabre, a laser-guided derivative of Rapier proposed by British Aerospace. VJ291 has extendable fore and aft wings and incorporates a simple inertial navigation system being developed by Sperry Gyroscope, allowing it to attack targets to one side of the launch-aircraft's flightpath and to be delivered from stand-off ranges of 4km to 8km. The weapon can be released at heights down to 30m from an aircraft flying at up to 1,100km/hr, the on-board navigation system being fed with target information immediately before release. Range and off-boresight angle can be fed from a laser designator pod, or the direction may be indicated by the pilot's helmet-mounted sight. As the bomb nears its target, retarded shaped-charge projectiles are ejected over an area selected by the pilot before release to match the target size. If the bomblets miss their target they automatically become mines which will detonate if a tank approaches close enough to operate the induction fuze. VJ291 will enter service in the mid-1980s, arming the Royal Air Force's Tornadoes, Jaguars and Harriers.

AST 1228 Air Staff Target 1228 calls for a defence-suppression weapon to improve the survival chances of penetrating aircraft such as Tornado. The chosen solution could take the form of a harassment drone or similar vehicle rather than a more conventional air-to-surface missile.

United States

Texas Instruments AGM-45 Shrike This anti-radiation missile remains in service and the USAF has launched a development programme aimed at improving the weapon's performance. Existing rounds will be updated to the improved standard.
Operators US Navy (A-4, A-6, A-7), US Air Force (F-4C/D/E/G and F-105G—two or four missiles each), Israeli Air Force (F-4, Kfir).

Hughes/Martin AGM-62 Walleye Three different versions of this TV-guided glide bomb have been developed: Walleye I with a 385kg warhead; Walleye II with a 907kg warhead; and Extended-Range Data Link (Mk 22) Walleye with a missile-to-aircraft data link and larger wings to extend the range. This latest version allows the launch aircraft to take evasive action after weapon release while a second can update the aiming point or steer the missile on to the target. Future rounds could be fitted with the Maverick imaging infra-red seeker, and trials with this homing head are due to begin this year.
Operators US Air Force, US Navy (A-4, A-7, F-4), Israeli Air Force.

General Dynamics AGM-78 Standard ARM Developed from Standard MR to attack surface-to-air missile radar sites. The missile originally used a Shrike

seeker, but in the Mod I variant a new head was fitted.

Standard ARM is also used in the ship-to-ship role by the US Navy (see Section 5).

Operators US Navy (A-6B/E), US Air Force (F-105G—one or two missiles each; Wild Weasel F-4Gs).

Texas Instruments Paveway A family of low-cost modular laser-guided bombs first used in Vietnam in 1967. New versions of the GBU-10 (900kg), GBU-12 (225kg) and GBU-16 (450kg) are in production as the Paveway II family; they incorporate an improved-performance Texas Instruments laser seeker which is also easier to maintain and cheaper to build. All use the same seeker and guidance unit, and the flip-out aerofoil surfaces are matched to the size, weight and shape of different warheads. Portsmouth Aviation is modifying the Mk 13/18 1,000lb bomb for use by the Royal Air Force's Buccaneers, Jaguars and Harriers; the former will carry Pave Spike designator pods, while the last two types will work in conjunction with ground-based illuminators.

Operators US Air Force, US Navy, Islamic Iranian Air Force, Turkish Air Force, Hellenic Air Force, Royal Saudi Air Force, Republic of Korea Air Force, Royal Netherlands Air Force, Royal Air Force, Royal Australian Air Force.

GBU-15 Two basic variants of GBU-15 are being developed; the Rockwell cruciform-wing version, a stand-off weapon for use against point targets such as surface-to-air missile sites; and the Hughes planar-wing version, also known as MGGB-II, intended for high-altitude launching against area-defence systems and high-value targets.

The television-guided Cruciform Wing Weapon (CWW) is ready for production. Hughes is due to deliver imaging infra-red (IIR) seekers this summer for integration with the CWW, and the Joint Service Weapon Link will also be incorporated. The Planar Wing Weapon (PWW), which can also use TV or IIR guidance, has been delayed as a result of technical problems, failures during testing and a shortage of money.

Hughes AGM-65 Maverick During combat in the Middle East and Vietnam, 99 Maverick rounds have been fired in anger, scoring 85 direct hits. According to the USAF, the CEP on trials has been less than 4ft. Production of AGM-65A (basic version) and AGM-65B (scene-magnification variant) ended in April 1978 and further versions are being developed for the 1980s.

AGM-65D This Maverick development uses the same basic missile as its predecessors, with an imaging infra-red seeker replacing the previous TV/laser heads. Commonality with other weapons is emphasised, the Hughes IIR homing head is also planned for the GBU-15 and Walleye glide bombs. A centroid tracker has been developed to replace the original edge-lock unit, which tended to shift to an adjacent target during an attack.

Flight trials have shown that AGM-65D, planned to attack close-support or interdiction targets obscured by darkness, smoke or haze, can acquire and lock on to targets at up to twice the range possible with the TV-guided variants in typical northwest European battlefield weather. The infra-red display allows the operator to distinguish live targets from dead hulks, fires or decoys at night or during bad visibility, and large objects such as power stations can be acquired at extremely long ranges. The seeker is then locked on to the target, and the launch aircraft can turn away or engage another objective once the missile has been fired. Full engineering development has begun under a 35-month $50 million contract awarded at the end of 1978, with a production decision due in early Fiscal 1982. More than 31,000 AGM-65Ds may be ordered, and the missile will be the primary weapon to be used with the Lantirn (low altitude navigation targeting infra-red for night) pod which is to be fitted to F-16s and A-10s.

Hughes AGM-65E Maverick under an A-4

AGM-65E Development of the laser-guided AGM-65C variant has virtually been abandoned, but the US Marine Corps plans to acquire the AGM-65E fitted with larger wings and carrying a 135kg penetrating warhead. Production is not likely to be authorised before 1983.

Operators US Air Force (two triple launchers on F-4D/E, A-7D, A-10), Israeli Air Force (two triple launchers on F-4E), Islamic Iranian Air Force (two triple launchers on F-4E), Royal Saudi Air Force (1,000 missiles worth $47 million; four single launchers on F-5E), Swedish Air Force ($20 million-worth to arm AJ37 Viggen), Korean Air Force, Hellenic Air Force (F-4), Turkish Air Force (F-4).

Texas Instruments AGM-88 Harm The High-Speed Anti-Radiation Missile is in full-scale development and, despite earlier problems, the US Navy now says that it is expected to meet the requirements for which it was designed. A production decision is now not expected until September 1981. The US Navy plans to arm the A-7E, F/A-18 and A-6E with the missile, which will correct the operational difficulties encountered with Shrike—Harm will be faster, have a greater range, improved sensitivity, flexible logic and broadband coverage with a single seeker head. The missile will also equip the USAF's F-4G Wild Weasel defence-suppression aircraft.

Hostile ground radars to be attacked with Harm are detected by an Itek ALR-45 radar warning receiver or by the missile's own seeker operating in the search mode. Threat priorities are computed by a Magnavox ALR-50 missile launch-warning receiver with its associated digital interface, allowing Harms to be fired against radars which are actively engaged in guidance of surface-to-air missiles. In the USAF's Wild Weasel aircraft the weapon will be interfaced with the McDonnell Douglas APR-38 radar homing and warning system. Texas Instruments is developing the AWG-25 command launch computer and a cockpit control panel to be installed in Harm-equipped aircraft.

Rockwell International Hellfire Rockwell is working under a $67 million contract awarded by the US Army in October 1976 for full-scale engineering development of Hellfire, initially to arm the AH-64 Advanced Attack Helicopter. The initial version will be fitted with

Rockwell International Hellfires on an AH-1

an inexpensive laser seeker that has been selected in place of the tri-Service laser previously planned for this application; this cheaper type has been judged superior for short-range and multiple-launch engagements, and has begun its flight trials successfully. The first guided firing from an AH-64 took place last September and initial production of laser Hellfire has been delayed by about a year to match the AAH's production schedule. Targets are illuminated by the AH-64's Martin Marietta Tads (target acquisition and designation system) or by a GLLD (ground laser locator designator).

The modular Hellfire missile has been designed from the outset to accept alternative seekers such as television, infra-red, radio-frequency and dual-mode RF/IR types. Full-scale development of an imaging infra-red seeker will begin in Fiscal 1984 to provide Hellfire with a true "launch and leave" ability. Focal-plane array detector technology will form the prime effort, with detectors of the current generation as a back-up; a final selection will be made in Fiscal 1982. The Army and other Services are also looking at alternative applications of the missile, including the A-10, US Army Black Hawk, USN/USMC AH-1Ts, USMC AV-8Bs, ground vehicles and other platforms.

General Dynamics Mrasm The US Department of Defense has accelerated development of Mrasm (Medium-Range Air-to-Surface Missile) for both the US Navy and the USAF, and has selected the General Dynamics Tomahawk to be modified for this role. Mrasm will be used to attack both stationary and moving targets on land and at sea at ranges up to some 550km following launching from aircraft such as the A-6E, F/A-18, P-3, F-16 and F-111. The DoD had been talking of taking a production decision in December 1984, but under the accelerated programme Mrasm is due to be operational with Tercom guidance by December 1983 and with an imaging infra-red seeker—which will allow moving targets to be hit—from a year later. The missile will be used to attack high-value targets with conventional warheads from ranges well beyond those possible with weapons such as the GBU-15. Mrasm may eventually grow into a family of tactical cruise missiles for specific applications.

Advanced Attack Weapons The USAF's Advanced Attack Weapons programme is designed to exploit advances in technology to provide advanced guidance and warhead components for future air-to-surface weapons. The programme includes two projects: WAAM (wide area anti-armour munitions) and ACSM (advanced conventional stand-off missile), with most resources being allocated to the former at present because the main threat to Nato is an armoured thrust by the Warsaw Pact.

WAAM The Wide Area Anti-armour Munitions programme is designed to give USAF aircraft the ability to kill several armoured targets per pass, even at night and in bad weather. The four types of munition originally being considered have been reduced to three: Anti-armour cluster munitions (ACM), extended-range anti-tank mine (ERAM) and the Wasp mini-missile; Cyclops has been abandoned. The ACM is an unguided munition designed for launching at low altitude from a special dispenser, with each submunition—several types may be carried in the same dispenser—descending by parachute and being detonated when a probe strikes the ground; high-velocity slugs are then produced to destroy the target. The "concept validation" phase of the ACM programme is nearing completion, and a decision will then be made on whether to proceed with full development.

ERAM is an air-dropped land mine dispensed from an unguided cluster weapon weighing some 450kg, each mine being detonated on command from a seismic/acoustic sensor which detects the presence of moving armoured vehicles. ERAM is at present in a 33-month validation phase being carried out by Avco and Hughes, which were awarded competitive contracts in June 1979.

The third member of the WAAM family, Wasp, has just started a three-year validation phase. Hughes and Boeing were awarded contracts worth $42·9 million and $45 million last December to design and test competing Wasp mini-missiles, leading to selection of one company to proceed with full-scale development. Wasp will be carried in 12-round pods aboard aircraft such as the F-16, F-111 and A-10, with the mini-missiles being delivered singly or in salvoes. Sperry is providing millimetre-wave seekers for the Boeing contender, with Raytheon supplying infra-red homing heads. Hughes is developing seekers of both types for its own competitor. Each main contractor will build 16 of the 45kg mini-missiles, six for in-house testing and ten for official trials.

ACSM Preliminary development is being carried out of a long-range subsonic Advanced Conventional Stand-off Missile designed to attack high-value interdiction targets. Congress has directed that a single stand-off weapon should be developed for use both by the USAF and by the USN, and the fate of ACSM in the light of the decision to proceed with Mrasm is not yet clear.

Soviet Union

AS-4 Kitchen Carried by Tu-22 Blinder Bs since 1967, one missile being semi-recessed in the weapon bay. Kitchen is reported to arm Tu-26 Backfires as an interim weapon.

AS-5 Kelt Carried in pairs by Tu-16 Badger Gs, this combination superseding Badger B/AS-1. Kelt is also operated by the Egyptian Air Force. The missile is normally launched at an altitude of about 9,000m and is capable of Mach 1·2 at this height, dropping to Mach 0·9 at low level.

AS-6 Kingfish Carried by Backfire and Tu-16 bombers. The missile is usually launched at an altitude of some 11,000m, then climbs to more than 18,000m for mid-course cruise.

AS-7 Kerry A radio-command missile carried by the Su-19 Fencer—possibly as an interim weapon until later models are available—and by other attack aircraft. Kerry is normally launched in the 300-3,000m height band.

AS-8 This fire-and-forget weapon, similar in concept to Hellfire, is reported to be under development to arm the Mi-24 Hind and the so-called A-10 helicopter gunship. Reports that the weapon entered service in 1977 suggest that "AS-8" is a garbled report of the helicopter-mounted AT-6 Spiral (see Section 10). Unless further evidence for the existence of AS-8 can be obtained, this missile must join the list of Soviet "weapons that never were" such as SS-N-10 and SS-15 (see Sections 1 and 5).

AS-X-9 This 80/90km-range missile is equipped with a passive radiation seeker and may be intended for anti-ship use.

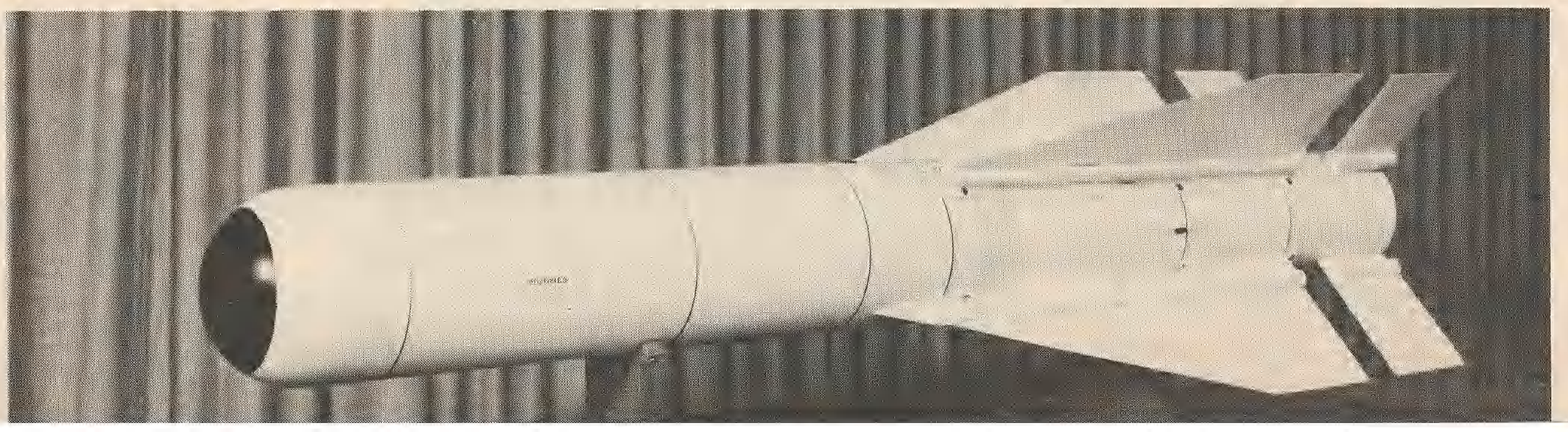
AS-X-10 The reported characteristics of this 10km-range electro-optically guided missile are so similar to those ascribed to the AS-8 as to cast doubt on whether both weapons actually exist.

AS-X-? Referred to as "Advanced TASM" in the US, this 40km-range weapon is thought to use a mixture of command or inertial mid-course guidance and electro-optical terminal homing.

AS-X-? A Mach 3·5 missile with a range of around 800km is being developed to replace the AS-6 Kingfish.

AS-X-? A missile is reported to be under development with a range of around 200km at Mach 0·8-1·2. Terrain following may be employed in the final stages of flight.

Hughes Wasp mini-missile



Anti-ship 5

China

CSS-N-1 Before the breakdown of Sino-Soviet relations, a number of Styx-armed Komar and Osa-class missile boats were transferred to China, and production lines for both boats and missiles have been set up there. The Chinese version of Styx has also been fitted to some of the larger Chinese warships and is probably in widespread use as a coastal-defence weapon.

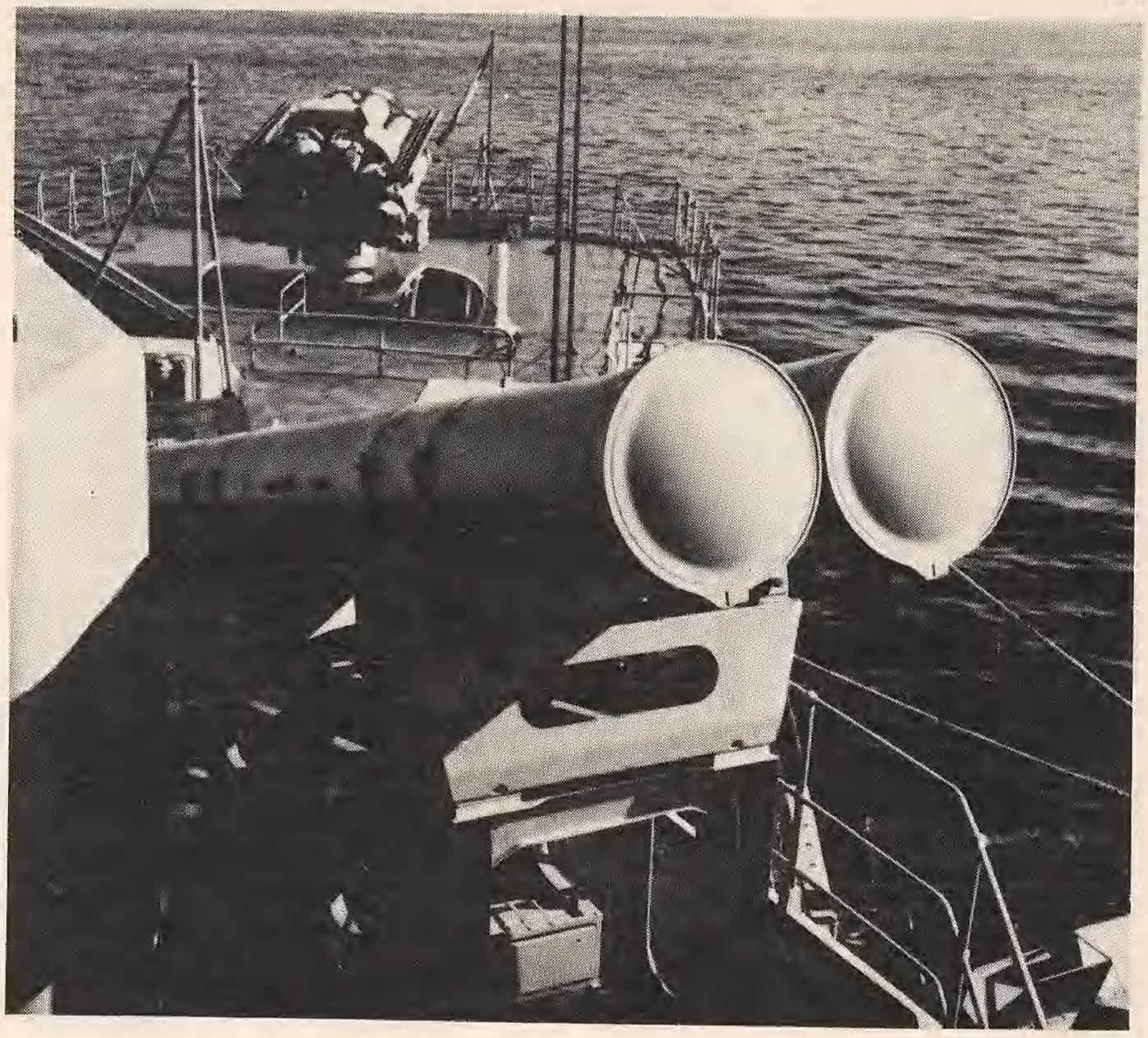
Ships fitted 60 Hoku-class (copy of Komar), 60 Hola-class (copy of Osa), six Luta-class destroyers (more under construction)—two twin launchers, four Gordy-class destroyers—two twin launchers, four Soviet-built Riga-class—two launchers.

New missile The new *Hai Dua* class of missile boats is reported to carry six anti-ship missiles of a new type. One ship is operational, and several more are under construction.

France

Aérospatiale MM.38 / AM.39 / SM.39/ MM.40 Exocet Orders now exceed 1,100 rounds for 23 customers, including at least 20 for the basic MM.38 version and two for the AM.39 air-launched derivative. More than 250 ships are scheduled to be armed with Exocet.

MM.38 The basic surface-launched variant, now in widespread service. Of 60 rounds fired during operational evaluation, 58 hit the target.
Operators French Navy (100+ missiles; helicopter carrier *Jeanne d'Arc*—six launchers; cruiser *Colbert*—four launchers; two *Saffron*-class destroyers—four launchers each; three F67 [*Tourville*-class] frigates—six launchers each; up to 24 C70 [*Georges Leygues*-class] corvettes—four launchers each; corvette *Aconit*—four launchers; 14 A69 [*D'Estienne d'Orves*-class] avisos—two launchers each; eight *Commandant Rieviere*-class frigates—four launchers; escort *Duperre*—four launchers), Royal Navy (300 missiles; four County-class destroyers—four launchers each; 18 *Leander*-class frigates—four launchers each; eight Type 21 frigates—four launchers each; ten Type 22 frigates—four launchers each), German Navy (200 missiles: 20 S148 missile boats—four launchers each; ten S143 missile boats—four launchers each; four *Hamburg*-class destroyers—four launchers each), Malaysian Navy (four *Perang*-class [*La Combattante II*] missile boats—two launchers each), Greek Navy (ten *Kymothoi*-class missile boats [*La Combattante II*]—four launchers each; ten *La Combattante III*—four launchers each). Chilean Navy (two *Almirante*-class destroyers—four launchers each; two *Condell*-class [*Leander*] frigates—four launchers each), Peruvian Navy (two *Palacios*-class destroyers — eight launchers each, six PR 72P boats—four launchers each), Argentinian Navy (one *Gearing*-class and two *Allen M Sumner*-class destroyers), Brazilian Navy (two general-purpose *Niteroi*-class destroyers



Aerospatiale MM.40 installation

—two launchers each), Belgian Navy (four E-71 [*Westhinder*-class] frigates—four launchers each), Ecuadorean Navy (three Lürssen TNC 45 missile boats—four launchers each), Moroccan Navy (likely to be retrofitted in two SFCN PR 72M missile boats), Portugal (three *Joào Coutinho*-class frigates), Nigeria (three CMN vedettes), Thailand (three *Ratcharit*-class Breda FPBs—four launchers each), Indonesia (four Tacoma PSMM), Brunei (three *Waspada*-class FPBs—two launchers each), Philippines? (six or seven PSSM Mk 6 under construction in USA), Ghana (two TNC 45 fast patrol boats— four launchers each), Oman (fast patrol boats).

