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LAC/513761

F-104A
WEAPON SYSTEM

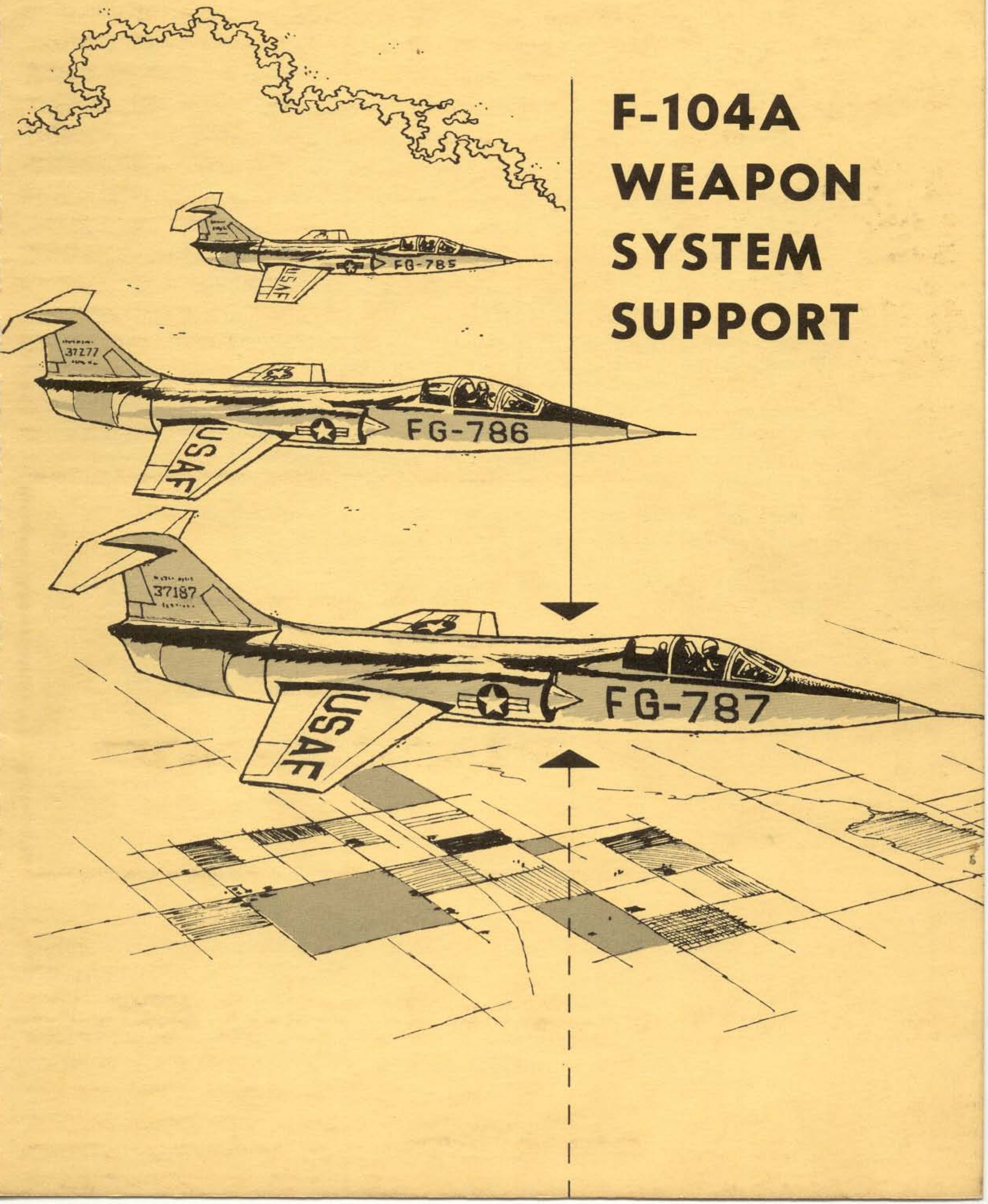
F-104A

LOCKHEED STARFIGHTER

LOCKHEED AIRCRAFT CORPORATION / CALIFORNIA DIVISION

CONFIDENTIAL

F-104A WEAPON SYSTEM SUPPORT



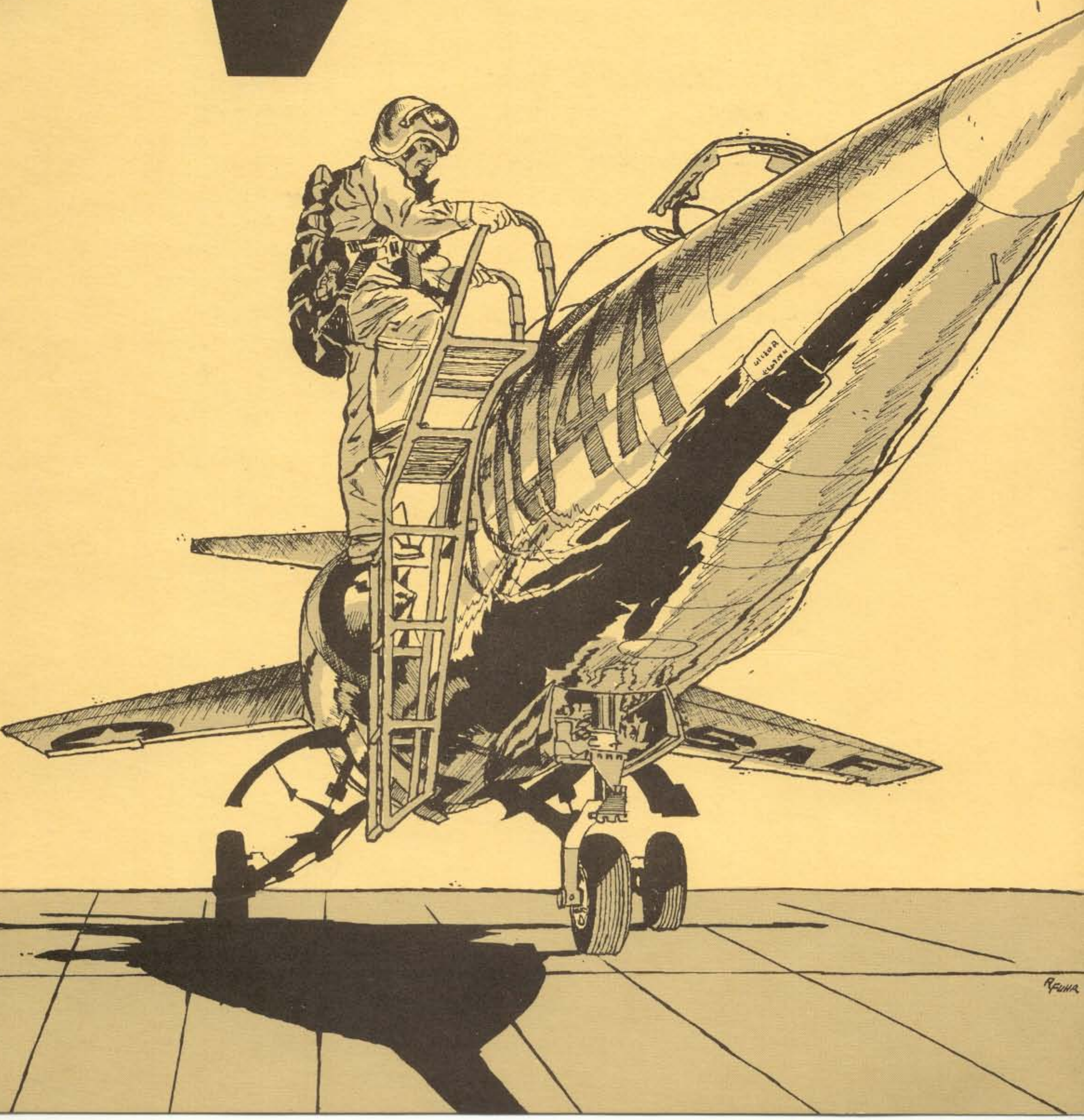
FOREWORD

The "F-104A Weapon System" is prepared to provide useful information to persons directly concerned with placing the F-104A Weapon System into active use. This publication gives general information on mission and related performance, function and operation of systems and sub-systems, support requirements for the weapon system in personnel, training, maintenance, equipment, supply and data. It has been prepared exclusively for use by the Air Defense Command.

Information presented herein has been gathered from sources within both the Air Force and Industry, and every effort has been made to incorporate the latest changes. In the event that a discrepancy is noted between this document and AF or ADC directives, the military documents will, of course, apply.

The information found in this book is accurate as of 15 April, 1957. No attempt will be made to keep it current.

OPERATIONS



CONTENTS

ILLUSTRATIONS

OPERATIONS

For the purpose of this document "Operations" is considered the participation of the F-104A Weapon System in defense of the United States' interests against enemy attack. The extent of participation is broadly defined under discussions of mission concept and planning, appearing on the following pages. A further breakdown of operations is presented in the form of mission elements, or task conditions. This latter discussion treats specific applications of the F-104A Weapon System and introduces phases of logistics as they relate to operational planning.

MISSION

The mission of the F-104A fighter interceptor aircraft operating in the Air Defense environment is to intercept and destroy the enemy threat within its level of capability under clear air mass conditions. The primary mode of employment will be from a ground alert status under control of the ground environment. Combat air patrol tactics may be used as required.

Under the concept of a short but intensive air war at the outbreak of hostilities, maximum readiness must be obtained at the earliest date possible after delivery of the prime weapon to the tactical organization. The Air Defense Command to which the F-104A weapon is assigned must receive full support or the weapon will fall short of optimum performance under its design characteristics.

The basic concepts under which the early stages of an air war will be executed are:

1. There will be no formal declaration of war; therefore, no period of warning or preparedness.
2. Detection and interception must be made against a "sneak" attack.
3. The attack may be one of two types:
   a. An intense initial attack involving hundreds of bombers or missiles, followed by sustained nuisance raids of limited numbers of bombers or missiles.
   b. An initial attack of a limited number of bombers or missiles directed against many targets over a wide area and sustained over a long period.

There will be no formal declaration of war or period of warning; Defense Commands must be ready to launch a mission on short notice at any time, twenty-four hours a day, seven days a week.

Radar warning nets must be maintained constantly to provide the maximum detection coverage to gain optimum time for intercept attack, thus precluding any successful enemy sneak attack.

To ensure maximum utilization of the F-104A Weapon System, the squadron will be capable of reservicing each aircraft within 15 minutes of engine shutoff whether the squadron returns "en masse" or singly. "En masse" is interpreted to mean a maximum of 18 aircraft with a minimum landing interval of 30 seconds per aircraft. Therefore, squadron reservice time is 15 minutes plus 9 minutes or a total of 24 minutes. Reservice time is computed from engine shutoff in the reservice area to readiness of the aircraft for scramble notification. Turn-around shelters will be required to meet alert and reservicing requirements under all weather conditions.

Squadrons are expected to operate on alert status as directed by the Continental Air Defense Command, CONAD Forces, CONAD Region, or Continental Air Defense Division (CONAD Division). Air Defense Squadrons have a capability of flying 40 hours per month per assigned aircraft and operate on a 24-hour, 7-day week basis.

Wide deployment of the F-104A Weapon System will be required to combat aircraft or missiles launched against many targets in an extended area. The plan for combating a large initial attack may also be applied to attack by limited numbers of aircraft or missiles.

ADC Manual 55-5 will be used as a guide to develop tactics and techniques of employing the F-104A. At present, full tactical capabilities of GAR armaments are unknown. As information becomes available, it will be incorporated into tactical doctrine. The F-104A, in general, will be employed within the Air Defense environment to fully utilize its fundamental design concept of a day fighter aircraft. While primarily, a day fighter, the F-104A is equipped with a search ranging radar and an infrared detector capable of sighting and attacking enemy aircraft at night and during periods of reduced visibility.

Scrambles will be made to fulfill the alert requirements. Aircraft may take-off singly, in pairs, or as directed; as determined by runways and other available facilities.

Climbs will be made under direction of the ground environment under manual or data link control information. Climbs will normally be made using optimum power and climb performance. Maximum power and acceleration during climb may be required for interceptors and may be implemented at the discretion of the pilot or GCI director.

Cruise out at optimum altitude and power will be used under normal conditions. However, maximum power cruise-out will be used as required, at the discretion of the pilot or GCI director.

The ground environment will position the F-104A within the detection range of the ASG-14 fire control system. Acceleration to combat speed will be performed prior to positioning, or as prescribed by the GCI director, or at pilot discretion.

When the target has been detected, the pilot will initiate an attack using pursuit or lead pursuit tactics. He will maneuver as required to within visual range of the target.

Return to base will be made using optimum cruise power settings and altitudes. Where applicable, return to base will be as directed by the GCI director.

Standard letdown procedures and/or GCI directions will apply for letdown procedures. Under marginal or minimum weather conditions at base, recovery will be made using ILS, GCA and/or TVOR.

Since the Air Defense System bears the entire weight of initial air battles, certain equipment and personnel requirements must be met well in advance to support the weapon system at the time of imminent attack. Furthermore, each squadron must be sufficiently equipped and manned to operate independently in the event that logistics support from depots temporarily cannot be maintained. Support equipment must be of sufficient quality and quantity and maintained by adequate numbers of trained personnel, or the prime weapon will become useless after the first or second mission.

Sufficient equipment and adequately trained personnel must be procured and assigned to the squadrons and bases to enable the squadron to maintain a high operationally ready rate and to mount a mission of 18 aircraft on short notice.

Air Defense plans and supporting Civil Air Regulations assume that during advance warning conditions (red, yellow, etc.) all aircraft in the Air Defense Zone will be under the control of the Air Defense Commander. Accordingly, no civil aircraft operations will be permitted to interfere with accomplishment of the Air Defense mission. Under these situations, alert aircraft will have priority and may take such positions as may be most advantageous for quickest take-off under a scramble order.

As additional concepts of operation become available, the plans set forth herein will be revised and the detailed discussion within the book will be realigned with concept changes.

TASK CONDITIONS

The general task is to intercept, identify, and destroy hostile aircraft or missiles at any altitude and in the shortest possible time after detection. There are many types and classes of aircraft, other than bombers, that must be intercepted and destroyed. These aircraft may be on reconnaissance, photo, ECM, or diversionary missions. There may be small bombers or missiles, comparable in size and speeds of fighter aircraft, launched from large long range bombers or from various fixed or mobile surface bases. In addition, two specific tasks — ferry and training — are essential parts of F-104A Weapon System Operations.

Interception

The high altitude task requires a capability to become airborne and climb quickly to altitudes equal to or above the operational capabilities of the bombers or missiles of the enemy, and to promptly destroy the intercepted target.

The low altitude task requires a capability to intercept hostile aircraft or missiles flying at very high speeds below 10,000 ft. The detection of aircraft or missiles by ground search radar is limited at low altitudes; therefore, the time for intercept from the instant of detection is materially reduced. Furthermore, ground return on the interceptor airborne radar limits its range and the effectiveness of the air-to-air missile.

The long range task requires a capability to intercept hostile aircraft as soon as possible after detection. With the expanding early warning net-work, the distance of the first detection will be greatly increased and aircraft must be equipped with a maximum of additional fuel in expendable tanks. In addition, control of interception may be passed from one Air Defense Direction Center to another, or to a controller at an early warning site, requiring the interceptors to recover at a forward or alternate base. Recovery away from the home base poses certain servicing requirements exclusive of rearming, such as:

a. Spare drag chutes or packing capabilities

b. Ladder — cockpit entrance

c. Appropriate starting equipment

d. Liquid and high pressure oxygen equipment

e. Expendable fuel tanks available and assembled

f. Oil, hydraulic and liquid spring reservicing equipment.

Ferry

The ferry task is to safely and quickly deliver complete aircraft and their inventory equipment (780) to using activities at their operating locations, or between changed locations. For the present, these locations are limited to the North American Continent, for this weapon system. Range must be such as to insure traverse of the greatest distance between bases normally equipped to handle the aircraft, and still arrive with an adequate reserve of fuel. This usually implies best cruise operation throughout the ferry flight. Flights may be made via airways but will be under ATC control. Aircraft must be equipped accordingly.

Training

The task of Air Defense Command is the day-to-day training in the operational task. The training task is differentiated from the operational task in that schedules and procedures are established which will yield controlled operations and measurable results with adequate safety. The same personnel, equipment, plans, etc., will be used as in the operational task. Minimum training requirements are set forth in ADC Regulations.

The task of Air Training Command is to provide flight and supporting ground personnel to operating activities at a level of skill sufficient to permit their immediate integration into the Air Defense activity, given only added skills in local doctrines, techniques, and conditions. Thus, aircraft utilized in the training task will usually have a higher utilization, higher attrition, and higher maintenance rate than aircraft assigned to operating activities. The requirement, methods, techniques, and schedules in support of these operations for the training tasks will be different from those for operational tasks.

CONVERSION

To provide a time-reference point from which various actions take place "D" Day is utilized and represents the date of receipt of the first F-104A aircraft. Current squadron UE authorization is 21 F-104A and 4 F-104B aircraft; however, F-104B's will not be available until after conversions take place.

Aircraft

Phase-out of old UE aircraft will begin on D minus 45 (D-45) with a gradual reduction to 6 old UE aircraft by D-15. Alert commitments will be met with 6 old UE aircraft during the period of D-45 to "D" Day. Disposition instructions for old UE aircraft will be provided by the ADC Aircraft Distribution Office. On "D" Day the 6 old UE aircraft will be transferred from the squadron. Five (5) F-104A aircraft will be provided by assignment directive issued by ADO at Headquarters ADC to arrive at the squadron for the period of "D" Day to D+30.

Flight Training

On "D" Day, the flying portion of the conversion training will begin with the arrival of 5 F-104A aircraft. The minimum training requirements for qualification in the F-104A will be published as Appendix 5 to ADC Regulation 51-2.

Instructor Pilots

Instructor pilots will be trained in Phase VI and VII and by Lockheed Aircraft Corporation.

Crew Training in Old UE

A reduction in UPD crew training on old UE aircraft is authorized beginning D-90. Many of the pilots and maintenance personnel will be involved in schools which will preclude generating or accomplishing sufficent flying time on old UE aircraft. A goal of 10 hours per month per pilot can be undertaken by the squadron during the period D-90 to "D" Day on old UE aircraft and augmented by T-33 aircraft.

Alert Commitments

Fighter Interceptor Squadrons converting to the F-104A will be relieved of alert commitments on "D" Day until D+105. Necessary action will be taken by the Squadron Commander to develop plans for utilization of those qualified crews and aircraft at D+60 to stand alert in the case of an Air Defense emergency. During the 105 day stand-down period, the maximum effort must be applied to train alert qualified crews. Headquarters ADC, Current Operations, will schedule squadrons converted to F-104A aircraft to weapons employment centers as soon as possible after D+105.

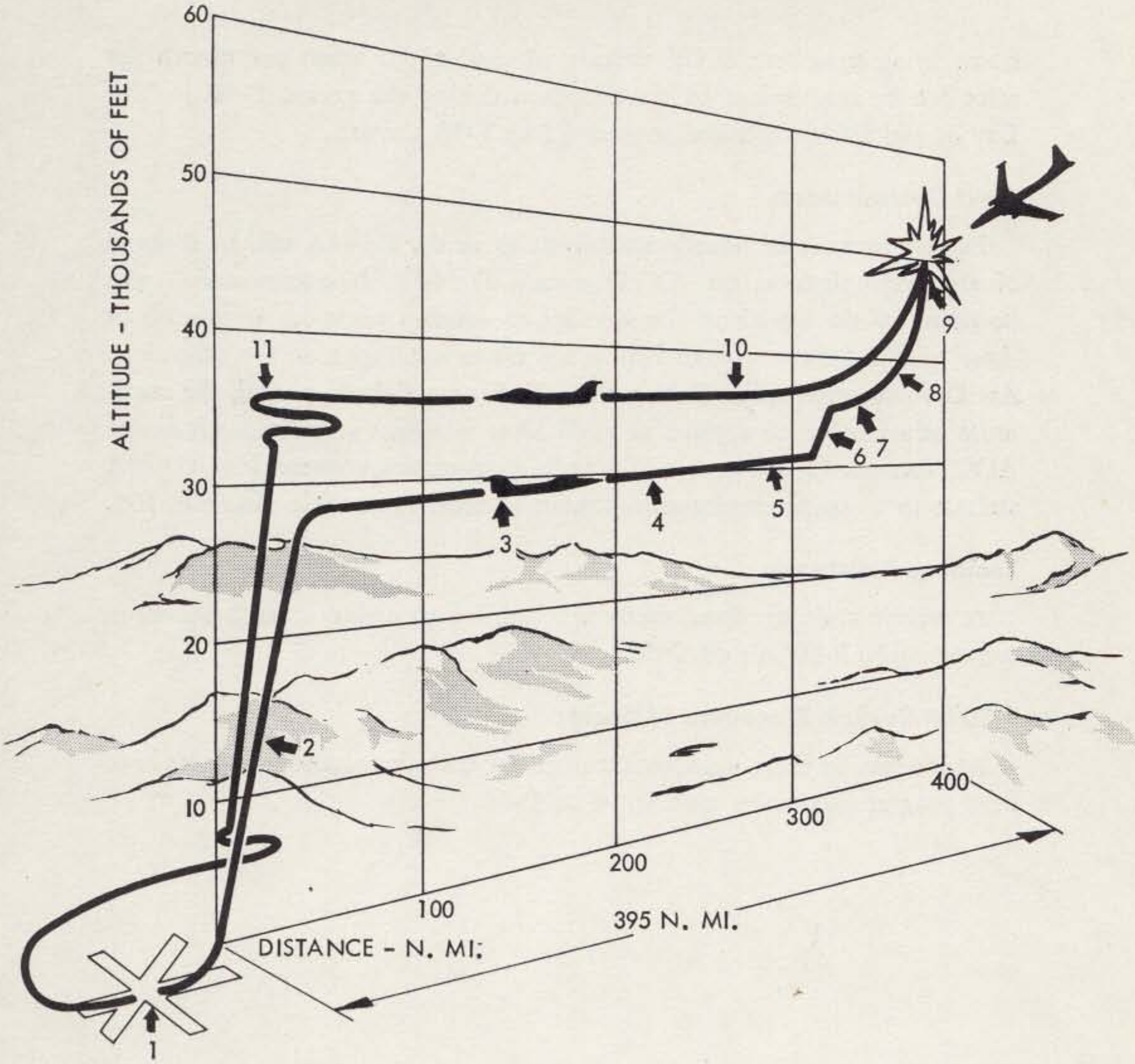
Training Assistance

A mobile training detachment is scheduled to arrive at each squadron converting to F-104A's on D-60.

F-104A Cockpit Procedure Trainers

At the base of those squadrons converting, cockpit procedure trainers have been programmed to be operational on D-60.

AREA INTERCEPT MISSION



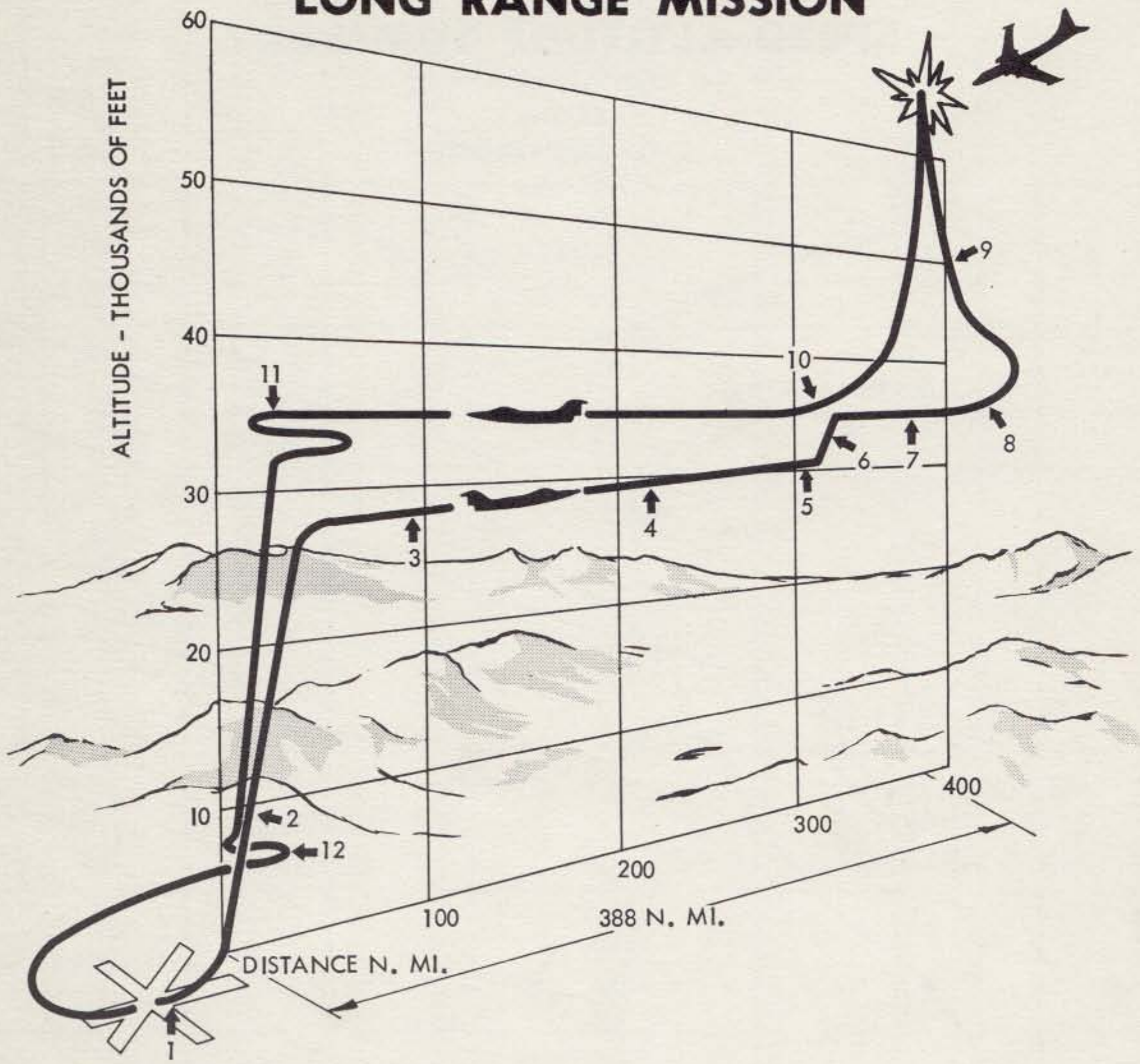
AREA INTERCEPT MISSION

INITIAL FUEL: 908 GALS. INTERNAL PLUS 400 GALS. PYLON TANKS
INITIAL WEIGHT - 22459 LBS.