AM.39 This air-launched development entered service in the summer of 1977. Atlantic NGs will carry two AM.39s in the bomb bay or under the wings, and Super Etendards have one beneath each wing. Both types can launch their missiles at any height between 50m and their operational ceilings.
Operators French Navy (Super Etendard—one or two missiles), Pakistan (four Sea Kings—two missiles), Iraq (Super Frelon—two missiles).

MM.40 Aérospatiale is developing MM.40 with private money and is understood to have secured an overseas order; the French Navy is also expected to buy the weapon, possibly for coastal defence. In the latter role MM.40 is fired from four glassfibre launcher/containers mounted on a Berliet six-wheeled lorry, and the missile is equally suitable for installation aboard ship. Modifications to the sustainer motor have allowed the range to be increased to 65km from the 45km or so possible with MM.38, and the adoption of lightweight containers permits a greater number of rounds to be installed on small ships; handling at sea is also eased. The missile descends below the normal sea-skimming flight-path in the last 300m before impact—as does AM.39—to ensure that it strikes the target.

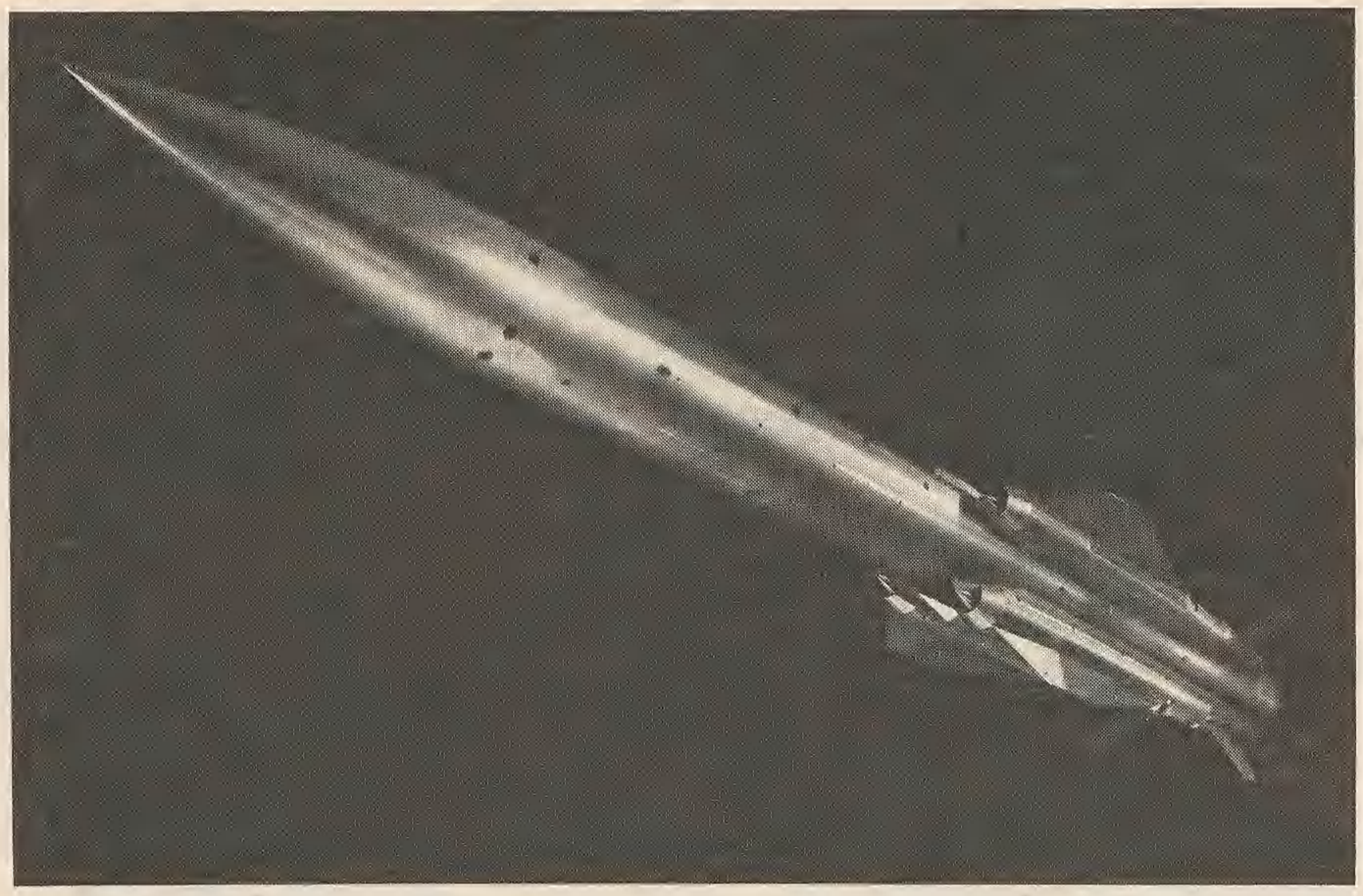
Aérospatiale AM.10 Lasso Development effort has been shifted from this project to the larger AS.15TT (see below).

Aérospatiale AS.15TT The AS.15TT (Tous Temps—all-weather) is operated in conjunction with the Thomson-CSF Agrion 15 radar, a derivative of the frequency-agile pulse-compression Iguane being developed to update the Alizé and Atlantic Nouvelle Génération anti-submarine aircraft. The missile's deviation from the line of sight to the target is measured by the radar, and azimuth steering commands are transmitted via the radar. A pre-programmed descent from launch altitude is made until the on-board radio altimeter becomes effective, the round then pulling out at sea-skimming height. When the missile approaches within 300m of the target, as measured by the helicopter radar, it is commanded to drop from its 3-5m cruise height to just above the sea surface so that it is sure to hit the ship.

AS.15TT is also being offered in a coastal-defence form, although there is some doubt as to whether the missile will ever reach the production stage.

Germany

MBB Kormoran About one-third of the 350 production rounds of Kormoran ordered by the German Navy have been delivered, and the last is due to be handed over at the end of 1982. The missile at present arms F-104Gs and will equip Tornadoes from next year.
Operator German Navy (350 missiles to arm F-104G and Tornado).



MBB ASSM windtunnel model

International

Anti-ship Euromissile ASSM ASSM (anti-surface ship missile) is designed to replace the first generation of anti-ship missiles such as Exocet and Kormoran. The weapon is required to have a longer range but no greater flight time than present missiles, better penetration of defences (achieved by modulating the motor thrust during the attack phase) and to be autonomous after launching. The programme has grown out of preliminary studies conducted by Aérospatiale and MBB in 1974; each was working on a second-generation anti-ship missile, designated MM.100 and Hydra (later FK80) respectively. In December of that year a pre-feasibility study group was set up at the request of the Nato national armaments directors, and the results were presented the following July. Nato then established Project Group 16, comprising members from the six countries listed above together with Italy, having been reduced from 12 countries with some 40 potential contractors. The French and German companies formulated a joint proposal in October 1977 and were joined the following month by Hawker Siddeley Dynamics.

The outline proposal for ASSM formulated so far is very similar to the parameters established by sub-group eight of Niag (Nato industrial advisory group). The required range of some 180km dictated the use of some type of ramjet, since an afterburning turbojet does not come into its own below about 200km and since a rocket motor is inefficient beyond some 110km. The most likely form of propulsion is a solid-propellant ram-rocket, giving a cruise speed of Mach 2·1-2·3. The initial weight targets of 600kg for air launch at Mach 0·75 and 700kg for operations from helicopters, using small boost motors, could not be met; the early studies showed that realistic weights would be 820kg for air launch and 970kg when fired from the surface or submarines, using strap-on boosters.

A dual-mode seeker is seen as being necessary to confer a high hit-probability in the face of diverse countermeasures. Active radar was the obvious choice as the main homing mode, and TV was originally the preferred back-up; this would have allowed the target to be positively identified and the desired impact point to be selected, but it would also have required a mid-course data relay for over-the-horizon engagements and could not have met the requirement for autonomy after launching. Infra-red homing has therefore been selected as the back-up mode. Mid-course guidance is likely to use a strap-down inertial system, and the warhead is expected to weigh between 160kg and 200kg.

Israel

Israel Aircraft Industries Gabriel The missile saw its first action in the October war, in which the Israeli Navy claims to have sunk nine Egyptian and Syrian vessels in four engagements with Gabriels and gunfire. The weapon has also been a successful export, foreign sales now exceeding $300 million. Taiwan may be licence-building Gabriel under the local designation Hsiung Feng (see Section 3).

Gabriel Mk 2 offers longer range, achieved by enlarging the sustainer motor and using a grain with higher specific impulse. The motor diameter is greater than in the Mk 1 version, and Mk 2 cannot be retrofitted without extensive modifications. The cruciform wings are mounted further forward in the uprated version, to compensate for the shift in centre of gravity, and the flight-control system is more sensitive. The major difference with Mk 2, apart from the doubled range, is the incorporation of additional guidance modes.

IAI has now progressed to the Mk 3 incorporating a fully active radar seeker. The fuselage has been lengthened by 35cm to accommodate this change, and the weight has increased by 40kg, but the missile can fit existing launchers.

Operators Israel (12 *Sa'ar*-class missile boats—first six with up to eight launchers each, second six with six launchers each; 15 *Reshef*-class missile boats—seven launchers each; planned for a new class of 850-ton corvettes—four launchers each), Singapore (six *Sea Hawk* missile boats—five launchers each), Thailand (three *Sea Hawk* missile boats—five launchers each), Malaysia (six *Sri Kedah* missile boats), Argentina (two TNC45 missile boats), Taiwan (several destroyers, including *Heng Yung*), South Africa (six corvettes and about six *Reshef* missile boats), Kenya?, also several unidentified customers.

International

Oto Melara/Matra Otomat Five customers have ordered more than 400 rounds of Otomat to arm 30-plus vessels, and the weapon has been selling steadily since its service entry in 1975-76. The original Mk 1 climbs to a height of 175m in the terminal phase, allowing it to dive on the lightly armoured superstructure of a ship; Mk 2, however, is a sea-skimmer. The version of the latter adopted by the Italian Navy and known as Teseo incorporates the TG-2 radio link, which allows mid-course guidance updates to be transmitted from a helicopter such as an Agusta-Bell A.109 or AB.212ASW. The full range conferred by adoption of an air-breathing powerplant can thus be used.

Egypt has ordered several batteries of the OCDS (Otomat coastal defence system), which comprises two sections: a command-and-control group, with vehicle-mounted search (Thomson-CSF TRS 3410) and tracking radars, optical sight, control console and test equipment, along with major spares; and a firing section comprising two Berliet six-wheeled vehicles carrying a pair of launchers each, a launch-control truck towing a trailer-mounted generator, a total of eight reload rounds in another vehicle and trailer, and a loading vehicle carrying a crane. One battery of this type could defend more than 300km of coastline with favourable geography and the use of relay stations for control and communications.

Operators (Mk 1) Libya (four *Wadi M'Ragh* corvettes—four launchers each; ten *Beir Grassa* FPBs—four launchers each; total 200 rounds), Egypt (six *October* FPBs—two launchers each; six *Ramadan* FPBs—four? launchers each; two *Lupo* frigates—eight launchers each), Ecuador (six CNR corvettes—four launchers each), Taiwan (two *Lun Chiang* FPBs—four launchers each).

(OCDS) Egypt (20 batteries, two or four launchers each).

(Mk 2 Teseo) Italy (four *Lupo* frigates—eight launchers each; six *Maestrale* frigates—four launchers each; *Giuseppe Garibaldi* cruiser—four launchers; seven *Sparviero* hydrofoils—two launchers each; two *Andrea Doria* cruisers—eight launchers each), Venezuela (six *Mariscal Sucre* frigates—four launchers each; three *Federacion* FPBs—two launchers each), Peru (four *Carvajal* frigates—eight launchers each). Other customers reported but not confirmed include Nigeria (three Blohm und Voss vedettes) and further orders from Taiwan to equip 15 PSMM Mk 5 missile boats and from Libya to arm 12 Saar-33 FPBs.

Italy

Sistel Marte Mariner/Sea Killer Mk 2 The Mk 2 version of Sea Killer, developed from the 10km-range transonic Mk 1, is operated by the Iranian Navy in conjunction with Contraves Sea Hunter 4 radars and fire-control equipment. The basic missile, with slight modifica-

tions, is also used in the Italian Navy's Marte system being fitted in SH-3D helicopters. The missile is guided in azimuth by an SMA APQ-706 search-and-attack radar, which tracks the target and missile simultaneously so that steering commands can be computed automatically and transmitted to the round via a radio link. A radio altimeter controls the missile's height, and a back-up optical sight can be used for guidance if the radar is inoperative.

Sistel and SMA are now offering Mariner, a surface-based derivative of Marte. A typical two-missile installation weighs less than 1,600kg, including all controls and an SPQ-711 radar—the shipboard version of the APQ-706. A land-based version proposed for coastal defence is light and compact enough to be housed in a single vehicle or shelter.

Operators Italy (Mk 1 version is on missile boat *Saetta*, possibility of Mariner being adopted), Iran (100+ missiles arm four *Saam*-class frigates—one rotating launcher each), Peru? (Marte on SH-3D?).

Briareo A consortium of Italian companies including Oto Melara, Sistel, Selenia, Snia-Viscosa, Breda Meccanica and Marconi Italiana is reported to be studying a long-range, anti-ship missile to succeed Otomat in the late 1980s.

Japan

Mitsubishi ASM-1 Test firings of some 30 examples of this air-launched anti-ship missile were completed at the end of 1979. Volume production is expected to begin next year.

Mitsubishi XSSM-2 This derivative of ASM-1, using turbojet propulsion in place of the solid-propellant rocket, is being developed for surface launching. It will have approximately twice the 25km range of ASM-1.

Norway

Kongsberg Vapenfabrikk Penguin. The Mk 1 version, developed jointly by the Norwegian Defence Research Establishment, the Royal Norwegian Navy and Kongsberg Vapenfabrikk—with funding partially supplied by the US and German governments—has been in service since 1971. The improved Mk 2 developed by Kongsberg Vapenfabrikk is now in production and is being interfaced with PEAB 9LV200 Mk 2 fire-control systems aboard Swedish FPBs and with the Thomson-CSF Vega aboard Hellenic Navy vessels. Penguin is also being promoted for coastal-defence applications, with several variants under study. A fixed installation comprises a search radar and/or other sensors, launcher and control equipment. In the semi-mobile version two launchers are mounted on wheeled trucks which deploy to preplanned sites for firing. A fully mobile self-contained variant is also being studied, and an air-launched version is being examined by the RNoAF for possible use on F-16s. The US Navy is carrying out a test and evaluation programme with Penguin Mk 2 aboard a 65ft Mk 3 FPB and may adopt the weapon to arm small craft.

Operators Royal Norwegian Navy (20 *Storm* FPBs—six launchers each; six *Snogg* FPBs—four launchers each; five *Oslo* frigates—six launchers each; 14 *Hauk* FPBs—six launchers each), Turkish Navy (nine *Kartal* FPBs—four launchers each), Royal Swedish Navy (16 *Hugin* FPBs—six launchers each), Greece (six *Combattante IIIB* FPBs—six launchers each).

British Aerospace Sea Skuas on a Lynx HAS.2

Sweden

Saab Rb04E Used to attack targets such as escorts, transports and landing craft at fairly long ranges. Release is possible between Mach 0·4 and near-sonic speeds, the missile flying a pre-programmed descent to low level for attack.

Operator Royal Swedish Air Force (Viggens, up to three per aircraft).

Saab Rb05A Intended for use against small ships, including fast patrol boats and surfaced submarines, and also land targets and slow-flying aircraft such as helicopters. The pilot steers the missile by means of a joystick, commands being transmitted over a radio link.

Operator Royal Swedish Air Force (Viggen, Saab 105).

SBMC RBS 15 In July 1979 the Saab Bofors Missile Corporation (SBMC) was awarded a SKr575 million contract by the Swedish Defence Materiel Administration to develop the RBS 15 anti-ship missile. The weapon will initially equip the Swedish Navy's 12 *Spica*-class torpedo boats, entering service in 1985, and may later also arm aircraft. Each *Spica* will carry eight RBS 15s fired from canister launchers.

United Kingdom

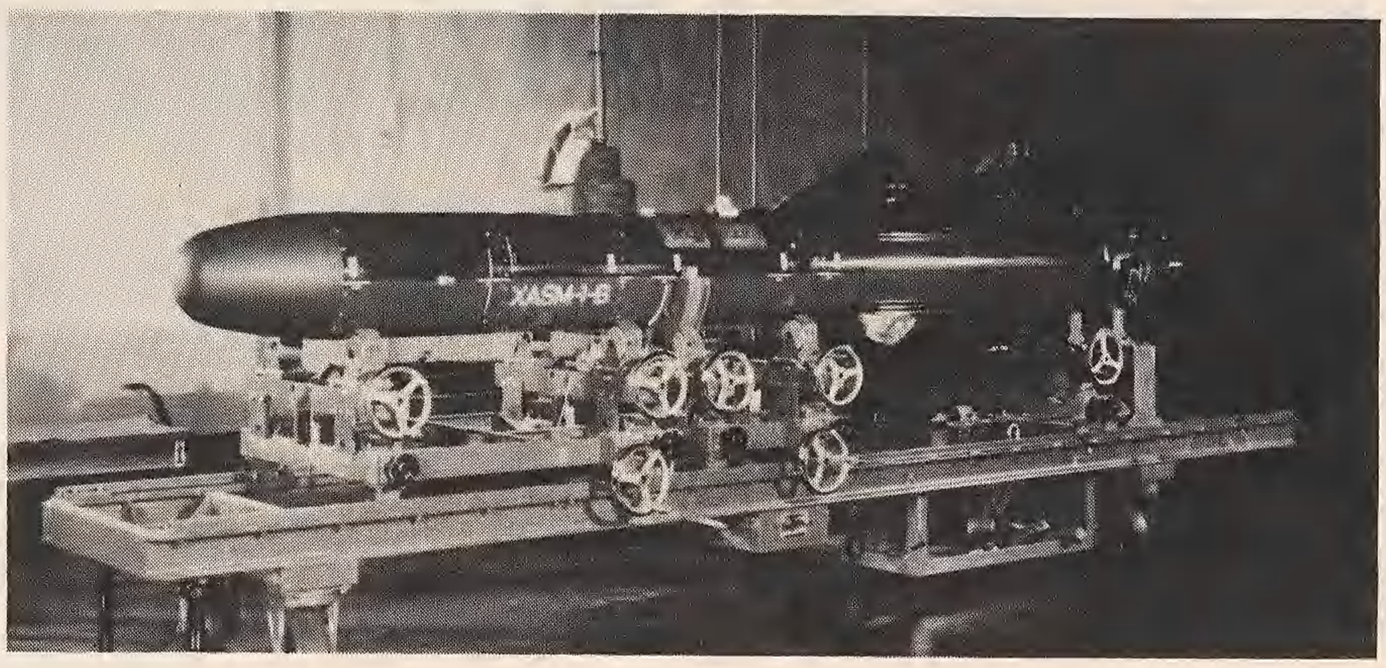
British Aerospace Sea Skua This semi-active-radar homing weapon is being developed to arm the RN's Lynx helicopters operating from frigates as a replacement for the Wasp/AS.12 combination. It provides long-range defence against missile-carrying fast patrol boats, hovercraft and hydrofoils which might threaten the frigate itself or the task force being protected. Guided firings from a Lynx began last year, following a series of launchings from a ground-based installation, and the missile system is due to enter service during 1981.

British Aerospace Sea Eagle Sea Eagle, previously known as P3T, is a turbojet-powered air-launched anti-ship missile being developed to enter service in the mid-1980s at a programme cost of £350 million. The weapon will replace rocket-powered AJ168 Martels, on which it is based, and is to be carried by Royal Air Force Buccaneers and Tornadoes together with Sea Harriers of the Royal Navy. Marconi Space and Defence Systems is developing a programmable active radar seeker to equip Sea Eagle.

United States

General Dynamics Pomona RGM-66D Standard ARM This missile is, in addition to its air-to-surface role, employed as an interim surface-to-surface anti-ship missile by the US Navy. It provides

Mitsubishi XASM-1B prototype



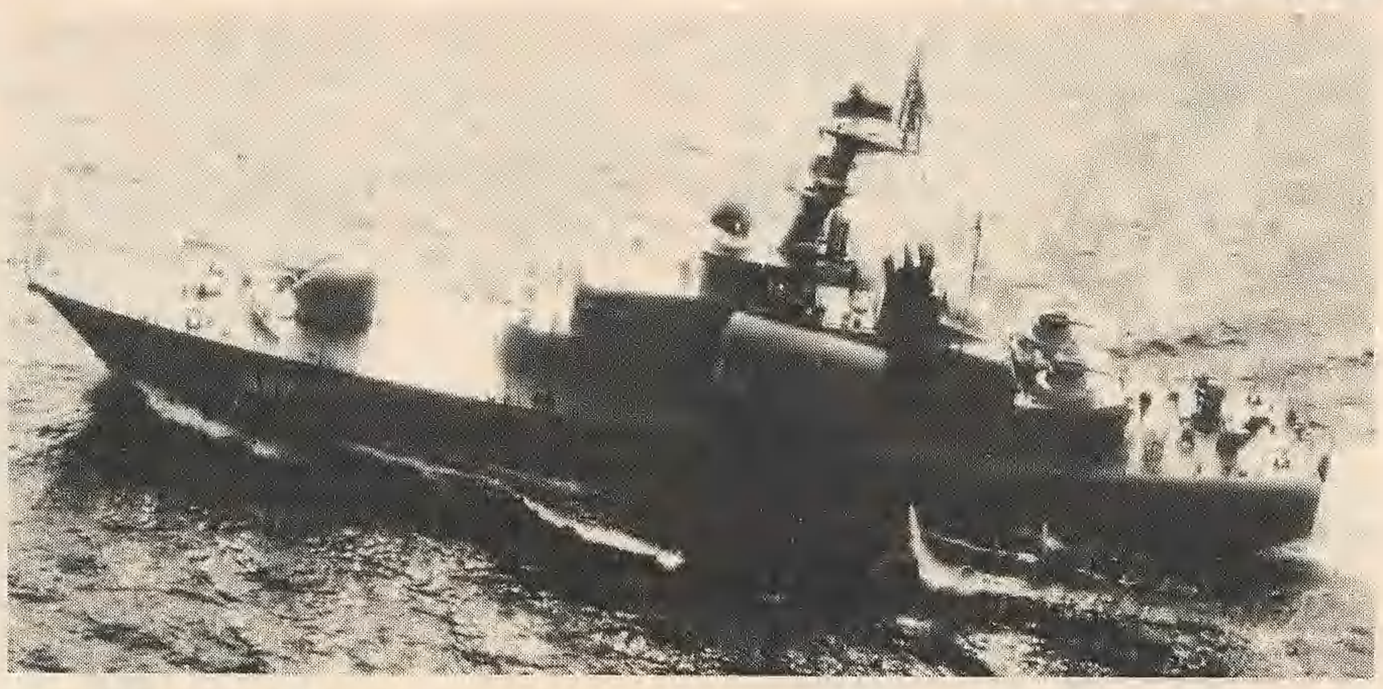
an over-the-horizon capability against radar-equipped targets.