1	START ENGINE, WARM-UP, TAXI, TAKE-OFF, ACCELERATE TO CLIMB SPEED	
2	CLIMB - MIL POWER, M=0.825, TO 27,300 FT.	(41 MILES)
3	CRUISE - M= 0.858	(173 MILES)
4	DROP PYLON TANKS	
5	CRUISE - M=0.892 (END CRUISE @ 31,300')	(105 MILES)
6	CLIMB - MIL POWER, TO 35,000	(10 MILES)
7	ACCELERATE - MAX. POWER, TO M=1.7	(37 MILES)
8	CLIMB - MAX. POWER, TO 50,000 FT.	(29 MILES)
9	COMBAT - MAX. POWER, 5 MIN. (FIRE MISSILES)	0
10	CRUISE - M=0.897, h 34,200 TO 36,500 FT.	(395 MILES)
11	RESERVES - 15 MINUTES LOITER @ 35,000' 10 MINUTES LOITER @ S.L.	

Figure 1-1

LONG RANGE MISSION



LONG RANGE MISSION (ADC)

INITIAL FUEL: 908 GALS. INTERNAL PLUS 400 GALS. PYLON TANKS
INITIAL WEIGHT - 22,459 LBS.

1	START ENGINE, WARM UP, TAXI, TAKE-OFF, ACCEL. TO CLIMB SPEED	
2	CLIMB - MIL. POWER, M = 0.825, TO 27,300 FT.	(41 MILES)
3	CRUISE - M = .858	(173 MILES)
4	DROP PYLON TANKS	
5	CRUISE - M = .892 (END CRUISE AT 31,400 FT.)	(137 MILES)
6	CLIMB - MIL. POWER TO 35,000 FT.	(10 MILES)
7	ACCELERATE - MAX. POWER., TO M = 1.9	(53 MILES)
8	TURN (180) & CLIMB - MAX. POWER, M = 1.9, 1.5g, TO 42,700	(± 15 MILES)
9	ZOOM - MAX. POWER, TO 65,000 FT., M = 1.18 (FIRE MISSILES AND AMMUNITION)	(-26 MILES)
10	CRUISE - M = 0.897, h 35,200 TO 37,300 FT.	(-388 MILES)
11	RESERVES - 15 MINUTES LOITER @ 35,000 FT. 10 MINUTES LOITER @ S.L.	

Figure 1-2

SPEED-ALTITUDE SUMMARY

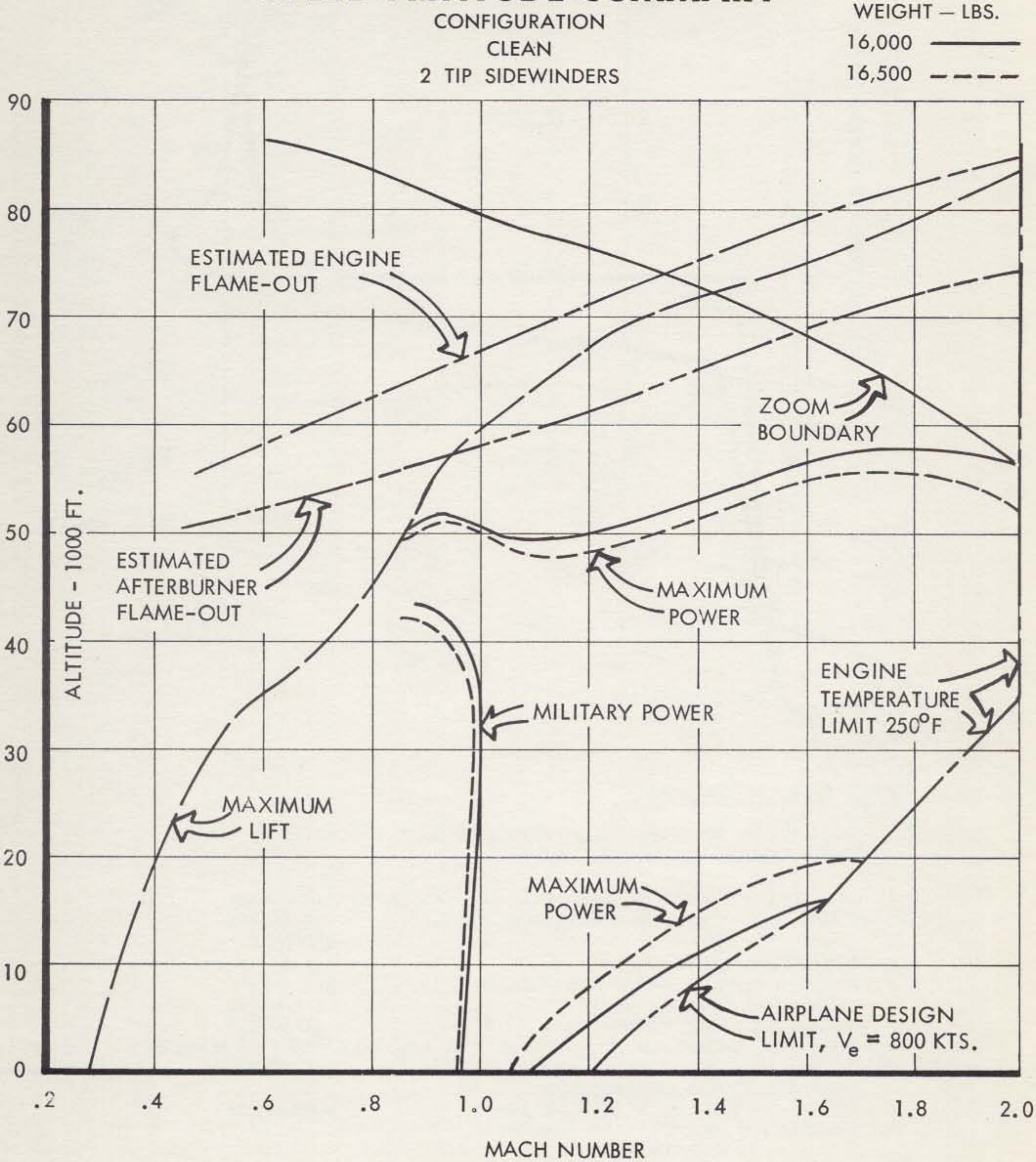
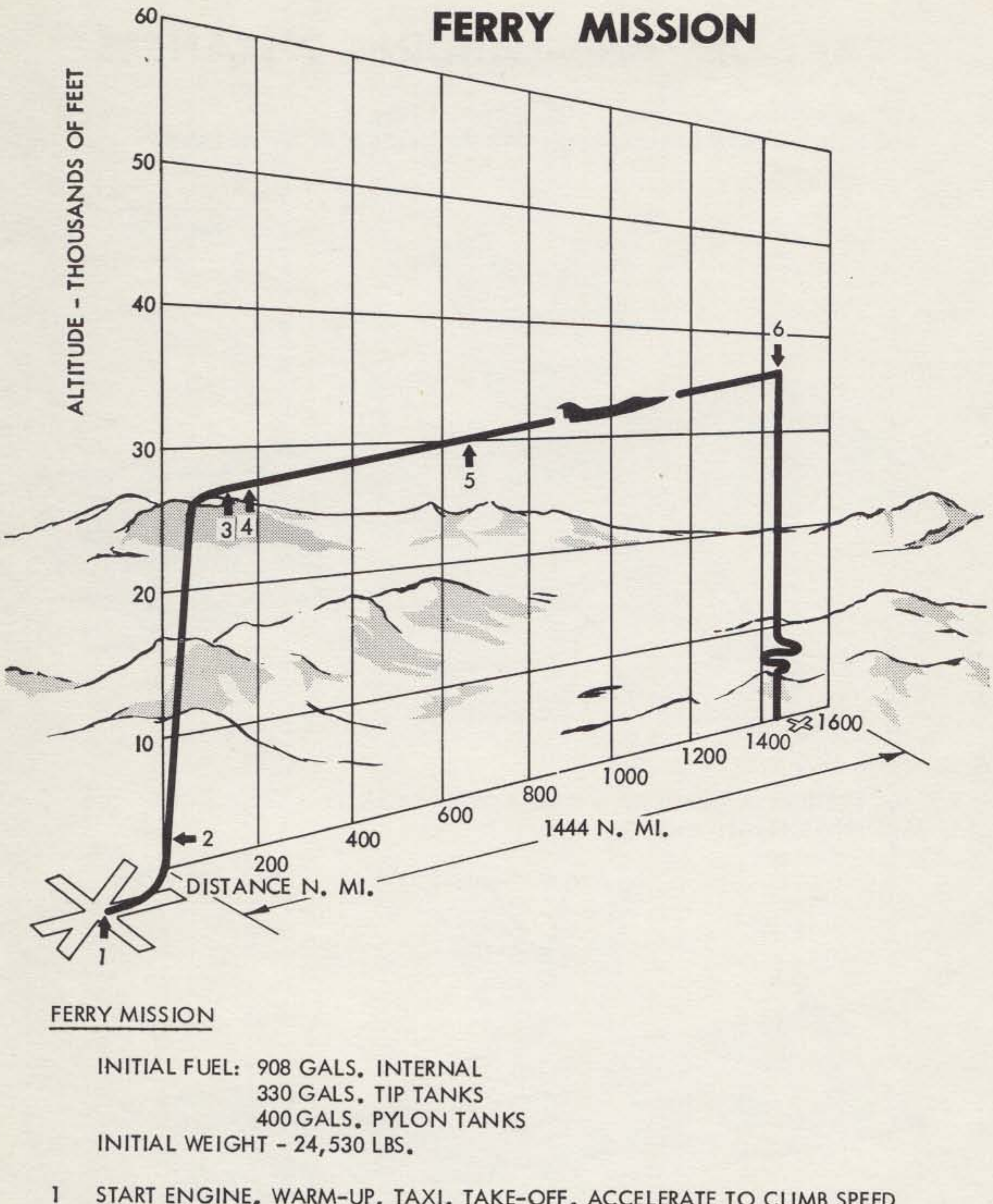


Figure 1-3



FERRY MISSION

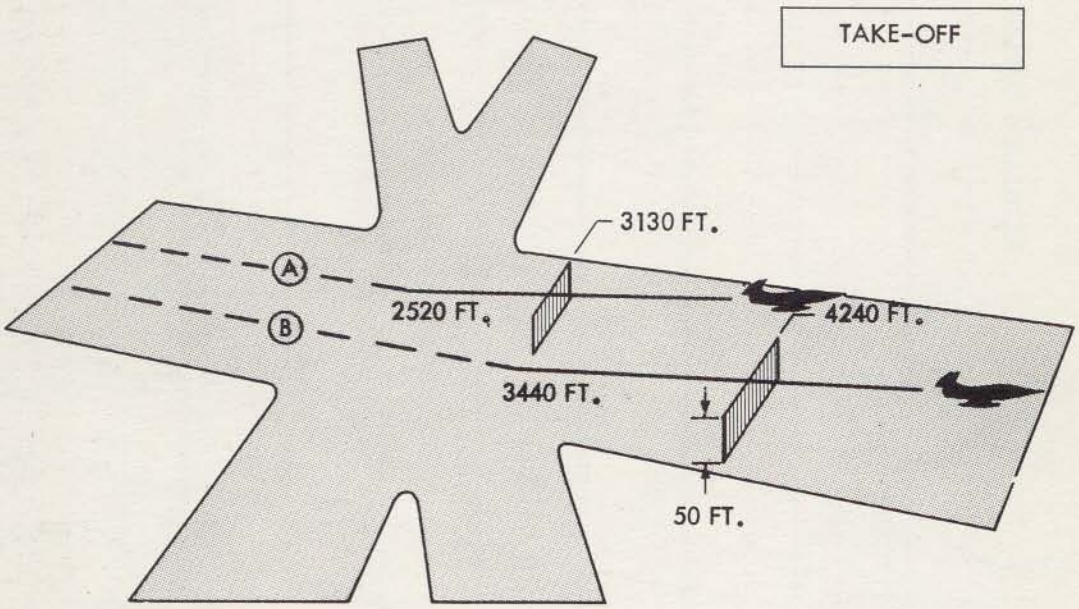
INITIAL FUEL: 908 GALS. INTERNAL
330 GALS. TIP TANKS
400 GALS. PYLON TANKS
INITIAL WEIGHT - 24,530 LBS.

1 START ENGINE, WARM-UP, TAXI, TAKE-OFF, ACCELERATE TO CLIMB SPEED
2 CLIMB - MIL POWER, M= 0.825, TO 25900 (44 MILES)
3 CRUISE - M = 0.874 (99 MILES)
4 DROP PYLON TANKS (h 26,600')
5 CRUISE - M=0.892 (END CRUISE @ 35,100') (1301 MILES)
6 RESERVES: 20 MINUTES LOITER @ S.L.
5% OF INITIAL FUEL (82 GALS.)

Figure 1-4

TAKE-OFF AND LANDING DISTANCES

A. ADC MISSION TAKE-OFF WT. - FULL INTERNAL FUEL
B. ADC MISSION TAKE-OFF WT. - FULL INTERNAL FUEL AND PYLON TANKS



A. ADC MISSION LANDING WT. - OVER A 50 FT. OBSTACLE
B. ADC MISSION LANDING WT.

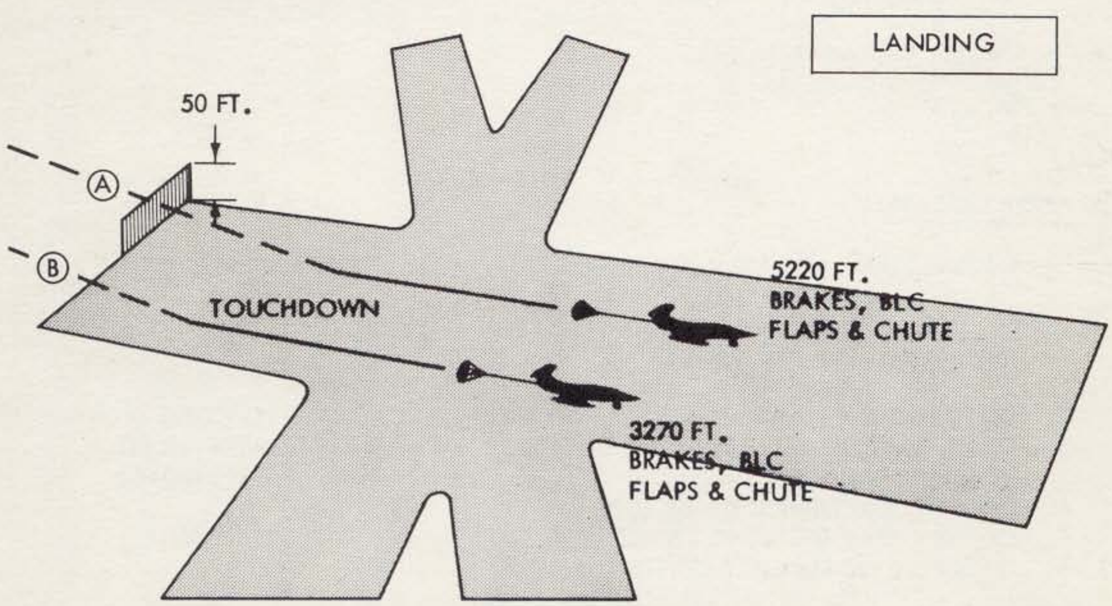
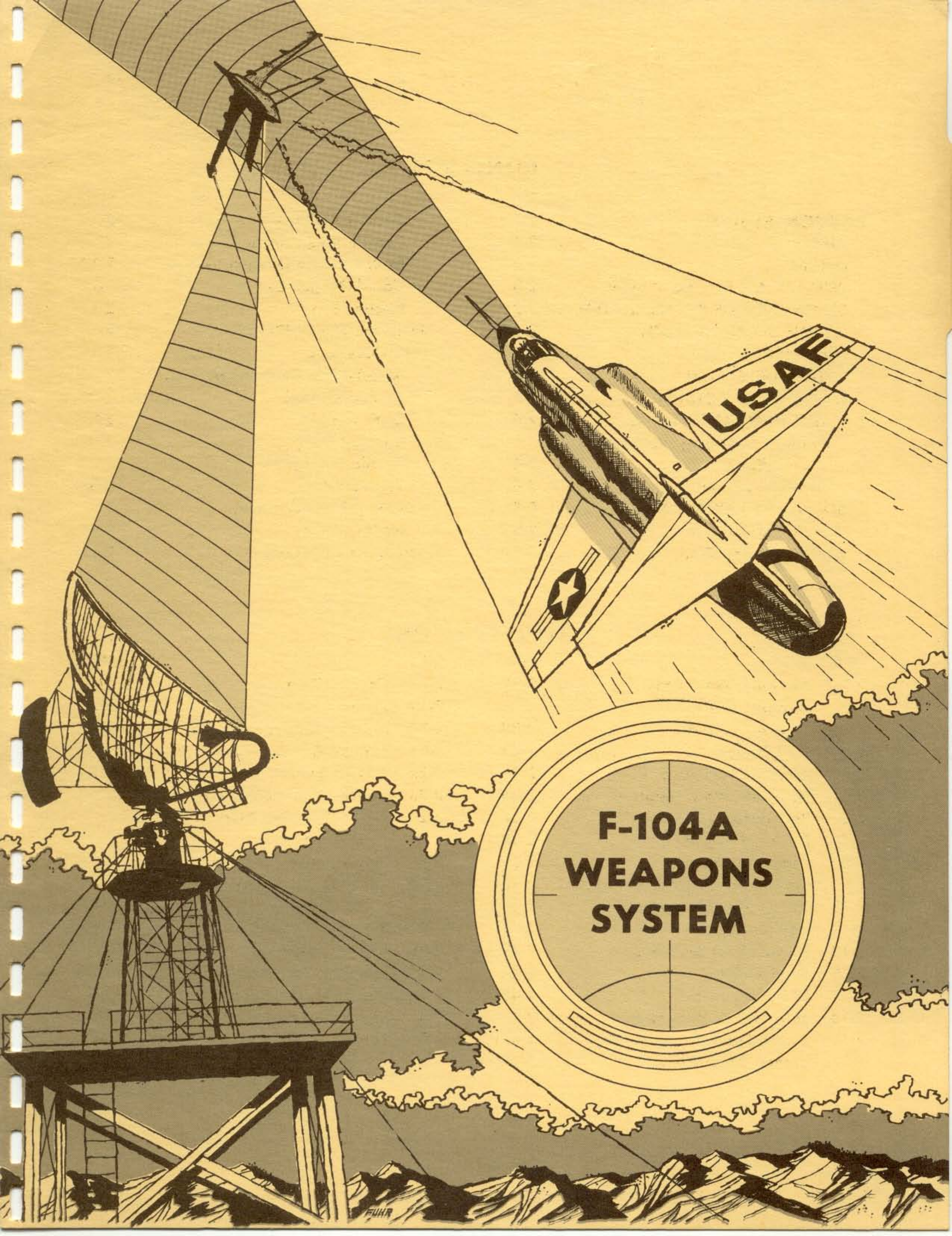


Figure 1-5


USAF
F-104A
WEAPONS
SYSTEM

CONTENTS

ILLUSTRATIONS

WEAPON SYSTEM

A complete weapon system consists of all weapons and allied equipment necessary to perform a designated military mission.

An Air Defense Command weapon system includes several other systems and sub-systems, some of which are employed in the tactical operation of more than one type aircraft. It is considered that any one designated weapon system is not complete and will not perform its mission unless all components of the prime weapon, all sub-systems, necessary supporting equipment, and personnel are available.

The F-104A Weapon System is so designated because the F-104A is the prime vehicle. In practical use, however, it employs components and/or sub-systems currently in use in support of other aircraft. In addition, the F-104A will employ components and sub-systems which are still in development. The F-104A Weapon System consists of, or must be directly supported by:

a. Airplane

b. Fire control systems

c. Armament

d. Tactical control

e. Readiness capability

f. Personnel to maintain, support, and operate each of the above.

g. Specialized support equipment

h. Common support equipment

i. Spares and components

j. Facilities peculiar to F-104A operations.

AIRPLANE

The F-104A is a single-place, light-weight fighter aircraft designed and manufactured by the Lockheed Aircraft Corporation for day and night high performance. It is primarily for the destruction of enemy aircraft in air-to-air combat, but has additional capabilities as a fighter-bomber with nuclear and conventional weapons and a clear air mass fighter interceptor when employed with a suitable AC & W System. The F-104A (Figures 2-1 and 2-2) is designed for high subsonic cruise and high supersonic combat. The airplane is powered by a General Electric J79-3 axial flow turbojet engine with afterburner. ASG-14 fire control system provides sighting information for a T-171E-3 20 mm gun and Sidewinder IA (GAR 8) missiles. Release is at the discretion of the pilot and guidance of the missiles is automatic. Outstanding physical characteristics and noteworthy features are: extremely thin flight surfaces, short straight wings with 10 degrees cathedral, irreversible hydraulically powered ailerons and controllable one unit horizontal stabilizer, leading and trailing edge wing flaps to reduce stall speed for landing and take-off, boundary layer control for the trailing edge wing flaps, drag chute to reduce landing roll, engine intake ducts located on each side of the fuselage, speed brakes located on each side of the fuselage aft of the wings, internal refueling is accomplished by a single filler and automatic internal fuel management.

ENGINE

The engine (Figure 2-3) is a light-weight, variable stator, three bearing, axial flow turbojet incorporating a seventeen stage compressor and a three stage turbine. The first six stages of the compressor are variable and are operated by hydraulic actuators using engine oil. They are automatically controlled by the main fuel control to avoid compressor stall and engine air inlet over-temperature conditions, by controlling the volume of air passing through the engine compressor. The compressor section also provides bleed air for pressurizing, anti-icing, boundary layer control, and hot section cooling. The combustion section includes 10 cylindrical combustion liners in an annular configuration. The main igniter is located in the #3 burner with ignition being propagated through the rest of the engine through combustion cross-fire tubes. A hydromechanical main fuel control is mounted on the accessory section on the lower portion of the engine. The accessory section also mounts two A.C. generators, an afterburner fuel pump, a nozzle pump, the #1 and #2 hydraulic pumps, the main fuel pump, a tachometer and a topping governor. The exhaust ejector nozzle section (afterburner) incorporates manifolds, flame holder, spark plug, tailpipe and inner liner, an aerodynamic converging-diverging variable exhaust nozzle, and four hydraulic actuators. There are five operating systems on the engine; fuel, electrical, hydraulic, anti-icing, and linkage. Integrated components of the five operating systems implement a functional sixth system (the control system) which purpose it is to integrate and mix proportionately such variable controlling factors as engine speed, altitude, temperature, and air speed. These variables are funneled by the functional control system into one primary requisite, the absolute regulation of exhaust gas temperature through control of fuel flow and jet nozzle opening.

PRIMARY AIR INTAKE SYSTEM

The inlet air for the engine is routed through two ducts on the sides of the fuselage. These ducts converge at the firewall to mate with the inlet of the engine. At the mouth of each duct, a conical centerbody and boundary layer bleed, assures even distribution of air at a uniform rate to the engine.

SECONDARY AIR BYPASS SYSTEM

Because the engine uses an aerodynamic converging-diverging exhaust nozzle, a secondary airflow system is required. The secondary air is routed from the firewall aft around the engine and between the movable fingers of the primary and secondary engine exhaust nozzles. This air provides an aerodynamic cushion against which the expanding exhaust gas flow can act to effect the diverging section of the converging-diverging exhaust nozzle.

To control the secondary airflow from the main ducts, a set of hydraulically-operated automatically-controlled flaps are installed at the forward end of the engine compartment at the firewall. Opening the flaps admits secondary airflow from the main ducts. Flow of hydraulic fluid to the flap actuators is controlled by a solenoid operated selector valve on the firewall.

ENGINE STARTING SYSTEM

The engine starting system is electrically controlled and pneumatically operated. The pneumatic starter is installed on the front of the engine and with the engine installed, the starter mates with an air supply duct at the forward end of the engine compartment. The duct contains a self make-break connection. There is no access to the starter area with the engine installed. A ground starting connection is provided in the right wheel well. Ducting from the wheel connection leads to the make-break connection at the starter. Exhaust air from the starter is directed into the engine compressor.

FUEL SYSTEM

The basic fuel system (Figure 2-4) consists of one main fuel tank which is comprised of four separate interconnected fuel cells, four tank mounted booster pumps, a supply line incorporating a shut-off valve and a strainer, and a tank venting and pressurizing system which are automatically controlled. A space forward of the main forward cell is provided for an additional cell which has a capacity of 145 gallons.

The four internal fuel cells have a total capacity of 763 gallons and are located in the fuselage and are all interconnected with drains and vents. Flapper valves are installed between the forward and aft cells which allow flow from aft to forward by gravity feed only. The single filler neck is provided in the aft cell. Four centrifugal booster pumps which operate continuously are installed in the four corners of the forward cell and are manifolded together through check valves into the main fuel supply line to the engine. Any two of these pumps are capable of supplying maximum engine fuel requirements. During approach, the attitude of the airplane is nose down, so a warning system has been provided which will signal the failure of both forward pumps.

The main fuel supply line is routed aft from the forward cell above the wheel well to the shut-off valve at the firewall. This valve is actuated electrically from the cockpit or can be manually closed from the wheel well. Downstream of the shut-off valve is a 200 mesh strainer and is accessible for servicing through the left lower panel which incorporates an air inlet for ground operation of the engine. A flexible hose routes the fuel from the strainer to the engine driven fuel pumps.

For accomplishment of certain missions, provisions are made for installation of jettisonable tip and pylon tanks which have capacities of 165 gallons and 200 gallons respectively.

HYDRAULIC SYSTEM

Two completely independent hydraulic systems and an emergency hydraulic system provide power to the various hydraulically-actuated units in the airplane (Figure 2-5). The No. 1 and No. 2 systems are in simultaneous operation during all normal conditions. Both are closed center systems providing 3000 psi. Each of these systems is served by its own engine-driven, variable displacement, piston-type hydraulic pump.

Most of the hydraulic units are mounted on the inside of a large engine access door on the underside of the fuselage. These units are exposed for servicing when the door is opened. A ground test selector valve is located on the door while bleed and air valves, and quantity indicators are mounted on a panel at the forward end of the engine access door opening.

No. 1 System

The No. 1 hydraulic system provides power exclusively to the flight controls. It operates the stabilizer (aft cylinder), aileron (inboard five cylinders in each wing), auto pitch actuator, and yaw damper (including directional trim).

Emergency System

In cases of stoppage or failure of both engine-driven hydraulic pumps, the ram air turbine-driven, 3000 psi, constant displacement-type pump provides emergency pressure directly into the No. 1 hydraulic system. The ram air turbine release mechanism consists of a manual release handle on the left side of the lower instrument panel, a cable operated latch mechanism at the door, and a damping cylinder. The damper cylinder spring loads the ram air turbine in the closed position and provides damping action during door extension.

No. 2 System

The No. 2 hydraulic system provides power to operate the remainder of the flight controls; stabilizer forward cylinder, five outboard aileron cylinders in each wing, pitch and roll dampers, and through a priority valve operates the speed brakes, landing gear, main gear downlock and forward doors, door uplocks, nose gear uplock, nose steering, and engine air bypass flaps.