Operators US Navy (four patrol gunboats—USS *Douglas, Antelope, Ready* and *Grand Rapids;* also six DDGs and six FFGs), Iranian Navy (four box launchers on each of three destroyers —*Babr, Artemiz* and *Palang).*

McDonnell Douglas AGM-84A/RGM-84A Harpoon McDonnell Douglas delivered its 1,000th Harpoon last November; by that date, 1,753 rounds had been ordered by the US forces and by those of 12 other countries, with production running at 40 missiles a month. Also by that date, 65 surface ships, 19 submarines and 13 aircraft had been equipped with Harpoon and a hit rate of more than 90 per cent had been achieved in 100-plus firings. The missile will be widely deployed throughout the US Navy's surface fleet, using a variety of launchers including the Asroc box, the Mk 26, a canister developed for use aboard PHM hydrofoils, an armoured box launcher also suitable for Tomahawk, and vertical launchers. The Royal Navy's nuclear attack submarine HMS *Churchill* has completed six test firings of Harpoons following more than 100 ejections of missile capsules.

Operators Ordered by US Navy (FF1052 and FFG7 frigates; DDG37, DDG47 and DD963 destroyers; CG guided-missile cruisers; PHMs; SSN594, 637, 688 and 700 submarines; P-3Cs and A-6Es), Turkish Navy (four Lürssen Type 57 missile boats), Royal Dutch Navy (12 *Standaard-* and six *Van Speyck*-class frigates; destroyers *Tromp* and *De Ruyter*), Royal Danish Navy (ten *Willemoes*-class missile boats, two *Peder Skram* frigates?, three KV72 corvettes). Iranian Navy (12 *La Combattante* II missile boats, DD963 destroyers, P-3Fs—222 rounds), Royal Australian Navy (two FFG7 frigates, three destroyers, P-3Cs), Israeli Defence Forces (100 rounds), South Korea ($80 million-worth—120 rounds—for Pack Ku-class coastal-patrol vessels and four locally built frigates), Saudi Arabia (117 missiles), Bundesmarine (12 F122 frigates, three *Lutjens*-class destroyers), Royal Norwegian Air Force (F-16s), Royal Navy (600 rounds to arm nuclear-powered attack submarines—production decision due in October), Japan (destroyers, destroyer escorts, P-3Cs).

General Dynamics BGM-109 Tomahawk One of the major roles for which the versatile Tomahawk is being developed is anti-ship attack from both submarines and surface ships. TASM (Tomahawk anti-ship misiles) have been launched from ground platforms and from the submarine *Guitarro,* with the first firing taking place (unsuccessfully) from the destroyer *Merrill* in March. Anti-ship Tomahawks do not carry the Tercom guidance equipment but use a repackaged version of the Harpoon active radar seeker, and the warhead used in Bullpup replaces the nuclear payload carried by SLCM Tomahawks. Launchings from *Guitarro* have included use of the Outlaw Shark over-the-horizon targeting system which provides computer analysis of data from various sources to provide details of the target and other vessels in the missile flight area. Anti-ship Tomahawks are planned to enter service aboard submarines in mid-1982 and on surface ships in early 1983. Some destroyers and cruisers will carry four-round armoured box launchers which can be loaded with either Tomahawk or Harpoon, or a combination of the two. Firings of Tomahawks from the box launcher, which can be elevated to 35°, began from both land platforms and from the USS *Merrill* in March. Some other vessels will fire Tomahawks from vertical launchers, and the first test of this method took place in September 1979.



Unidentified Soviet fast patrol boat (Swedish Air Force)

Soviet Union

SS-N-2 Styx A variety of launcher/hangars are used on the fast patrol boats which carry the weapon and some sources distinguish two types of Styx —SS-N-2A and B, the latter having additional infra-red terminal homing. Two Styx are carried on Komar (Mosquito) patrol boats and four on Osa I (Wasp) vessels; Osa II boats carry the SS-N-11 (see below).

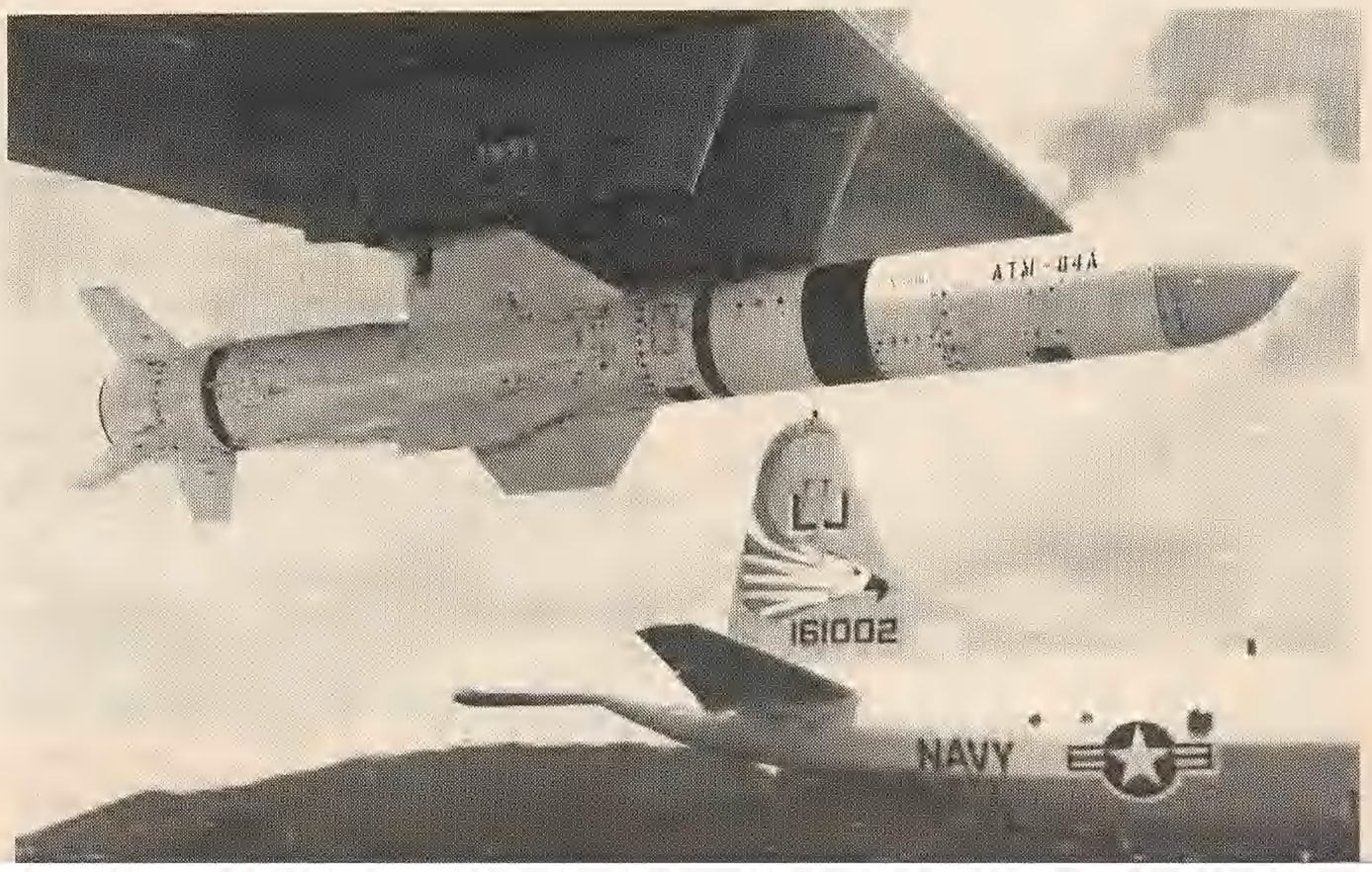
Operators (O=Osa, K=Komar) Algeria (14O), Bulgaria (3O), China (17O, 6K, +unlicensed copies—see separate entry for China), Cuba (1O, 18K), East Germany (12O), Egypt (12O, 1K—war losses have not been replaced), Finland (4O +missile boat *Isku*), India (70+frigates *Talwar* and *Trishul*—three launchers removed from Osas have replaced the forward gun turret), Indonesia (12K—probably not operational), Iraq (1OO), Jugoslavia (1OO, ten locally designed Type 211 missile boats under construction), Libya (24O), Morocco? (6O?), N. Korea (8O, 1OK+new missile boats), Poland (12O), Romania (5O), Somalia (3O), South Yemen? (2O?), Sri Lanka (up to 6O), Syria (6O, 6K), USSR (12OO), Vietnam (2K).

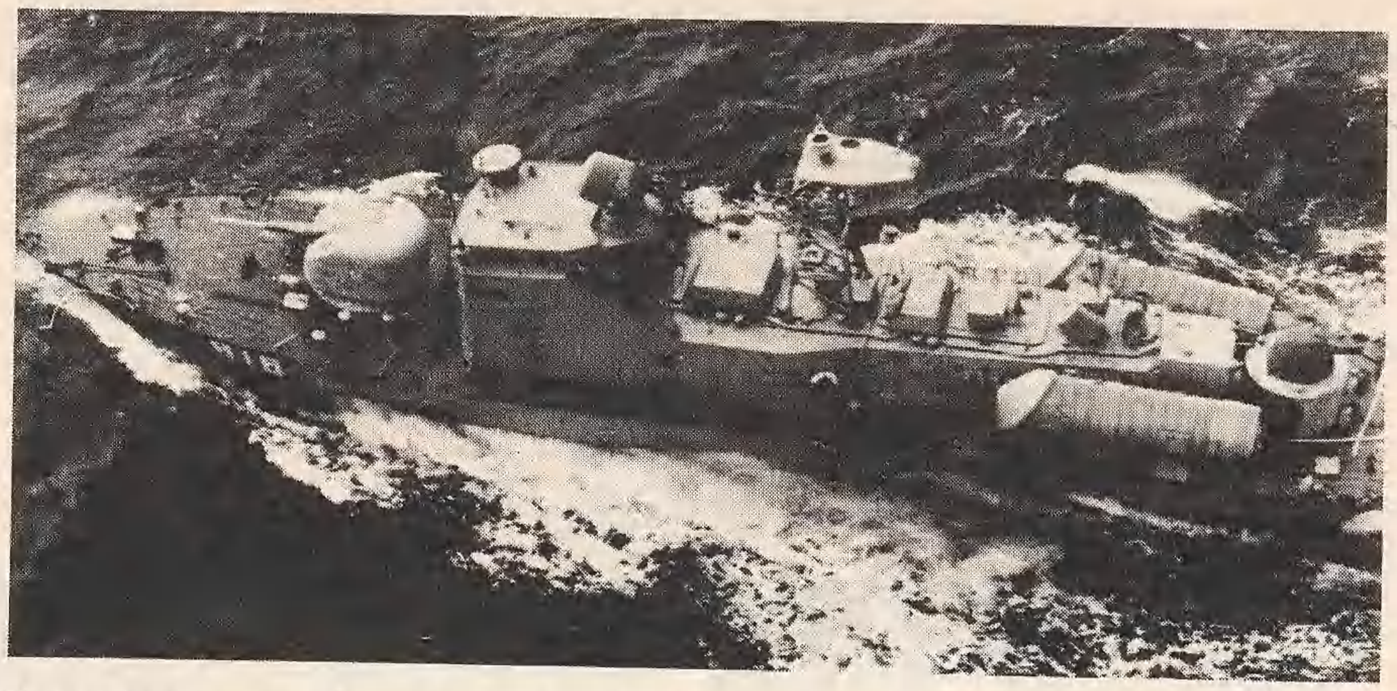
SS-N-3 Shaddock This sea-launched long-range cruise missile is being replaced by SS-N-12 (see below). Surface ships operating Shaddock carry the twin-antenna Scoop Pair radar. The weapon cruises at a height of 3,000-6,000m, and errors detected early in flight are corrected via the command data link.

Operator Soviet Navy. First deployed in five diesel-powered Whisky Twin Cylinder submarines from 1958 (two launchers elevated from aft casing), though it is doubtful whether this weapon system ever became operational. Followed by seven diesel Whisky Long Bin (four inclined launchers) and, from 1962, 16 diesel Juliet (pairs forward and abaft fin). Also up to five nuclear-powered Echo I (six elevating launchers) from 1960 and 27 Echo II (eight launchers) from 1963. All these are thought to remain in service apart from the Whisky Twin Cylinders and four of the Echo Is. Surface ships armed with Shaddock are four Kynda cruisers (two quadruple launchers which rotate through 250° and elevate to 30°; separate guidance for each bank of four) from 1962 and four Kresta I cruisers (two twin launchers abreast of bridge).

SSC-1B Sepal A coastal-defence variant of the weapon which, in its SS-N-3 form, is carried by some Soviet Navy vessels (see above). The missile is launched from a container transported by an eight-wheeled cross-country vehicle, each coastal-defence missile battalion having 15-18 Shaddocks/reloads.

McDonnell Douglas Harpoon on a P-3 Orion





SS-N-11 launchers on a Soviet Matka-class missile boat

SS-N-7 A cruise missile which can be fired from submarines while submerged. Range about 50km. Deployment began in 1967-68. May be a development of the SS-N-2/SS-N-9 missiles. The parent submarines are thought to be able to detect targets using passive sonar at about 50km range, identifying them by analysing the acoustic signature. Under favourable conditions this technique is reported to work at ranges of up to 100km.
Operator Soviet Navy (12 Charlie I and at least two Charlie II submarines of the Northern Fleet—eight launchers each in foredeck; also Charlie II and Papa submarines?).

SS-N-9 Siren Medium/long-range missile deployed since 1969. The associated ship-mounted radar has the Nato code-name Band Stand. Two triple launchers abreast of bridge on Nanuchka corvettes.
Operators Soviet Navy (at least 14 Nanuchka corvettes—two triple launchers each).

SS-N-11 Replaces the SS-N-2 Styx (see entry), from which it has been developed, on Osa II missile boats and supersedes SS-6-1 (see above) on destroyers.
Operator Soviet Navy (at least two Mod Kashin destroyers—*Ognevoi* and *Sdergiannyi*—four single rearward-facing launchers abreast of rear funnel; four Kildin destroyers—four single rearward-facing launchers amidships; 55 Osa II missile boats—four single forward-facing launchers; also on new Matka-class missile boats—two single foward-facing launchers), Iraq (four Osa II), India (six to eight *Vijadurg* [*Nanuchka*] corvettes—four SS-N-11 launchers replace the two triple bins for SS-N-9, three locally designed frigates intended for service in the early 1980s), Finland (five Osa II on order).

SS-NX-12 Replacement for SS-N-3 Shaddock (see entry) and able to use existing Shaddock launchers. Understood to be turbojet-powered at Mach 2·5 over ranges similar to those attainable by Shaddock, but could be adapted to fly more than 3,000km at transonic speed. The only ships known to carry this weapon are the aircraft carriers *Kiev* and *Minsk*. An associated radar which operates in E or F band (C or D band according to one source) is carried on a retractable mounting in the *Kiev's* bows. *Kiev* has eight launch tubes forward of the flight-deck area, and may carry reloads below deck.

SS-NX-13 Submarine-launched ballistic missile intended to carry a nuclear warhead at Mach 4 over a range of 750km and to be compatible with the SS-N-6 launch tubes in Yankee submarines. Probably intended for use against aircraft carriers and fleet ballistic-missile submarines. No tests have been reported since November 1973, so the programme has presumably been cancelled.

SS-N-? If the launchers on Kara and Krivak-class ships carry anti-submarine missiles, this apparently leaves these vessels without a long-range anti-ship weapon. The Russians may have developed an anti-ship missile similar to Harpoon but capable of being fired from the launcher used by the SA-N-3 anti-aircraft missile.

Anti-Submarine 6

Australia

Department of Productivity Ikara The UK Government decided not to take part in a proposed programme to upgrade Ikara by fitting a new lightweight torpedo in place of the present Mk 44. The existing version will remain in service with the Australian, Brazilian and UK navies.
Operators Royal Australian Navy (three *Perth*-class destroyers—two launchers each; six River-class destroyer escorts—one launcher, 30 missiles each), Royal Navy (one Type 82 destroyer—one launcher, 32 missiles; eight *Leander*-class frigates—one launcher each), Brazilian Navy (four *Niteroi*-class frigates—one launcher each).

France

Latecoére MQ1 Malafon Malafon's two boost motors are jettisoned after burnout and the missile is then unpowered, constant altitude being maintained by increasing angle of attack as speed decays. At the point of desired torpedo release the angle of attack is reduced to zero and a parachute is streamed from the missile; the torpedo is then released and enters the water. Some 370 rounds have been built and additional missiles have been ordered.
Operator French Navy (two *Suffren*-class guided missile leaders—one single launcher each; three F67 *Tourville*-class frigates—one single launcher, 13 missiles each; *Aconit*—single launcher; *La Glissonière*—single launcher; five *Surcouf-class* destroyers; six *Georges Leygues*-class anti-submarine destroyers).

United States

Honeywell RUR-5A Asroc An unguided rocket which flies a ballistic trajectory before releasing its torpedo (lowered by parachute) or a nuclear depth-charge.
Operators US Navy, Brazil, Canada, Germany, Greece, Indonesia, Iran, Italy, Japan, Spain, Taiwan, Turkey. Offered to Pakistan.

Goodyear UUM-44A Subroc Subroc is launched from standard submarine torpedo tubes. After an underwater firing the missile pitches up into the atmosphere and flies towards the target. The nuclear depth-charge warhead is released by explosive bolts and flies a ballistic path before re-entering the water, the bomb being manœuvred to its entry point by means of vanes.
Operator US Navy (SSNs—four-six missiles each).

Stand-Off Weapon SOW is intended to replace Subroc from the late 1980s. The project is at present in the concept-definition phase, with studies being carried out by General Dynamics, Goodyear, Gould/Boeing and McDonnell Douglas.

Soviet Union

SS-N-14 A missile system similar in concept to Ikara and Malafon. A small winged missile with a range of about 30km drops a homing torpedo or nuclear depth charge into the water near the position of the target submarine.
This missile can be launched from a container (as on the Kara and Krivak classes) or from a multi-purpose SUW-N-1 launcher carried by the *Moskva* and *Kiev* classes.
Operator Soviet Navy (ten Kresta II cruisers—two quadruple launchers abreast of bridge; five Kara cruisers—two quadruple launchers abreast of bridge; ten Krivak destroyers—one quadruple launcher forward; two *Moskva*-class carriers, *Kiev*-class ASW cruisers).

SS-N-15 A 40km-range submarine-launched missile similar to Subroc. Carries a nuclear warhead, and is deployed aboard Victor-class submarines.

SS-N-16 A submarine-launched, torpedo-carrying missile.

FRAS-1 An unguided rocket fired from the multi-purpose SUW-N-1 launcher. The Russian equivalent of Asroc, it carries a nuclear depth-charge or warhead over a range of 25km.

Anti-ballistic 7

United States

US ABM programmes The only remaining functional element of the Safeguard ABM system is the Perimeter Acquisition Radar Attack Characterisation System, which has been transferred to the USAF for use with Aerospace Defence Command. The US Army continues its ballistic-missile defence (BMD) programme, however, with the aims of developing technology for possible future use. The Department of Defence has authorised funding of a low-altitude defence (LoAD) pre-prototype demonstration programme designed to demonstrate and test technology suitable for a cost-effective nuclear-warhead ABM system for short-range defence of hardened targets such as MX and Minuteman siloes. LoAD uses present-technology radars and missiles; because it is a short-range system, these items can be smaller and hence cheaper than those developed in the past.

The overall BMD programme consists of two separate but complementary efforts: the advanced technology programme (ATP) and the systems technology programme (STP). The ATP is intended to exploit new technology, using research and limited proof-of-principle experiments. Areas of particular interest include optical sensors, advanced interceptor missiles, improved radars, non-nuclear warheads, directed-energy (beam) weapons and simple but novel ideas that could be developed rapidly. Work in these areas also has the advantage of pinpointing weaknesses in offensive systems and in understanding Russian ABM developments. During Fiscal 1979 and 1980 the ATP continued important tests of exo-atmospheric optical discrimination, designation and tracking. Launchings of the Designating Optical Tracker (DOT) have begun as part of the planned layered (the so-called overlay/underlay) type of BMD. The third and fourth DOT launches are planned for Fiscal 1981; and other work will include further proof-of-principle experiments on the collective accelerator for particle-beam technology. The Forward Acquisition Sensor (FAS) programme will be started and significant efforts are planned in the fields of millimetre-wave radar, advanced optics, endo-atmospheric interceptors, discrimination and missile-borne processing.

The STP takes ATP technology and integrates it into complete systems. In Fiscal 1980 the STP emphasised development of the layered BMD concept in which the first layer consists of autonomous long-range missiles using long-wavelength infra-red (LWIR) optics to detect, home in on and kill attacking re-entry vehicles outside the atmosphere without using nuclear weapons. The Homing Overlay Experiment (HOE) designed to test this concept is moving towards a first launching in 1982. The second layer, or underlay, uses a more conventional terminal area-defence system consisting of radars and missiles to destroy re-entry vehicles that have leaked through the overlay.

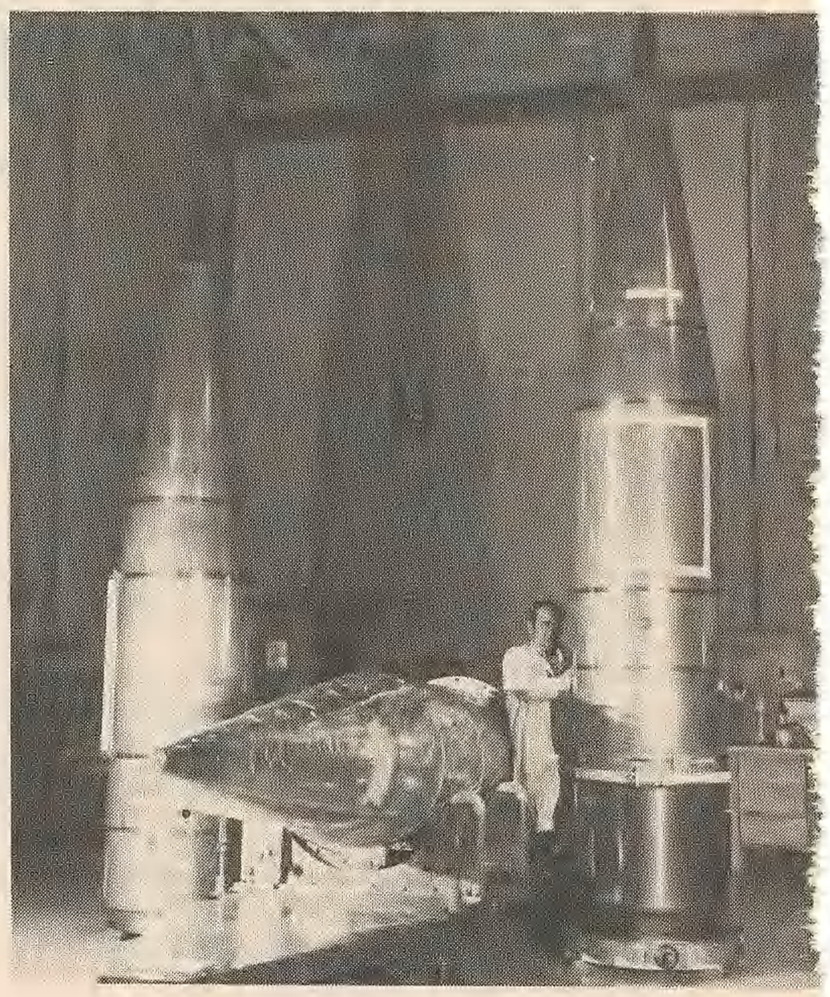
Soviet Union

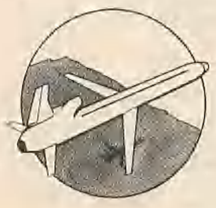
ABM-1B Galosh Four 16-missile sites are operational around Moscow, each being associated with two Try Add engagement-radar sites.

SH-4 At first thought to be similar in concept to Galosh, this missile is understood to be able to start and stop its propulsion system four or five times at very high altitude, allowing the missile "loiter" while ground radars and/or atmospheric re-entry sorts out incoming warheads from decoys.

SH-? A hypersonic surface-to-air missile capable of intercepting incoming US Sram missiles. Could form the basis of a new mobile anti-ballistic missile system. Reported to use a C-band phased-array radar, known in the US as the X-3.

US ballistic-missile optical tracker **left** *and payload vehicles* **right**





Surface-to-air 8

Brazil

Brazilian SAMs The Brazilian Army's Development and Research Institute has produced prototypes of two long-range surface-to-air missiles, according to General Silvio Otavio do Espiritu Santi, commander of the Army's Fourth Infantry Brigade. No further details were given.

Canada

Canadian Sea Sparrow Uses AIM-7E2 Sparrow missiles (Section 9) fired from quadruple launchers and Hollandse Signaalapparaten M22 fire control.
Operator Royal Canadian Navy (four DDH280 Iroquois destroyers—four launchers each; two support ships).

China

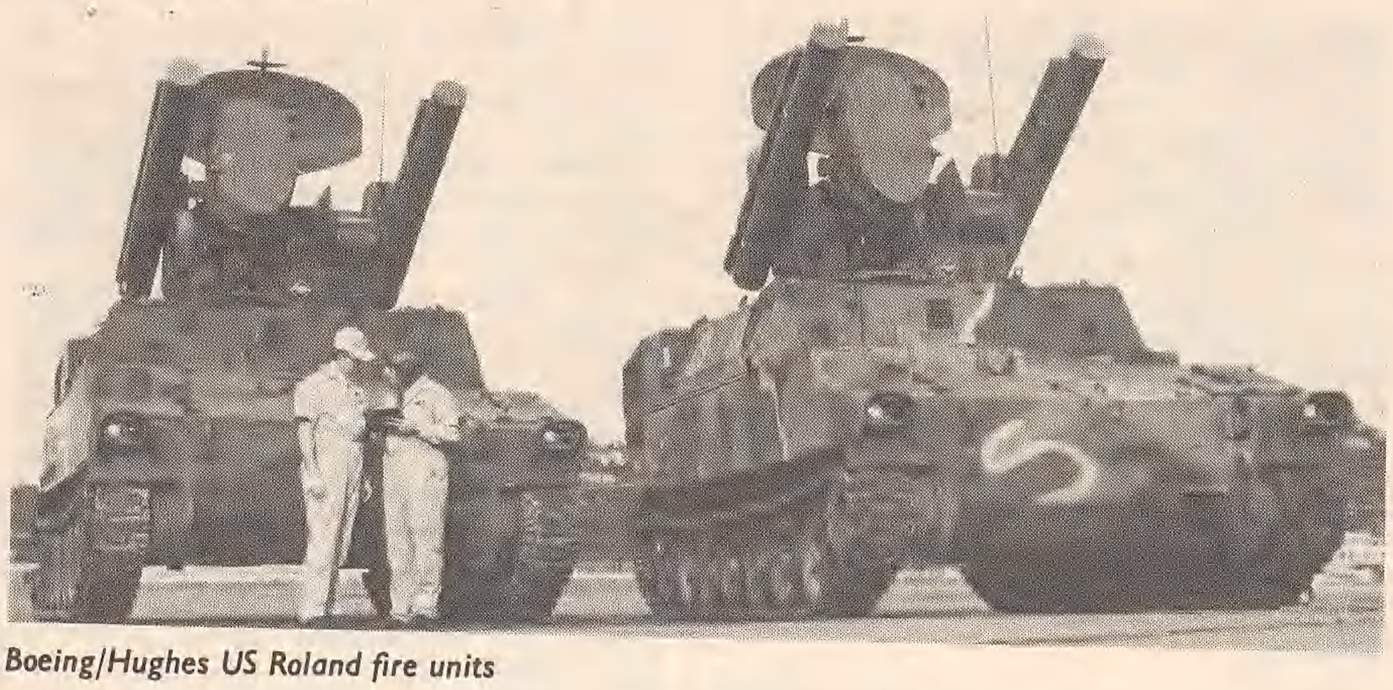
CSA-1 Production of this Chinese version of the Russian SA-2 Guideline is declining. The missile is thought to be widely deployed. A number of systems have been supplied to Albania.

CSA-? Carried by the locally designed frigate *Kiangtung*, lead ship of a class of at least two vessels. Could be an unlicensed copy of the Russian SA-3 Goa supplied to Vietnam, or a new locally designed missile of similar size and performance. Although a land-based version has not yet been reported, China has an obvious requirement for a weapon of this type to supplement the CSA-1 force.

France

Thomson-CSF/Matra R.440 Crotale Crotale was developed at the instigation of the South African armed forces, by which it is known as Cactus, although Thomson-CSF says that Crotale is so different from Cactus that it should be considered as a separate weapon system.

The S-band pulse-Doppler surveillance and target-designation radar is mounted on an electrically propelled 12-tonne Hotchkiss-Brandt cross-country vehicle and can direct three similarly mounted firing units with four missiles each. The turret-mounted missile launchers are slaved to a central target-tracking radar with associated infra-red gathering equipment and television for back-up guidance at low level. Between October 1979 and January 1980, six successful firings of Crotale were carried out by the French Air Force, a foreign army and Thomson-CSF, targets being intercepted at ranges between 7·5km and 9·5km. Two engagements were carried out in very difficult conditions: one was in bad weather, and the other against a target being towed at less than 50m



Boeing/Hughes US Roland fire units

over the sea. Production continues at a rate of some ten units a year, each comprising an acquisition unit and two or three firing units.

Operators French Air Force (20 fire units), South Africa (18 fire units), Royal Saudi Air Force, Egypt (20 fire units), Pakistan (six to 12 batteries), Libya (up to 60 fire units in three regiments?), Abu Dhabi, Kuwait, Spain, Greece, Morocco. Offered to Somalia? Iraq negotiating, China reported negotiating.

Thomson-CSF/Matra Crotale Naval The naval version of Crotale has been accepted for service by the French Navy, having completed acceptance trials aboard the corvette *Georges Leygues* and the frigate *Duguay Trouin*. Of the 12 consecutive successful launchings carried out so far, four missiles hit the target and the others passed within the warhead's lethal radius. A salvo has been fired from the *Georges Leygues* and engagements have taken place in weather conditions up to Force 5.

Crotale Naval differs from the land-based version in a number of ways, including a doubling of the number of missile tubes on the launcher (from four to eight) and the use of semi-automatic reloading.

Thomson - CSF / Matra Shahine / Sica/ Storads Saudi Arabia has ordered a derivative of Crotale known as Shahine, which forms part of a family collectively referred to as Sica (previously designated SA.10). Sica/Shahine uses an uprated missile, giving a maximum range of 10km, and is based on tracked chassis—AMX30s in the case of Shahine—rather than wheeled vehicles. The number of launcher tubes carried by each vehicle is increased to six, and the surveillance radar is modified for greater performance. Guided firings began at the end of 1978 from shelter-mounted launchers and delivery of production systems began this year.

Sica in turn forms part of the Storads (site tactical optimised-range, air-defence systems) being developed jointly by Thomson-CSF and Siemens to defend against low-flying aircraft carrying stand-off weapons. The Storads range will include all the detection, communications and data-processing equipment needed for point defence, in addition to different types of gun and missile (including Sica).

Operator (Shahine) Saudi Arabia.

International

Nato 6S A vertically launched naval surface-to-air missile has been examined by sub-group 9 of the Nato Industrial Advisory Group as a possible collaborative weapon for the late 1980s. France has selected Thomson-CSF as its major participant, and VFW-Fokker has developed suitable technology under its Kumar and Sesta programmes. The latter, with a maximum range of 10-16km, would incorporate thrust-vector control using gimballed nozzles to give lateral accelerations up to 30g. AEG-Telefunken has proposed a system known as FlaM80 (Flugabwehr-Marinè 80) to succeed the US-German Ram (see entry) on the German Navy's F122 frigates from 1985. Nato 6S as envisaged by German defence planners would have an 18cm-diameter fuselage and be powered by a solid rocket motor of about 3,600kg thrust, using a TVC system with nozzles deflecting through ±8°. Following release from an eggbox-type launcher the missile would come under the control of its on-board processor very rapidly—in about 0·3sec—having reached an apogee of only 30m before pitching over to intercept a sea-skimmer. An active radar seeker would be fitted, the currently preferred contractor being Raytheon.

Euromissile Roland Aérospatiale is prime contractor for the clear-weather Roland 1 and MBB has overall responsibility for the all-weather (down to 400m visibility) Roland 2. The French Army and German Army took delivery of their first systems in 1977, as did Brazil—the first export customer. Roland has also been selected by the US Army and is being built under licence by Hughes and Boeing. The two companies have so far received two production contracts totalling nearly $250 million in value for 21 fire units and 485 missiles. The US Army expects to equip four battalions in Europe with the weapon, but the original total of 184 fire units has been cut back to 95 in order to save money. The first production US missile is due to be delivered in July 1981, with the initial fire unit following in October. Some 90 per cent of the field-replaceable parts will be interchangeable between European and US systems.

Operators French Army (AMX30 chassis), German Army (Marder FlaRakPz Marder chassis), Brazilian Army (four Marder chassis, 50 rounds), US Army (95 fire units on KM975 vehicles based on modified M109, 3,000 rounds). Also planned for use by the Luftwaffe and German Navy from 1983.

Italy

Selenia Albatros This shipborne weapon system using the Selenia Aspide multi-role missile (see Section 9 and also Spain entry) is available with a variety of fire-control equipment from different manufacturers. A lightweight version is also on offer.

Operators Peruvian Navy (four *Lupo*-class frigates—octuple launcher on quarter deck), Venezuelan Navy (six *Lupos*), Nigerian Navy (one Blohm & Voss Type 122 frigate), Ecuador Navy (lightweight version for six 650-ton corvettes), Italian Navy (four *Lupos*, six *Maestrale*-class frigates, other vessels planned), Egypt (two *Lupos*), Greek Navy negotiating (four *Themistokles*-class destroyers), Spain (*Descubierta*-class frigates), South Africa? (three Type 12 *President*-class frigates), Argentina?

Selenia Spada The Spada system, using Aspide missiles, was planned to be deployed by the Italian Air Force to defend its bases. Cost overruns on Italy's air-defence modernisation programme have, however, put the Spada project in jeopardy.

Sistel Indigo - MEI After protracted development, a self-propelled variant of Indigo has, according to Sistel, been selected by the Italian Army; it had been competing with a mobile version of Spada (see above). Indigo-MEI, with Selenia radars substituted for the Thomson-CSF equipment used with the prototypes, will be deployed to defend troops and armoured formations on the move and to protect fixed installations. Each battery comprises a search-and-

Thomson-CSF/Matra Crotale Naval

tracking unit, two launching units with six ready-to-fire missiles each, and a logistics unit with 12 reload rounds; all are mounted on M548 tracked vehicles. The design was virtually frozen in early 1978 and the weapon could be in service by 1982.

Oto Melara Vanessa A team led by Oto Melara is reported to be developing a naval point-defence missile for service in the late 1980s. A comparatively large subsonic missile has been selected in place of the more usual Mach 2-plus round, allowing a powerful warhead to be installed and advanced designs of proximity fuze to be employed. Guidance would be by radar command to line-of-sight and should give an anti-missile capability. Vanessa is planned for installation on *Maestrale*-class frigates and the cruiser *Giuseppe Garibaldi*.

Japan

Toshiba Tansam Tokyo Shibaura Electric has developed the Tansam short-range surface-to-air missile to fill the gap between air-defence guns and Hawk medium-range SAMs. The four-round launcher and the fire-control system are each carried on a Type 73 3·5 tonne truck. Targets are tracked by a pulse-Doppler phased-array radar and the missile is fitted with an infra-red seeker. The JGSDF plans to buy 24 Tansam systems, the first of which will be financed in Fiscal 1981.

Sweden

Bofors RBS70 A man-portable system now in service with the Swedish Army, replacing 20mm and 40mm guns. Firing units are deployed 3-5km apart and can receive target information from the LM Ericsson Giraffe surveillance radar.

Vehicle-mounted installations are now being developed; a version based on a Land-Rover will be tested this year, to be followed next year by vehicles using the Ikv 103 chassis for the Swedish Army. A third variant, using an armoured turret equipped with a target-acquisition radar mounted on an M113 armoured personnel carrier, is also to be tested during 1981.

Operators Sweden, Norway, Dubai.

United Kingdom

British Aerospace Rapier More than 10,000 rounds of this low-level SAM have now been built, and more than 3,600 have been fired. The original version, optical Rapier, has since been followed by the Blindfire variant using the Marconi Space and Defence Systems DN181 tracking radar. A third version, Tracked Rapier, was originally under development for Iran and is now being evaluated by the British Army. The assessment programme has included a series of firings from a prototype Tracked Rapier vehicle—a modified M548 chassis known as the RCM748—and a decision on procurement is expected this year. The basic Rapier now in service with the British forces is the subject of a £250 million improvement programme that includes incorporating the Ferranti Argus M700/20 minicomputer and adding a night firing channel, probably using the Barr & Stroud IR18 thermal imager.

Operators British Army (Nos 9 and 58 batteries of No 12 Light Air Defence Regiment, Royal Artillery), RAF Regiment (No 4 Wing: 63 Sqn [Gutersloh], 26 Sqn [Laarbruch], 37 Sqn [Bruggen] and 16 Sqn [Wildenrath]; also 27 Sqn [Leuchars, Scotland] and one other to be established at Lossiemouth; Islamic Iranian Air Force (five squadrons, plus training unit at less than squadron strength), Zambian Army (one battery, plus additional units supplied in October 1978), Sultan of Oman's Armed Forces (28 fire units [2^1_3 batteries]; more on order), Abu Dhabi Defence Forces (£35 million-worth including Blindfire), Australian Army (£36 million-worth including ten Blindfire), Brunei (£90 million-worth including Blindfire, on order).

British Aerospace Sea Dart The GWS30 version of Sea Dart has been in service for several years and is due to be followed in the mid-1980s by GWS31 Sea Dart Mk 2. The extent of the improvements to be incorporated in the Mk 2 has not yet been decided, but modifications are expected to include the use of larger wings and fins for engagements of high-flying manœuvring targets, miniaturisation of the guidance and control electronics (which will in turn make more space available for fuel and hence increase the missile's range) and possibly the addition of thrust-vector control to the boost motor to reduce the minimum range and improve performance against high-speed crossing targets.

A lightweight fixed launcher has been developed for the standard Mk 1 missile, allowing it to be fitted on ships as small as 300 tons, and Marconi Radar Systems has designed the ST804 tracker/illuminator radar for this role.

Operators Royal Navy (one twin launcher on the single Type 82 destroyer, 14 Type 42 destroyers and three anti-submarine carriers), Argentine Navy (two Type 42 destroyers).

British Aerospace Seawolf The GWS25 full-system version of Seawolf has entered service aboard HMS *Broadsword* and is expected to equip the remaining Type 22 frigates; it will also arm ten modernised *Leander*-class frigates. GWS25 comprises Marconi Radar Systems surveillance radars, tracking radars with boresighted television cameras, six-round launchers, the Seawolf missile and associated data-handling equipment. The surveillance radars, the antennas of which are colocated on a stabilised mounting, are the E-band monopulse Type 968 and the pulse-Doppler D-band Type 967; the former detects low-level targets and the latter searches at comparatively high angles (up to about 75°).

The pulse-Doppler Type 910 tracker operates in I/J-band and employs monopulse techniques for clutter suppression. The weight and size of GWS25 prevents it from being fitted to fairly small vessels, and a lightweight version known as Seawolf/VM40 is therefore being developed. This uses the Hollandse Signaalapparaten VM40 tracking radar, derived from the company's Stir equipment, and the missiles are fired from lightweight two-round launchers that can rapidly be reloaded from below decks. Seawolf/VM40 has been proved by a series of firings in the past few months. VM40 is a narrow-beam monopulse tracker using dual frequency bands and can therefore track targets at low level over the sea in addition to being lighter than the Type 910 radar used in GWS25.

Short Blowpipe This shoulder-launched SAM has been given a new lease of life by an additional £20 million order to equip a further 12 or more (possibly up to 36) detachments of the Territorial Army, and by development of a semi-automatic command to line-of-sight version. Shorts is also working on a four-round launcher that could be fitted on a trailer or carried by vehicles such as the M113 and Spartan.

Operators British Army, Royal Marines, Territorial Army, Canadian Armed Forces.

Short Seacat The basic point-defence system for many of the world's navies, being operated with a wide range of fire-control systems. Shorts has developed a modification package which allows standard Seacat rounds to be converted for operation near the sea surface so that they can intercept sea-skimmers or attack small vessels. A new wing containing a height-measuring device is fitted in place of the existing unit, and the electronics pack is modified on site by the user. Once the missile has descended to within 20ft of the surface any further "down" commands are overridden automatically to prevent

British Aerospace Tracked Rapier on British Army trials

the round from ditching.
Operators Argentina (two launchers), Australia (six launchers), Bangladesh (one launcher), Brazil (13 launchers), Chile (four launchers), India (eight launchers), Iran (five launchers), Libya (two launchers), Malaysia (one launcher), Netherlands (12 launchers), New Zealand (four launchers), Nigeria (two launchers), Sweden (four launchers), Thailand (one launcher), United Kingdom (c. 80 launchers), Venezuela (two launchers).

Short Tigercat A Mk 2 version of Tigercat, using lightweight components and solid-state electronics, is the subject of an £11 million order from an unspecified overseas customer.
Operators Royal Air Force Regiment, Islamic Iranian Air Force (25 systems), India (40 launchers), Jordan (since passed on to South Africa), Argentina (ten launchers), Qatar (five launchers?).

Vickers Slam Slam (submarine-launched airflight missile) consists of a cluster of six Blowpipe missiles in launch canisters surrounding a central optronics enclosure, the whole assembly being mounted on a hydraulically operated mast which retracts into the glassfibre pressure vessel within the submarine's bridge fin. The system enables the submarine to attack shallow-draught and surface-effect craft, to deter ASW helicopters and to inflict severe damage on merchant shipping. Several European manufacturers have designs incorporating Slam, which has been installed in a number of types.
Operators Israel and at least one other (Argentina or Ecuador?).

United States

Raytheon RIM-7M Sea Sparrow In 1978 Raytheon was awarded a contract for full-scale development of a new Sparrow variant incorporating an advanced monopulse seeker; in its AIM-7M form it will be carried by aircraft, and as the RIM-7M—with clipped tail fins and folding wings—it is to be deployed as part of the Nato Seasparrow Surface Missile System (NSSMS). The NSSMS installations aboard the US Navy's DD963 and high-value auxiliary ships are to be improved by adding the Hughes Mk 23 target-acquisition system (TAS), a pulse-Doppler radar that automatically acquires and tracks targets as they approach low over the horizon. The first of seven TASs being built during 1980 has been delivered to equip the USS *Seattle*, and a further 33 systems are on option.
Operators US Navy (attack carriers, escorts, amphibious assault vessels, FF1052 frigates, DD963 destroyers), Norwegian Navy (five *Oslo*-class frigates), Royal Netherlands Navy (standard frigates and two *Tromp*-class destroyers), Belgian Navy (E-71 frigates), Japanese Maritime Self-Defence Force (destroyers—Mitsubishi is to licence-build), Danish Navy, German Navy. See also Albatros.

Raytheon MIM-23B Improved Hawk The MIM-23B Improved Hawk has largely superseded the MIM-23A Hawk, and the missiles operated by most of Nato are to be enhanced further under a $150 million four-year product-improvement programme organised under the leadership of Thomson-CSF and MBB. Raytheon has developed a number of PIPs to increase the reliability, ease of maintenance and performance of Improved Hawk in three areas: the continuous-wave acquisition radar, data link and pulse acquisition radar.

The Improved Continuous Wave Acquisition Radar (ICWAR) has a new klystron transmitter, new built-in test equipment and other modifications. These changes have more than doubled transmitter MTBF, reduced MTTR to less than one-tenth of its previous value, produced a 25 per cent improvement in radar reliability, doubled the output power and increased the detection range. Improvements to the Army tactical data link include an enlarged memory and reformated data language, providing a computer-to-computer interchange of data between an Improved Hawk system and a higher-level (battalion) fire-distribution system. Resulting benefits include more target tracks and threat-ordering information, greatly reduced system reaction time, improved reliability and increased performance. Changes to the pulse acquisition radar include addition of a more modern solid-state control oscillator and the addition of a digital signal processor.

Further improvements will be afforded by the Tracking Adjunct System (TAS), for which Northrop was awarded a $14·7 million letter contract in April. The TAS is an electro-optical system that will provide missile operators with a visual image of targets, allowing them to distinguish targets that are close together or near objects on the horizon. TAS will be added to US Army Improved Hawk batteries.
Operators US Army* (target is 95 battery sets), USMC* (target is 14 battery sets), German Air Force* (36 batteries, 216 launchers), French Army* (three regiments, 54 launchers), Italian Army* (four regiments, 68 launchers), Danish Air Force* (four squadrons), Dutch Air Force* (11 squadrons, 66 launchers), Belgian Army* (two battalions), Swedish Army,* Israeli Defence Forces (15 batteries, 90 launchers), Spanish Army* (one battalion), Japanese Ground Self-Defence Force (eight groups—Mitsubishi is to licence-build Improved Hawk), Saudi Arabia* (ten battalions), Korean Army* (three battalions), Taiwanese Army* (two battalions), Greek Army* (one battalion, 12 launchers), Iranian Army* (one battalion), Thai Army (one battalion), Kuwait* (50 systems), Jordan* (14 fixed-site batteries and c.530 rounds on order), Philippines. Asterisk indicates Improved Hawk in service or on order.