LANDING GEAR SYSTEM

The F-104A airplane is equipped with a tricycle-type retractable landing gear comprised of main gear, nose gear, doors and associated structure and equipment. The main gear is retracted by hydraulic cylinders which also serve as links in the drag strut assemblies, and which incorporate the main gear downlock assemblies. During retraction the main wheels are folded 90 degrees inward by the wheel positioning rods attached to bellcranks mounted on each gear leg. The main gear forward doors are hydraulically operated by separate cylinders. Each main gear aft door is mechanically operated by a rod attached to the gear leg. Each main gear door is provided with a hydraulic door latch. When closed, the forward doors serve as main gear uplocks. In the event of hydraulic failure, the doors hold the gear securely in the retracted position.

Shock loads are cushioned by a liquid spring mounted between each main gear leg and fuselage structure. The liquid spring consists of a cylinder, piston assembly, and a sealing gland. The steel cylinder is completely filled with fluid on both sides of the piston. Shock loads are absorbed by both compression of the fluid and metal stretch of the steel cylinder barrel. Total travel of the piston rod from fully extended to fully compressed is 4.2 inches. This allows the main wheel a vertical travel of 10.7 inches.

The major components of the nose gear are the conventional air-oil shock strut and drag strut assemblies. The gear retracts forward into a wheel well that is fitted with two doors. The nose gear is hydraulically operated and the doors are mechanically operated through contact with the nose gear strut.

The nose wheel is steerable to 25 degrees each side of center by means of a combination power steering and shimmy damper unit mounted on the shock strut. Steering is accomplished by movement of the rudder pedals. The upper nose gear torque link incorporates a quick disconnect so that the link can be disconnected for towing the airplane. A static wire on the fork electrically grounds the airplane when the wheel touches the ground. A manual release system is provided for emergency extension of the gear. This system releases the main gear door latches and the nose gear uplock allowing the gear to extend through gravity and air loads.

FLIGHT CONTROL SYSTEMS

Flight controls for the F-104A airplane are divided into primary and secondary controls. Primary controls consist of the components used to actuate the ailerons, stabilizer, and rudder. Secondary controls consist of the components used to actuate wing flaps and speed brakes.

Primary Controls (Ailerons and Stabilizer)

Primary controls for the ailerons and stabilizer consist of the control stick, cables, pushrods, linkages, hydraulic power control assemblies, hydraulic cylinder assemblies, mechanical and electrical follow-up mechanisms, hydraulic systems, and electrical systems. These surfaces require a complete hydraulic power control system for operation. In such a system, the control surfaces are irreversible and varying flight loads imposed upon them are not transmitted back to the control stick.

The flight control systems for the ailerons and stabilizer are further divided into three phases; power control, augmentation control, and trim control.

Power Control

The power control system is composed of the control stick assembly, cables and pushrods, power control assemblies, and cylinder assemblies which respond directly or indirectly to movement of the control stick.

Stability Augmentation

The stability augmentation system is composed of the electro-hydraulic and mechanical-hydraulic servo mechanisms, electronic amplifiers, and electrical gyros which respond to and compensate for rapid variations in fundamental airplane stability due to speed or attitude changes.

Trim

The trim system is composed of electrical trim motors, jackscrew actuators, flexible driveshafts, and control switches by means of which the airplanes may be trimmed on the roll, pitch and yaw axes. Damage can be inflicted to the trim flex shafts if the trim system is operated without hydraulic pressure up.

Critical components of the aileron and stabilizer power control systems are duplicated and separately supplied with hydraulic pressure from two independent 3000 psi hydraulic systems. Failure of one hydraulic system reduces the control capability by 50 percent but still provides adequate control for high-speed maneuvering, approach and landing.

Rudder

Primary controls for the rudder consist of conventional rudder pedals, torque tubes, and bellcranks to which are attached cables. The cables run aft through the fuselage to a rudder lock assembly located at, and splined to, the lower end of the rudder torque tube. Movement of the pedals in the cockpit causes the cables to rotate the rudder lock horn, unlocking and moving the rudder. When the pedals are returned to neutral, or if pedal pressure is removed, a centering spring aids in returning the rudder to neutral position where it again locks to prevent movement by external forces.

Secondary Flight Controls

The secondary flight controls for the F-104A aircraft consists of the leading edge flaps, trailing edge flaps, and the speed brakes.

Wing Flaps

The leading edge flaps are composed of two surfaces, one left and one right, which form the leading edge of each wing panel. The flaps are located between the fuselage and wing tip fairings. The flaps are mechanically locked in the retracted position and are electrically actuated and controlled.

The trailing edge flaps are composed of two surfaces, one left and one right, which form part of the trailing edge of each wing panel. The flaps are located between the fuselage and the inboard end of the ailerons. The flaps are electrically actuated and controlled.

The leading edge and trailing edge flaps are electrically interlocked through their control circuits and are operated from a single control lever in the cockpit. Actuators of each flap system are mechanically interlocked through flexible driveshafts so that either actuator will drive both control surfaces, should one actuator fail.

Speed Brakes

The speed brakes are two surfaces which may be extended for aerodynamic braking and are located on each side of the fuselage just aft of the wing trailing edge. They are electrically controlled and hydraulically actuated.

BOUNDARY LAYER CONTROL

The wing trailing edge flap boundary layer control system is provided to increase the aerodynamic lift of the wings and flaps during approach and landing. The system (Figure 2-6) consists of engine bleed air connections, shut-off valves and distribution ducts. Air bleed ducts are tapped into the seventeenth stage of the engine compressor and deliver air at approximately 225 psi and 482° C (900° F) to the shut-off valves.

Selection of the "LAND" position of the flap control lever starts the leading edge and trailing edge flaps to their full-down travel. As the trailing edge flaps move past the "TAKE-OFF" position, the boundary layer control shut-off valves begin to open and are fully open before full-down flap travel. This provides high-pressure, high-velocity airflow from the boundary layer control ducts. The high-velocity airflow over the upper surface of the trailing edge flaps and the increased velocity over the upper surface of the wings produces a greater vertical lift component which allows a reduced landing speed.

ELECTRICAL SYSTEM

The airplane is provided with a high voltage (200/115 V) A.C. electrical power system (Figure 2-7). Power is normally supplied by two engine-driven 20 KVA A.C. generators. Emergency power is supplied by a ram air turbine-driven 5.5 KVA A.C. generator. The 20 KVA generators are not paralleled as each unit powers a separate bus system.

Normally the No. 1 A.C. bus is supplied by the No. 1 generator and the No. 2 bus is supplied by the No. 2 generator. An automatic bus transfer system is provided whereby failure of either generator will parallel the No. 1 and No. 2 busses to the operating generator. These generators supply 3-phase power at variable frequency. The emergency A.C. bus is paralleled with the No. 2 A.C. bus when either or both the 20 KVA generators are operating. If both 20 KVA generators should fail, due to engine stoppage or other causes, the emergency bus can be supplied (in flight) by the emergency A.C. generator which is driven by the ram air turbine. This generator is governed to supply fixed-frequency, 3-phase power.

The external power receptacle provides a means for energizing the system from a ground test cart. When ground power is connected, the airplane generators are automatically disconnected from their associated busses and the busses are paralleled and connected to the external power source.

The direct current requirements of the airplane are normally supplied through a transformer-rectifier which is fed from the No. 1 bus to the D.C. monitored bus. The emergency D.C. bus, which carries D.C. loads necessary to maintain flight, is normally fed from the D.C. monitored bus.

It should be noted that when the 20 ampere transformer-rectifier is supplying the D.C. requirements of the airplane, the flap control bus transfer system disconnects the emergency D.C. bus from the transformer-rectifier when the airplane flaps are in operation.

The battery bus is normally paralleled with the emergency D.C. bus. The battery is a small 4 ampere-hour unit and is maintained fully charged from the emergency D.C. bus. If power fails on the emergency D.C. bus, the battery will supply power to the battery bus but will be prevented from supplying the emergency bus by a blocking rectifier.

A.C. power governed-frequency is supplied to the A.C. instrument bus and the fire control sight system from inverters. Input to the inverters is from the D.C. monitored bus. The instrument power transfer system senses instrument inverter output and, in case of inverter failure, connects the instrument power transformer to the A.C. emergency bus and puts the transformer output on the instrument A.C. bus. When the A.C. instrument bus is powered from the transformer, frequency is variable if the emergency A.C. bus is paralleled with No. 2 A.C. bus and fixed if it is powered from the emergency A.C. generator.

AUXILIARY SYSTEMS

Comfort in flying is no longer a luxury, it is a necessity. An increase in fatigue, or a decrease in pilot efficiency from increased fatigue or encumbrances, will definitely affect the crewman's ability to fly the weapon system. This is true because of the longer missions and the greater amount of environmental protection required.

Any pilot who flies the F-104A "Starfighter," is concerned with all of the human factor aspects of flight. Lockheed has the responsibility of protecting the crewman from all environmental factors and of increasing his efficiency and comfort in the cockpit. The following systems will do this job:

Cockpit Air Conditioning

Heated compressed air, for cockpit air conditioning and pressurization, is obtained by bleeding air from the last stage of the engine compressor (Figure 2-8). The temperature of this air as it leaves the seventeenth stage of compression is approximately 900° F, and the pressure is 250 psi at maximum engine rpm and maximum airspeed. After passing through a primary heat exchanger, a small part of the air is directed to the fuel tank and hydraulic reservoir pressurization systems. The main flow of air passes through a shut-off valve, after which a portion goes to the rain removal duct, canopy and electronic compartment seals, anti-G suit, and radar pressurization systems. The rain remover duct is also tapped to supply the gun compartment purging system. The remainder then passes either through or around a refrigeration unit, depending upon the positions of the hot air bypass valves. The hot compressor air, which goes through the bypass valves, is directed to an air mixing chamber where it meets and mixes with the air which has gone through the refrigeration unit. This mixture is directed through a water separator, and enters the cockpit through shoulder outlets and foot warmers. The temperature of the air entering the cockpit depends upon the position of the hot air bypass valves. For maximum heating, the bypass valves will be fully opened and most of the air entering the cockpit will bypass the refrigeration unit. For maximum cooling, the bypass valves will be completely closed and all the air entering the cockpit will pass through the refrigeration unit which includes a secondary heat exchanger, a water boiler, and a cooling turbine. The water boiler operates in such a manner that if the inlet air temperature is above water boiling temperature, the water will boil and the air will be cooled through this evaporation process. The temperature of the air entering the cockpit can be varied by the pilot's cockpit heat rheostat which controls the position of the bypass valves. This temperature range extends from —60° F in the full cold position to 250° F in the full hot position at maximum engine rpm. In normal operation, however, air temperature is maintained between 40° F and 100° F automatically by means of a thermostat control. This senses cockpit discharge temperature, compares this temperature with the cockpit heat rheostat selection, and sends electrical signals to the bypass valves to change their positions as necessary to make cockpit air temperature correspond with rheostat selection. The pilot can also control the temperature manually by means of the cockpit heat rheostat. When this is done, the thermostat control is cut out of the system and the bypass valves are directly positioned in accordance with rheostat selections.

Cockpit Pressurization

Cockpit pressurization is maintained at the proper level by an automatic cockpit pressure regulator located in the left forward cockpit area. There is no pressurization in the cockpit below 5,000 ft. (Figure 2-9). Between 5,000 and 18,500 ft., the cockpit altitude will be constant, while the differential pressure will vary from 0 to 5.0 psi. Above 18,500 ft., cabin pressure is maintained at 5.0 psi differential, regardless of aircraft altitude.

Exhaust air from the cockpit pressure regulator is ducted through the radar set forward of the cockpit for cooling purposes. The cockpit pressure regulator unit incorporates a cooling fan which will force cockpit air into the radar compartment any time the aircraft is on the ground. This fan is also actuated whenever the ram airscoop is opened. If the pressure regulator malfunctions, excessive cabin pressure will be relieved through the cockpit pressure relief and dump valve. If the air entering the cockpit becomes contaminated, the pilot can alleviate the condition by use of the ram airscoop. This will allow outside ram air to enter the cockpit as well as shutting off the flow of compressor air into the cockpit and releasing cabin air overboard through the cockpit pressure relief and dump valve.

High Pressure Oxygen System

(In aircraft Serials 55-2955 through 56-805 only)

Oxygen is stored under high pressure in three 147 cu. in. cylinders located in the fuselage aft of the nose wheel well (Figure 2-10). Oxygen is introduced to the cylinders through a filler valve which can be reached from the ground through an access door aft of the nose wheel well on the right side of the fuselage. When fully serviced, oxygen pressure in these storage cylinders should be 1800 (plus or minus 50) psi. Figure 2-11 shows duration for both gaseous and liquid oxygen.

Liquid Oxygen System

(In aircraft Serials 56-806 and subsequent)

The five-liter liquid oxygen supply is contained in the liquid oxygen converter mounted in the oxygen compartment just aft of the nose wheel well. A full five liters of liquid oxygen will yield 185 cu. ft. of gaseous oxygen at standard conditions of temperature and pressure; however, the converter cannot be completely filled because of the immediate conversion to gas of some of the liquid as the converter is filled. Also, there is a slow loss of gas as the relief valve vents overboard; therefore, the oxygen supply duration is based upon an estimated 107 to 120 cu. ft. of gas rather than 185 cu. ft. This conservative estimate of available oxygen allows for twenty-four hours of stand-by condition after the system is filled and before the airplane is flown. The duration curves show that the five-liter supply is marginal for the condition of maximum fuel and cruise in the 15,000 ft. to 20,000 ft. region; however, this supply is based on the above mentioned estimate, and there will be more than enough oxygen if the converter is topped off before a maximum duration flight. The duration curves for fuel and oxygen are based upon six minutes at sea level for warm-up and take-off, time to climb, maximum cruise time at altitude, followed by twenty minutes at sea level for loiter and landing. MC-1 suit breathing rates are used.

The converter will supply gaseous oxygen at 70 psi at all breathing rates as long as there is any liquid in the system. The converter can be filled from the transfer cart in less than 5 minutes and will reach operating pressure and be ready for use in less than 10 minutes.

Relief valves and pressure control valves in the system will limit the stand-by pressure to 110 psi and will maintain a minimum operating pressure of 70 psi.

A heat exchanger is installed in the supply line just aft of the seat and is used to keep the oxygen temperature within a few degrees of the cockpit ambient temperature.

Ejection Seat

The aircraft is equipped with a downward ejection system (Figure 2-12). The seat assembly is mounted on rails to permit seat adjustment. A combined quick disconnect fitting is installed on the aft left side of the seat. This fitting permits single point disconnection for the microphone, headset, faceplate leads, G-suit line, and oxygen line. A headrest, crotch belt, knee guards, ankle restrainers or foot retraction straps, shoulder harness, inertia reel-lock assembly, and an initiator-operated seat belt are provided. Below the seat, and attached to the fuselage by four quick release hooks, is the escape hatch. An initiator-operated thruster and an initiator-operated catapult provide power for ejection. The seat rails support the seat and provide a track, down which the seat slides during ejection.

Ejection is accomplished by pulling the seat "D" ring located on the seat bucket between the pilot's legs. Pulling the "D" ring fires an M-3 initiator which operates a pre-ejection thruster. The thruster converts the M-3 initiator gas pressure into mechanical motion by rotating a torque tube mounted under the seat. This action accomplishes the following: drops the cabin pressure, tightens the pelvic restraint, locks the inertia reel, stows the control stick forward, and raises the leg guards.

As the right leg guard reaches full up, another M-3 initiator is fired which in turn fires the catapult. The first inch of downward movement releases the escape hatch by rotating bomb shackle-type hooks. Cams on the hooks force the hatch partly into the airstream. As the seat travels down the rails an M-4 seat belt initiator (2 second delay) is fired. As the pilot leaves the seat, a lanyard attached to the seat belt arms the parachute aneroid control.

A handle located on the right of the center control stand may be used to jettison the ecsape hatch in case the automatic ejection system fails. Manual release of the hatch and seat is accomplished by first pulling the "HATCH ESCAPE" handle. This action manually jettisons the hatch and pulls the pin on the catapult free-fall disconnect. The "D" ring must then be repulled. The first inch of travel will fire the catapult initiator and if that again doesn't fire, the pilot will pull out the ring farther which will cause the free-fall disconnect to revolve and the seat to fall clear of the aircraft.

PERSONNEL EQUIPMENT

MC-3 and MC-4 Pressure Suits

The MC-3 and MC-4 pressure suits are fabricated from a nylon-cotton combination, thus improving the strength of the garment. The porosity of this fabric permits adequate ventilation. The suits consist of a close-fitting non-elastic garment covering all of the body except the feet and head; pressurized gloves are provided for the hands. Small rubberized tubes called "capstans," or pneumatic levers, extend down the back and along the sides of the arms and legs of the suit. The tubes are attached to the fabric of the suit by means of crossing tapes. When oxygen under pressure is introduced into the capstan tubes, the tubes expand and draw fabric tight around the body. The tightening effect thus affords sufficient counter-pressure to the outside of the body to balance the required high breathing pressure which is delivered by an appropriate regulator to the helmet. The suit is worn immediately over long underwear and is donned by entry through the shoulder zipper openings. Laces are provided along the arms, legs, and back for individual fit adjustments.

The type MC-4 differs from the MC-3 in that it provides anti-G protection which operates independent of the partial pressure function.

The capstan tubes of the suit are inflated automatically by means of the oxygen regulator assembly whenever the cabin altitude reaches 43,000 ft. (plus or minus 1,500), regardless of the actual altitude of the aircraft. By means of the crossing tapes on the suit, one-fifth of the capstan pressure is applied to the close-fitting fabric, thus pressurizing the body. (This 5 to 1 loss of applied pressure is a result of the graded capstan diameter being one-fifth the diameter of the portion of the body it protects. Thus, to apply 1 psi of pressure on the body, 5 psi is supplied to the capstans.) This pressure on the body provides the necessary counter-pressure to allow the wearer to breathe the high mask pressures required at extreme altitudes to maintain adequate oxygenation of the blood.

Proper operating procedures for the pilot, or rescue team, concerning de-activation of the partial pressure suit, is of utmost importance. If the suit is activated during an emergency such as a bail out, or inadvertently on a crash landing, the first step performed should be that of faceplate removal. The pressure in the helmet is offset by pressure to the chest cavity and abdomen areas, allowing the pilot to breathe under otherwise intolerable pressures. Should the suit (capstan) pressure be relieved before helmet pressure, the probability of lung rupture would be very high. Once the faceplate has been removed and after several breathing cycles, the capstan pressure may be relieved.

MA-2 Modified MB-5 Helmet

The MA-2 modified MB-5 helmet incorporates the AIC/10 interphone system and consists of a sponge-rubber covered inner frame that is worn directly on the head as a support for the rest of the helmet. Adjustable earphone cups are mounted on this inner support frame. A thin latex bladder covers this inner frame, and contains inturned flap opening for sealing at the neck. This bladder is covered by a fabric hood which, together with the bladder, is clamped to the helmet inner frame by an outer frame which forms a seal around the face-piece opening. The fabric hood prevents excessive ballooning of the bladder, and is provided with a lacing adjustment for sizing. A hard outer shell provides normal protection against buffeting. This shell is attached to the outer frame by three-turn button fasteners. An adjustable tie-down cable assembly is attached to the inner side of the hard shell to prevent excessive lift when the helmet is pressurized. A removable plastic face-piece is held in place by means of a snap-lock and hook so that it can be removed quickly and easily when desired. This face-piece is provided with pressure breathing respiratory valves and an oxygen hose terminated with an A-2 quick disconnect fitting.

The face-piece contains electrical heating wires to prevent fogging thereby providing clear visibility to the wearer. The communication equipment cord and the face-piece heater cord complete the helmet assembly.

Firewell Survival Kit

The survival kit container is made out of reinforced fiberglas and is made to fit in the seat bucket (Figure 2-13). The container is divided in two main sections. The rear section, a rectangular parallelepiped, containing the emergency oxygen bottles, regulator, etc. This section has a hinged door on the top, and is also a support for the back style parachute. The front section is for survival gear; such as, gun, food, fishing kit, candle, razor, knife, sharpening stone, etc., all packed in a plastic bag (rucksack) and tied down with straps to the bottom of the container.

On top of this bag is a life raft with a lanyard to the kit, and one to the suit or parachute harness of the pilot. A door on top of this front compartment is used for supporting a sponge-rubber seat cushion. This cushion is according to the MIL Specification and will provide an optimum recline angle to prevent undue forward movement with a maximum of comfort while performing normal duties within the aircraft.

The normal oxygen supply (aircraft) enters through a disconnect on the seat with a pressure of 70 psi; this disconnect assembly accommodates the microphone, headphone and faceplate heater electrical circuits. The disconnect action is accomplished upon ejection by a lanyard. One end of the lanyard is connected to the trigger and the other end is permanently attached to the airplane structure.

Upon ejection, the downward movement of the seat creates the lanyard force which trips the trigger in the disconnect; at the same time another cable attached to the knee brace with a break-away fitting turns on the emergency oxygen supply by operating the pressure reducer valve (reducing the 1800 psi pressure to 70 psi). The pressure reducer valve forms a part of the manifold, attaching two 25 cu. in. bottles (1800 psi); the total output of these two bottles guarantees the pilot a minimum fifteen minute regulated supply of oxygen.

The manifold assembly contains a pressure gauge, relief valve, check valve and a filler valve. The pressure gauge is placed on the top and just below the hinged door in which there is a small window to obtain a preflight gauge reading.

The aircraft oxygen supply is also connected to this manifold; thus, either aircraft or emergency oxygen will give an inlet pressure of 70 psi to the mask and suit regulator (one unit). The mask/suit regulator delivers, for breathing, the correct amount of oxygen from sea level up to 70,000 ft. and a 5 to 1 ratio for capstan pressure.

The leads from the regulator to the pilot, along with the electrical circuit for microphone, earphone, faceplate heater, and a cable (green apple) from emergency supply reducer valve, leave the survival kit from the right-hand rear corner through a disconnect fitting. The "green apple" will actuate (manual) the emergency oxygen supply and may be used if the aircraft's oxygen supply fails.

The breathing oxygen hose (⅜″) from the kit to the "T" connector on the suit will have electrical circuits integrated. The capstan hose is also ⅜″. These hoses and connections are to be used for the Air Force type MC-3 and MC-4 suits with a MA-2 or modified K-1 helmets. For flying with an A-13A mask, there is an adapter available which is attached on a spring-clip in the oxygen compartment.

A push-to-test button connected with a hose to the regulator is placed on the front right-hand side of the survival kit so that it may be readily operated by the pilot and so that it will not be subject to accidental or inadvertent operation. By pushing this button there will be a slight pressure in the capstan tubes and a slight flow of oxygen through the mask.

The basic container with cushion, emergency oxygen, and survival gear is attached on the left-hand and right-hand side with a quick release fitting to the parachute "D" rings. Two tie-down or leg straps on the center front will give the survival kit a fixed position during ejection.

On the right-hand side of the survival kit is a release handle located near the front in an accessible position. By pulling this handle, the personal leads between kit and man are disconnected. The attachments between kit and parachute harness are also disconnected, and the carbon dioxide bottle (in front section) will inflate the life raft. This should be done before hitting the earth's surface. For normal egress from the aircraft, a handle is provided with a manual override to prevent operation of the kit-to-man disconnects which exhausts the emergency oxygen supply and blows up the life raft.

FIRE CONTROL

The F-104A Weapon System utilizes the ASG-14 fire control system and is armed with a T-171E-3 20 mm and Sidewinder IA (GAR 8) missiles (Figure 2-14).

The ASG-14 will normally be used for initial detection of the target. The radar display will provide range information and the position of the target with respect to the F-104A. Employing a pure pursuit course, the aircraft is flown to within visual range of the target and the attack completed by use of the optical gunsight. The infrared sight is used in conjunction with the optical sight in case of darkness or high haze conditions.

This fire control system was developed in conjunction with the F-104A to facilitate the performing of attacks at supersonic speed on both fighter and bomber type airplanes. By concurrent development of the airplane and its fire control system, the over-all kill probability of the weapons system is optimized.

ASG-14 Fire Control System

The ASG-14 consists, basically, of a simple search and range tracking radar, an optical computing gunsight and an infrared tracking sight. The radar has three modes of operation; search, track, and ECM-HOM.

During the search mode of operation, a range of 20 miles is displayed; the antenna covering a spiral scan pattern of 90°. When a target is detected by the radar, it will be presented as a blip on the indicator, positioned in relation to the aircraft itself; for example (Figure 2-15): No. I shows the search display with no targets. No. II indicates a target detection at 12 miles, positioned up and to the right. No. III the aircraft is being maneuvered to bore-sight the target. No. IV indicates by the full circle that the target is boresighted and, since it is at a range of 9 miles, the radar is ready to go to track.

By the pilot's actuation of the track button on the control stick, the radar will go into the track mode with a display range of 10 miles and the antenna covering a spiral scan of 20°. At this time, a range strobe will begin to sweep back and forth between 300 and 3000 yards; this is the automatic acquisition mode. If the track button is held down, the range strobe will sweep out in range to a point where the button is released. Pressing the button again will cause the range strobe to reverse and sweep toward zero range. Consequently, the pilot can position the strobe to correspond with the target, at which time a light on the indicator indicates that lock-on is accomplished. The radar is now providing the optical sight with the radar range information required to develop the necessary lead angle. A meter on the control box indicates rate of closure to target. In the case of radar jamming, the equipment can be put in ECM-HOM position. This disables the transmitter portion of the ASG-14 leaving only the receiver in operation. The aircraft can now be homed on the target using the radar interference. A brief description of each major component of the search radar follows (Figure 2-16):

1. **Antenna**

   The search antenna is a simple dynamically-balanced paraboloid, 24 inches in diameter, which gives a pencil beam radiation pattern of approximately 4°. A spiral scan angle of 90° is achieved for the search mode while a 20° cone scan angle is used during the track operation.

2. **Duplexer-Mixer**

   This unit acts as the electronics switch whereby on transmit the energy is coupled to the antenna while, at the same time, protecting the receiver. On receive, the duplexer couples the return target echo signal to the receiver where it is mixed, resulting in the IF frequency. AGC and anti-clutter features are included.

3. **Elapsed Time Meter**

   This meter indicates accumulative running time of the radar.

4. **Test Plug**

   The plug is provided for connecting external test equipment.

5. **Mounting Frame**

   The frame includes mounting provisions, interconnecting cabling, electrical connections, and also directs the cooling air to the individual units.

6. **Automatic Range Tracking Pallet**

   This unit is capable of supplying range voltage to the gunsight. It operates at ranges from 250 yards to 10 nautical miles and at closing rates from 400 knots opening to 1600 knots closing. The unit is capable of locking-on and tracking any target which has sufficient amplitude of signal.

7. **Electrical Synchronizer**

This unit contains the necessary circuitry for the generation of the master trigger for the modulator at a repetition rate of 1,000 pulses per second, the video amplifier, the indicator sweep, anti-clutter circuits, and ECM homing.

8. **Low Voltage Power Supply**

This unit produces all the necessary D.C. plate voltages, both regulated and unregulated, required by the equipment.

9. **Receiver Power Supply and Relay**

This unit supplies the necessary voltage for the receiving section of the radar as well as including all the overload devices and relays for switching A.C. power in the radar system.

10. **IF Amplifier**

This unit amplifies the intermediate frequency.

11. **AFC Unit**

The automatic frequency control unit maintains the radar local oscillator frequency so that "difference" frequency between it and the magnetron is held constant.

12. **Magnetron**

A tuneable magnetron supplies the 9000 to 9600 megacycle carrier frequency.

13. **Modulator**

The modulator supplies the 1000 cps repetition rate for both search and track modes with a one microsecond pulse width in search and a one-half microsecond pulse width in track at a peak power of approximately 500 kw.

Unified Control

1. **Type 1 Presentation**

Target range is given by distance from center of screen (Figure 2-17).

Target, whether up or down, right or left, is indicated by position of echo; "angle-off" boresight is indicated by length of target arc.

2. Range Rate Meter

400 knots opening, 1600 knots closing.

3. Main Radar Control

(a) Overload reset and stand-by operation.

(b) Radar operation.

(c) ECM receiver operation (radar off).

(d) Emergency operation overrides time delay and thermal overload (push knob in and turn).

4. Indicator Intensity

5. Anti-Clutter Switch

Optional anti-clutter to reduce effects of clutter and jamming.

6. Dual Light and Switch

Light comes on when target acquisition (range lock) is obtained. When light is pressed, the radar returns to the search mode and light goes out.

7. Automatic Frequency Control

Normally employed for radar operation. (Manual tuning is used when homing on enemy radar or jamming.)

8. Receiver Gain

9. Radar Test Set

With this small simple unit, a quick check can be made to see if each of the major units in the system is in operation. If one or more units should prove faulty, they can easily be removed and quickly replaced by a spare.

Optical Sight

The terminal attack is accomplished by utilizing the optical gunsight which is a disturbed reticle computing sight (Figure 2-18). The principle computing element is a single electrically-driven gyroscope. It is designed for fixed forward firing weapons and may be used for air-to-air gunnery and rocketry. The sight accepts either manual or radar range voltage inputs and transmits lead angle outputs electrically and optically. It is equipped with a projection optical system employing a variable diameter reticle adjustable for use in manual ranging.

Infrared Sight

With the use of the infrared (IR) sight, attacks can be made in cases where the pilot is unable to see the target visually (Figure 2-19). The infrared radiation emitted by the target is scanned by a disc having two pairs of slits and a field of view of approximately 14°. The energy passing through a certain portion of the slits is detected by an infrared sensitive photocell and turned into electrical energy. The electrical energy is amplified and actuates a neon lamp. In front of this lamp rotates a disc similar to the scanning disc. Whenever the lamp is lit, an illuminated line will be projected onto the combining glass of the optical sight. Since there are two pairs of slits and the lines in each pair are effectively perpendicular, the lines will form a cross. The intersection of the cross represents the angular target position. The pilot flies the airplane to superimpose the sight reticle on the IR cross in the same manner as he would with a visual target.

Missile Description

Sidewinder IA (GAR 8) is a passive infrared-homing air-to-air guided missile. It homes on infrared energy radiated by heated parts of the target. Since the missile is a passive homing device, it does not need to transmit a signal for guidance and is, therefore, relatively impervious to jamming.

When launched, the Sidewinder IA turns into a collision or constant bearing course to the target. If the target maneuvers, the missile turns at about four times the turning rate of the target to maintain the collision course. After launching, the aircraft is free to maneuver since all corrections originate within the missile.

The missile is 5.0 inches in diameter, 9 feet in length and weighs 155 pounds. It consists of four sections: Guidance and Control Section, Warhead, Influence Fuse, and Rocket Motor (Figure 2-20).

The guidance and control section contains the optical system for tracking, a hot gas-operated control servo with aerodynamic fins to control the flight of the missile to the target, the electronic components to convert target signals into missile control signals, a hot gas-driven generator to supply electrical power during missile flight, and the contact fuse. While the missile is on the aircraft, stand-by electrical power is furnished by the aircraft through an umbilical connection to the launcher.

The warhead, a 25-pound controlled fragmentation type, is detonated by the action of either the contact or the influence fuse. When exploded, it puts out approximately 1,500 metal fragments that travel 6,000 feet per second, and are capable of penetrating 1 inch of aluminum or ⅜ inch steel plate at 30 feet.

The influence fuse converts near misses into kills. If the missile passes within 30 feet of the target, this fuse detonates the warhead.

The motor is a standard 5-inch HVAR rocket motor which accelerates the missile to Mach 1.7 above the speed of the launching aircraft. This section also carries the fixed aft stabilizing fins and the suspension lugs.

Missile Firing Envelope

In order to get a hit the aircraft must be within the firing envelope (Figure 2-21). This firing envelope is determined by the radiation envelope of this target and the performance envelope of the missile. The radiation envelope of a particular aircraft is the area in which its IR radiation can be received. The missile envelope is determined by the maximum and minimum guidance range of the missile and the maximum G that the missile can pull at a given altitude.

The aircraft must be within both these envelopes in order to fire. When the pilot is receiving the target signals in his earphones, the aircraft is within the radiation envelope of the target. It can be determined whether the aircraft is within the missile envelope in range by checking the aircraft radar range indicator, or by getting range information from CIC or GCI to determine whether the aircraft is inside the G limitations of the missile envelope and can successfully fire. If the aircraft is below 40,000 feet and is pulling 2 G's or less while tracking the target, the missile can be fired; above 40,000 feet, the same is true if the aircraft is pulling 1.6 G's or less. This rule may appear to limit the aircraft to a very small amount of G's normally reserved for instrument flying, but when it is considered that the normal firing range will be 10,000 to 15,000 feet, the target can be pulling a violent evasive maneuver and can be tracked at long range with a small G force on the aircraft. Also, if necessary, the aircraft can pull any amount of G in the initial phase of the intercept to get into position, and the 2-G restriction applies only while the aircraft is tracking and firing. This G limit is, also, usually the limit of the firing envelope in range, and if the aircraft is pulling more than 2 G's while tracking, it may not be getting a target signal to fire.

T-171E-3 20 mm Gun

The T-171E-3 weapon is an externally-powered automatic multi-barrel gun (Figure 2-22). The weapon varies from conventional weapons in that it incorporates six barrels and six bolt assemblies which revolve about the longitudinal axis of the weapon. This gun, located in the lower left side of the forward fuselage, is capable of firing 20 mm electrically primed cartridges at rates in excess of 4,000 rounds per minute. The gun is operated by a double winding electric motor.

COMMUNICATION AND NAVIGATION

AN/ARC-34

Radio set AN/ARC-34 permits line-of-sight voice transmission and reception from aircraft-to-aircraft, or aircraft-to-ground. The frequency range of the equipment is from 225.0 to 399.9 megacyclces, providing 1750 frequencies in steps of one-tenth megacycles. Twenty preset channels are available at the control and any frequency may be selected manually without disturbing these preset channels.

AN/ARN-14

The AN/ARN-14 installed in the F-104A is a standard VOR equipment. Since it is a standard equipment, it does not require new procedures.

Glide Scope, Localizer, and Marker Beacon

The glide scope, localizer, and marker beacon receivers are standard systems in a combined repackaged configuration. It will be operated and maintained in conformation with existing procedures.

Identification

The AN/APX-19 system provides both IFF Mark X and IFF Mark XI capabilities. The system is subminiaturized and packaged to conform with the gas-can type configuration utilized in the F-104A. This configuration lends itself to rapid replacement of defective black boxes, thereby increasing aircraft availability.

Repackaging

Requirements for additional communication and navigation equipment for the F-104A airplanes have been established and will be included in later F-104A ADC airplanes.

Installation

Standard government-furnished equipment items come in such a large variety of sizes and shapes that it is impossible to design them into the limited electronics space available in the F-104A aircraft. Therefore, the electronics equipment required for the F-104A missions will be repackaged to a shape that efficiently utilizes the space available. The width of each can varies with the bulk of equipment it is required to contain. These cans are stacked side by side, in two rows that are back to back, forming an overall shape comparable to the electronics compartment just aft of the cockpit. The inclined panel of each equipment contains a simple "go-no-go" preflight test panel.

Communications Package

The communications equipment will be a repackaged version of the AN/ARC-34 UHF transmitter-receiver. There are 1750 voice communication channels in the frequency range of 225 mc to 399.9 mc. Any channel can be selected within a maximum switching time of 4 seconds. Any 20 channels can be preset for rapid selection. All other frequencies within the band must be selected by manually setting the frequency dial. Reliable distance of operation is essentially line-of-sight; in other words, up to 250 miles air-to-ground or 500 miles air-to-air depending on altitude.

IFF Package

The IFF equipment will be a repackaged version of the AN/APX-19. It is basically designed for Mark XI operation. However, a small printed circuit board containing a few resistors, condensers, and three miniature tubes has been added to provide Mark X operation during the transition interim. A switch inside the equipment allows either Mark X or Mark XI operation. At such time as the Mark XI system is completely implemented, the Mark X system will be dropped and a small subassembly can be removed from IFF package. Mark XI contains SIF (Selective Identification Feature). When interrogated under the Mark XI system, an aircraft will not only reveal itself as friendly, but will also be able to identify itself with regard to serial number, flight number, mission, or any other method previously arranged.

VOR Navigation Package

The Visual Omni-Range navigation equipment will be a repackaged version of the AN/ARN-14. This package is primarily intended to provide the pilot with VOR navigation; however, the frequency range is great enough to include other navigational aids in the UHF band of 108.0 to 135.9 mc.

TACAN Navigation Package

The Tactical Air Navigation system will perform identical to the ARN-21. The TACAN package has not yet been subcontracted; therefore, its exact configuration is not established. Advances have been made since the ARN-21, and it appears that the F-104A will not use a repackaged version of that unit, but rather a new, smaller and lighter unit retaining all the operational advantages of the ARN-21 (the F-104A has the ability to use either VOR or TACAN, but not both simultaneously). The TACAN system provides continuous precision bearing and distance information from a ground station. There are 126 channels from 1025 to 1150 mc for bearing information and 126 channels between 962-1024 mc and 1151-1213 mc for distance information. Useful range is line-of-sight.

Compass Package

The J-4 compass system is used. The electronics portion of the system will be repackaged to standard form; therefore, it is only part of the J-4 compass which is a precise, fighter-size, all latitude gyromagnetic compass.

ILS Package

The instrument landing system will be a repackaged version of the ARN-31 and ARN-32; therefore, the single package contains facilities for localizer, glide slope, and marker beacon reception. Localizer reception is 108.1 mc to 111.9 mc, glide slope reception is 333.8 mc to 334.4 mc, and marker beacon is 75 mc.

Broficon

The Broadcast Fighter Control receiver is so miniaturized that it is not part of the repackaged system. It is a small broadcast-frequency receiver that is mounted on, and is essentially part of, the control panel. Emergency control of fighter airplanes is possible through this receiver by using standard broadcast stations in the 550 kc to 1750 kc frequency band.

Gun Sight Amplifier Package

The electronics portion of the gunsight and the power supply for the infrared sight are combined in a single package of standard form. These circuits are part of the fire control system described elsewhere.

Air-to-Air IFF

The F-104A is not currently equipped with an air-to-air IFF system. The requirement was established very recently and a preliminary investigation of equipment now available or under development has not produced anything compatible with the F-104A Weapon System.

Data Link

The F-104A will be equipped with an airborne data link that is originally compatible with the contemporary frequency multiplex system in use by the USAF and will be capable of conversion to the future time multiplex system on a plug-in basis.

TACTICAL CONTROL

Attack by air on the Continental United States, or its areas of interest, can be detected and stopped only by careful surveillance and readiness on the part of the Air Defense System.

It is assumed that the attack will not be preceded by a declaration of war and that only limited time will be available for alerting the United States and implementing tactical plans.

The tactical control is managed, in a broad sense, at Air Division level and directly at Air Defense Direction Center (ADDC) level. The local air battle is observed on the radar scopes in an Air Defense Direction Center, and engagement by defense aircraft with hostile aircraft is controlled by voice vectoring. Upgrading of the tactical control of interceptor aircraft is gradually taking place and radar changes in the entire system will start with the advent of the AN/GPA-37, the interim system to be used for data link, and TAF progressive steps of the SAGE (Semi-Automatic Ground Environment) system.

Control Procedures

Control procedures may be defined as those tactics employed by the Air Defense Director in the interception of unidentified or hostile aircraft. Specific tactics used depend upon the situation and the armament (guns, rockets, or missiles) to be employed. The decision as to method of interception rests with the Director in the Air Defense Direction Center.

The F-104A Weapon System has been designed to use the most advanced tactical control methods. At present, however, tactical control of the F-104A Weapon System does not differ basically from tactical control of existing Air Defense weapon systems. In the initial employment of the F-104A, close control will be employed as it is generally used in normal operations at present. The pilot will be given specific vectors, altitudes, and speeds to fly, and will be guided to the intercept point by voice control.

In the development of modern weapon systems, tactical control planning and provisioning have been considered for a major upgrading within the Air Defense System. This upgrading will take place in three general steps:

1. **SAGE System**

   The SAGE system will initially place digital computer centers into existing radar nets, providing a foundation for the future system. The computer centers will use data link for transmitting tactical target data in digital form to weapon on intercept missions. The SAGE system should be able to meet most Air Defense needs. It is estimated that a single computing center will be able to handle 400 aircraft tracks and at the same time calculate mid-course guidance and return-to-base instructions for about 200 Air Defense Command weapons simultaneously.

2. **Future System**

   The future system, which will be an improvement of SAGE, will retain all of the equipment used in the basic Air Defense net and will have additional radar sets of new design for covering higher and lower flying aircraft. Additional computing facilities will be added as the task increases. The future system may eventually evolve into effective defense against ballistic missiles, but this phase will not be treated further at this time.

3. Broadcast Control (BROFICON)

The transmission of intelligence concerning the attacking force will be used only in emergencies.

ALERT STATUS

The F-104A Weapons System and associated sub-systems must be capable of meeting alert conditions as specified below. Aircraft will move progressively from one state of alert to the next higher state of alert. Cockpit alert (highest state of alert) may be implemented for short periods of alert under normal conditions.

Flight instruments and communications equipment must be operating prior to take-off from alert status. The following alert conditions may be imposed at the discretion of the Air Division Commander (Figures 2-23 and 2-24).

1. Released

Aircraft and aircrew released from defense commitment.

2. Reserve

Aircraft will be capable of becoming airborne within 3 hours of notification. These aircraft may be used for training or maintenance if they can meet prescribed alert requirements.

3. Backup

Aircraft will be capable of becoming airborne within 1 hour of notification. These aircraft may be used on local training flights or undergo maintenance if they can meet the prescribed alert requirements.

4. At Ease

Aircraft will be airborne within 30 minutes of scramble notification. Maintenance can be performed only if the prescribed alert requirements can be met.

5. Available — 15 Minute Alert

Aircraft will be airborne within 15 minutes of scramble notification. This is the normal state of alert for a limited number of aircraft. Specific requirements are:

a. Aircraft: On flight line, in alert shelter, or turn-around shelter.

b. Aircrew: In ready room of readiness building or vicinity of aircraft. If altitude suits are worn, a temperature control and ventilation system will be required in ready room or alert hangar.

c. External heat and cooling: As required.

d. All systems: Off.

e. Starters/Starting power: Available.

f. External power: Available.

g. Shelter and/or cover: Required under conditions of inclement weather.

6. Readiness — 5 Minute Alert

Aircraft will be airborne within 5 minutes of scramble notification. This is the normal state of alert for a limited number of aircraft in alert hangars. Specific requirements are:

a. Aircraft: In or near alert hangars.

b. Aircrew: In ready rooms. If altitude suits are worn, a temperature and ventilation system will be required.

c. External heat and cooling: As required.

d. ASG-14 fire control system: Off.

e. Communications system: Off or as required.

f. Engine: Off.

g. Starters/Starting power: Connected.

h. External power: As required.

i. Shelter and/or cover: As required during conditions of inclement weather.

7. Stand-by Cockpit Alert

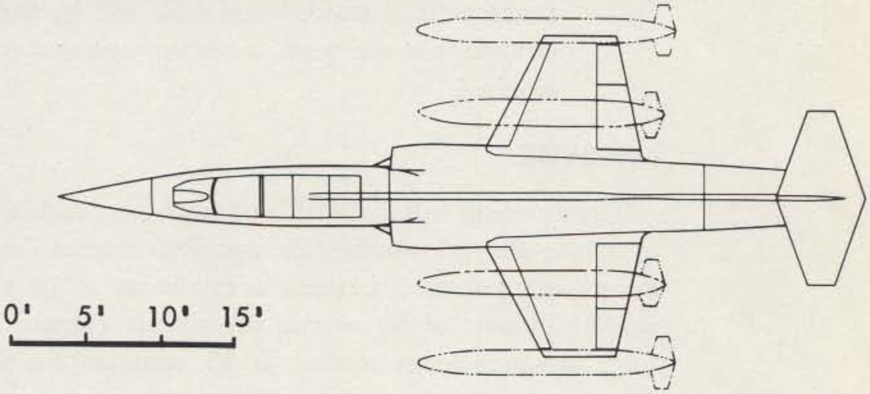
Aircraft will be airborne as soon as possible after scramble notification, but not later than 5 minutes. This is not a normal state of alert but may be used to integrate the greatest possible number of aircraft into the air battle in a minimum amount of time. Specific requirements will be the same as for 5 minute alert except for the pilot who will be in the cockpit ready to start the engine with starters/starting power connected and on. Ground crew will be standing by the aircraft. If altitude suits are worn, a temperature and ventilation system will be required.

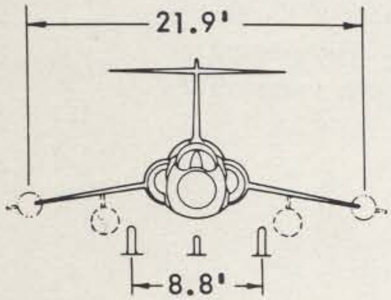
RESERVICE

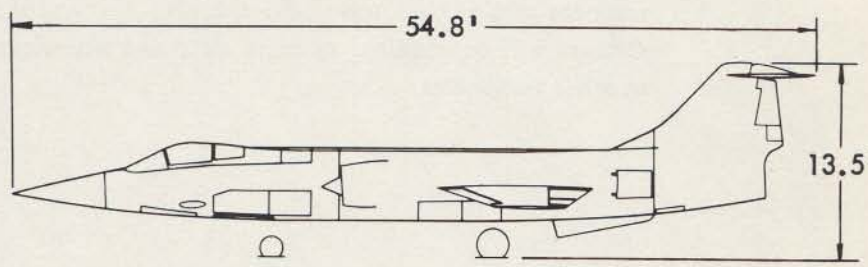
The squadron will be capable of reservicing each aircraft within 15 minutes of engine shut-off whether the squadron returns "en masse" or singly. "En masse" is interpreted to mean a maximum of 18 aircraft with a minimum landing interval of 30 seconds per aircraft (Figure 2-25 and 2-26). Therefore, squadron reservice time is 15 minutes plus 9 minutes or a total of 24 minutes. Reservice time will be computed from engine shut-off in the reservice area to readiness of the aircraft for scramble notification. Turn-around shelters will be required to meet alert and reservicing requirements under all weather conditions.

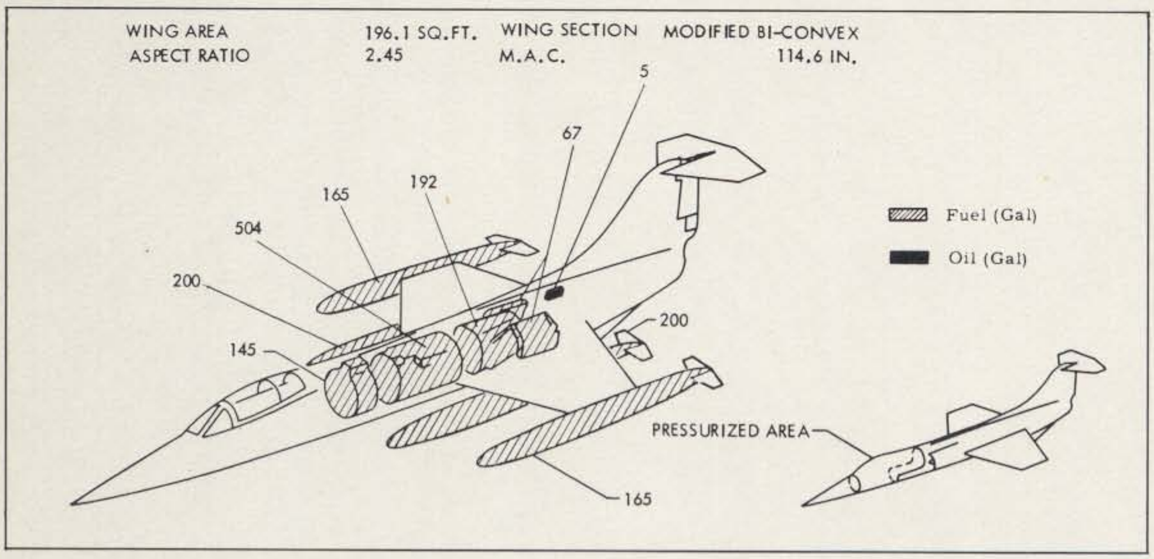
AIRPLANE DIMENSIONS AND STATIONS

WING AREA	196.1 SQ. FT.
AILERON AREA	9.4 SQ. FT.
TRAILING EDGE FLAP AREA	23.1 SQ. FT.
LEADING EDGE FLAP AREA	17.0 SQ. FT.
STABILIZER AREA	48.2 SQ. FT.
RUDDER AREA	4.3 SQ. FT.
SPEED BRAKES AREA (PROJECTED)	8.2 SQ. FT.









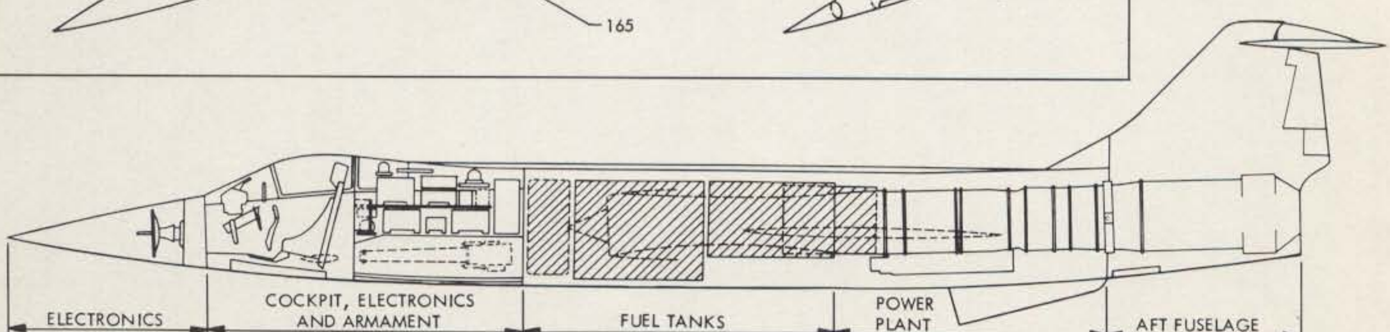
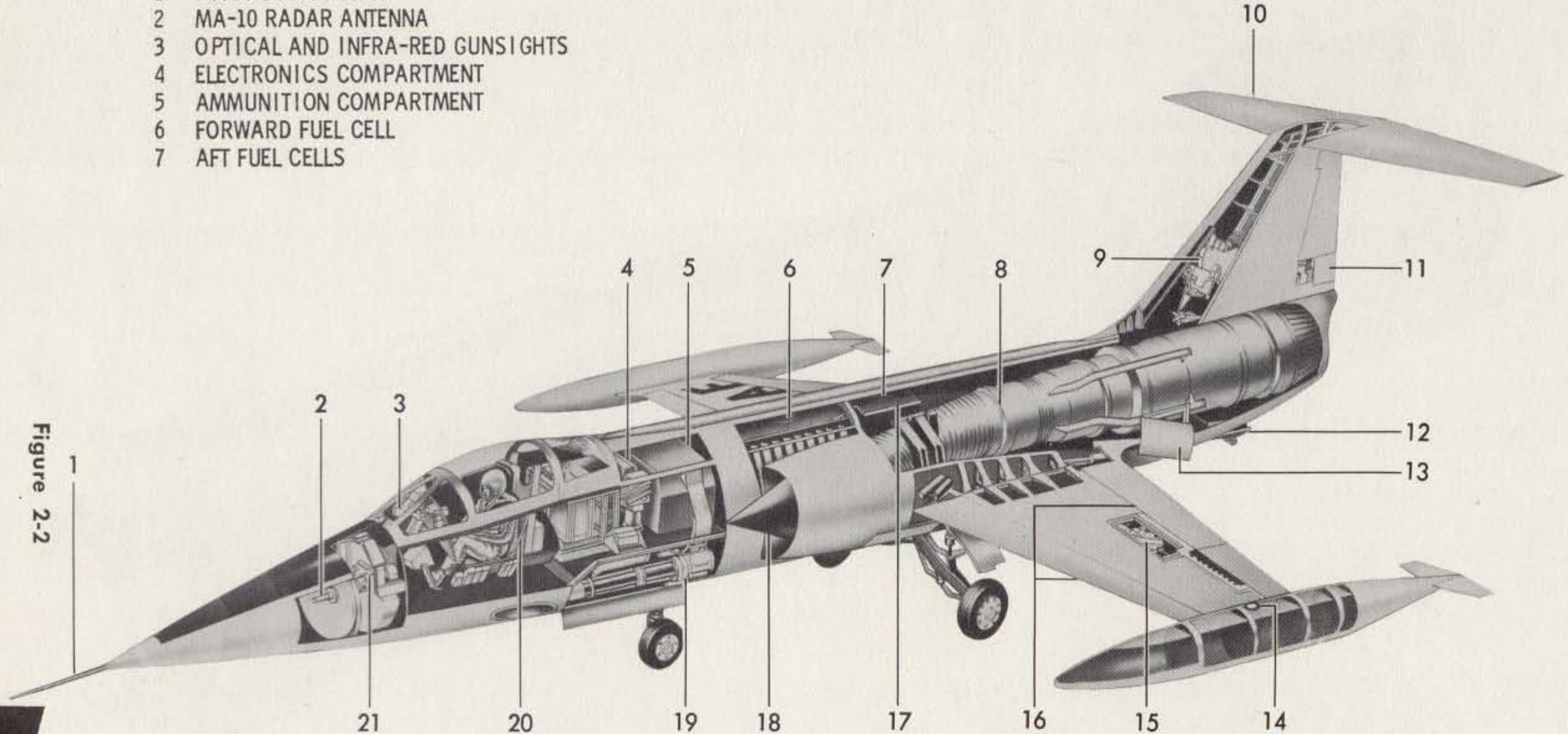