General Dynamics FIM-43A Redeye This first-generation shoulder-fired SAM remains in service and is destined to be replaced by Stinger.
Operators US Army, US Marine Corps, Swedish Army, German Army (1,400 rounds), Australian Army, Danish Army (uprated version also known as Hamlet), Israeli Army, Jordanian Army (300 rounds).

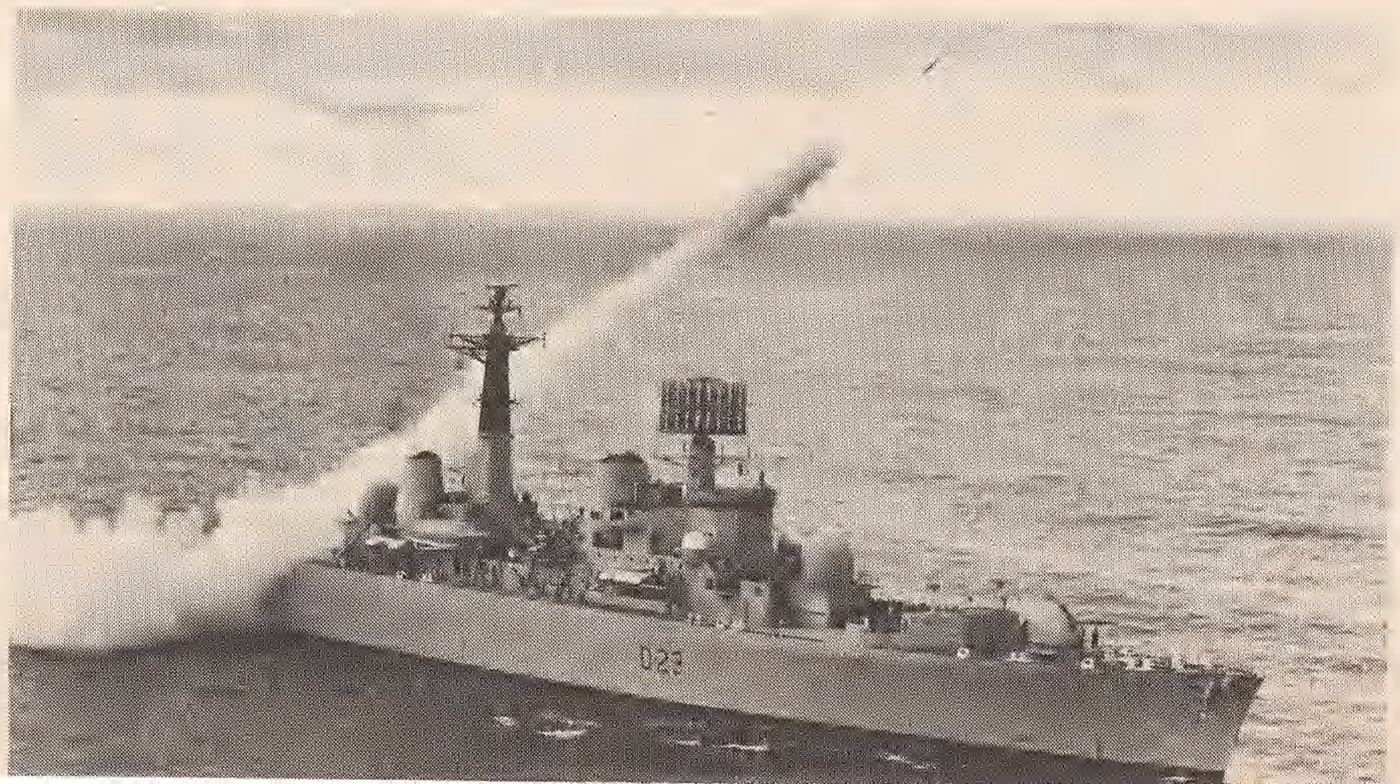
General Dynamics Pomona RIM-66/RIM-67 Standard 1 The RIM-66A MR (medium-range) variant is replacing Tartar, while the RIM-67A ER (extended range) is superseding Terrier. Development of the Block 7 version, with an improved rocket motor and updated guidance, is due to be completed in 1982. The Standard missile, as its name suggests, is also used for a variety of other roles, including AGM-78 Standard ARM (air-to-surface, Section 4) and RGM-66D Standard ARM (surface-to-surface, Section 5).
Operators US Navy, Spain, Italy, Holland, Japan, Australia, Iran, Germany.

General Dynamics Pomona RIM-66C Standard 2 SM-2 has been developed for use with the RCA Aegis area-defence system and with the Terrier shipboard weapon system aboard existing vessels. The missile uses the same airframe and motors as SM-1 but incorporates an inertial reference unit for mid-course guidance; this increases the performance envelope of the medium-range version by 60 per cent compared with SM-1, while that of the extended-range variant is more than doubled.

The Aegis Weapon System Mk 7, which will incorporate SM-2, is being developed to arm the USN's CG47 cruisers, the first two of which have been authorised out of a planned total of 16. Aegis technology may also be applied to the DD963 destroyers, aircraft carrier escorts and possibly cruisers in the 1980s. Aegis includes the Raytheon SPY-1A search/track radar, which generates smooth tracking data in less time than a conventional rotating scanner takes for one revolution. The radar uses four flat, fixed arrays mounted at right angles to give all-round coverage and tipped back slightly so that they can search from the horizon to directly above the ship, which may be rolling through 30° and pitching through 10°.

The SM-2 missile, with its on-board mid-course guidance, does not require continuous target illumination. As the round nears its target the Aegis weapon-

British Aerospace Sea Dart launching



control systems orders an illuminator to support the final stages of the interception, that illuminator being slaved to co-ordinates derived from the SPY-1A. Four Raytheon I/J-band monopulse SPG-62 illuminators within Mk 99 fire-control systems would normally be installed to provide continuous-wave target illumination.

SM-2 enters service this year. The New Threat Upgrade programme, to give the CG36/38, CG16/26 and DDG37 ship classes the ability to fire SM-2 (ER), has been completed and all these vessels are due to be upgraded by 1991; this may be brought forward to 1988 under an accelerated programme. The CG47s and possibly other types will fire SM-2 from the Martin Marietta EX-41 vertical launching system.

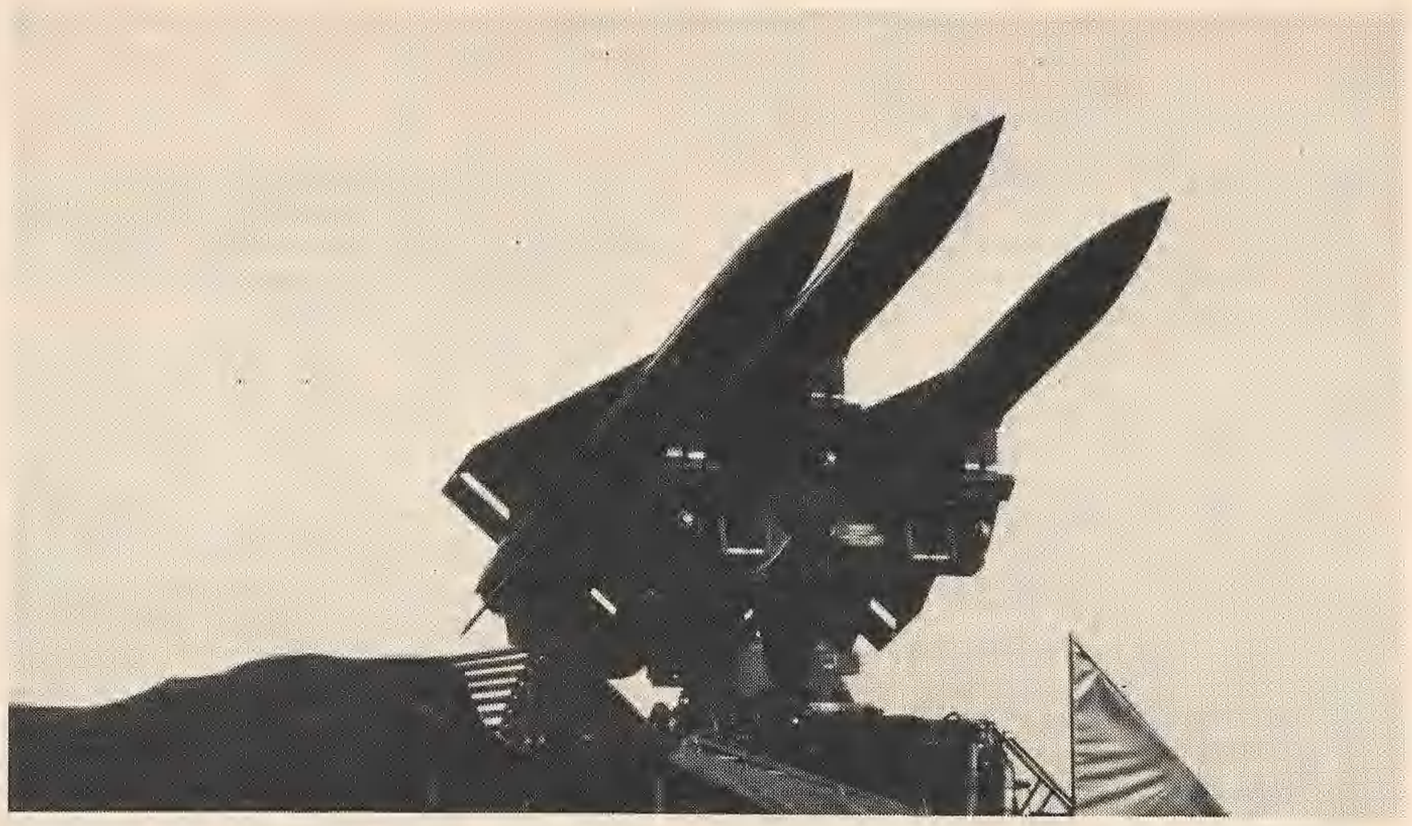
Ford Aerospace MIM-72C Chaparral The first production improved MIM-17C variant was delivered to the US Army in July 1978 and units in the field are being updated. The new version includes an all-aspect seeker, blast-fragmentation warhead and new proximity fuze, together with a smokeless motor and an anti-glint canopy for the launcher. Trials have been carried out of Chaparral rounds guided by a Marconi Space and Defence Systems DN181 Blindfire radar, as used with the British Aerospace Rapier, with a radio link installed for command-to-line-of-sight guidance, Chaparral will remain in service after Roland has been deployed.
Operators US Army, USMC, Israel, Morocco, Tunisia, Ecuador.

Night Chaparral This version now being developed uses a forward-looking infra-red set for target detection, and the missile incorporates the Post seeker being developed for Stinger.

Sea Chaparral The naval version of Chaparral uses a slightly modified launcher that can be controlled locally or remotely. The same missile is used as in the land-based variant.
Operator Taiwan.

General Dynamics Pomona FIM-92A Stinger A pilot production batch of this man-portable SAM was delivered to the US Army last December, and the production rate should be 200 missiles a month by the end of this year. Stinger is faster than Redeye, which it replaces, and has a greater maximum range. An all-aspect seeker is fitted and IFF is incorporated. An improved seeker—Post (passive optical scanning technique)—is in engineering development. It features better target discrimination and greater resistance to countermeasures.
Operators US Army, USMC, Italy, Norway and Holland have expressed interest in purchase or co-production.

Raytheon XMIM-104 Patriot Being developed to replace both Nike Hercules and Hawk, Patriot will form the cornerstone of the US Army's air defence in the field during the 1980s. The system is designed to intercept high-level and medium-altitude targets in the face of heavy countermeasures. The phased-array radar and launcher are operated remotely from the engagement control station, which contains display and control systems, a high-speed digital computer and communications. Patriot is likely to enter production at the end of 1980, with service entry in 1982.



Raytheon Improved Hawk battery

General Dynamics RIM-116A Ram In June 1979 General Dynamics was awarded a $95 million contract for full-scale engineering development of Ram. The 50-month development programme will include construction of prototype command and launching equipment together with engineering-model missiles and some rounds for flight-test and evaluation. The contract was awarded following signature of a memorandum of understanding by the United States, Germany and Denmark, which will jointly sponsor development.

Ram uses components from several existing missiles, including the Stinger infra-red seeker and Sidewinder rocket motor, fuse and warhead. Guidance during the early stages of flight is by an interferometer, using twin aerials on the front of the missile to detect emissions from the radar of an attacking aircraft or missile, with terminal homing by infra-red. Two types of launcher will be used: a specialised type, the EX-31, which has 24 launch tubes on the Phalanx mount and elevation/train drive assemblies; and Ram Ordalt (ordnance alteration), which converts the two upper-centre cells of a Sea-Sparrow launcher to carry five Rams each.

Ram can be installed on a wide variety of vessels, primarily to defend against anti-ship missiles, and production is due to begin in early 1983.
Operators Planned for German Navy (F122 frigates, S143A FPBs), US Navy (various ships), plus others likely.

Soviet Union

SA-2 Guideline The missile is understood to be designated V750VK by the Soviet Union, the complete system being V75SM. Guideline has seen extensive action in South-East Asia and the Middle East, and is standard equipment in many armed forces.

Various combinations of warhead and fuze have been reported. Most rounds have high-explosive warheads fitted with contact, proximity or command fuzes, but a larger version of the missile, first seen in 1967, is reported to have a nuclear warhead.

A Soviet Army Group deploys three SA-2 batteries, each comprising six mobile launchers, a Fan Song radar and a loading vehicle. The two forward batteries are reported to be located 45km from the front and the third 80km. The number of SA-2 sites operational in the Soviet Union itself is declining at the rate of 100-200 launchers per year as SA-3/SA-5 forces build up.

SA-2, in its SA-N-2 form, is operational on one vessel of the Soviet Navy (see entry).
Operators Soviet Union (approx 3,500 launchers), Afghanistan Air Force, Albanian Air Force, Algerian Air Force, Bulgarian Air Force (two battalions), Chinese Air Force and Naval Air Force (see SA-1 entry under China), Cuban Air Force (24 battalions, 144 launchers), Czechoslovak Air Force (approx 20 sites), Egyptian Air-Defence Command (25-30 batteries), East German Air Force (two battalions), Hungarian Air Force (two battalions), Indian Air Force (approx 20 sites), Iraqi Air Force, Jugoslav Air Force (eight batteries), North Korean Army (20 battalions), Libyan Air Force (a total of eight SA-2/SA-3/SA-6 batteries [62 launchers] protect Okba Ben Nafi air base) Mongolian Air Force (one battery), Polish Air Force (30 sites), Romanian Air Force, Syrian Army, Vietnamese Army (approx 300 launchers).

SA-3 Goa Has seen extensive action in South-East Asia and the Middle East. The missile is normally carried in pairs on a ZIL 157 tractor, the weapon being fired from ground-mounted trainable launchers; the missile has also been seen on tracked vehicles. Also deployed on ships as the SA-N-1 (see entry). A quadruple launcher deployed since 1973 is now known to be of Russian origin.
Operators Soviet Union, Polish Air Force, East German Air Force, Jugoslav Air Force, Czech Army and Air Force, Indian Air Force (known locally as Pichora), Egyptian Air-Defence Command (approx 60 twin ramps), Ethiopia, Iraq, Libya (eight batteries [62 launchers] of SA-2/SA-3/SA-6 defend Okba Ben Nafi air base), Peruvian Army, Syrian Army, Vietnamese Army, Uganda, Finland.

SA-4 Ganef Carried in pairs on a tracked transporter/launcher. Long-range surveillance is provided by an E-band Long Track radar (beam is c.7·5° in elevation and 3·5° in azimuth, completes scan every 4sec), while target acquisition and fire control are the responsibility of the H-band Pat Hand radar. Some reports credit the weapon with a secondary surface-to-surface role.

A Soviet Army Group deploys nine SA-4 batteries—comprising one Pat Hand, one loading vehicle and three twin launchers—in the gaps between SA-6 batteries. The leading three batteries are reported to follow some 10km behind the Army's forward forces, the other six batteries moving in a belt 25km behind the front.

SA-3 missiles installed in Finland

Operators Soviet Union, Czech Army, East German Army.

SA-5 Gammon A long-range, high-altitude SAM of which about 1,100 are in service; SA-3 and SA-5 forces are being built up as SA-2 deployment is reduced. Gammon, which operates in conjunction with a Square Pair radar, may have some ABM capability.
Operator Soviet Union.

SA-6 Gainful SA-6 was first used operationally in the Yom Kippur War, its capability taking Israel (and the US) somewhat by surprise. The missile, which uses all-solid-propellant integral rocket/ramjet propulsion, is carried in threes on a modified PT-76 chassis. Rocket power accelerates the missile at about 20g to a speed of Mach 1·5. The tail cone (which contains the rocket motor nozzle) is jettisoned at burnout, and the ramjet system takes the missile up to about Mach 2·8.

A Soviet Army Group deploys five SA-6 batteries, each comprising one Straight Flush vehicle, one loading vehicle and three triple launchers. Three of the batteries are located 5km back from the front line and the remaining two are deployed about 10km further back, filling the gaps between the three forward units.
Operators Soviet Union, Egyptian Air-Defence Command (several dozen vehicles), Iraqi Air Force (25 launchers), Libya (eight SA-2/SA-3/SA-6 batteries [62 launchers] defend Okba Ben Nafi air base), Syrian Army (60 vehicles?—may have taken delivery of an improved version in early 1978), Vietnamese Army, Bulgarian Army, Czechoslovak Army, Hungarian Army, Polish Army, Mozambique Army (24 vehicles). Finland reported negotiating.

SA-7/SA-N-7 Grail (Strella) The Russian equivalent of Redeye, widely used in South-East Asia and the Middle East. It is effective against targets flying at less than 500kt, and the infra-red guidance system has been fitted with a filter to screen out decoy flares.

As with Redeye, a booster ejects the round from the tube but burns out before the rear of the missile is clear. As soon as a safe distance has been reached, the sustainer starts and takes the missile up to supersonic speed.

The Mk 2 version has an uprated charge, enabling the missile to reach a greater speed, although the burn time is not increased. Maximum altitude is also increased, to about 14,000ft (a Hunter of the Sultan of Oman's Air Force has been hit by an SA-7 while at 11,500ft above ground level). The SA-N-7 is carried on small boats for protection against aircraft attack.
Operators SA-7; Warsaw Pact, Angola, Cuba, Egyptian Army (infantry-operated and also by operator standing on American Motors Jeep-type vehicle which carries four reload rounds), Kuwait, Syrian Army, Vietnamese Army, People's Democratic Republic of Yemen, Jugoslavia, North Korean Army, Libyan Army, Iraqi Army, Ethiopia, Finland, Mozambique, Peru, Kuwait?, various rebel/terrorist organisations, SA-N-7: Soviet Navy (some or all of 65 Osa I and 55 Osa II missile boats, 45 Shershen torpedo boats), Egyptian Navy (4 Shershen, 2 Osa).

SA-8 Gecko This 8km-range mobile system is now entering service. Roughly equivalent to Crotale, it comprises a new six-wheeled amphibious vehicle carrying a rotating four-round launcher surmounted by a folding surveillance-radar aerial, with a forward-mounted target-tracking radar flanked by two command dishes. Fewer than ten rounds are thought to be carried. The search radar is believed to operate in the 4-8-GHz band and to have an effective range of some 30km against a typical target; the tracking radar, in the 13-15GHz band may have a range of 20-25km. Two missiles can be launched at the same target, and controlled by the twin-antenna I-band command link. A low-light television camera mounted on top of the tracking command assembly is used for optical target tracking and probably for automatic missile gathering.
Operators Soviet Army, Syrian Army reported to have ordered.

SA-9 Gaskin A vehicle-mounted development of SA-8, the missile being larger, heavier, carrying a larger warhead and being capable of greater range/altitude. The mounting consists of twin quadruple canister launchers on a modified BRDM. The missile obviously has fixed fins and may be derived from the AA-2 Atoll rather than the SA-7 Grail.
Operators Warsaw Pact, Egyptian Army, Syrian Army?

SA-10 Development of this rapid-acceleration SAM seems to have been unduly protracted, suggesting that Soviet engineers are adapting the weapon for use against targets such as cruise missiles. The system uses three CW radars and may be vertically launched. US sources have suggested that a shipboard variant may exist but there is no real evidence as yet of such a weapon. Initial development could begin some time this year but the weapon is not expected to be in widespread service until the mid-1980s. An anti-cruise-missile defence system would need between 500 and 1,000 ten-launcher sites, claims the US Department of Defence, and would cost the equivalent of $50,000 million.

SA-11 As the absence of an "X" in the designation suggests, deployment of this 20km-range radar-guided SAM has already begun. Three and four-rail launch vehicles have been observed operating in conjunction with SA-6 systems. The Mach 3 missile can cope with targets at altitudes between 25m and 15,000m. These performance figures strongly suggest a weapon in the SA-6 class rather than, say, an SA-3 Goa replacement. SA-11 could conceivably be the "improved SA-6" which Syria was reported to have received early in 1978.

SA-? A new man-portable SAM may be about to enter service to replace the SA-7 Grail. The Soviet Union was reported in the mid-1970s to be working on a laser-beam riding missile which could be the same weapon.

SA-N-1 Goa The naval variant of SA-3 (see entry) is fired from a roll-stabilised twin launcher mounted on top of the magazine. In service since 1962. The associated radars are the E/I-band Peel Group.
Operator Soviet Navy (Four Kresta I cruisers; four Kynda cruisers; 19 Kashin and Modified Kashin destroyers; eight SAM Kotlin destroyers; seven Kanin destroyers [converted from Krupnys]; Polish Navy (one SAM Kotlin destroyer), Indian Navy? (on several *Kashin*-class destroyers?).

SA-N-2 Guideline The naval variant has apparently proved unsuccessful, only one vessel having been equipped.
Operator Soviet Navy (*Sverdlov*-class cruiser *Dzerzhinski*).

SA-N-3 Goblet Fitted to the latest larger Russian vessels. A drawing published in the magazine *Aviation and Marine International* depicts a 6·0m-long Seawolf-configuration weapon with a diameter of 60cm, but most sources think that an SA-6 missile is used. Associated with Headlight G, H and I-band radars.
Operator Soviet Navy (two *Kiev*-class aircraft carriers—two twin launchers on foredeck; two *Moskva*-class helicopter carriers—two twin launchers on foredeck, 180 reload rounds; five Kara cruisers—one twin launcher forward and one aft; ten Kresta II cruisers—one twin launcher forward and one aft).

SA-N-4 A short-range system using the same missile as the SA-8 Gecko but fired from a twin launcher housed within a circular bin when not in use. The associated Pop Group radar is almost identical with that used by Gecko, but has only a single command-link antenna.
Operator Soviet Navy (two *Kiev*-class aircraft carriers; five Kara cruisers; two *Sverdlov*-class cruisers converted to command ships; at least five Krivak destroyers; Nanuchka corvettes; Grisha I corvettes; Koni corvettes; *Ropucha*-class assault craft; amphibious-warfare ship *Ivan Rogov;* replenishment ship *Berezina*. Indian Navy.

Air-to-air 9

France

Matra Super 530 The Super 530 entered operational service with the French Air Force last December, arming Mirage F.1s, and is additionally planned to equip the Mirage 2000. The missile can snap up through 9,000m to engage high-flying targets and will be able to attack aircraft flying in ground clutter when it is mated with the Doppler radar being developed for the Mirage 2000.

Matra R.550 Magic A dogfight missile intended to augment or replace the cannon at short ranges and to intercept targets at 7km or more at high altitudes (maximum 18,000m) or 2·5km at low level. Magic can be fired from a Mirage F.1 pulling up to 6g and the missile itself is stressed for 30g manœuvres. The weapon can be fired singly or at 1sec intervals, and may cross the bows of the launch aircraft only 50m ahead. There is no minimum launch speed, and the maximum is more than 700kt. Magic can be fired against targets anywhere in a forward sector of at least 140°. The infra-red seeker is cooled by an air bottle mounted in the launcher. Magic will form the basis of a family of improved variants which can attack targets head-on.
Operators French Air Force (Mirage III/5/F.1; Jaguar), French Navy (Super Etendard, F-8), Sultan of Oman's Air Force (Jaguar), Royal Saudi Air Force (F-5E, F-5F), South African Air Force (Mirage F.1CZ), Iraqi Air Force (Mirage F.1), Indian Air Force (MiG-21), Egyptian Air Force (Mirage III/5), Ecuador Air Force (Jaguar), Syrian Air Force, Abu Dhabi Air Force (Mirage III/5), Pakistani Air Force.

Germany

Dornier Tirailleur Dornier is working on a third-generation air-to-air missile using body lift and carrying alternative radar (probably active) and infra-red seekers.

Israel

Rafael Shafrir The initial operational version, the Mk 2, entered service in 1969 and has since averaged a kill ratio of 60 per cent in extensive combat. The Mk 3 variant now being developed is more manœuvrable and has a larger launch envelope, as well as being able to intercept targets at all aspects.
Operators (Mk 2) Israeli Air Force (Mirage III, Kfir), Taiwan, Chile, Turkey, Argentina? Plus possibly others.

Italy

Selenia Aspide This multirole missile is planned to be used in the air-to-air role as well as in surface-launched applications (see Spada and Albatros entries in Section 8), but the AAM portion of the programme appears to be in limbo.

South Africa

Development of an **air-to-air missile** has been completed and the weapon is entering production. A missile in this class known as Whiplash was developed in the late 1960s and licence production of the R.550 Magic has been reported but never confirmed. The new weapon could be either of these or even a licence-built version of Shafrir.

United Kingdom

British Aerospace Sky Flash Sky Flash, developed from the AIM-7E Sparrow, is in service aboard RAF Phantoms and is planned to arm the Tornado ADV. The US Air Force carried out an evaluation of the weapon culminating in a series of firings from an F-4E last summer, and Sky Flash notched up a 100 per cent success record in firing trials carried out as part of the now-complete three-year integration programme with the JA37 Viggen.

British Aerospace is now developing Sky Flash Mk 2 under a £75 million contract. Improvements in the new variant include greater all-round coverage, increased range, enhanced performance against manœuvring targets and greater resistance to electronic countermeasures.
Operators Royal Air Force (Phantom, Tornado F.2), Swedish Air Force (JA37 Viggen).

United States

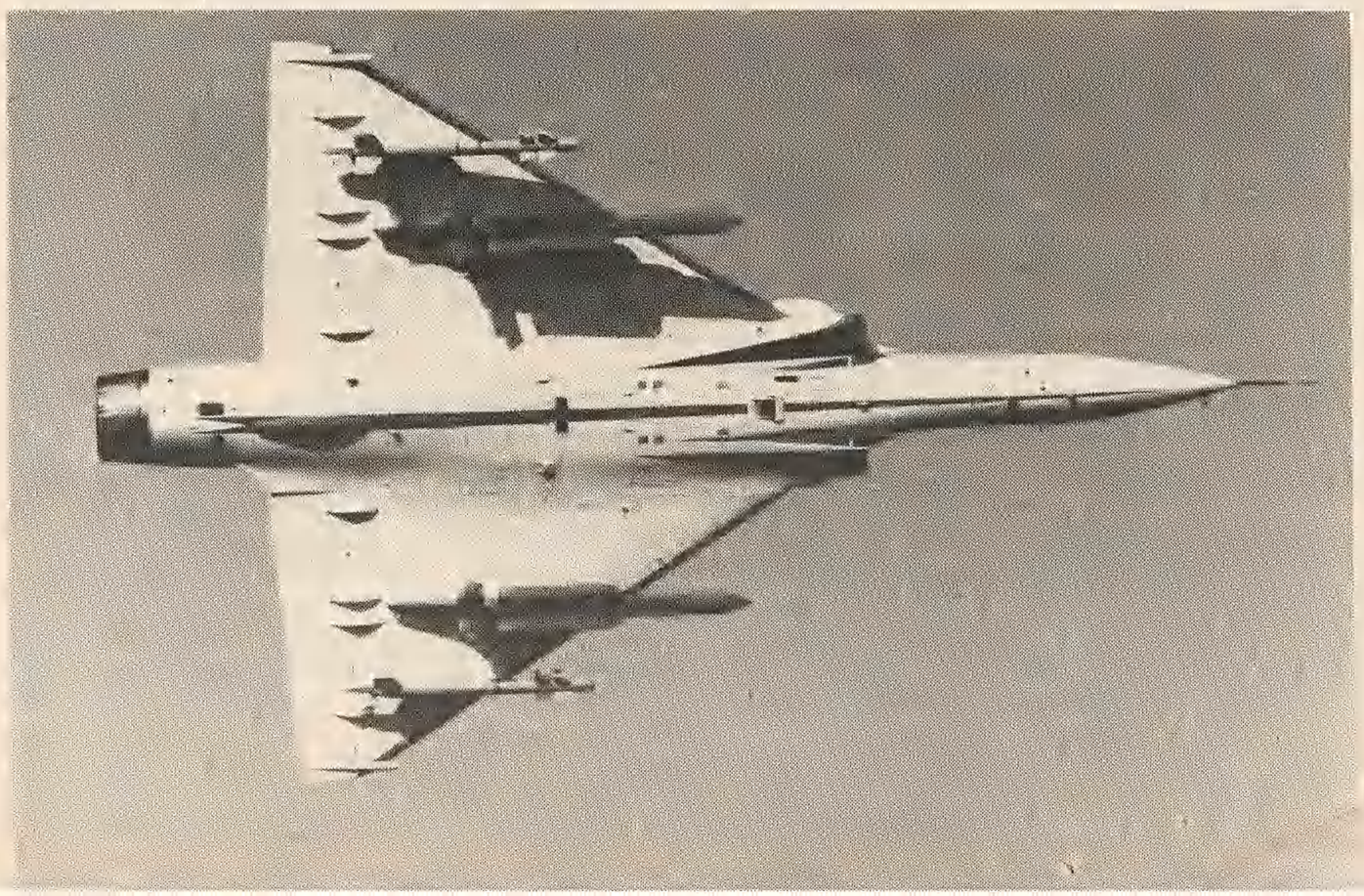
Raytheon/General Dynamics AIM-7 Sparrow Production is in the process of changing from the AIM-7F, which has been built by both Raytheon and General Dynamics, to the Raytheon AIM-7M incorporating a monopulse seeker. The new seeker, combined with a digital signal processor, new autopilot and new fuze, gives AIM-7M much better performance against targets in ground clutter and improves its resistance to countermeasures. The AIM-7M is expected to enter service in mid-1981 and to continue in production until replaced by Amraam in 1986-87.
Operators AIM-7E: USAF, USN, USMC, Hellenic Air Force, Israeli Air Force, Islamic Iranian Air Force, Republic of Korea Air Force, Japanese Air Self-Defence Force (missiles built under licence by Mitsubishi as the AIM-7EJ), Royal Air Force, Royal Navy (all F-4), Italian Air Force (F-4 and F-104S), Turkish Air Force (F-4 and F-104S), Spanish Air Force?
AIM-7F: USAF, (F-4E, F-15), USN (F-14, F-18 planned), Israeli Air Force (F-4E). Planned for Royal Saudi Air Force F-15s.

Raytheon/Ford Aerospace AIM-9 Sidewinder Production continues of this seemingly unreplaceable AAM. Ford Aerospace has been building guidance and control sections for the AIM-9L version since 1977 and delivered the first production batch of AIM-9Ps last November. Some 13,000 AIM-9Ps are expected to be produced both as all-new rounds and by conversion from the AIM-9B/E/J series. The other major contractor involved in the Sidewinder programme, Raytheon, is in production with the AIM-9L and is providing the US Navy with industrial support on development of the AIM-9M, which has further improvements to the seeker together with a cleaner-burning motor. The AIM-9L is also entering production in Europe by a consortium under the leadership of Bodenseewerk. The German company is responsible for building the guidance and control section as well as for project management, with other major contractors being Snia Viscosa (warhead), British Aerospace (wings, fins, rollerons and some mechanical assemblies) and Raufoss Vapenfabrikk (rocket motor).
Operators (AIM-9L) US Air Force (F-15, F-16, others), US Navy (F-14, F-18), Germany (Tornado), Royal Navy (Sea Harrier), Royal Air Force (Tornado and others), Norway (F-16), Italy (Tornado and others?), plus other customers.

Hughes AIM-54 Phoenix A total of 143 Phoenix long-range AAMs had been fired from F-14s by March, of which 83 per cent were successful. Hughes is now building 15 engineering-development models of the improved AIM-54C, which has a programmable digital signal processor, a solid-state transmitter/receiver and a digital autopilot, together with a new proximity fuze being developed by the Naval Weapons Centre. Low-rate production of 60 AIM-54Cs is expected to begin this year.
Operators US Navy (F-14), Islamic Iranian Air Force (F-14).

Amraam The United States Air Force and Navy have selected Hughes and

Matra Super 530 and R.550 Magic on a Mirage 2000



Raytheon to develop prototypes of a Sparrow replacement to enter service in 1986, becoming the standard US beyond-visual-range air-to-air missile in the late 1980s. Requirements for the Advanced Medium-Range Air-to-Air Missile (Amraam) include an active radar homing head to remove the need for the launch aircraft to illuminate the target, and to allow multiple targets to be engaged in rapid sequence; a high-impulse motor to give short flight times; and a significant reduction in size and cost compared with Sparrow. Amraam will additionally use all-digital electronics and a strapdown inertial mid-course guidance system. Each contractor is building 16 missiles for flight trials this year and in 1981. A 40-month full-scale development contract is then expected to be awarded to the winner of the evaluation by the end of 1981, leading to service entry in late-1985.

Allied programmes include the introduction of the F-15C, incorporating a programmable signal processor in the radar; this provides Doppler beam-sharpening and increases performance against multiple targets. Similar processors will be retrofitted in F-14s and are planned for the F-18. The second area of development in long-range, non-visual identification involves analysis of target signatures—such as engine harmonics—derived from millimetre-wavelength radars. Returns from a variety of sensors will be processed by computer and displayed to the crew, allowing them to engage targets outside visual range with a high degree of confidence.

The Pentagon has asked European companies to provide technical details of Tornado and the Mirage 2000 so that the new missile can be made compatible with both. If adopted as a Nato-standard, weapon. Amraam could be built by production lines on both sides of the Atlantic.

Asraam A joint USAF/USN operational requirement for a successor to Sidewinder was established in January 1979. The Asraam (advanced short-range air-to-air missile) programme is of lower priority than Amraam, because AIM-9L Sidewinder still has potential for further performance improvements; the new weapon is expected to enter service in the late 1980s or early 1990s. Basic information about the performance required for Asraam was provided by the Aceval/Aimval programme, and parallel work includes the Pave Prism studies of possible seekers, both infra-red and active laser. The US has proposed that if Amraam becomes a Nato-standard weapon, British Aerospace could become the Asraam prime contractor and would work with companies such as Matra and Bodenseewerk Gerätetechnik to produce a missile which could also be adopted by the USAF and US Navy, then co-produced in North America.

Martin Marietta M712 Copperhead Martin was awarded a $62 million contract in March this year for production of the Copperhead laser-guided 155mm artillery projectile for use against tanks and other armoured vehicles. The projectile will be fired from the US Army's M109 and M198 guns and will additionally be co-produced in Europe under the direction of PGM Systems, a consortium formed by Martin and Diehl. Other contractors involved would include FM, Selenia, Hollandse Signaalapparaten, MSDS and possibly a Greek company. Copperhead can be fired from European howitzers such as the FH70 and SP70, and can use the Ferranti LTM laser ranger/designator for illumination in addition to US types such as the GLLD, LTD, Mule and Tads.

Martin Marietta 5in guided projectile Martin is developing a rocket-powered laser-guided projectile to fit the US Navy's Mk 42 and Mk 45 gun mountings, using shipborne designators such as the Honeywell/Northrop Seafire system for target illumination. Airborne or land-based designators may also be used. A larger version for firing from 8in guns has been abandoned.

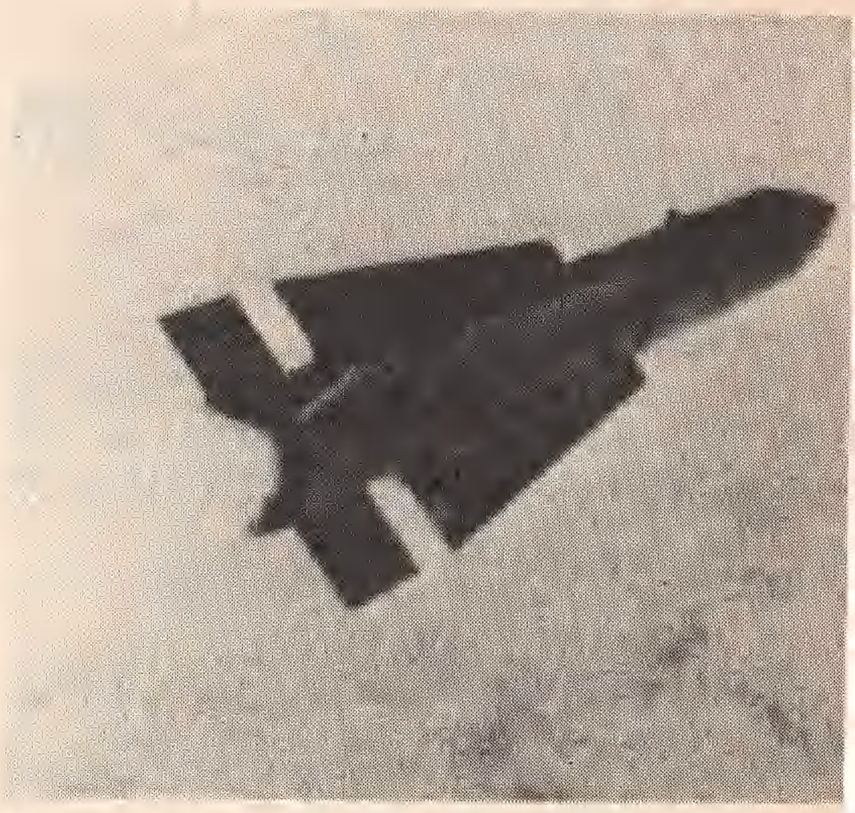
Ford Aerospace Siam The Self-Initiated Anti-aircraft Missile is being developed to protect submarines, ships and land installations against aircraft attack. The weapon is vertically launched and uses a dual-mode seeker (active radar for the initial stages of flight, followed by infra-red terminal homing). The first flight test of a complete Siam was successfully conducted at the White Sands Missile Range in April. Siam is designed to be launched vertically, but for this test the launcher was inclined and both seekers were locked on to the target before firing. The missile's launch motor ejected the round from the tube at low velocity; the main motor was then ignited and accelerated the missile until burnout. The target was a QH-50 drone helicopter carrying a transponder and infra-red flare pots to simulate a larger moving helicopter. The QH-50 was hovering at a height of 450m and was 3,300m downrange; the Siam struck and nearly severed the aluminium beam which held the flare pots. Siam is about 2·5m long, 32cm in diameter and weighs 68kg.

Soviet Union

AA-2 (K-13A) Atoll and AA-2-2 Advanced Atoll This Russian equivalent of Sidewinder has seen widespread use in the Middle Eastern and Indo-Pakistani conflicts and in South-East Asia. It has poor performance, even in the advanced version, and the seeker does not always lock on to the target, although the launch aircraft may be in the optimum firing position.

Some sources suggest that the Advanced Atoll exists in both infra-red and semi-active homing versions. An all-aspect infra-red seeker could be operational on Atoll by the mid-1980s.
Operators Warsaw Pact, Afghanistan, Algeria, Bangladesh, China, Cuba, Iraq, Jugoslavia, Laos, Libya, Mozambique, Nigeria, North Korea, Peru, Somalia, Syria, Uganda, Vietnam, Yemen (PDRY), Albania?
Types equipped MiG-21 Fishbed C—two AA-2s; MiG-21PF Fishbed D—two AA-2s; MiG-21PFMA Fishbed F—two or four AA-2-2s; MiG-21M Fishbed J—four AA-2-2s; MiG2-SMT Fishbed K—four AA-2-2s; MiG-17 Frescoe E—two AA-2-2s; Flogger E, Su-22.

AA-3 Anab and AA-3-2 Advanced Anab Several thousand of these missiles have now been built. Two versions are in service—I/J-band semi-active homing and infra-red—and launch aircraft normally carry one missile of each type.
Types equipped Su-11 Fishpot C—two AA-3s or AA-3-2s; Su-15 Flagon—two AA-3-2s, one under each wing; Yak-28 (being phased out of service)—two AA-3s or AA-3-2s under outer wings—



Hughes AIM-54C improved Phoenix

all aircraft listed carry the Skip Spin radar.

AA-5 Ash Like the smaller AA-3, this missile exists in both infra-red and I/J-band semi-active homing forms, and the number built certainly exceeds a thousand.
Type equipped Tu-28P—two infra-red and two radar under wing—Big Nose radar.

AA-6 Acrid Similar to AA-3 Anab but larger. Standard MiG-25 armament, each Foxbat carrying four missiles—two using infra-red homing and the other pair employing semi-active radar guidance—on underwing pylons. It is likely that the weapons are ripple-fired in pairs, the IR round preceding the radar missile by about 1sec. The MiG-25 Foxbat A interceptor is known to carry a Fox Fire fire-control radar derived from the Big Nose equipment fitted to Tu-28 Fiddlers. Maximum detection range is believed to be 80 to 100km, targets being tracked out to about 50km. Missile speed is likely to be about Mach 2·2 greater than that of the carrier aircraft at launch.

Missile performance is probably limited by the Foxbat's Fox Fire radar and a maximum range of 70 to 80km can be expected when operating with the improved radar in Foxbat D. Given suitable radar technology both in the homing head and launch aircraft, Acrid could achieve a range of more than 100km. It also arms the Su-15 Flagon D and E.

AA-7 Apex Standard MiG-23S fighter armament, each Flogger carrying one missile under each wing (one using infra-red homing and the other semi-active radar guidance). Designed for use at low and medium altitudes. The radar version operates in conjunction with Flogger B's High Lark radar, which has a limited look-down search and tracking capability. Also carried by Foxbat A.

AA-8 Aphid Dogfight weapon thought to be derived from AA-2 Atoll. Two are carried under the belly of MiG-23 fighters. May be similar in performance to AIM-9L Sidewinder.

AA-X-9 This new missile was being tested in simulated snap-down attacks during 1978.

Anti-tank 10

Argentina

The Argentine Armed Forces Scientific and Technical Research Centre is reported to have developed an anti-tank missile for service with the Argentine Army; it may be based on the MBB Cobra.

International

Euromissile Hot A heavy, long-range anti-tank missile designed to arm a wide variety of existing and specialised vehicles and helicopters. About 30,000 have been ordered, and production is running at 800 a month. Hot is equipping the French Army's SA.341F Gazelle helicopters and the German Army's SPZ Jaguar 1 tank destroyer. The German Army will receive a total of 316 SPZs and is also fitting Hot to its PAH-1 (BO105) helicopters. The French Army's primary Hot ground vehicle will be the four-wheeled Saviem VAB fitted with the Méphisto firing installation, this combination replacing AMX13 tanks armed with SS.11. Méphisto comprises a four-round launcher, which is retracted when not in use and which can be rotated through 360°, a stabilised periscopic sight and the Hot guidance equipment; eight reload missiles are carried within the vehicle. France has ordered 160 SA.342M Hot-armed Gazelles.

Other Hot installations can include the AMX10P light tank fitted with a Lancelot four-round turret and containing ten reloads; the Panhard VCR/VTH M3B six-wheeled vehicle carrying a UTM 800 turret, with four missiles ready to fire and a further ten reloads. The SA.342L uprated Gazelle, with an M334 sight; and the SA.361H Dauphin, which is fitted with the M397 sight and eight missile launchers. A night sight using the Hector infra-red camera in the Venus stabilised sight has been selected to equip Hot-armed Dauphins for export.

Euromissile has studied alternative interchangeable warheads to fit Hot, including an anti-ship type which will penetrate 12mm of steel at an incidence of 65° and an anti-personnel flechette head. Potential overseas customers have expressed interest in both developments.

Operators French Army (SA.341—four rounds; VAB—four rounds), German Army (SPZ—single launcher fed by eight-round magazine, 20 reloads; BO105—six rounds), Egypt (SA.342 Gazelle), Kuwait (SA.342), Syria (SA.342), Iraq, Libya, Saudi Arabia? China reported negotiating.

Euromissile Milan The Milan weapon system comprises three elements: the round of ammunition, the firing post and the support and monitoring equipment. The round of ammunition consists of the missile in its launch tube, which is handled and stored as ordinary ammunition, requiring no checking before firing. The firing post consists of a sighting and guidance assembly mounted on a firing ramp.

The missiles are assembled by Aérospatiale, with some electronic components being supplied by MBB. The German company is also responsible for the tripod/launcher, glassfibre launch tube and warhead. British Aerospace is also building launchers and missiles under licence in a £200 million programme.

Euromissile Hot-equipped Aérospatiale Gazelle

Present production rate is some 1,600 a month and more than 90,000 rounds have been ordered by about 19 customers. Milan is mounted on the Germany Army's Kraka collapsible trucks and will be fitted to the French Army's VAB wheeled vehicles, using a Creusot-Loire turret; other possible platforms include the Lohr VP90 and VPX110 and the Beherman Demoen BDX. The TRT/Siemens Mira 2 thermal-imaging night sight has been selected for use with Milan and will enter production in 1983. The specification calls for targets to be detected at a range of 2,000m and engaged at 1,200m. The figures claimed for Mira 2 are 3,200m, and 1,500m respectively.