Figure 2-1

AIRPLANE GENERAL ARRANGEMENT

1 PITOT STATIC BOOM
2 MA-10 RADAR ANTENNA
3 OPTICAL AND INFRA-RED GUNSIGHTS
4 ELECTRONICS COMPARTMENT
5 AMMUNITION COMPARTMENT
6 FORWARD FUEL CELL
7 AFT FUEL CELLS



8 J79-GE-3 ENGINE WITH AFTERBURNER
9 HORIZONTAL STABILIZER POWER CONTROL ASSEMBLY
10 CONTROLLABLE HORIZONTAL STABILIZER
11 YAW DAMPER
12 DRAG CHUTE STOWAGE COMPARTMENT
13 SPEED BRAKE
14 TIP TANK FILLER CAP
15 LEFT AILERON POWER CONTROL ASSEMBLY
16 LEADING EDGE AND TRAILING EDGE FLAPS
17 SINGLE POINT REFUELING WELL
18 ENGINE AIR INTAKE DUCTS
19 T-171 E-3 20MM GUN
20 DOWNWARD EJECTION SEAT
21 MA-10 RADAR

Figure 2-2

J-79-3 ENGINE

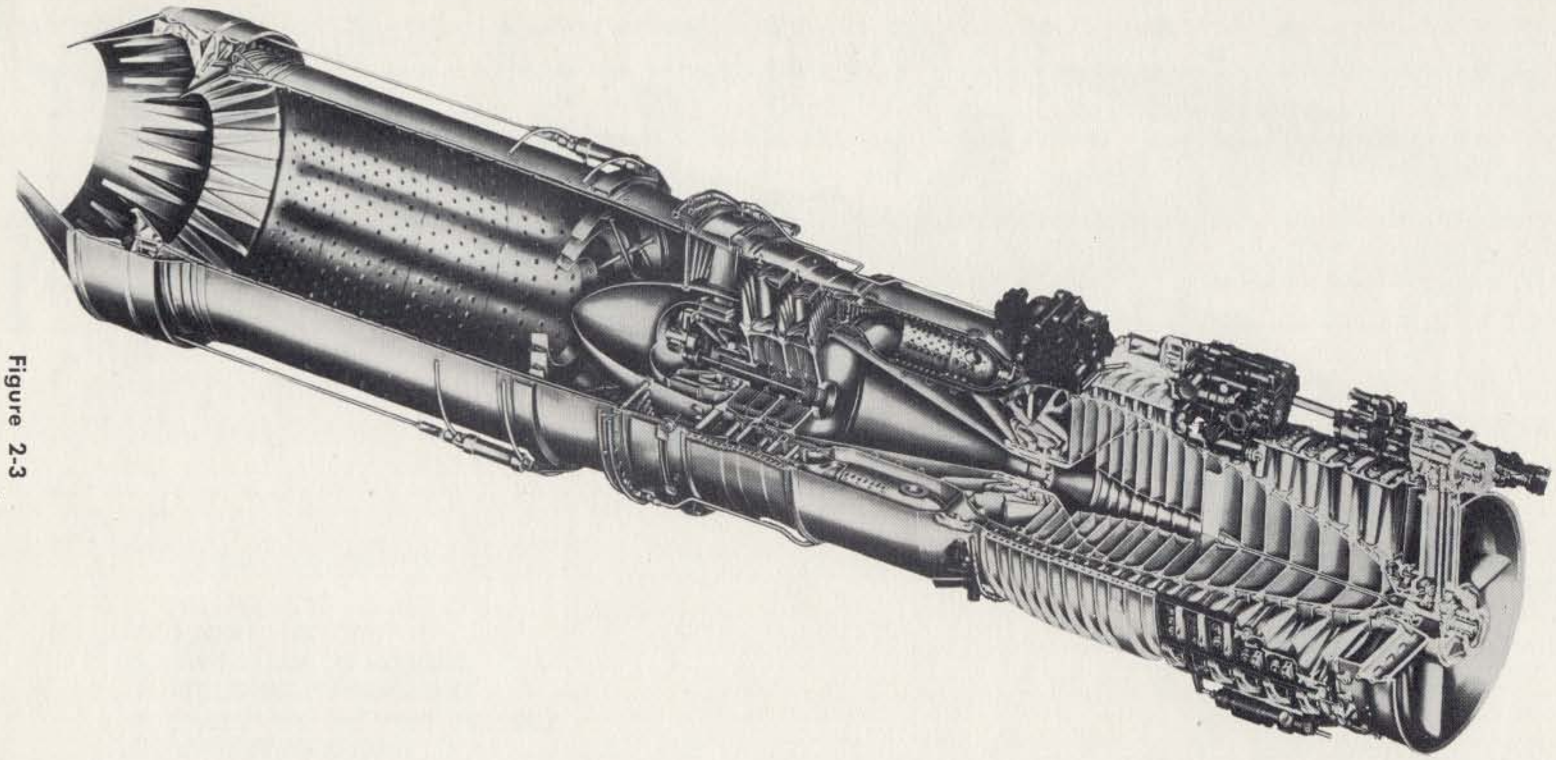


Figure 2-3

AIRCRAFT FUEL SYSTEM

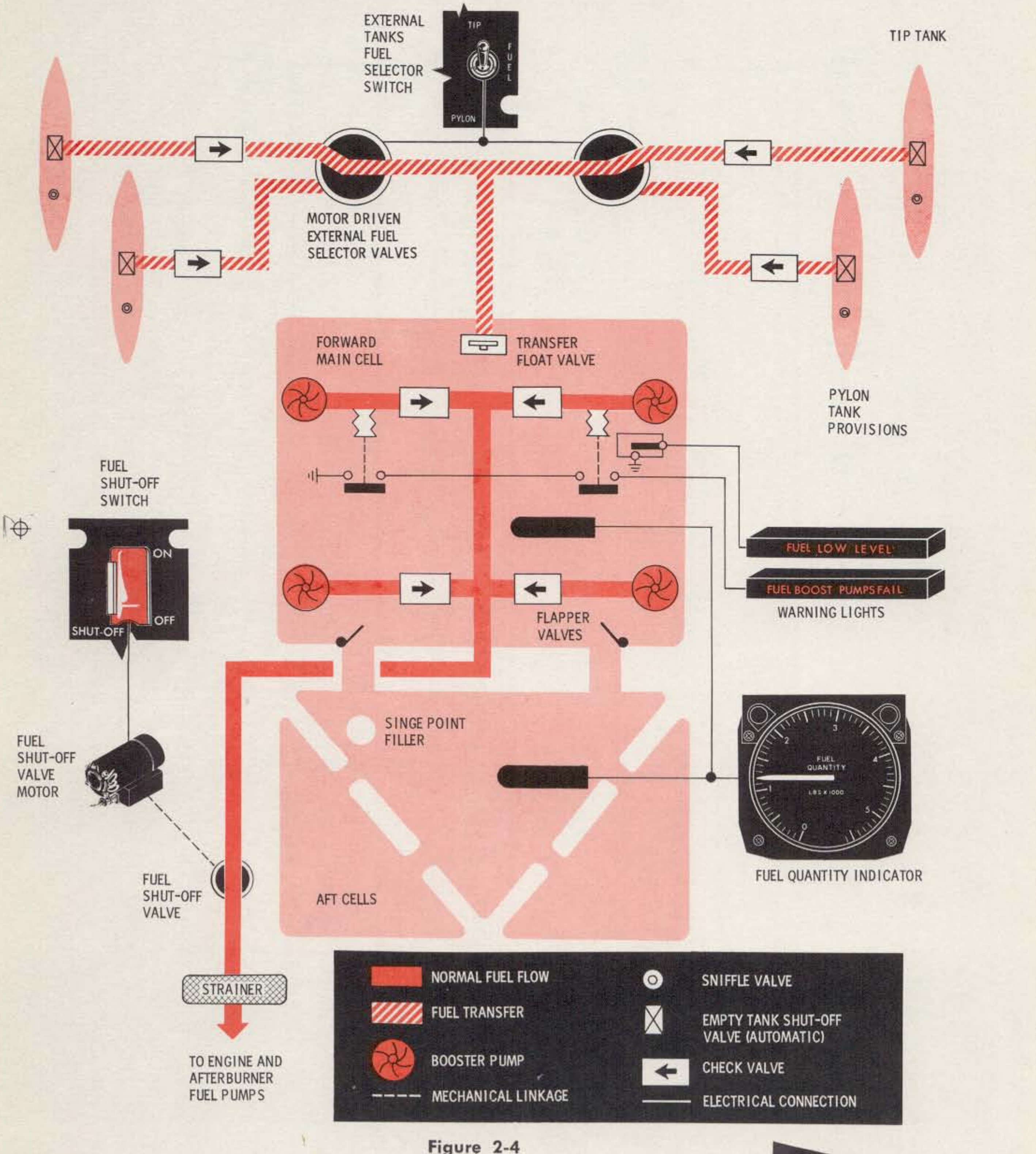


Figure 2-4

HYDRAULIC BLOCK DIAGRAM

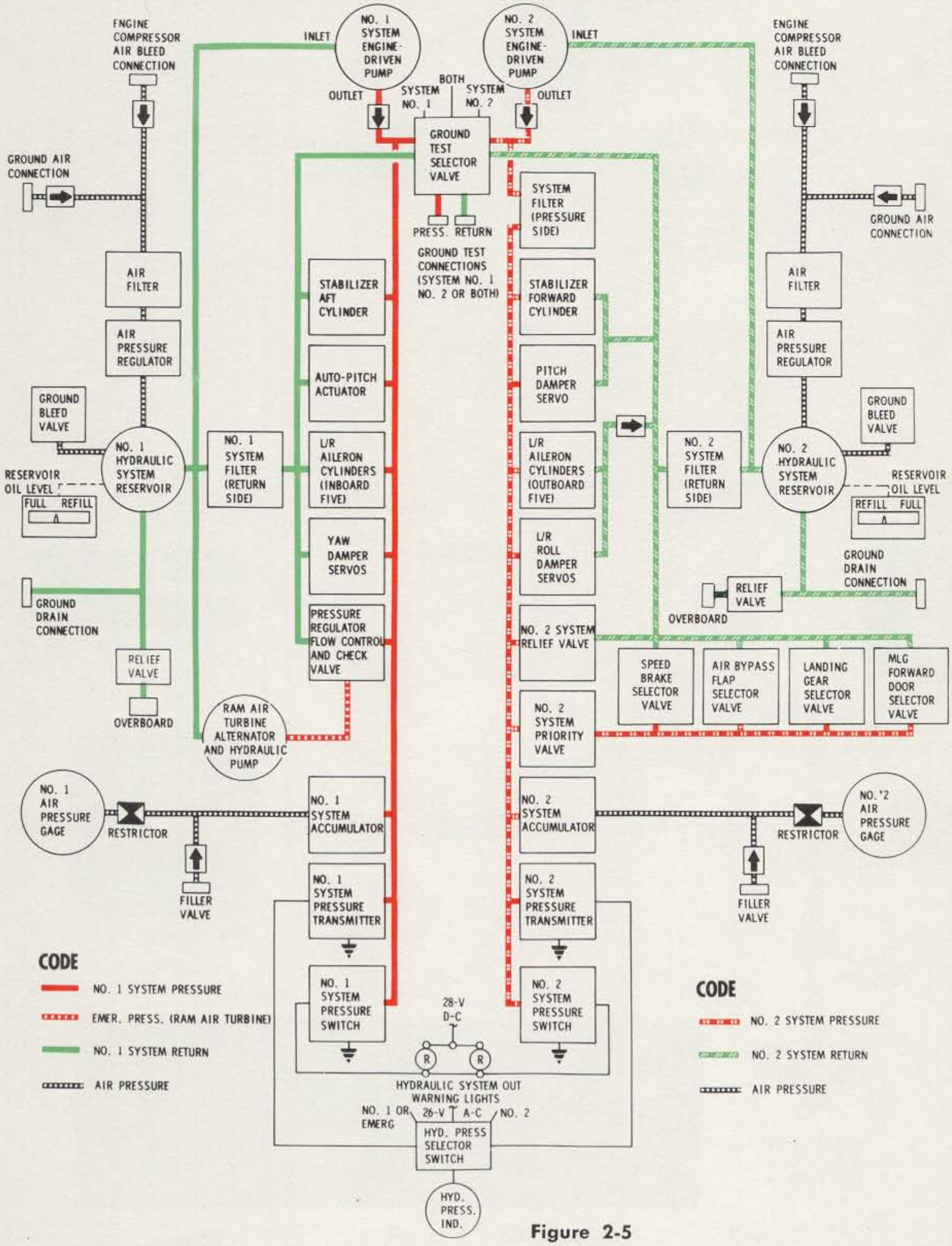
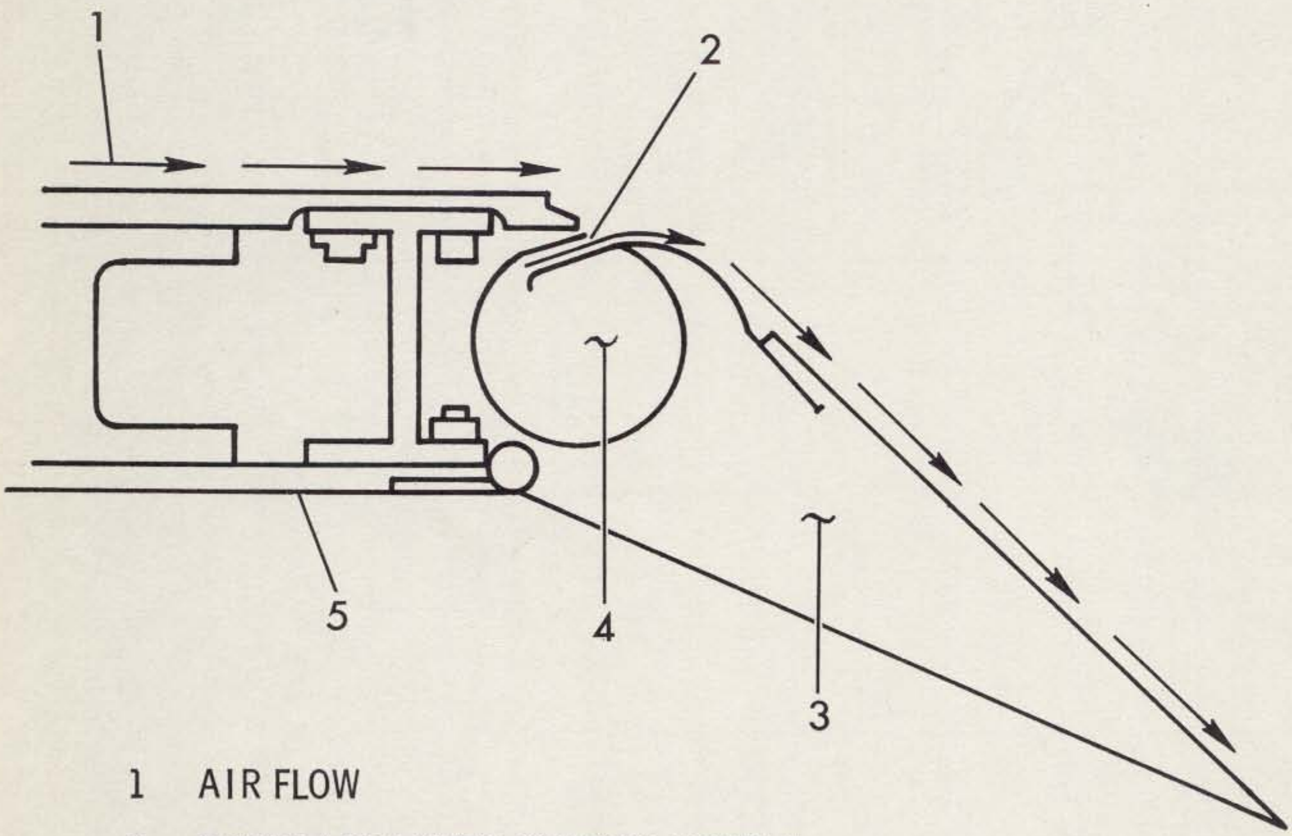


Figure 2-5

BOUNDARY LAYER CONTROL



1 AIR FLOW

2 BOUNDARY LAYER CONTROL NOZZLE

3 TRAILING EDGE FLAP

4 BOUNDARY LAYER CONTROL DUCT

5 WING SECTION

Figure 2-6

ELECTRICAL POWER SUPPLY SYSTEM

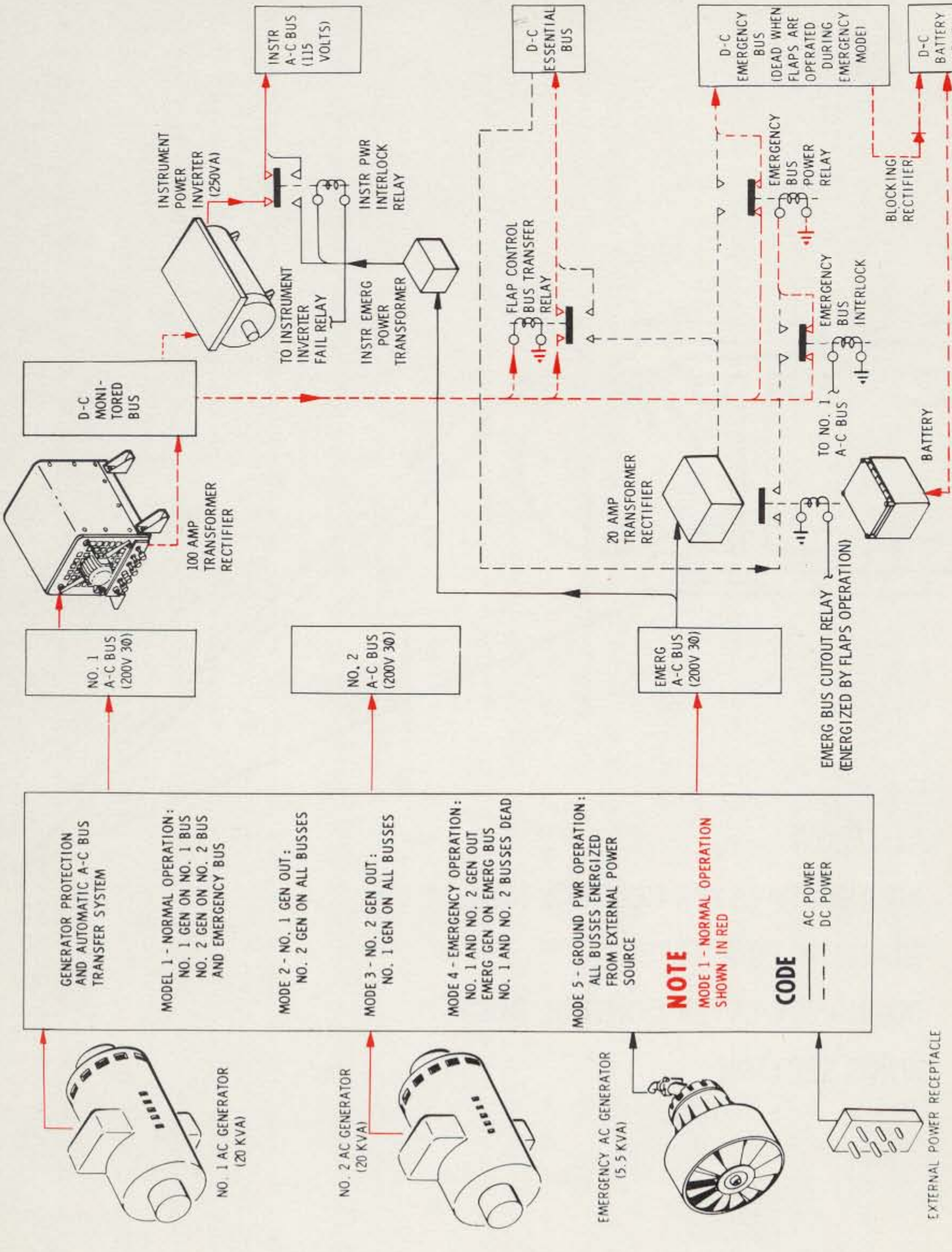


Figure 2-7

PNEUMATIC SYSTEM

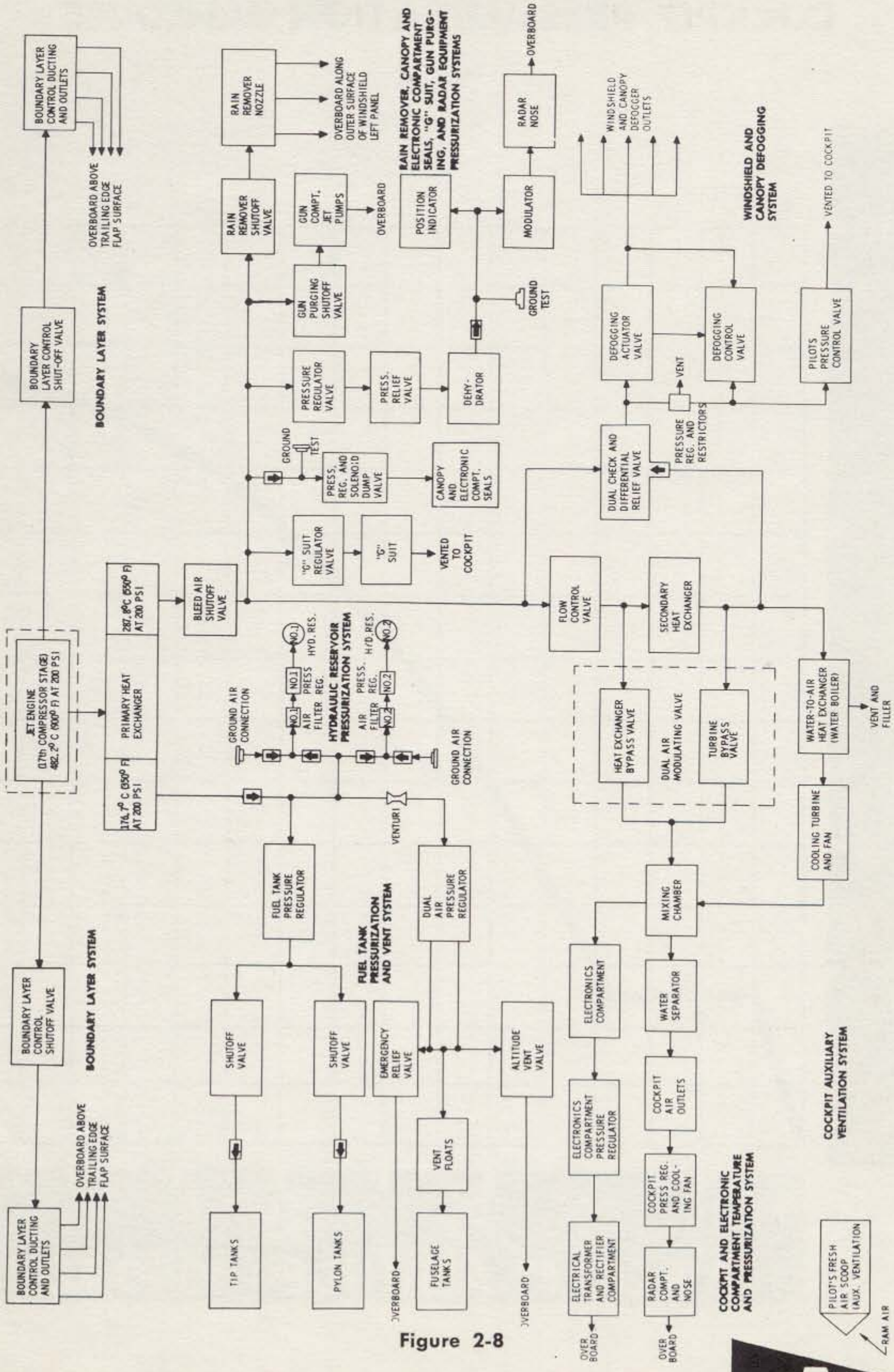


Figure 2-8

COCKPIT PRESSURIZATION SCHEDULE

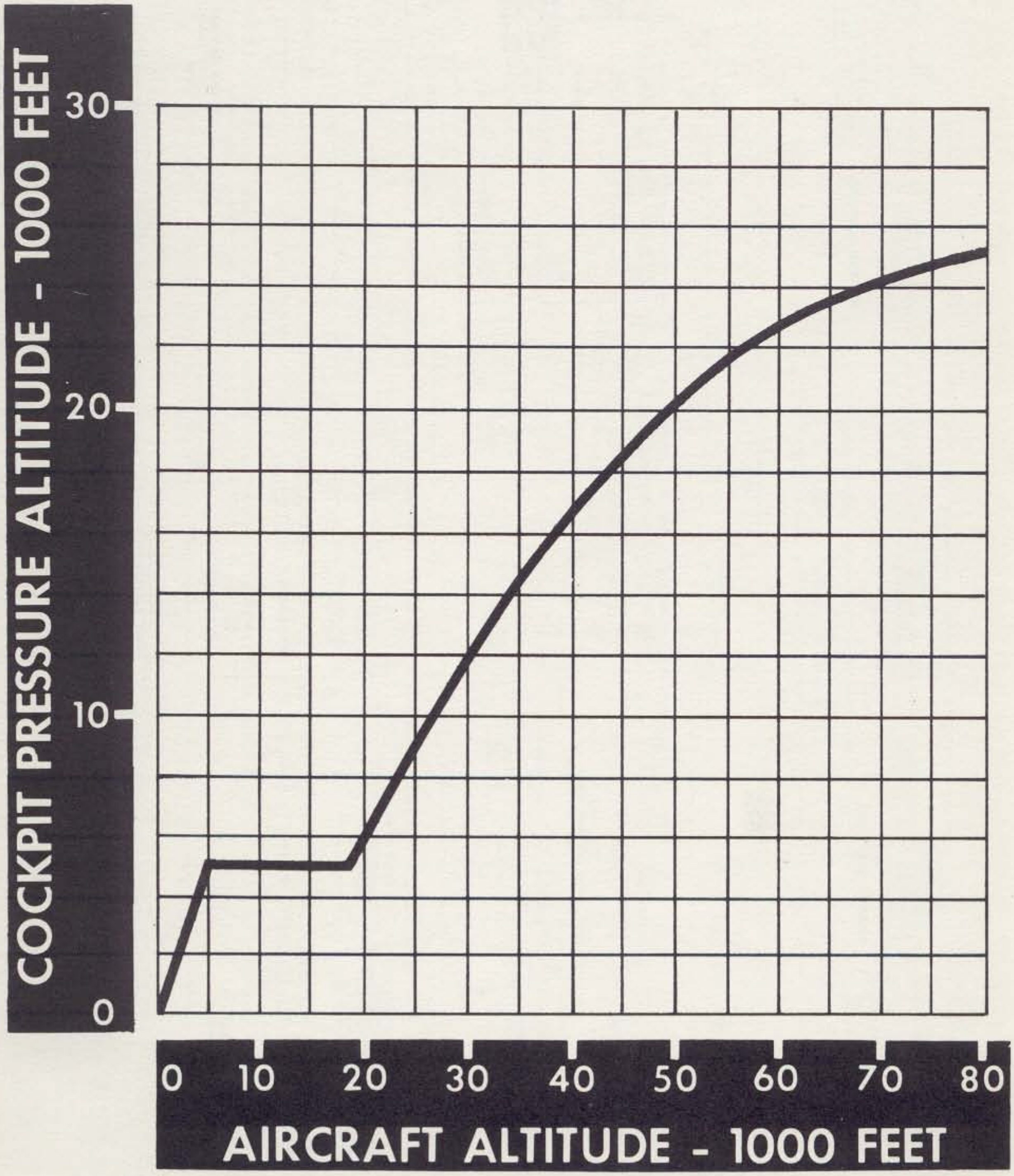


Figure 2-9

OXYGEN SUPPLY SYSTEM

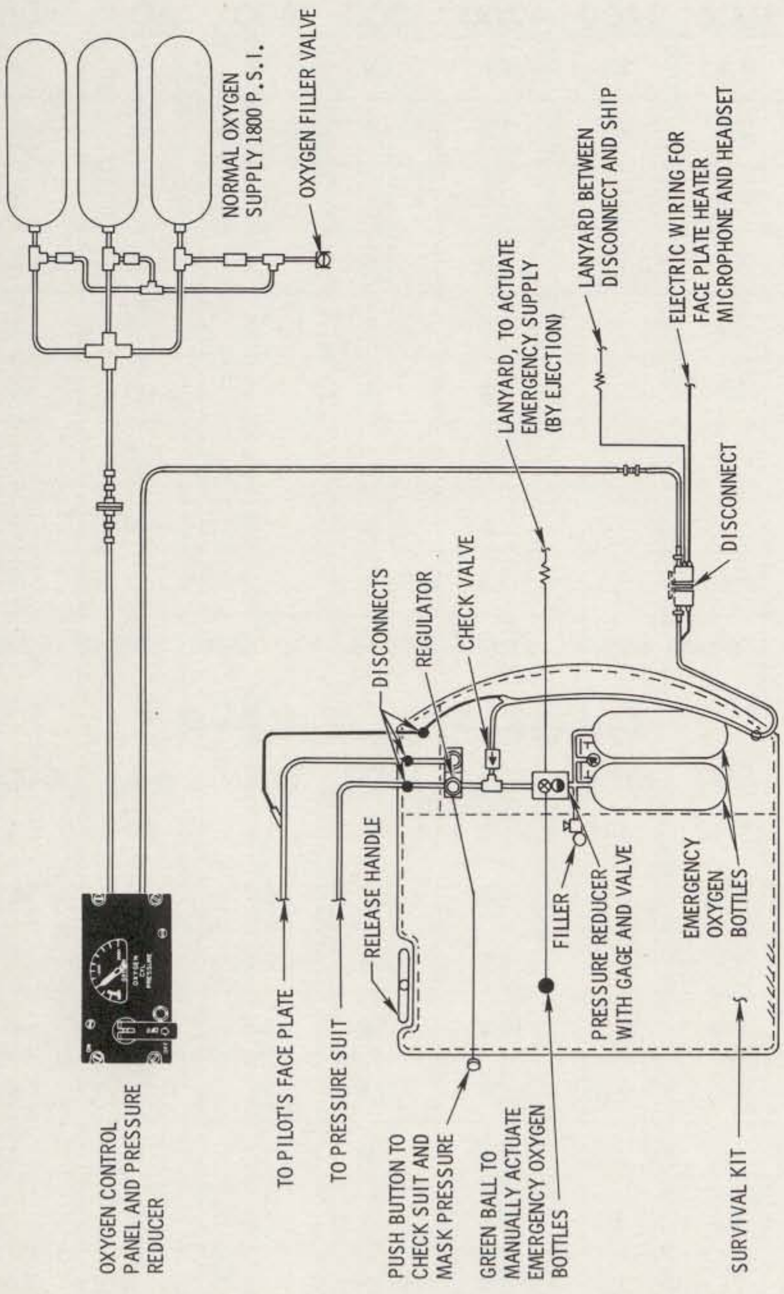


Figure 2-10

OXYGEN DURATION

COCKPIT ALTITUDE (FEET)	GAGE PRESSURE–P.S.I. 1800	1600	1400	1200	1000	800	600	400	BELOW 400
40,000 & UP	3.2	2.8	2.5	2.1	1.8	1.4	1.1	.7	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
35,000	3.2	2.8	2.5	2.1	1.8	1.4	1.1	.7	
30,000	2.5	2.2	1.9	1.6	1.4	1.1	.8	.5	
25,000	1.9	1.7	1.5	1.3	1.0	.8	.6	.4	
20,000	1.5	1.3	1.1	1.0	.8	.6	.5	.3	
15,000	1.2	1.0	.9	.8	.6	.5	.4	.3	
10,000	.9	.8	.7	.6	.5	.4	.3	.2	
5,000	.8	.7	.6	.5	.4	.3	.3	.2	
SEA LEVEL	.6	.5	.5	.4	.3	.3	.2	.1	

DURATION FOR FACEPLATE AND MC-4 PRESSURE SUIT. 3 CYLINDERS : AN 6025 AX147

COCKPIT ALTITUDE (FEET)	GAGE PRESSURE–P.S.I. 1800	1600	1400	1200	1000	800	600	400	BELOW 400
40,000 & UP	6.0	5.4	4.7	4.0	3.3	2.7	2.0	1.3	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
35,000	6.0	5.4	4.7	4.0	3.3	2.7	2.0	1.3	
30,000	4.4	3.8	3.5	2.9	2.4	2.0	1.5	.9	
25,000	3.5	2.9	2.5	2.2	1.8	1.5	1.1	.7	
20,000	2.5	2.4	2.0	1.6	1.5	1.1	.9	.5	
15,000	2.0	1.8	1.6	1.5	1.1	.9	.7	.5	
10,000	1.6	1.5	1.3	1.1	.9	.7	.5	.4	
5,000	1.3	1.1	1.1	.9	.7	.5	.4	.4	
SEA LEVEL	1.1	.9	.9	.7	.5	.5	.4	.2	

ESTIMATED DURATION FOR A-13A PRESSURE DEMAND MASK. 3 CYLINDERS: AN6025 AX147

Figure 2-11

EJECTION SEAT SYSTEM

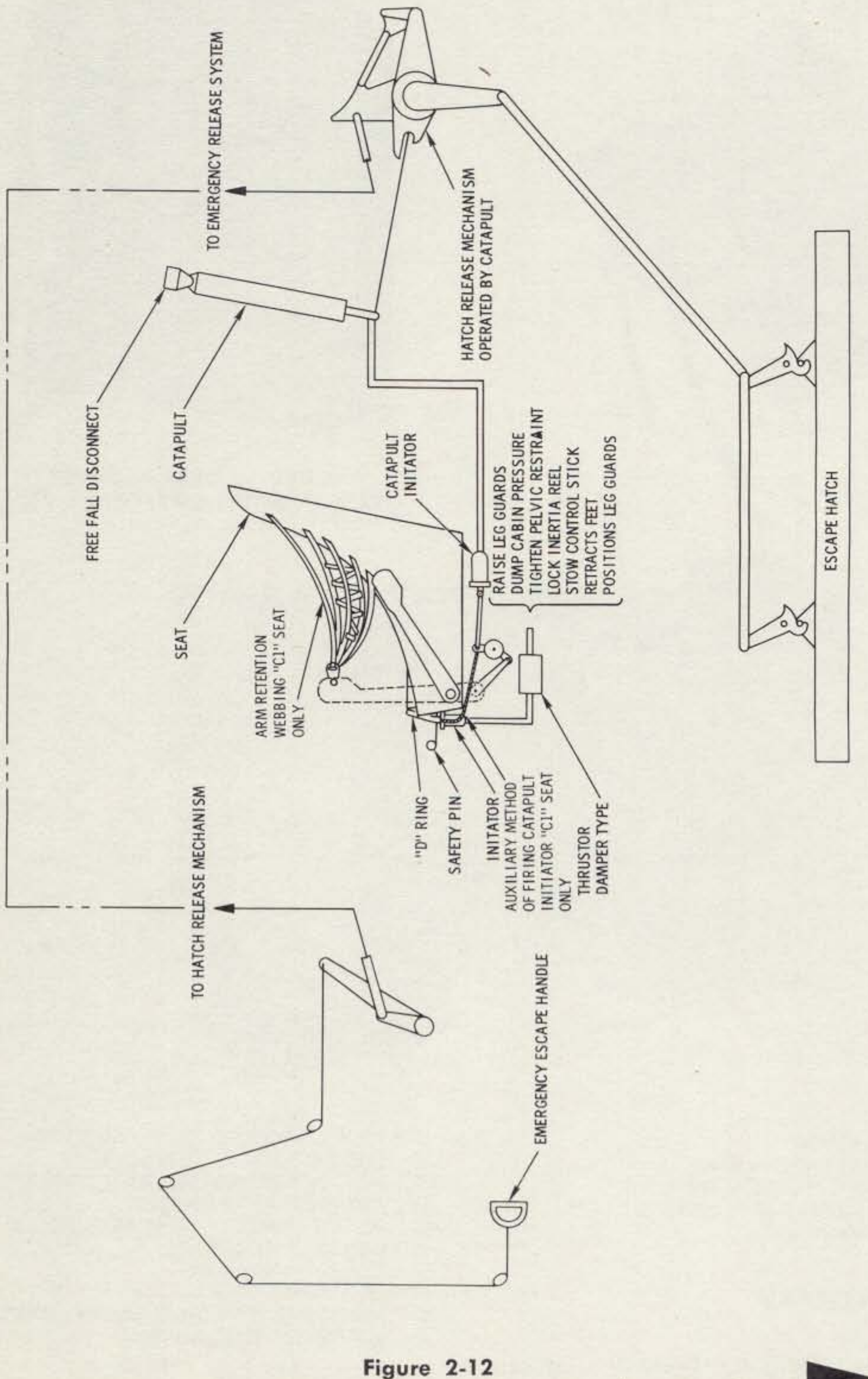


Figure 2-12

SURVIVAL KIT

SURVIVAL GEAR PACKAGE
(SEAT CUSHION & RAFT REMOVED)

1 SURVIVAL KIT CONTAINER
2 LANYARD TO PILOTS PERSONAL GEAR
3 ZIPPERED SURVIVAL PACK (ATTACHED TO KIT)
4 SURVIVAL GEAR (CONTENTS TO BE DETERMINED BY MISSION OR COMMAND)
5 RUBBER PARKA
6 NYLON LANYARD
7 LANYARD HOLDER (EXPENDED)
8 SEAT CUSHION
9 PK-2 ONE MAN RAFT
10 SURVIVAL KIT (AS RETREIVED AFTER BAIL OUT)
11 PILOT'S OXYGEN AND RADIO CONNECTIONS
12 EMERGENCY BOTTLES FILLER VALVE
13 EMERGENCY OXYGEN PRESSURE INDICATOR
14 EMERGENCY OXYGEN SUPPLY
15 QUICK DISCONNECT FROM AIRCRAFT SUPPLY
16 PARACHUTE ATTACHMENTS
17 MC-4 SUIT CONNECTION
18 LEG STRAPS
19 MANUAL EMERGENCY OXYGEN SUPPLY ACTUATOR
20 SURVIVAL KIT RELEASE HANDLE