Operators French Army, German Army, Belgian Army, British Army, Turkey (6,250 rounds, 483 firing posts), Spanish Army, Syria (at least 2,000 rounds), Greece, Lebanese Army, Egyptian Army, Somalia, South Africa, plus three others.

International

European third-generation weapon France, Germany and Britain have agreed to collaborate on development of a third-generation anti-tank missile to replace Swingfire, Hot and Tow in the late 1980s. The weapon would be the responsibility of EMDG (Euromissile Dynamics Group), a consortium comprising Aérospatiale, MBB and British Aerospace. General requirements include long range and probably a supersonic cruise speed, although the originally specified "fire and forget" capability may be abandoned in order to reduce costs.

Germany

BGT/AEG/Diehl Bussard A proposed 120mm laser-guided mortar bomb being studied by the German companies Bodenseewerk Gerätetechnik, AEG-Telefunken and Diehl Elektronik. Bussard would be fitted with flip-out wings and control surfaces.

Italy

Breda Meccanica Sparviero A semi-automatic system being developed for service in the 1980s. The complete system weighs 60kg and guidance is by an infra-red system developed by Officine Galileo. It can also be operated from light helicopters.

Japan

Kawasaki/Mitsubishi KAM-9 TAN SSM A semi-automatic missile which is replacing KAM-3D in the anti-tank and counter-landing-craft roles. The weapon is known as the Type 79 Heavy MAT in JGSDF service.

Yugoslavia

An anti-tank missile is reported to be under development.

Sweden

Bofors RB56 Bofors is working on an anti-tank missile for the Swedish Army. This may be a fire-and-forget weapon, perhaps with infra-red homing.

Switzerland

As part of the industrial offset associated with the Swiss order for F-5Es, Martin Marietta has signed an agreement with Oerlikon-Bührle to assist the latter in developing an anti-tank missile with some surface-to-air capability. The weapon will use Martin Marietta's modular Flir guidance system.

Taiwan

During a National Day parade on October 10, 1978, an armoured-car-mounted anti-tank missile was displayed and was claimed to be of local origin.

United Kingdom

British Aerospace Swingfire A heavy, long-range anti-tank weapon, Swingfire initially equipped the Ferret scout car and FV438 armoured personnel carrier and more recently has been introduced in Striker, one of the CVR(T) range of

reconnaissance vehicles. The Egyptian Army operates the missile from Land-Rovers carrying four-round pallets, and a production line has been established in Egypt under the terms of a licensing contract covering progressively increasing local assembly over six years.

A new sighting and guidance station, which incorporates all the electronics necessary for the launching and guidance of Swingfire missiles, has been developed. This allows Swingfire (using a new lightweight launcher) to be mounted on to practically any vehicle. This system is the Light Air-transportable Swingfire. It can be slung under a helicopter or dropped by parachute. One man can fire and control up to four missiles without reloading. A night sight developed by British Aerospace and Barr & Stroud is now entering service.

Operators British Army (Ferret Mk 5 scout car—four missiles in launchers plus four spares; FV438 armoured personnel carrier—2+12; 43 Striker—5+5), Belgian Army (41 Striker, 2,000 rounds?), Egyptian Army (one-tonne Land-Rover—four-round pallet; initial purchase in 1974 of 2,000 rounds to be followed by local production of several thousand missiles), Kenya.

United States

Hughes BGM-71A Tow More than 250,000 Tow rounds have now been delivered. Some 1,100 M901 Improved Tow Vehicles (ITVs) based on the M113 APC are being supplied to units in Germany by the end of 1981, and the eventual ITV total could reach 2,526 units. Tow will also be carried by the XM2 Infantry Fighting Vehicle and KM3 Cavalry Fighting Vehicle which together make up the US Army's Fighting Vehicle System to accompany the KM1 main battle tank.

In the airborne role, Hughes is building 44 LAAT (Laser Augmented Airborne Tow) sights for delivery from July to equip AH-1s, and in the autumn of 1979 the company carried out a series of firings using Facts (Flir-augmented Cobra Tow sight) incorporating US Army thermal-imaging common modules.

Future Tow rounds will carry a larger-diameter (6in) warhead to improve the missile's chances against new Russian tanks protected by advanced armour, and with the operating wavelength of the tracking lamp changed so that it can be seen through smoke and mist. As an interim step, an improved warhead of the present diameter (5in) but with better armour penetration is being developed.

Operators US Army (M151 Jeep, M274 Mechanical Mule, M113 APC, M901 ITV, infantry, 630 AH-1S helicopters planned by 1982), USMC (tank battalions, improved AH-1Js), Canada (150 launchers), Denmark, Germany (427 launchers, others planned), Greece, Holland, Iran (M113s, 65 AH-1Js), Israel (M113s, R311, AH-1, Hughes 500MD, Italy (M113s, 30 A.109 Hirundos planned; original order 130 launchers, 5,000 rounds), Jordan, Kuwait (1,800 rounds, Land-Rovers, trucks), Lebanon (18 to 20 launchers), Luxembourg (six launchers), Norway (90 launchers, 389 rounds), Oman (ten launchers, 180 rounds), Turkey, Morocco, South Korea (100 Hughes 500M-D), Sweden (340 launchers, 6,700 rounds), Saudi Arabia (1,000 rounds initially), Britain (up to 100 Lynx with modified M65 sights, 8,400 rounds), Pakistan, Tunisia, Taiwan, Portugal, Spain, Kenya (15 Hughes 500MD Defenders), Zambia? Ethiopia (supply embargoed).

McDonnell Douglas/Raytheon FGM-77A (M-47) Dragon Developed to replace the 90mm recoilless rifle as the US Army's infantry-portable anti-tank weapon, being assigned down to squad level. The missile entered service in Europe in late 1974, and the US forces alone have a requirement for some 250,000 rounds. Since 1976 all Dragons have been built by Raytheon and the trackers have been produced by Kollsman Instrument.

The re-usable tracker contains an X6 optical sight, infra-red sensor, electronics package and trigger. It is attached to a factory-sealed launcher/container consisting of a smooth-bore glass-fibre tube with propellant container and breech, plus the missile. After use the tracker is removed and attached to a new round.

Operators US Army, USMC, Iran, Israel, Saudi Arabia, Jordan, Switzerland (15,000 rounds), Holland (350 trackers, 6,000 rounds), Morocco, Denmark.

Imaaws The Infantry Manportable Anti-armour/Assault Weapons System, previously known as CCAS (Close combat anti-armour system), is the US contender for the Nato family of future anti-tank missile systems. The European element would be a vehicle-mounted long-range missile.

Soviet Union

AT-2 Swatter Fired from triple launchers on BRDM-1 vehicles and probably used as interim armament on the Mi-24 Hind attack helicopter.

Operators Soviet Union, Hungary, Romania.

AT-3 Sagger (Miliuka) Mounted on a variety of vehicles, including the BRDM-2/BTR-40P scout car (six launchers under a retractable plate), BMP-76PB armoured personnel carrier (one launcher, total of four rounds), BMD-1 (one launcher) and Polish Skot eight-wheeled APC (one launcher on either side of turret). A portable rail launcher can be deployed up to 100m from the carrier vehicle and the missile is also operated by two-man infantry teams; one soldier positions the missile, tensions the wires and attaches the fuzes and the other, from a distance of a few metres, operates the missile. A Saclos version has been reported.

Operators Soviet Union (each armoured division has 12 infantry-operated launchers, 132 BMPs and nine BRDMs; each mechanised division has 36 infantry-operated launchers, 102 BMPs and 27 BRDMs), Bulgaria, Czechoslovakia, Egypt, East Germany, Hungary, Jugoslavia (licence manufacture reported), Poland (Skot APCs), Romania, Syria (approx 6,000 rounds), Vietnam (BTR-40P and BMP), Libya, Uganda, Algeria, Iraq, Angola, Mozambique, Afghanistan, Ethiopia, (Iran was reported to have ordered but the fate of this contract remains uncertain), Israel may be using captured stocks.

AT-4 Spigot Tube-launched from a tripod-mounted installation which is presumably similar to the infantry version of Tow, this weapon is a direct replacement for the man-portable Sagger.

Operator Soviet Army.

AT-5 Spandrel In November 1977 BRDM four-wheeled armoured cars each carrying five launch tubes took part in the annual Red Square parade. The new weapon has been described as "Fagot" and "AT-4?" by several publications but is now known to have the US code AT-5. The Nato reporting name is Spandrel.

A range of 3,000 to 4,000m has been suggested, but this seems a little optimistic. Launch tube dimensions suggest that the actual missile must be comparable in size and weight to the AT-3 Sagger.

Like Milan, Hot, Dragon and Tow, Spandrel uses semi-automatic command-to-line-of-sight (Saclos) guidance. AT-5 replaces vehicle-mounted Swatter and Sagger installations, and is operational with Soviet units in East Germany.

AT-6 Spiral This missile is a replacement for the airborne AT-2 Swatter variant carried by Mi-24 Hind D helicopters. Unlike AT-4 and AT-5, this missile has a semi-active seeker.

Ranges of 7-10km have been advanced for such a missile suggesting that it is a fairly large weapon. The heaviest warhead carried by a Nato anti-tank missile is the 7kg Swingfire unit.

Emerson Electric Improved Tow Vehicle

1 — STRATEGIC, BALLISTIC

Designation	Dimensions		Weight (kg)	Range (km)	Control
	Length (m)	Dia (cm)			
CSS-1	c.21	c.160	c.26,000	c.1,800	?
CSS-2	?	?	c.27,000	2,700-3,200	?
CSS-3	?	?	?	4,800-5,600	?
CSS-X-4	c.35	c.300	150,000-200,000	11,000-12,800	?
CSS-N-X	c.10	c.150	13,700-14,000	2,200-2,700	?
SSBS S2	14·8	150	31,900	c.3,000	1: four gimballed nozzles 2: four gimballed nozzles
SSBS S3	13·8	150	25,800	3,000+	1: four gimballed nozzles 2: Freon injection into single fixed nozzle
MSBS M20	10·4	150	20,000	3,000+	1: four gimballed nozzles 2: Freon injection into single fixed nozzle
MSBS M4	11·05	193	35,000	4,500	1, 2+3: flexible nozzle
LGM-25C Titan II	31·3	305	150,000	15,000	Gimballed motors
UGM-27C Polaris A3	9·85	137	15,900	4,000	1: four rotating nozzles 2: fluid injection into single fixed nozzle
LGM-30F Minuteman II	18·2	183	31,800	11,000+	1 & 3: four movable nozzles 2: fluid injection into single fixed nozzle
LGM-30G Minuteman III	18·2	183	34,500	13,000+	As Minuteman II
MX	21·6	233	86,400	13,000+	?
UGM-73A Poseidon C3	10·36	188	29,500	4,600	1 & 2: one gimballed nozzle
UGM-93A Trident I C4	10·36	188	32,000	7,000	?
Trident II D5	c.14	188 or 210	up to 50,000	max 11,000	?
SS-14 Scapegoat	11	140	c.12,000	4,000	Movable nozzles?
SS-16	c.20	c.170?	c.36,000	?	Fluid injection?
SS-17	c.24?	c.250?	c.65,000	10,000+	Gimballed nozzles?
SS-18	c.36	c.300	c.220,000	12,000	Gimballed nozzles?
SS-19	c.27	c.250	78,000	10,000+	Gimballed nozzles?
SS-20	16?	c.170	c.25,000	4,000	Fluid injection?
SS-N-5 Serb	10	c.150	18,000	1,300	?
SS-N-6 Sawfly	13	c.180	c.19,000	Mod 1: 2,400 Mod 2 & 3; 3,000	?
SS-N-8	c.17	c.200	c.20,000	8,000	?
SS-N-17	c.11	165?	?	5,000+?	?
SS-N-18	c.14	180?	?	6,500-7,700	?

2 — STRATEGIC, NON-BALLISTIC

Designation	Dimensions			Weight (kg)	Range (km)	Speed	Control
	Length (m)	Span (cm)	Dia (cm)				
AGM-69A Sram	4·25	?	45	c.1,000	60-160	M3+	Cruciform rear fins
AGM- 86B ALCM-B	6·32	366	61	1,270	2,400+	M0.7	Elevons and rudder
BGM-109 Tomahawk (land-attack)	6·40	254	53	1,443	2,400+	M0.7	Cruciform rear fins
GLCM	6·40	254	53	1,443	2,400+	M0.7	Cruciform rear fins

3 — TACTICAL, BALLISTIC

Designation	Dimensions			Weight (kg)	Range (km)	Control
	Length (m)	Span (cm)	Dia (cm)			
Pluton	7·64	141·5	55	2,350	Min 10 max 120	Cruciform rudders
MGM-31A Pershing	10·6	—	100	4,600	Min 160 max 640	1: deflectors in motor efflux 2: fins

Propulsion	Guidance	Warhead
Single-stage liquid	Inertial	c.20KT
Single-stage liquid	Inertial	20-200KT
Multi-stage liquid	Inertial	2·3MT
Three/four-stage liquid	Inertial	3MT
Two-stage solid	Inertial	20-200KT
1: Aérospatiale/SEP Type 902 Herisson (P16), 55,000kg thurst, 76sec burn; 2: Aérospatiale/SEP Type 903 (P10), 45,000kg thrust, 50sec burn. Both stages A1/AP/PU isolane propellant	Inertial	150KT nuclear (fission). Single RV
1: As S2; 2: Aérospatiale/SEP Rita II (P6), 32,000kg thrust, 52sec burn	Inertial	1MT thermonuclear (fusion). Single RV
1: Aérospatiale/SEP Type 904 (P10), 45,000kg thrust, 50sec burn; 2: Aérospatiale/SEP Rita II (P6), 32.000kg thrust, 52sec burn	Inertial—EMD Sagittaire digital computer	MR-60 1MT thermonuclear (fusion) plus penetration aids
1: Aérospatiale/G2P 401, 70,000kg thrust; 4: Aérospatiale/G2P 402, 30,000kg thrust; 3: Aérospatiale/G2P 403, 7,000kg thrust	EMD/Sagem inertial	Seven Mirvs. 150KT each
1: two Aerojet LR87-AJ-5s, 98,000kg thrust each; 2: Aerojet LR91-AJ-5, 45,500kg thrust. All burn N_2O_4/Aerozine	AC/IBM inertial	General Electric Mk 6 single RV, c. 10MT thermonuclear, plus penetration aids
1: Aerojet, 36,000kg thrust, PU/AP propellant; 2: Hercules, Nc/Ng/AP propellant	GE/MIT/Hughes Mk 2 inertial	Lockheed Mk 2, three MRVs, 200KT each
1: Thiokol TU-120 (M55E), 91,000kg thrust, 60sec burn, AP/PBAA propellant; 2: Aerojet SR19-AJ-1, 27,500kg thrust, PU/AP propellant; 3: Hercules, 16,000kg thrust, Nc/Ng/AP propellant	Rockwell (Autonetics) inertial	Avco Mk 11B/C, single RV, 1-2MT thermonuclear, plus Tracor Mk 1/1A penetration aids
1 and 2: as Minuteman II; 3: Aerojet/Thiokol SR73-MJ-1, 15,500kg thrust, 59·6sec burn; plus PBCS	Rockwell (Autonetics) inertial	Three General Electric Mk 12 Mirvs, 165KT each, plus penetration aids
1: Thiokol solid; 2: Aerojet solid; 3: Hercules solid; 4: Rockwell hypergolic liquid	Northrop Airs inertial	Ten GE Mk 12A Mirvs
1: Thiokol/Hercules; 2: Hercules	GE/MIT/Hughes/Raytheon inertial	Ten Mk 3 Mirvs, 50KT each at max 5,200km range; 14 × 50KT at 4,000km, plus penetration aids
1, 2, 3: Thiokol/Hercules, plus PBCS	Stellar-inertial	Seven Mk 4 Mirvs with 100KT W-76 warhead
?	Inertial	Possibly ten Mk 12A Mirvs with 335KT warheads
Two-stage solid	Inertial	Thermonuclear
Three-stage solid	Inertial	Single RV
Two-stage liquid	Inertial	Four MRVs of 1MT each, or single RV
Two-stage liquid	Inertial	Mod 1: Single RV, up to 50MT; Mod 2: eight Mirvs, 600KT each; Mod 3: single RV
Two-stage liquid	Inertial	Six Mirvs, 550KT each, or single RV
Two-stage solid	Inertial	Three Mirvs, 150KT each
Two-stage liquid	Inertial	1MT?
Two-stage liquid	Inertial	1-2MT
Two-stage liquid	Stellar-inertial	Mod 1: 1-2 MT; Mod 2: three MRVs
Two-stage solid	?	Single RV?
Two-stage? liquid	?	Three Mods: single warhead, three Mirvs or seven Mirvs

Propulsion	Guidance	Warhead
Lockheed SR75-LP-1 (LPC-415) two-pulse solid	Singer-Kearfott KT-70 inertial with Delco Magic computer plus terrain-avoidance radar altimeter	W-69 200KT thermonuclear
Sustain: Williams Research F107-WR-100 turbofan, 272kg thrust. BGM-109 and GLCM only have Atlantic Research solid rocket boost, 3,200kg thrust, 6-7sec burn	Cruise: inertial (Litton P-1000 platform + Litton LC-4516C computer) with McDonnell Douglas AN/DPW-23 Tercom; attack; SMAC	W-80 200KT thermonuclear, 123kg

Propulsion	Guidance	Warhead
SEP/SNPE Styx solid. Two burn rates: boost 10·5sec burn, 14,000daN impulse; sustain 18sec burn, 7,000daN impulse	Simplified inertial: Sagem platform, Sfena gyro, Aérospatiale computer	Interchangeable 10KT or AN51 25KT nuclear air or surface burst, CEP 150-300m
1: Thiokol XM 105 solid, 12,000kg thrust; 2: Thiokol XM106 solid, 7,000kg thrust	Inertial: Bendix navigation & control	60-400KT nuclear

3 — TACTICAL, BALLISTIC (continued)

Description	Dimensions			Weight (kg)	Range (km)	Control
	Length (m)	Span (cm)	Dia (cm)			
MGM-52C Lance	6·17	198	56	1,530	120 (70 with 454kg warhead)	Fluid injection into single nozzle
SS-1C (Scud B)	11·2	180	85	6,300	Max 280	Vanes in efflux
Frog 7	9·0	200?	60	c. 2,500	60	Unguided, spin-stabilised

4 — AIR-TO-GROUND

Designation	Dimensions			Weight (kg)	Range (km)	Speed	Control
	Length (m)	Span (cm)	Dia (cm)				
Argentina ASM	?	?	?	115	?	?	?
MAS-1 Carcara	1·2	42	12·5	45	?	?	?
AS.30L	3·65	100	34·2	520	10	450-500m/sec at impact	Deflectors in motor efflux
AGM-45 Shrike	3·05	91·4	20	117	16	M2	Cruciform centrebody wings
AGM-62 Walleye I	3·44	114	38·1	500	?	Subsonic	Elevons
Walleye II	4·04	130	45·7	1,061	?	Subsonic	Elevons
AGM-65 Maverick	2·49	72	30	210	22·5	Subsonic boost, subsonic glide	Cruciform rear fins
AGM-78 Standard ARM	4·57	108	34·3	635	25	M2+	Cruciform rear fins
AGM-85A Harm	4·17	113	24·1	367	18·5	M2+	Cruciform centrebody wing/fins
Hellfire	1·62	33	17·7	43	6 (helicopter launch)	Subsonic	Aerodynamic surfaces on cruciform wings
AS-4 Kitchen	11-11·3	c.245	c.50	6,000+	Up to 300	M2+	Aeroplane configuration
AS-5 Kelt	9·4-10	455-495	100	?	Up to 320	M0.9-1·2	Aeroplane configuration
AS-6 Kingfish	?	?	?	c.5,000	220	M3	?
AS-7 Kerry	?	?	?	c.1,200	10	M0.6	?
ASX-9	?	?	?	?	85-100	Subsonic	?
ASX-10	?	?	?	?	10	M0.6-0·8	?
ASX-? (Advanced TASM)	?	?	?	?	40	High subsonic	?