Figure 2-13

FCS COMPONENTS

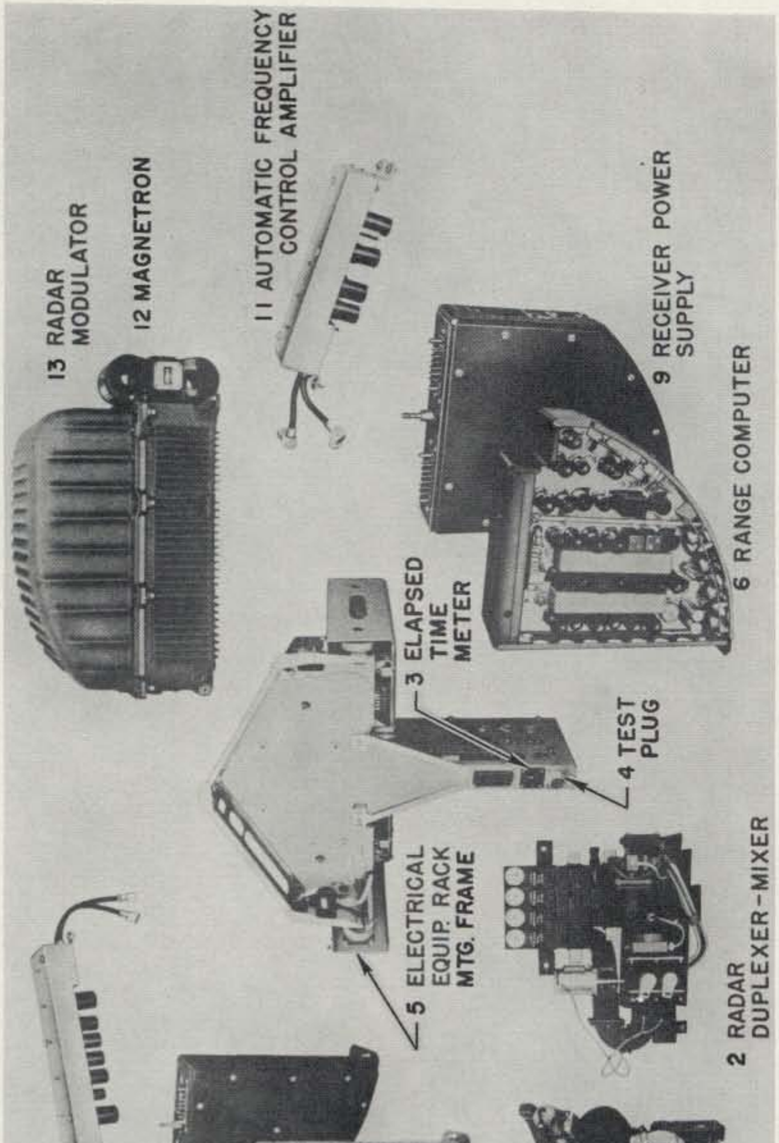


Figure 2-14

RADAR SCOPE PRESENTATION

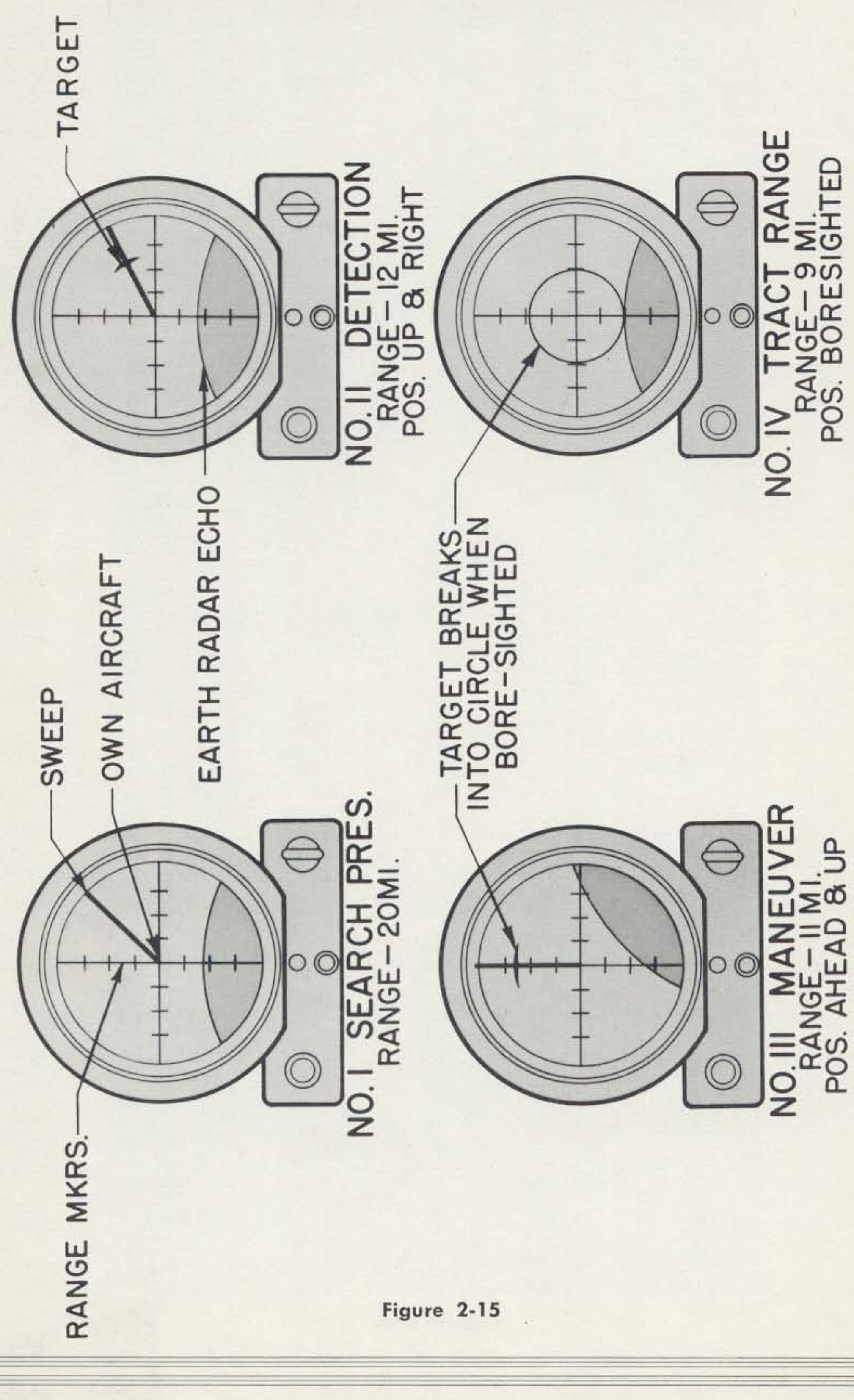


Figure 2-15

SEARCH RADAR COMPONENTS

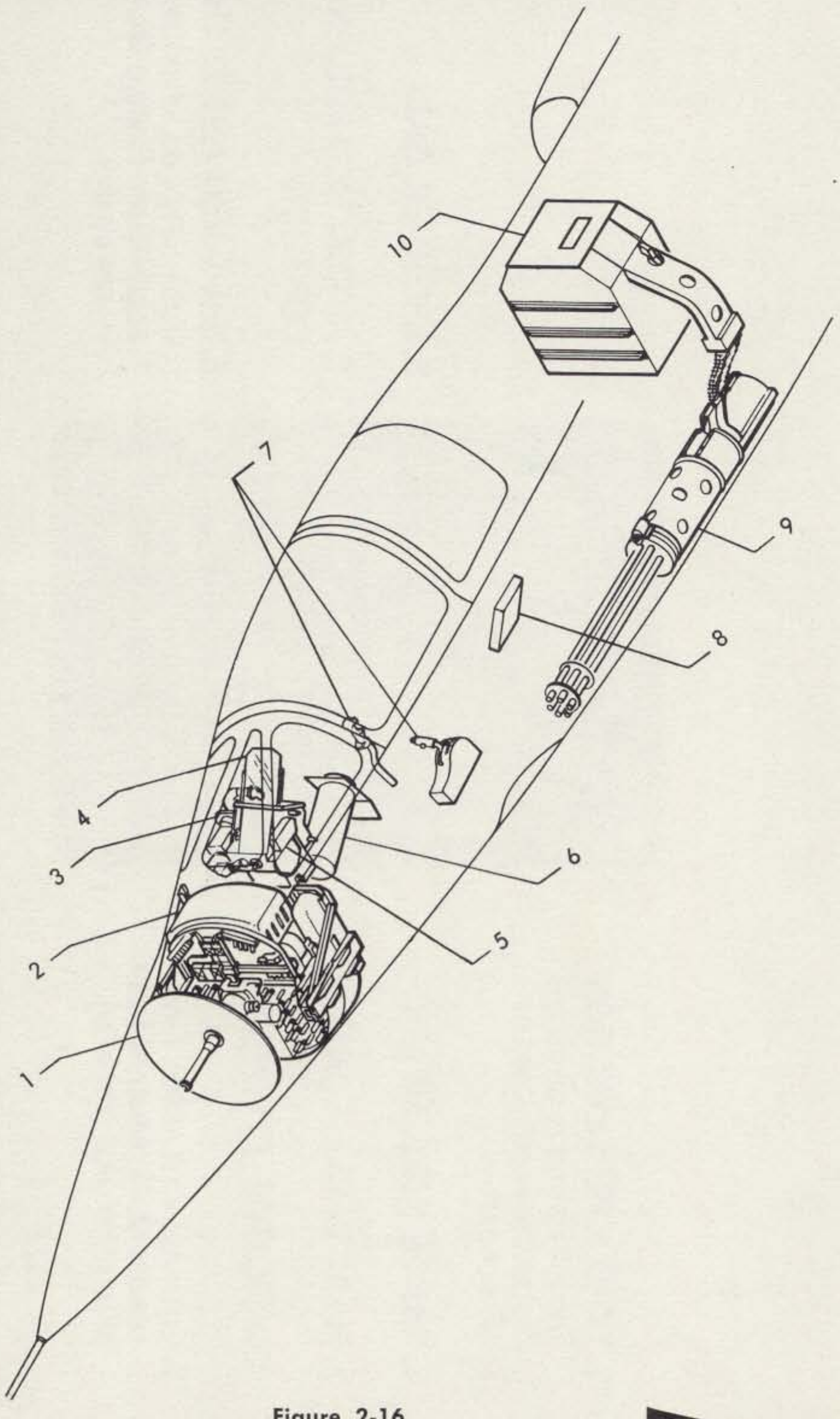


Figure 2-16

UNIFIED CONTROL

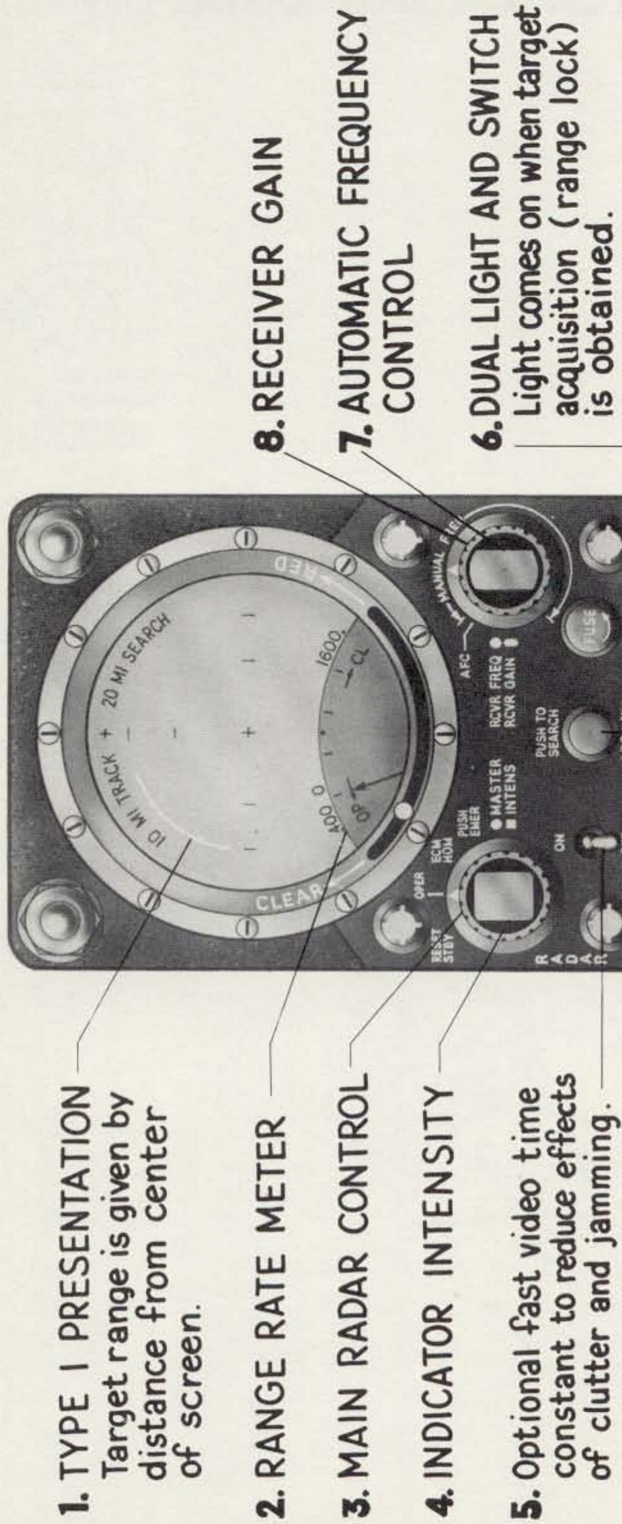


Figure 2-17

OPTICAL SIGHT

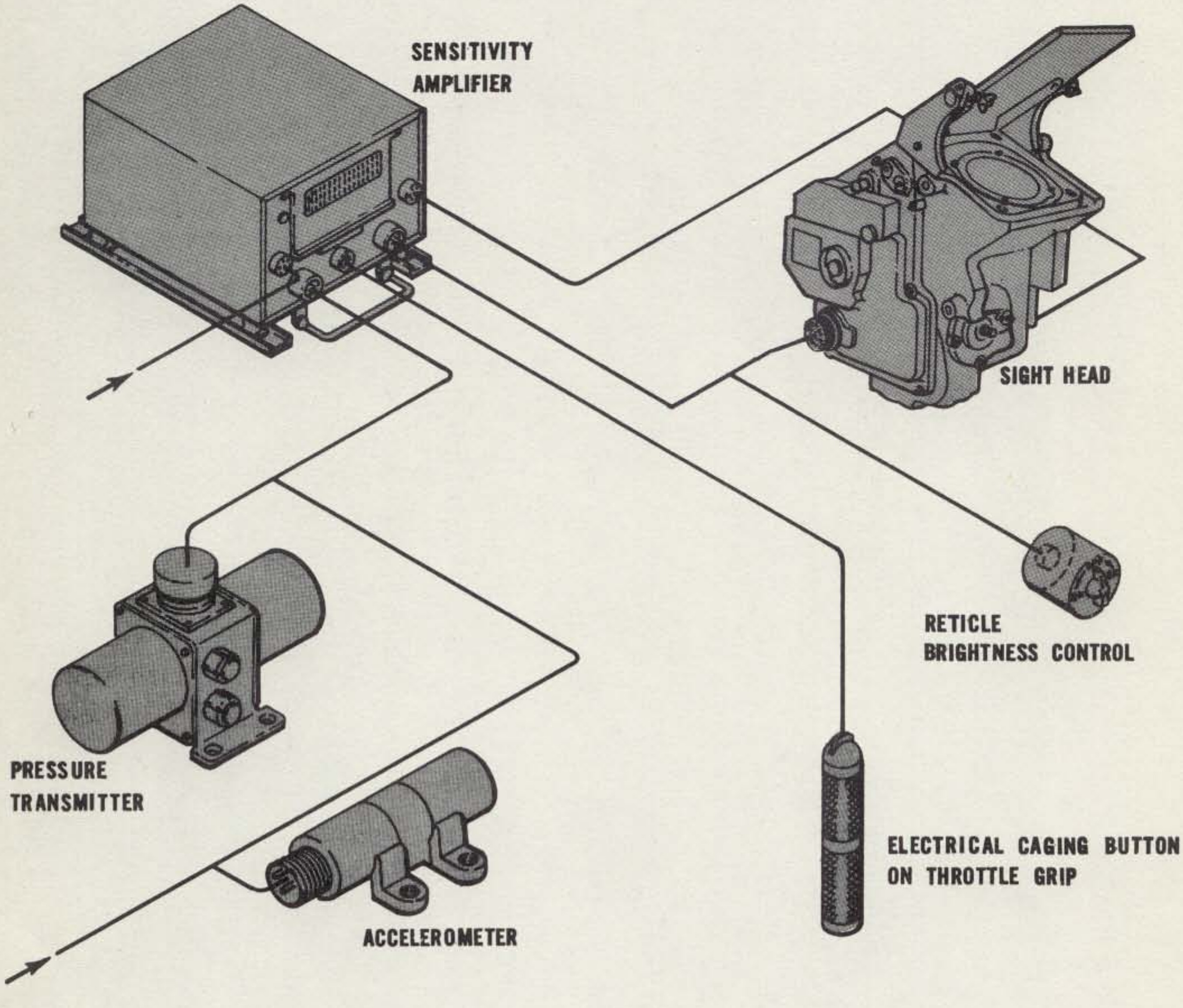


Figure 2-18

INFRARED SIGHT

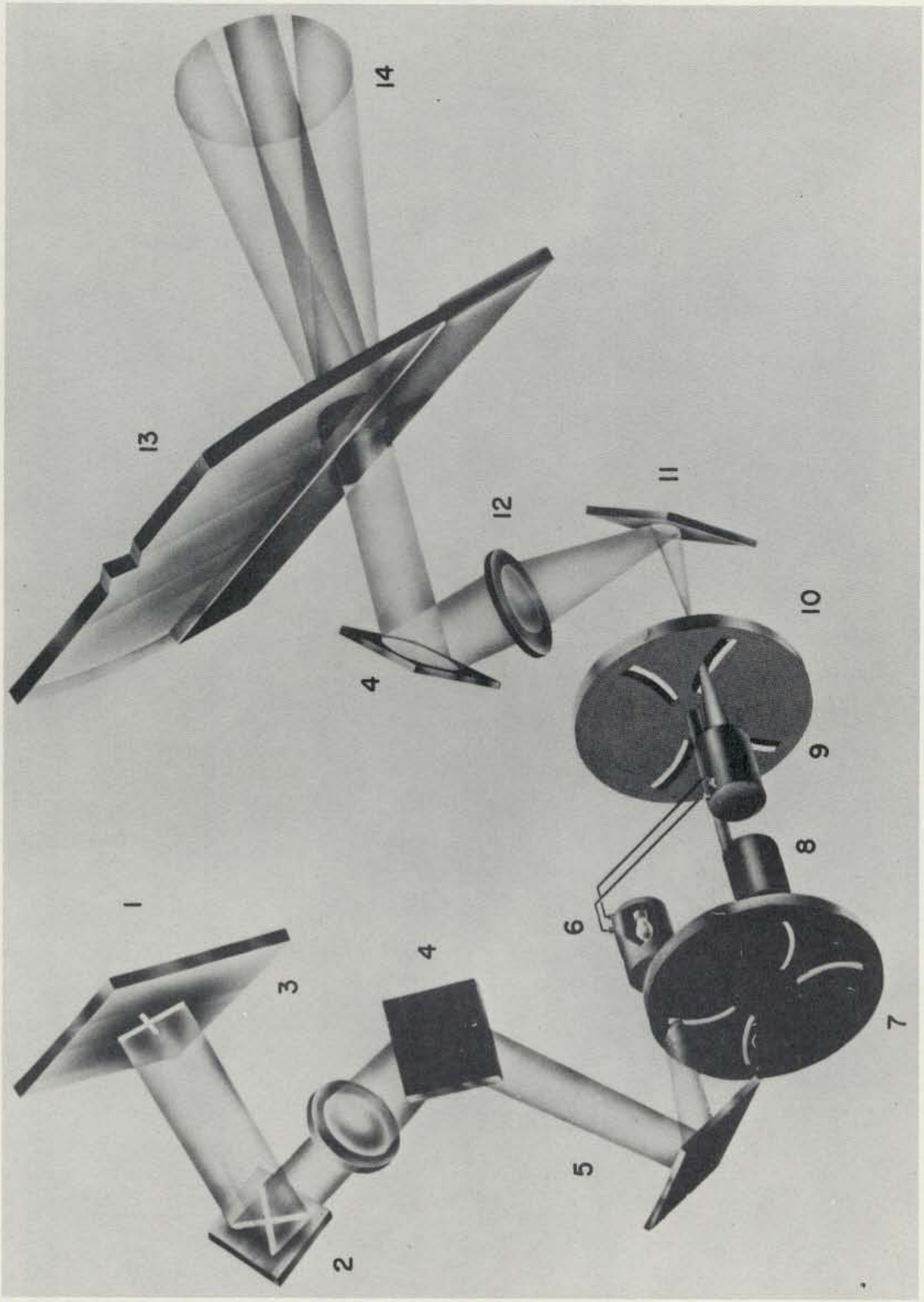


Figure 2-19

SIDEWINDER 1A (GAR 8) MISSILE COMPONENTS

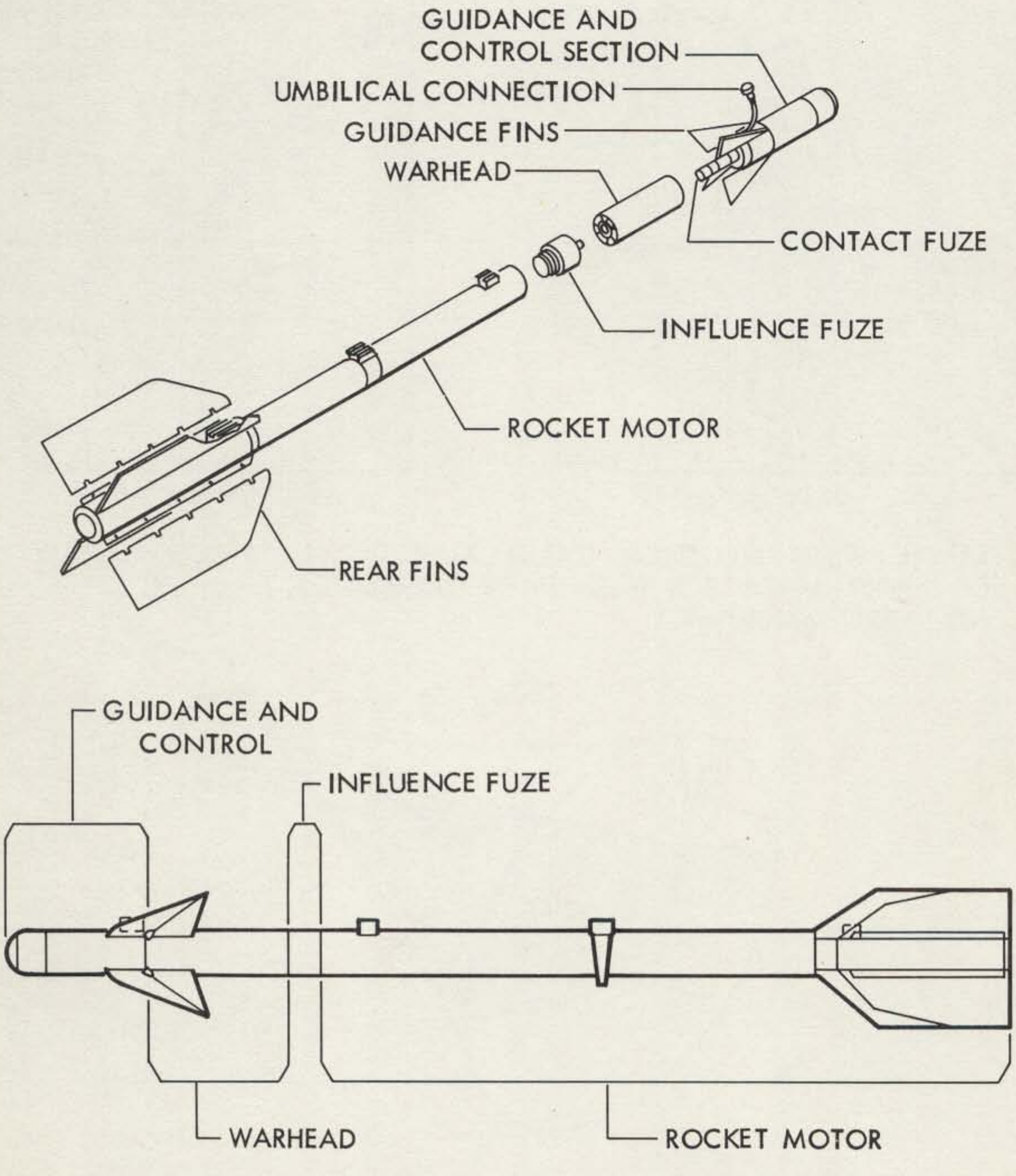
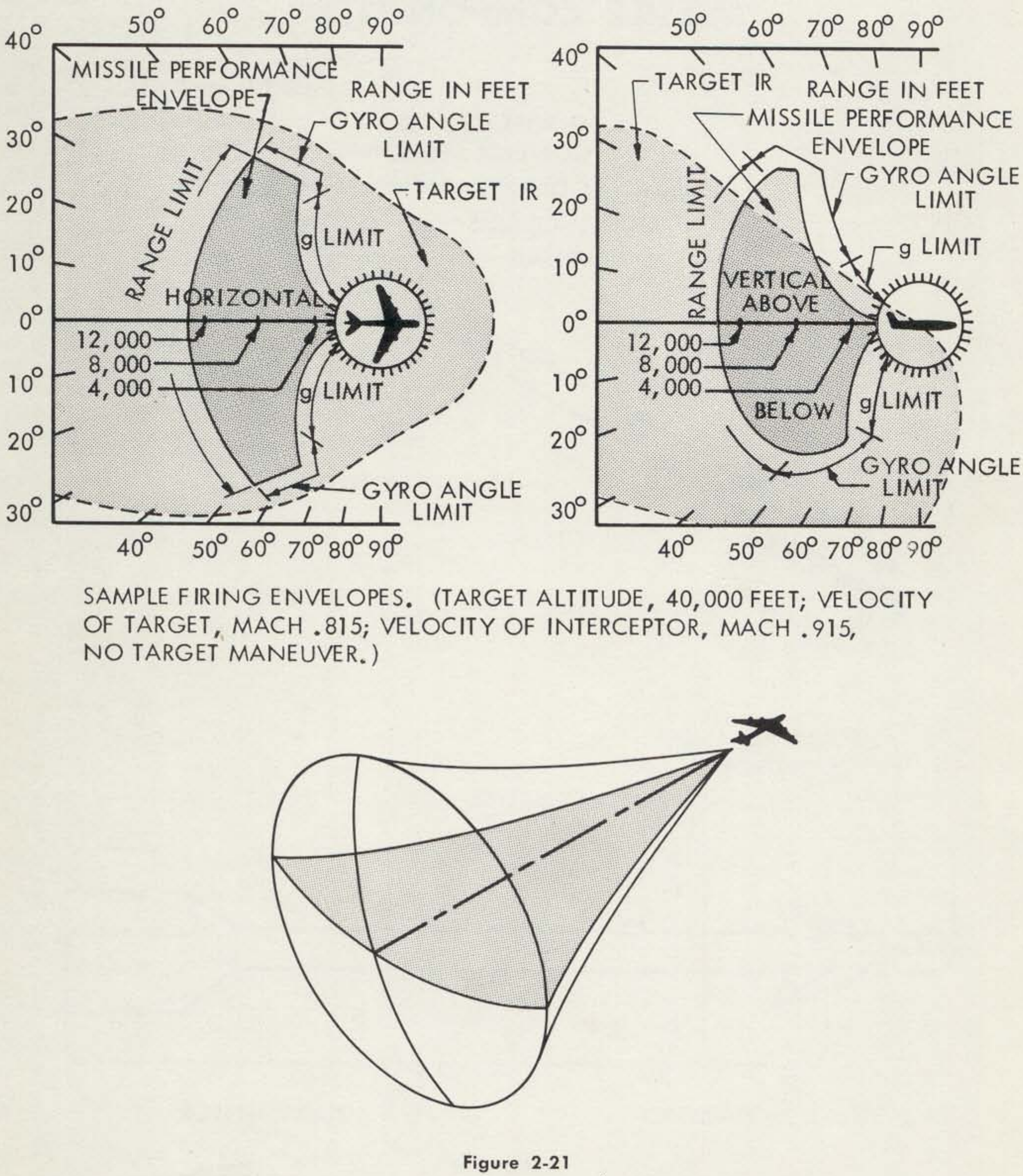


Figure 2-20

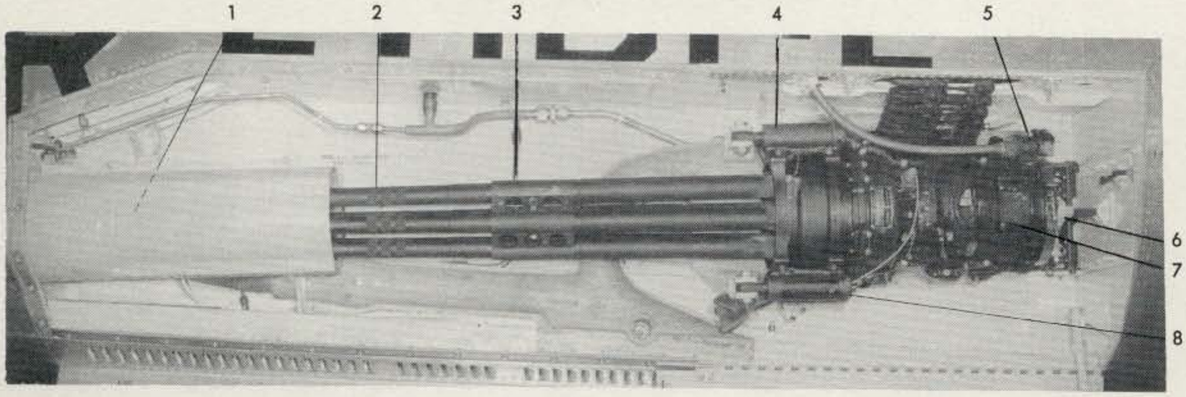
MISSILE FIRING ENVELOPE

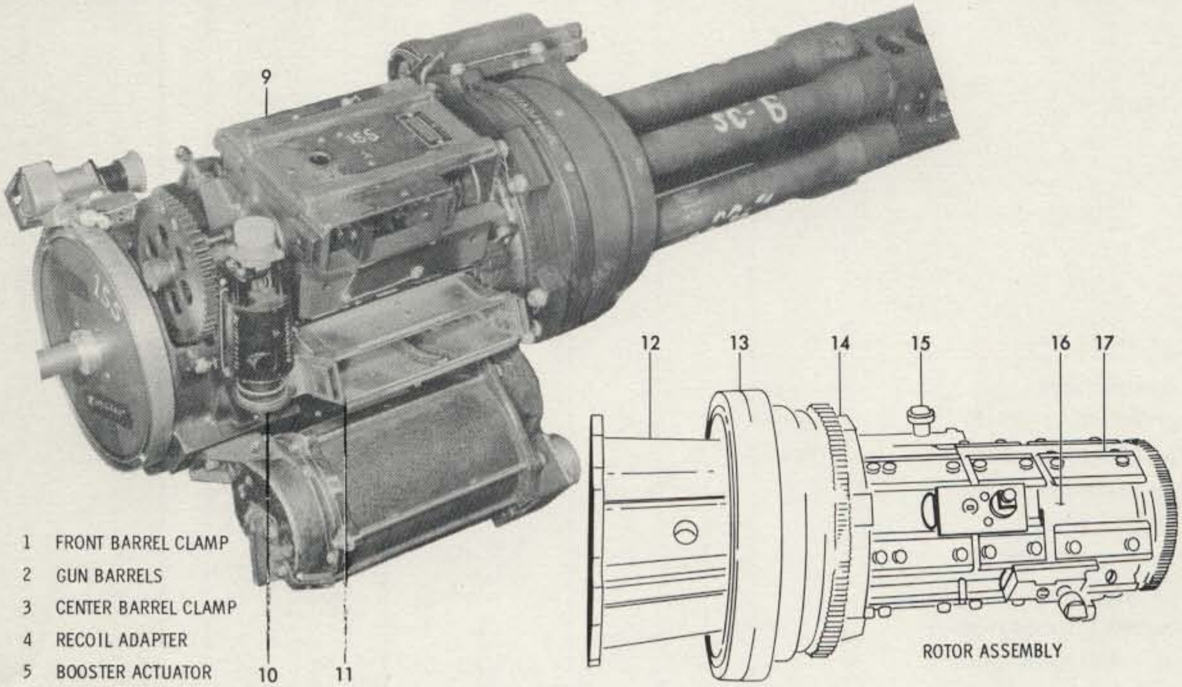


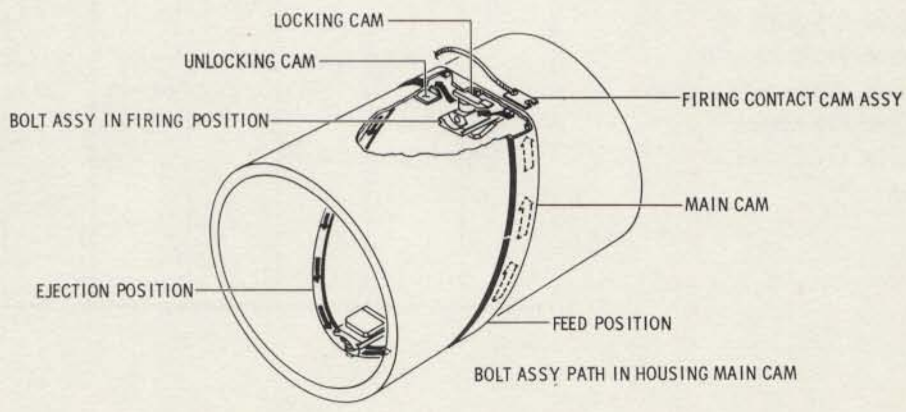
SAMPLE FIRING ENVELOPES. (TARGET ALTITUDE, 40,000 FEET; VELOCITY OF TARGET, MACH .815; VELOCITY OF INTERCEPTOR, MACH .915, NO TARGET MANEUVER.)

Figure 2-21

T-171E-3 GUN







1 FRONT BARREL CLAMP
2 GUN BARRELS
3 CENTER BARREL CLAMP
4 RECOIL ADAPTER
5 BOOSTER ACTUATOR
6 HOUSING ASSY
7 BOLT ACCESS DOOR
8 DRIVE UNIT
9 FEEDER ASSY
10 CLEARING CAM ASSY
11 CASE EJECTION CHUTE
12 STUB ROTOR
13 THRUST BEARING
14 CONNECTOR BLOCK
15 BOLT ASSY
16 REAR ROTOR
17 AFT TRACK

Figure 2-22

ENEMY WARNING ALERT START

(1 min. 15 sec.)

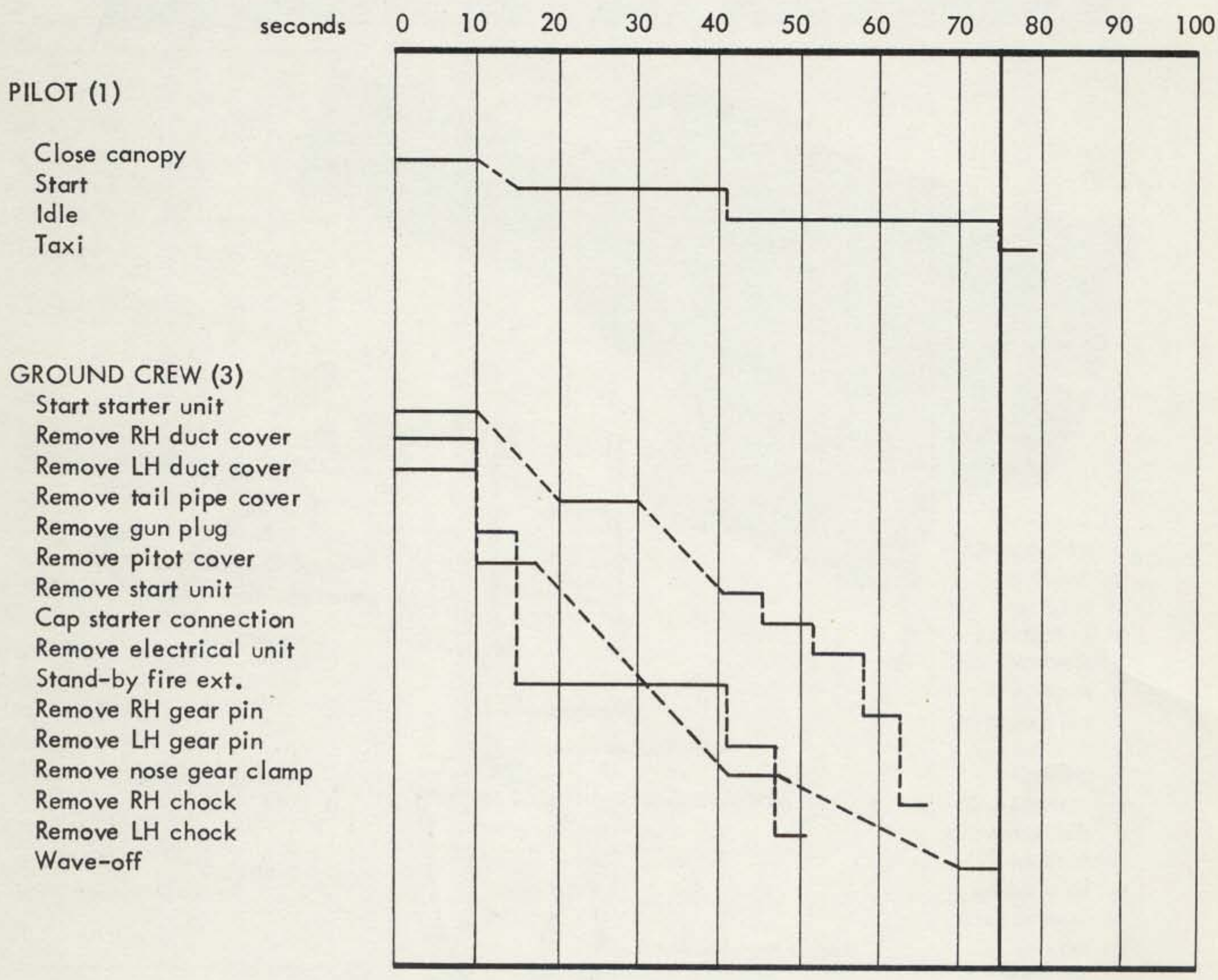
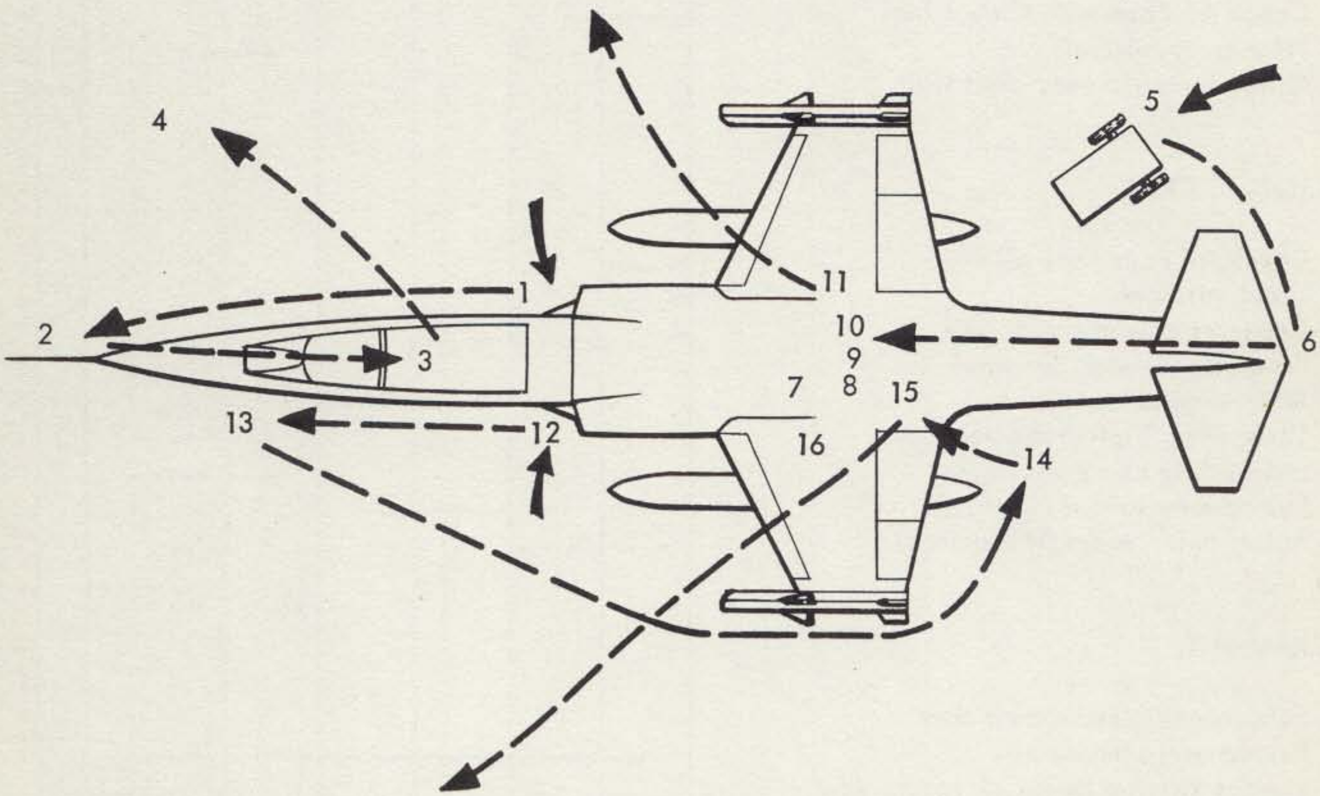


Figure 2-23

ENEMY WARNING ALERT START EQUIPMENT

(1 min. 15 sec.)