5 — ANTI-SHIP

Designation	Dimensions			Weight (kg)	Range (km)	Speed	Control
	Length (m)	Span (m)	Dia (cm)				
MM.38 Exocet	5·21	100	35	750	Min 4·5, max 42-45	M0.93	Cruciform rear fins
AM.39	4·7	110	35	652	Max 50-70	M0.93	Cruciform rear fins
MM.40	5·8	113·5	35	850	Max 65+	M0.93	Cruciform rear fins
AS.15TT	2·16	53	18·5	96	15+	280m/sec	Cruciform rear fins
Kormoran	4·40	100	34·4	600	Max 30+	M0.9	Cruciform rear fins
Gabriel Mk 1	3·35	138·5	32·5	400	20km+?	M0·7	Cruciform rear fins
Gabriel Mk 2	3·35	138·5	35	500	40km+		
Otomat	4·82	119	46	770	Mk 1: min 6, max 60 (single missile), 80 (salvo), Mk 2: 100+	M0·9	Cruciform rear fins
Sea Killer Mk 2	4·70	99·9	20·6	300	25+	300m/sec	Cruciform centrebody wings
ASM-1	3·95	120	35	610	Max 45	M0·9	Cruciform rear fins
Penguin	3·00	140	28	340	Mk 1: 20 Mk 2: 30	M0·9	Canard fins

Propulsion	Guidance	Warhead
Rocketdyne P8E-9. Boost: 19,300kg thrust; Sustain; 2,040kg thrust max, infinitely throttleable, max 6sec burn. Both sections operate during boost, inner section only during sustain. UDMH/IRFNA storable liquid propellants	Simplified inertial (DC-Automet); Redstone Arsenal/E-Systems/Systron Donner/Ambac AN/DJW-48	10KT, 212kg M234 nuclear or Honeywell 454kg XM251 cluster
Storable liquid UDMH/IRFNA?	Simplified inertial	HE or nuclear
Single-stage solid	Unguided	450kg nuclear or HE

Propulsion	Guidance	Warhead
Solid rocket?	Radio command	40kg
Avibras MFB 20 solid rocket	Television	HE
Two-stage SNPE/Aérospatiale solid. Boost: composite; sustain: cast DB	Thomson-CSF Ariel semi-active laser seeker	240kg interchangeable general-purpose or SAP, instantaneous or delay fuzes
Aerojet Mk 53 Mod 2 or Mk 78 Mod O, or Rocketdyne Mk 39 Mod 7; all single-stage solid	Texas Instruments passive radiation seeker	66kg fragmentation
Unpowered	Radio command/TV	385kg
Unpowered	Radio command/TV	c.900kg
Thiokol TX-481 dual-thrust solid	Automatic television homing or semi-active laser or infra-red	59kg hollow charge or 135kg HE/ fragmentation
Aerojet Mk 27 Mod 4 dual-thrust	Maxson Electronics passive radiation seeker	HE
Thiokol solid	Texas Instruments passive radiation seeker	Modified Shrike fragmentation, Motorola prox fuze
Solid rocket	Rockwell semi-active laser	Firestone hollow charge, approx 9kg.
Liquid rocket	Inertial?	Nuclear
Liquid rocket	Active radar seeker, has also been fitted with passive radiation seeker	HE
?	Cruise: inertial, attack: active radar or passive radiation seeker	Nuclear, 200KT
Solid rocket	Radio command	HE
Solid rocket	Passive radiation seeker	HE
Solid rocket	Electro-optical	HE
Solid rocket	Electro-optical + command link or inertial	HE

Propulsion	Guidance	Warhead
Boost: Servia des Poudres Epervier 2·4sec burn 10,000 daN impulse, free-standing radially burning composite propellant; sustain: Servia des Poudres Eole V, 93sec burn, end burning cast DB propellant, 300daN	Cruise: Inertial + TRT AHV-7 radio altimeter; attack; EMD Adac X-band single-axis active monopulse radar seeker, search begins 12-15km	GP1 blast/fragmentation, 165kg, hexolite in steel block, effective up to 70° incidence, delay + prox fuze
Boost: SNPE Dondor, 2 sec burn; sustain: SNPE Helios 130—150sec burn, Steel motor casings replace light alloy	As MM.38 (some modifications)	As MM.38
Boost as MM.38 (but with steel casing); sustain 200-220sec burn	As MM.38	As MM.38
Solid rocket	Azimuth: command from Thomson-CSF Agrion 15 radar in launch aircraft; height: pre-programmed descent, then radio altimeter	29·7kg, derived from warhead in AS.12
Boost: two SNPE Prades, 1 sec burn, 2,750kg thrust each, extruded DB propellant; sustain; SNPE Eole IV approx 100sec burn, 285kg thrust cast DB propellant	Cruise: Sfena/Bodenseewerk inertial platform/ + modified TRT AHV-7 radio altimeter; attack; modified Thomson-CSF RE576 two-axis active radar seeker	165kg. 16 radially mounted projective charges, 56kg of explosive, delay fuze
Boost: solid; sustain; solid	Cruise: interial + radio altimeter; attack: I-band SAR or optical	150—180kg
Boost: 2 × Hotchkiss-Brandt/SNPE composite solid, 4sec burn, 3,500kg thrust each, jettisoned; sustain: Turboméca TR 281 Arbizon turbojet, 400kg thrust	Cruise: autopilot + radio altimeter; attack: Mk 1— Thomson CSF two-axis active radar seeker (12km from target, +20° search in azimuth); Mk 2 —SMA single-axis active radar seeker	65kg explosive + incendiary material for total of 210kg SAP, + residual fuel gives 250kg. Can penetrate 4cm+ Ni-Cr armour plate
Boost: SEP 299 double-base, 1·7 sec burn, 4,400kg thrust; sustain: SEP 300 composite, 73sec burn, 100kg thrust	Beam rider + command + radio altimeter, optical back-up (Clos in Marte/Mariner)	70kg SAP, impact + prox fuzes
Nissan Motors	Cruise: Japan Aviation Electronics inertial, TRT/ Japan Radio ANV-7 radio altimeter; attack: Mitsubishi Electronics active radar seeker	200kg
Dual-thrust A/S Raufoss Ammunisjons Fabrikker solid	Cruise: Kongsberg Vapenfabrikk inertial; attack: Kongsberg Vapenfabrikk IR	120kg SAP

5 — ANTI-SHIP (continued)

Designation	Dimensions			Weight (kg)	Range (km)	Speed	Control
	Length (m)	Span (cm)	Dia (cm)				
Rb04E	4·45	204	50	600	20+	High subsonic	Ailerons + canard elevator rudder
Rb05A	3·6	80	30	305	9	Supersonic	Cruciform rear fins
RBS 15	4·35	140	50	560 (excluding boosters)	?	High subsonic	Cruciform rear fins
Sea Skua	2·85	62	22·2	147	14	High subsonic	Cruciform canard fins
AGM-84A/RGM-84A Harpoon	4·58 (3·84 for air launch)	91·4	34·3	667 (522 for air launch)	Max 110	M0·85	Cruciform fins
SS-N-2 Styx	6·25-6·5	275	75	2,500-3,000	Up to 42	M0·9	Ailerons + rudder
SSC-1/SS-N-3 Shaddock	c.10	c.210	c.100	c.4,500	up to 850 max 200 optimum	M1·4	Aeroplane configuration
SS-N-7	c.7	?	50·55	c.3,500	55–60	M1·5	?
SS-N-9 Siren	c.9	?	?	c.3,000	110	M0·8	?
SS-N-11	c.6·4	?	?	?	c.50	M0·9	As SS-N-2?
SS-N-12	c.10	c.250	?	c.5,000	c.500	M2·5	Aeroplane configuration

6 — ANTI-SUBMARINE

Designation	Dimensions			Weight (kg)	Range (km)	Speed	Control
	Length (m)	Span (cm)	Dia (cm)				
Ikara	3·43	153	?	?	15-18	Subsonic	Elevons
Malafon	6·15	330	65	1,450	Min 2, max 13	Average 140/m/sec (max 230m/sec)	Aeroplane configuration
RUR-5A Asroc	4·57	76	32	435	Min 2, max 9 (Mk 46) or 9·8 (Mk 44)	c.M1	Unguided
UUM-44A Subroc	6·25	—	53·3	1,850	Max 56	Supersonic	TVC—four jetavator nozzles
SS-N-14	7·8	?	?	?	40	Subsonic	Aeroplane configuration

8 — SURFACE-TO-AIR

Designation	Dimensions			Weight (kg)	Min/Max range (km)	Altitude limits (m)	Speed	Control
	Length (m)	Span (cm)	Dia (cm)					
Crotale	2·93	54	15·6	85·1	0·5/8·5	50/3,600	M2·3	Pitch + yaw, canard fins, roll/rear surface
Sica/Shahine	3·0	54	15	90?	0·5/10	?	M2·5?	As Crotale
Roland	2·40	50	16	63	0·26/6·2	20/3,000	M1·6	Deflector in motor efflux
Indigo-MEI	3·3	81·3	19·5	120	1/10	15/5,000	850m/sec at burnout, M2·5 max	Cruciform centrebody wings
Tansam	2·7	?	16	100	—/10	?	M2·4	Cruciform rear fins
RBS70	1·32	32	10·6	15	—/5	0/3,000	Super-sonic	Cruciform rear fins
Rapier	2·24	38	13	42·5	0·5/7	0/3,000	M2+	Cruciform rear fins
Seawolf	1·9	56	18	82	—/5	?	M2+	Cruciform rear fins
Sea Dart	4·40	91	42	550	—/80+	30/25,000	M2 at boost burnout, M3·5 cruise	Cruciform rear fins
Blowpipe	1·40	27·5	7·6	11	—/3+	—/2,000	M1·5	Cruciform canard fins
Seacat/Tigercat	1·47	65	19	63/68	—/5+	?	M0·9?	Cruciform wings
RIM-7H Sea Sparrow	3·65	102	20	205	1/18	15/5,000	M3·5+	Centrebody wings
MIM-23B Improved Hawk	5·08	120	37	625	—/40	30/18,000	M2·5	Elevons
FIM-43A Redeye	1·22	14	7	8·2	—/3·4	—/2,500	?	Cruciform canard vanes
RIM-66A Standard MR	4·48	108	34·3	612	—/20	—/20,000+	M2+	Cruciform rear fins
RIM-67A Standard ER	8·23	157	34·3	c.1,060	—/55	—/20,000+	M2·5+	Cruciform rear fins
MIM-72A Chaparral	2·91	64	12·7	84	—/3+	?	?	Cruciform canard fins
FIM-92A Stinger	1·52	c.9	c.7	15·1	—/5	—/4,800	?	?
MIM-104A Patriot	5·18	92	41	c.1,000	—/60	—/24,000	M3	Cruciform rear fins
RIM-116A Ram	2·80	?	12·7	70	—/6	?	Supersonic	Cruciform canard fins

Propulsion	Guidance	Warhead
IMI single-stage double base	Cruise: autopilot + radio altimeter; attack active seeker (last 6km) + radio altimeter	Fragmentation, impact & prox fuzes
Volvo Flygmotor VR35 prepackaged liquid—hydyne + red fuming nitric acid	Radio command	Förenade Fabriksverken, prox fuze
Microturbo TR1 60-2 turbojet + two solid boosters	Active radar	Förenade Fabriksverken
Solid	SAR—illumination by Ferranti Seaspray radar	c.35kg
Boost: Aerojet, 6,600kg thrust 2·5sec burn, composite propellant, boosts to M0·75; cruise: Teledyne CAE J402-CA-400 turbojet, 300kg thrust, 15min endurance	Cruise: Lear-Siegler or Northrop strapdown platform IBM 4PiSP-OA computer, Honeywell AN/APN-194 radar altimeter; attack, Texas Instruments PR-53/DSQ-28 two-axis active radar seeker	Naval Weapons Centre 227kg penetration blast, contact (with time delay) + prox fuzes
Boost: solid; cruise: turbojet	Cruise: autopilot or radio command; attack; active radar seeker or IR	360-400kg HE, linear or polygon charge
Boost: two Jato units: cruise: turbojet or ramjet	Cruise: autopilot + midcourse update attack: active radar	Nuclear, KT range; or HE, c.1,000kg
1 solid rocket (some sources say turbofan)	Cruise: autopilot attack: active radar	Nuclear or HE, c.500kg
Liquid (air-breathing?)	Cruise: autopilot + midcourse update; attack: active radar/IR	Nuclear or HE, c.500kg
As SS-N-2?	As SS-N-2?	c.500kg HE
Boost: Jato units Cruise: turbojet or ramjet	As SS-N-3?	Nuclear or HE, c.1,000kg

Propulsion	Guidance	Warhead
Dual-thrust solid	Command + autopilot + altimeter	Acoustic-homing Mk 44 or Mk 46 torpedo
Boost: SNPE Venus composite, 2·8sec burn jettisoned	Command + autopilot + altimeter	Acoustic-homing 525kg L4 torpedo, 100kg + warhead
Boost: Naval Propellant Plant solid	Unguided	Mk 44/46 acoustic-homing torpedo or nuclear depth charge
Thiokol TE-260G, composite propellant	Singer-Kearfott SD-510 inertial	Nuclear depth charge, 5-7km effective radius
Solid	?	Acoustic-homing torpedo

Propulsion	Guidance	Warhead
Single-stage SNPE Lens, 4,850kg thrust, 2·3 sec burn, 2,450daN, extruded double-base propellant	IR autogathering, then beam-rider (monopulse Ku-band radar, 1·1° beam) with X-band command; TV back-up for low levels	15kg focalised fragmentation (2,300m/sec fragments lethal up to 8m), IR prox fuze
Improved version of Crotale motor?	As Crotale	As Crotale
Boost: SNPE Roubaix, 1·7sec burn, extruded DB propellant, 1,600kg thrust; sustain: SNPE Lampyre, 13·2sec burn, cast DB propellant, 200kg thrust	IR autogathering, then SACLOS—optical (Roland 1) or radar (Roland II)	6·5kg, contains 65 projectile charges lethal up to 6m; TRT radio-electric prox fuze
IMI single-stage solid, 3,750kg thrust, 2·5sec burn	Radar or optical CLOS	21kg axisymmetrical fragmentation, impact + IR prox fuzes
Nissan Motor solid rocket	Toshiba IR	HE
Boost: Bofors solid, jettisoned; sustain: IMI solid	Laser beam-rider	1kg prefragmented; Bofors laser prox+ impact fuzes
IMI Troy dual-thrust solid	SACLOS—optical or with MSDS DN181 Blindfire radar	0·5kg semi-armour piercing, impact fuze only
Bristol Aerojet/RPE Blackcap solid, 2-3sec burn	SACLOS—TV + target-tracking radar	13·4kg impact + EMI prox fuze
Boost: IMI, 16,000kg thrust, 2·5sec burn, composite modified DB propellant; sustain: R-R Odin ramjet with variable thrust	SAR	Fragmentation with externally grooved casing; EMI prox fuze
Boost: extruded DB propellant, 0·2sec burn; sustain: Crake, extruded DB propellant	IR autogathering, then CLOS	2·2kg dual-purpose (blast + shaped charge), impact + MSDS capacitance fuzes
IMI dual-thrust solid	CLOS (TV autogathering in GWS-24)	Blast, EMI prox fuze
Single-stage Aerojet Mk 53 Mod 2, 2·9sec burn	CWSAR	30kg continuous-rod, impact + prox fuzes
Aerojet XM112 dual-thrust	Raytheon CWSAR	54kg +
Atlantic Research M115 dual-thrust	IR homing	Fragmentation with smooth fragmentation casing
Aerojet/Hercules Mk 56 Mod 0 dual-thrust	SAR	Impact + prox fuzes
Boost: Atlantic Research Mk 30 Mod 2; sustain: Naval Propellant Plant Mk 12 Mod 1	SAR (mid-course command in RIM-66C)	Impact + prox fuzes
Rocketdyne Mk 36 single-stage solid	GE Aerospace Electronic Systems Dept IR homing	5kg continuous-rod
Atlantic Research dual-thrust	GD (Pomona) IR homing, proportional nav	3kg Picatinny Arsenal fragmentation with smooth fragmentation casing, Motorola prox fuze
Thiokol TX-486 single-stage solid	Raytheon track-via-missile (SAR + command)	HE
As Sidewinder	Interferometry, than IR (Stinger seeker)	As Sidewinder

8 — SURFACE-TO-AIR (continued)

Designation	Dimensions			Weight (kg)	Min/Max range (lcm)	Altitude limits (m)	Speed	Control
	Length (m)	Span (cm)	Dia (cm)					
SA-2/SA-N-2 Guideline	10·7	missile: 170 booster: 220	missile: 50 booster: 70	2,300	—/40-50	up to 28,000	M3·5	Cruciform rear fins
SA-3/SA-N-1 Goa	6·7	missile: 122 booster: 150	missile: 46 booster: 70	600	—/30-35	100-300/ 10,000-15,000	M2	Cruciform fins
SA-4 Ganef	9·0	260	80	1,000	—/c.70	25,000	M2·5	Cruciform canard wings
SA-5 Gammon	16·5	396	missile: 80 booster: 100	c.9,000	80/250	c.30,000	M3·5+	?
SA-6 Gainful	6·2	152	33·5	550	—/35	100/13,000	M2·8-3	Cruciform centrebody wings
SA-7 Grail	1·35	?	7	9·2	—/3·6	45/1,500	M1·5	Cruciform canard fins
SA-8 Gecko	3·2	64	21	180-200	—/12	50/6,000	M1·5?	Cruciform canard fins
SA-9 Gaskin	1·8	30	11	30?	—/6	—/5,000	M1·5+?	Cruciform canard fins
SA-10	c.7	?	c.45	c.1,500	—/50	300/5,000	M5·6	?

9 — AIR-TO-AIR

Designation	Dimensions			Weight (kg)	Range (km)	Speed	Control
	Length (m)	Span (cm)	Dia (cm)				
Super 530	3·5	64	26	250	35	M4·5	Cruciform rear fins
R.550 Magic	2·75	66	15·7	90	Min 0·3, max 10+	M2+ (high alt)	Cruciform canard fins
Shafrir	2·5	52	16	93	5	?	Cruciform canard fins
Aspide	3·7	100 (80 as SAM)	20·3	220	50-100	M4	Cruciform centrebody wings
AAM-1	2·5	c.50	15	76	5	?	Cruciform canard fins
Sky Flash	3·7	102	20·3	192·8	Up to 50	M4	Cruciform centrebody wings
AIM-7E Sparrow	3·7	100	20	205	25-50	M4	Cruciform centrebody wings
AIM-7F Sparrow	3·7	100	20	228	Min <0·6, max 50-100	M4	Cruciform centrebody wings
AIM-9H Sidewinder	2·9	63	12	84·5	10-18	M2·5	Cruciform canard fins
AIM-9J Sidewinder	3·1	56	12	78			
AIM-9L Sidewinder	2·85	63	12	84·5			
AIM-54 Phoenix	4·0	91·5	38	443	200+	M5+	Cruciform rear fins
AA-2 Atoll	2·8	53	12	70	5·7	M2·5	Cruciform canard fins
AA-3 Anab	3·6—4·0	c.130	c.28	c.275	16+	?	Cruciform canard fins
AA-5 Ash	c.5·5 (IR) c.5·2 (SAR)	c.130	c.30	c.200	30	?	Cruciform rear fins
AA-6 Acrid	6·3 (SAR), 5·9 (IR)	225	40	700-800 650-750	45-50 (SAR), 20-25 (IR)	M4·5	Ailerons + canard fins?
AA-7 Apex	4·5 (SAR), 4·2 (IR)	140	26	320	33 (SAR), 15 (IR)	M3·5	Rear fins
AA-8 Aphid	2·2 (SAR), 2·0 (IR)	52	13	55	15 (SAR), 7 (IR)	M3	Canard fins?

10 — ANTI-TANK

Designation	Dimensions			Weight (kg)	Min/max range (m)	Speed	Time to max range (sec)	Control
	Length (cm)	Span (cm)	Dia (cm)					
Hot	127	31	14·3	23	75/4,000	240m/sec	17	Deflector in sustainer efflux
Milan	75	26·5	11·6	6·7	25/2,000	Max 200m/sec	12·5	Deflector in sustainer efflux
Sparviero	138	?	13	16·5	75/3,000	Max 140m/sec	10	?
KAM-9	156·5	33	15·2	?	—/4,000	200m/sec	20	Folding cruciform fins
Swingfire	107	39	17	28	150/4,000	185m/sec	26	TVC (jetavator)
BGM-71 Tow	118	34	14·7	18	65/3,750	312m/sec	c.15 to 3,000m	Cruciform rudders
M-47 Dragon	74·5	33	12·7	6·17	60/1,000	100m/sec at max range	11	60 small side thrusters, each pair produces 120kg thrust, burns 700msec
AT-2 Swatter	112	66	15	26·5	600/2,500	150m/sec	?	Elevons + canards?
AT-3 Sagger	87	46	12	11	500/3,000	120m/sec	25	Jetavator nozzles

Propulsion	Guidance	Warhead
Boost: solid, c.5sec burn; sustain; nitric acid/ hydrocarbons liquid, c.22sec burn	Radio command	130kg fragmentation with internally grooved casing. Nuclear can be fitted
Boost: solid, sustain: solid	Radio command	60kg HE
Boost: 4 × solid, sustain: ramjet	Radio command	HE
Boost: solid; sustain: solid	SAR	HE/nuclear
Integral rocket/ramjet (solid)	Radio command + CWSAR homing	80kg
Solid boost + sustain	IR homing	2·5kg fragmentation with smooth fragmentation casing + contact & graze fuzes
Dual-thrust solid	Command (+ IR terminal homing?)	40-50kg HE + prox fuze
Solid boost + sustain	IR homing	HE
Single-stage solid	SAR (+ active radar terminal homing?)	HE?

Propulsion	Guidance	Warhead
Thomson-Brandt/SNPE Angele, composite propellant, dual-thrust; 2sec boost burn, 3,800daN impulse; 4sec sustain burn, 2,500daN impulse	EMD Super AD26 SAR	Thomson-Brandt fragmentation, 30kg +, Thomson-CSF prox fuze
Single-stage SNPE Roméo, composite propellant, 1·9sec burn, 2,650daN impulse	SAT AD3601 IR (dogfight)	12·5kg total, 6kg explosive, impact + IR prox fuzes
Double-base	IR (lead-collision)	11kg (4kg explosive); impact + prox fuzes
Single-stage solid	Selenia I-band monopulse SAR	35kg fragmentation
Solid	IR	HE
As AIM-7E	Marconi CW SAR	30kg continuous-rod + EMI prox fuze
Rocketdyne Mk 38 Mod 4 single-level, 2·8 sec burn; or Aerojet Mk 52 Mod 2	Raytheon CW SAR (dogfight-capable)	30kg continuous-rod, prox + impact fuzes
Hercules Mk 58 Mod 0 two-level or Aerojet Mk 65 Mod 0	Raytheon CW SAR (dogfight-capable), provision for PD	40kg continuous-rod, prox+impact fuzes
Rocketdyne Mk 36	IR	Continuous-rod, IR or radio prox fuze
Thiokol Mk 17	IR	Fragmentation, IR or radio prox fuze
Rocketdyne Mk 36	IR	Blast-fragmentation, active optical fuze
Rocketdyne Mk 47 Mod 0	AN/DSO-26. Cruise: PD SAR; attack: PD active radar homing (last 20km)	60kg, prox + impact fuzes
Solid	IR	6kg fragmentation with smooth casing
Solid	IR or I/J band SAR	HE
Solid	IR or I/J band SAR	HE
Solid	SAR or IR	60-100kg; probably HE
Solid	SAR or IR	40kg HE
Solid	IR	6kg HE

Propulsion	Guidance	Warhead
Boost: SNPE Bugeat, extruded DB, 0·9sec burn; sustain: SNPE Infra, cast DB, 17·4sec burn, 24kg thrust	SACLOS: 6° aperture from autogathering, 1° for tracking	6kg (3kg explosive). Hollow charge, can penetrate 80cm + of solid armour struck at 0° incidence, 28cm at 65°
Accelerated to 75m/sec by gas generator in launch tube; 0·01 sec burn, 5,000kg thrust; laminated discs of double-base propellant. Boost: SNPE Artus, 1·5sec burn, accelerates to 130m/sec; sustain: Artus, 11sec burn, accelerates to 200m/sec. Both end-burning cast DB	SACLOS	3kg (1·45kg explosive). Average 35·2cm penetration of standard Nato target at 65° incidence. Fuze operates at up to 80°
Snia Viscosa solid launch, boost & sustainer	Infra-red beam-riding	4kg hollow charge
Boost: solid; sustain: Nihon Yushi solid	SACLOS	1·9kg hollow charge, can penetrate 50cm + of armour at angles of incidence up to 80°, or alternative warhead for anti-ship use
IMI single-chamber boost (6sec burn) + sustain	CLOS: autopilot + velocity control + autogathering	7kg hollow charge
Boost: Hercules K41; 0·05sec burn; sustain: solid 1·5sec burn	SACLOS: 6° aperture for autogathering, 1·5° for smoothing, 0·25° for tracking	3·6kg hollow charge (2·4kg explosive)
Boost: solid charge in launch tube; sustain; side-thrusters	SACLOS	M225 Linear hollow charge, 2·44kg; can penetrate 60cm of armour
Single-stage solid?	CLOS + IR homing	Weight not known; can penetrate 50cm of armour
Solid booster & sustainer	CLOS	2·7kg; can penetrate more than 40cm of armour