CREW CHIEF

1. Remove R.H. duct cover.
2. Remove pitot cover.
3. Remove nose gear safety clamp.
4. Wave off.

NO. 1 MECHANIC

5. Start starter unit.
6. Remove tail pipe cover.
7. Detach start unit.
8. Cap starter connection.
9. Remove ground power.
10. Remove R.H. gear pin.
11. Remove R.H. chock.

NO. 2 MECHANIC

12. Remove L.H. duct cover.
13. Remove gun plug.
14. Standby fire extinghisher.
15. Remove L.H. gear pin.
16. Remove L.H. chock.

Figure 2-24

TURNAROUND RESERVICE

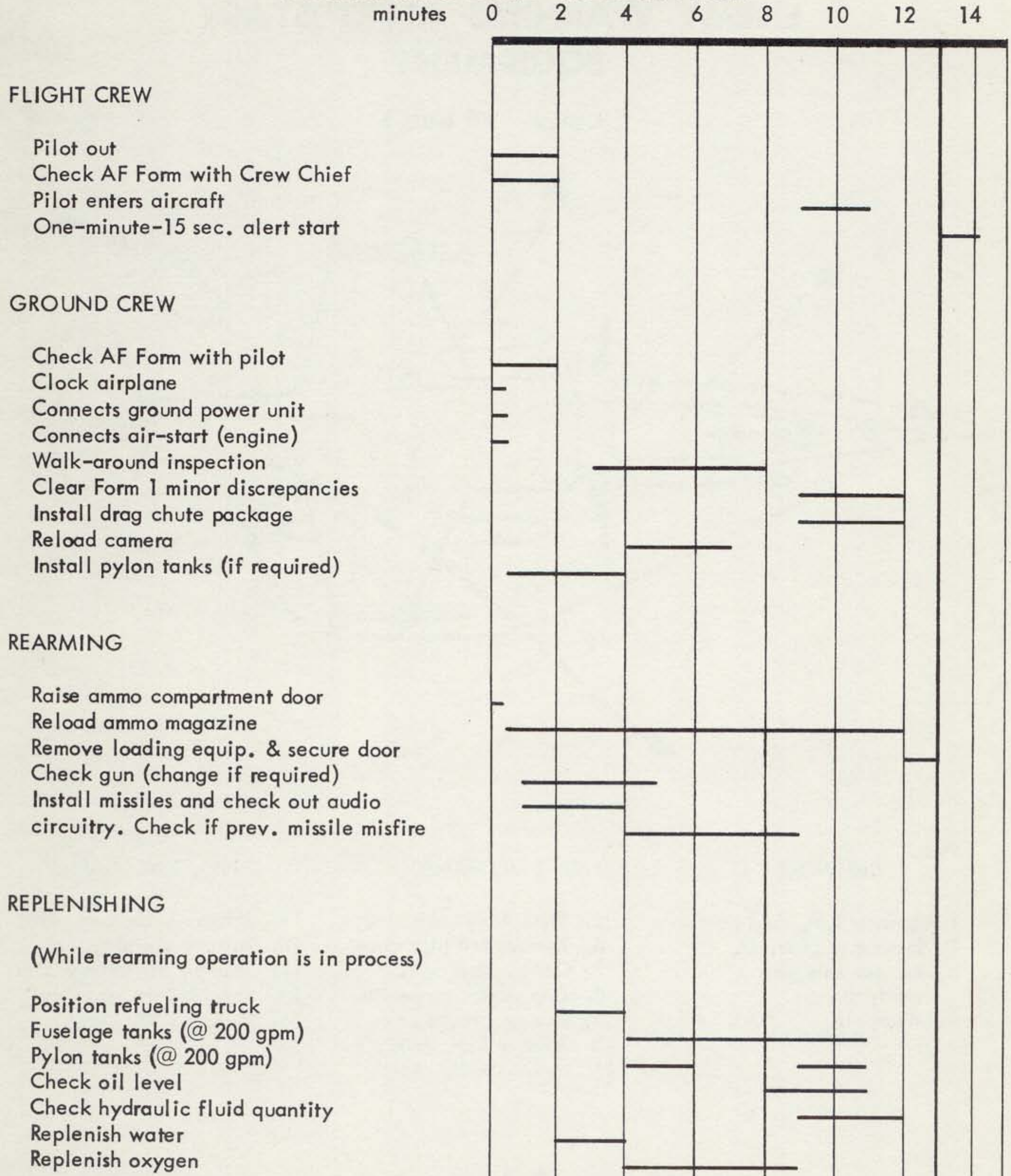
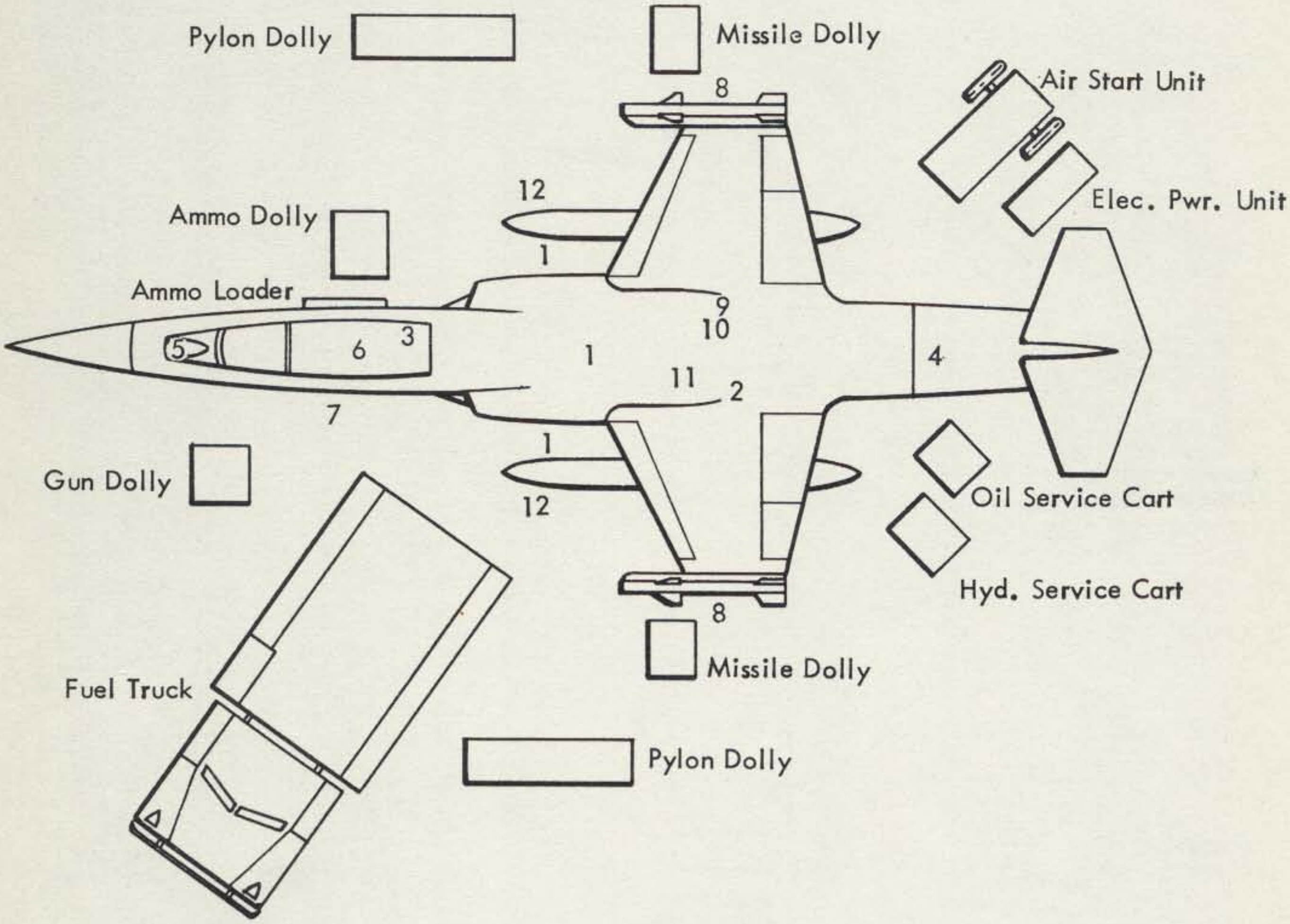


Figure 2-25

TURNAROUND RESERVICE EQUIPMENT

(13 min. turnaround)



1. REFUELING
2. REPLENISH OIL
3. REPLENISH OXYGEN
4. REPLACE DRAG CHUTE
5. RELOAD CAMERA
6. RELOAD AMMUNITION
7. REPLACE GUN
8. INSTALL MISSILES
9. ELECTRICAL POWER CONNECTION
10. AIR STARTER CONNECTION
11. HYDRAULIC REPLENISHING POINT
12. INSTALL PYLON TANKS (IF REQUIRED)

Figure 2-26

SERVICING DIAGRAM

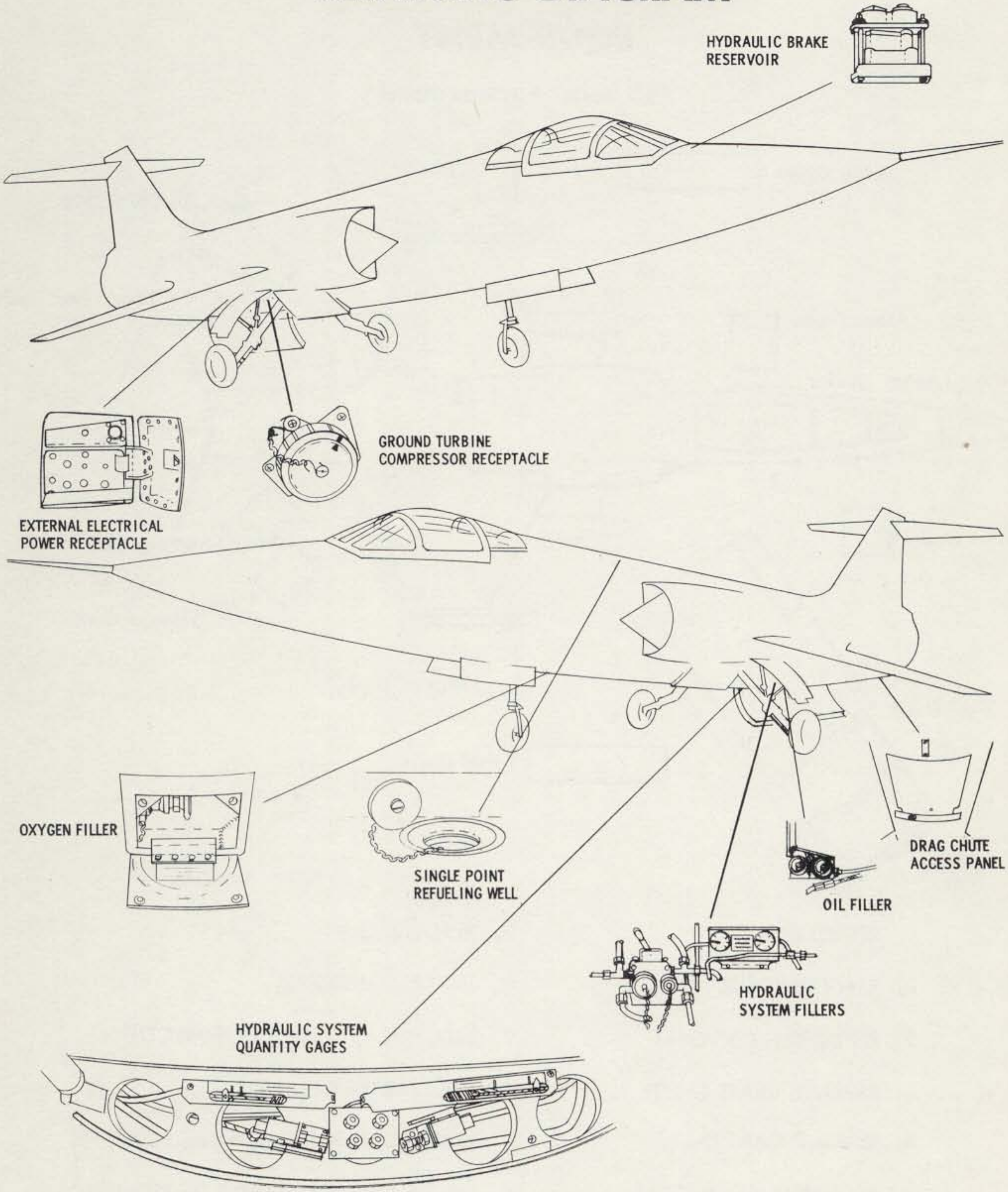
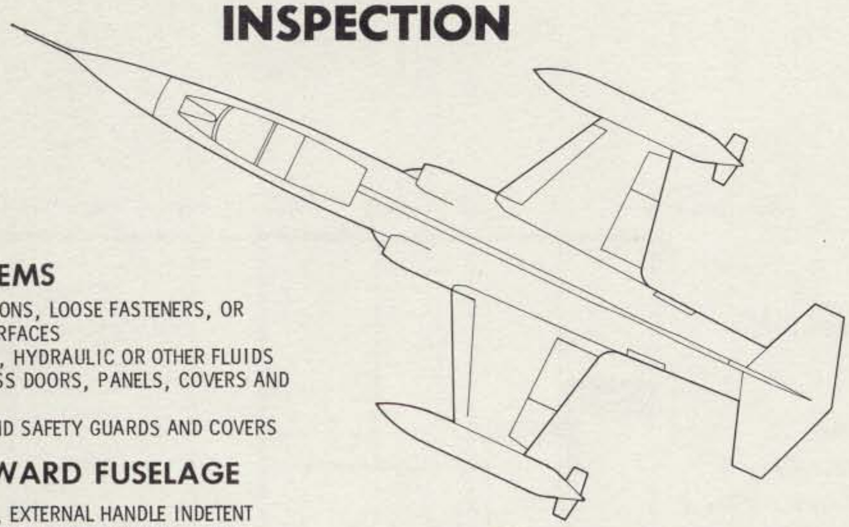


Figure 2-27

EXTERIOR INSPECTION



GENERAL ITEMS

- CRACKS, DISTORTIONS, LOOSE FASTENERS, OR DAMAGE ON ALL SURFACES
- LEAKS OF FUEL, OIL, HYDRAULIC OR OTHER FLUIDS
- SECURITY OF ACCESS DOORS, PANELS, COVERS AND FILLER CAPS
- REMOVAL OF GROUND SAFETY GUARDS AND COVERS

1 RIGHT FORWARD FUSELAGE

- CANOPY UNLOCKED, EXTERNAL HANDLE INDETENT
- OPEN CIRCUIT BREAKER ACCESS PANEL, CHECK CIRCUIT BREAKERS AND SECURE PANEL
- RAM AIR TURBINE SECURE, NO LEAKAGE
- ENGINE INTAKE DUCT UNOBSTRUCTED
- ELECTRONICS COMPARTMENT CHECK CIRCUIT BREAKERS, COVER SECURED
- NAVIGATION LIGHTS UNDAMAGED

2 MAIN LANDING GEAR

- GROUND SAFETY PINS IN
- DOWNLOCKS IN PLACE (KNOB ON DRAG STRUT DOWN)
- SHOCK STRUTS EXTENDED (1.8 - 1.4")
- LANDING LIGHTS SECURE AND UNDAMAGED
- GROUND-AIR SAFETY SWITCH (LEFT GEAR ONLY) CLEAN, UNDAMAGED
- WHEEL BRAKE LINES SECURE, NO LEAKAGE, SELF ADJUSTER EXPOSED NOT LESS THAN 1/4"
- TIRES-INFLATION, CONDITION AND SLIPPAGE
- WHEEL SHOCKS IN PLACE

3 RIGHT WING

- LEADING EDGE FLAP AND TIP CONDITION, NO CRACKS OR DISTORTIONS
- ATTACHMENT OF EXTERNAL STORES SECURE, NO LEAKAGE
- AILERON AND TRAILING EDGE FLAP CONDITION, NO CRACKS OR DISTORTIONS
- SURFACE CONDITION, NO CRACKS OR DISTORTIONS, PANEL SECURE

4 RIGHT AFT FUSELAGE

- SPEED BRAKE CONDITION, CONNECTIONS, NO LEAKAGE
- BLOW OUT PANEL SECURE
- NAVIGATION LIGHTS UNDAMAGED
- DRAG CHUTE INSTALLED

5 EMPENNAGE

- VERTICAL AND HORIZONTAL STABILIZERS AND YAW DAMPER SECURE, NO CRACKS OR DISTORTIONS
- EXHAUST NOZZLE FLAP LINKAGES AND SEGMENTS SECURE, NO CRACKS OR DISTORTIONS
- AFTERBURNER SPRAY BARS, FLAMEHOLDER AND LINERS CONDITION, NO CRACKS OR DISTORTIONS

6 LEFT AFT FUSELAGE

- NAVIGATION LIGHTS UNDAMAGED
- SPEED BRAKE CONDITION, CONNECTIONS, NO LEAKAGE
- HYDRAULIC SYSTEM ACCUMULATOR PRESSURES 1000 25 PSI
- HYDRAULIC SYSTEM MANUAL SELECTOR VALVE SAFETIED IN NUMBER 2 POSITION
- HYDRAULIC SYSTEM QUANTITY GAGES AT PROPER LEVEL
- HYDRAULIC ACCESS DOOR SECURE

7 LEFT WING

- AILERON AND TRAILING EDGE FLAP CONDITION, NO CRACKS OR DISTORTIONS
- ATTACHMENT OF EXTERNAL STORES SECURE, NO LEAKS
- LEADING EDGE FLAP AND TIP CONDITION, NO CRACKS OR DISTORTIONS
- SURFACE CONDITION, NO CRACKS OR DISTORTIONS, PANELS SECURE

8 LEFT FORWARD FUSELAGE

- FUEL FILLER CAP SECURED
- NAVIGATION LIGHT UNDAMAGED
- ENGINE INTAKE DUCT UNOBSTRUCTED

9 NOSE GEAR

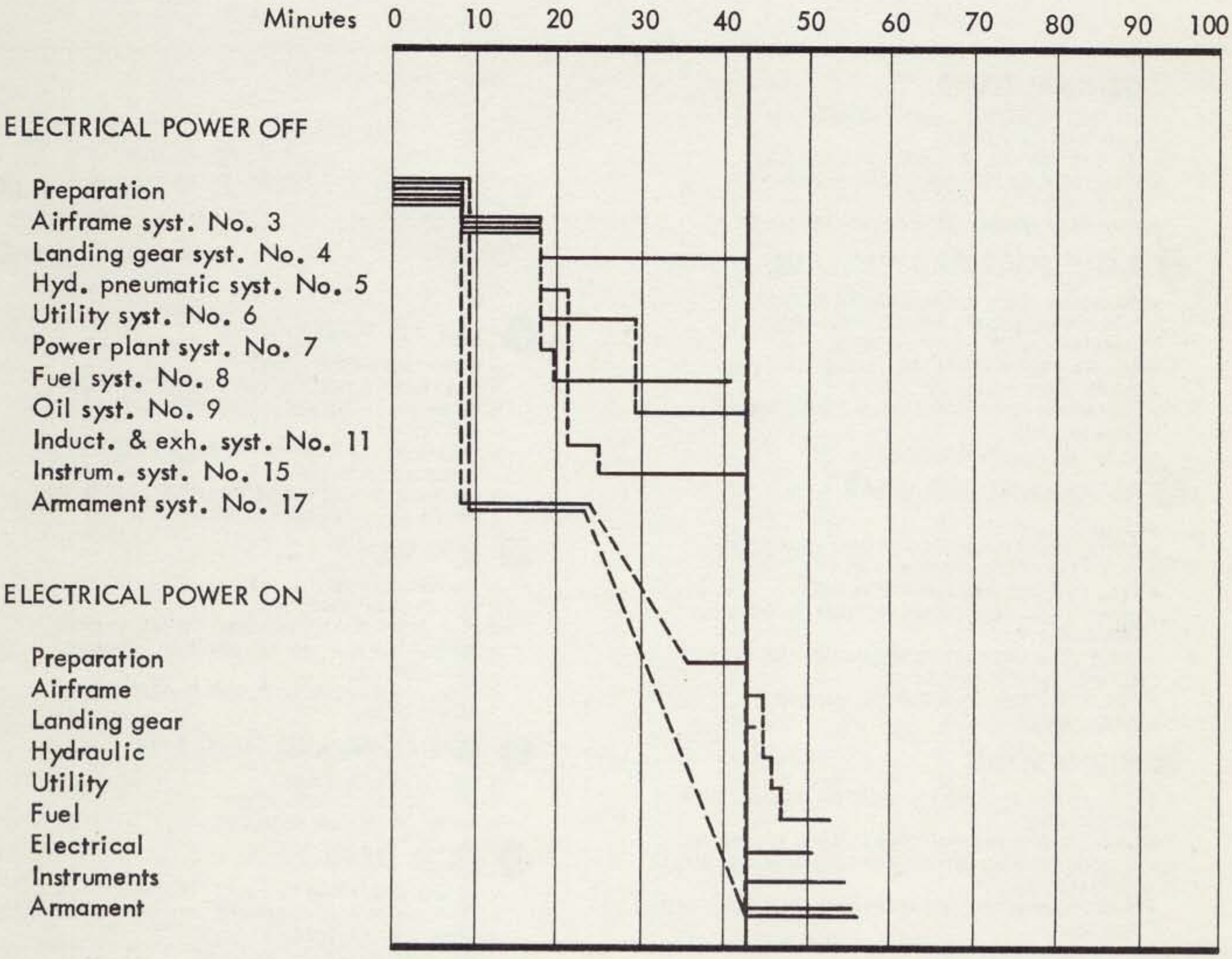
- GROUND SAFETY PINS IN
- SCISSORS PROPERLY CONNECTED
- DOWNLOCK FULLY ENGAGED IN SLOT
- TAXI LIGHT SECURE AND UNBROKEN
- SHOCK STRUT EXTENDED 2"
- TIRE-INFLATION, CONDITION, AND SLIPPAGE
- SEAT EJECTION HATCH PROPERLY SECURED

10 NOSE SECTION

- GUN PORT AND BLAST TUBES GENERAL CONDITION
- INFRA-RED SIGHT WINDOW UNDAMAGED
- RADOME LATCHES SECURE
- PITOT BOOM COVER REMOVED, OPENINGS CLEAN
- PITCH SENSOR VANES FREE TO MOVE, GUARDS REMOVED

Figure 2-28

PREFLIGHT INSPECTION

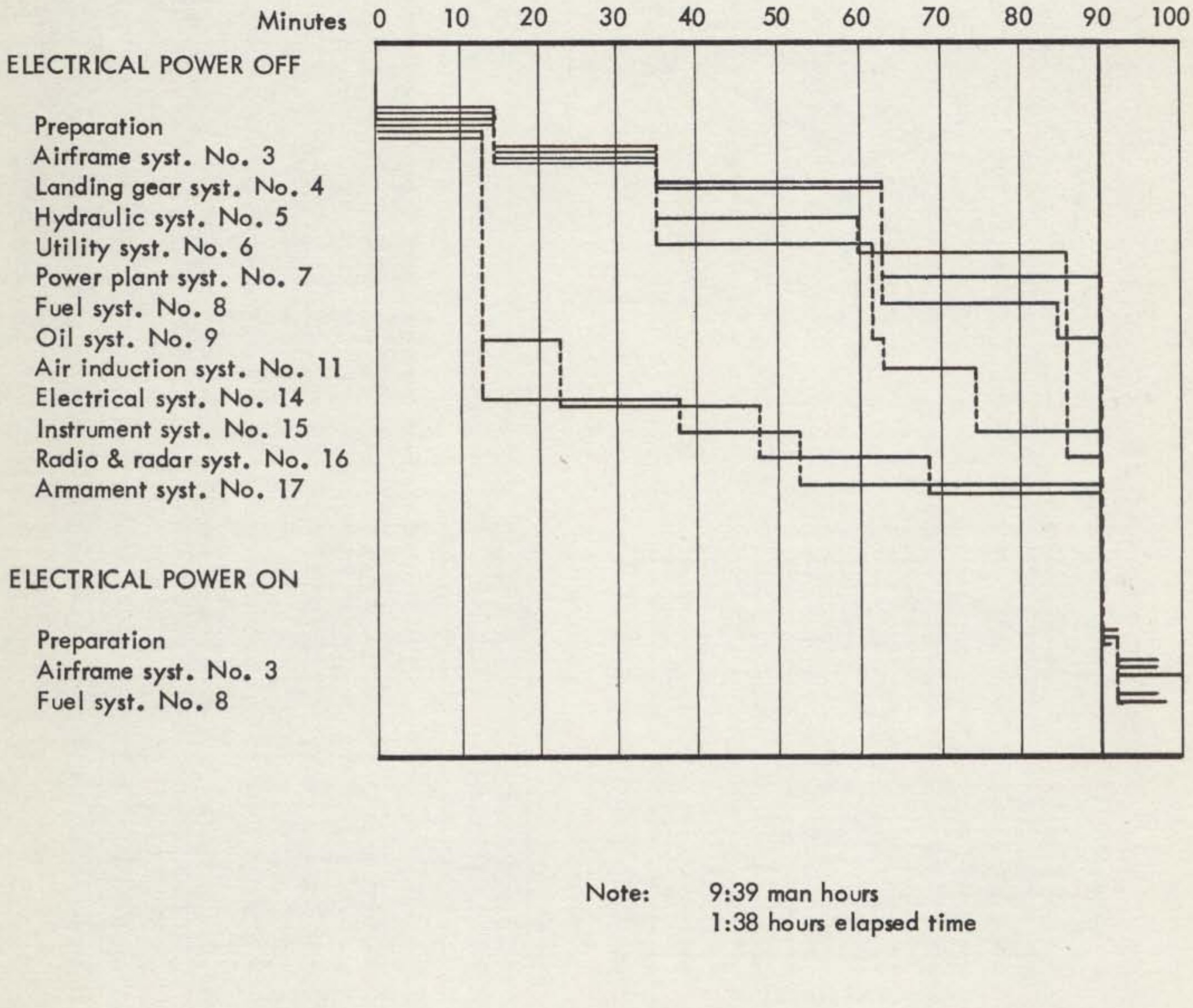


Note: 4.42 man hours
57 minutes elapsed time
6 man crew

Figure 2-29

POST FLIGHT INSPECTION

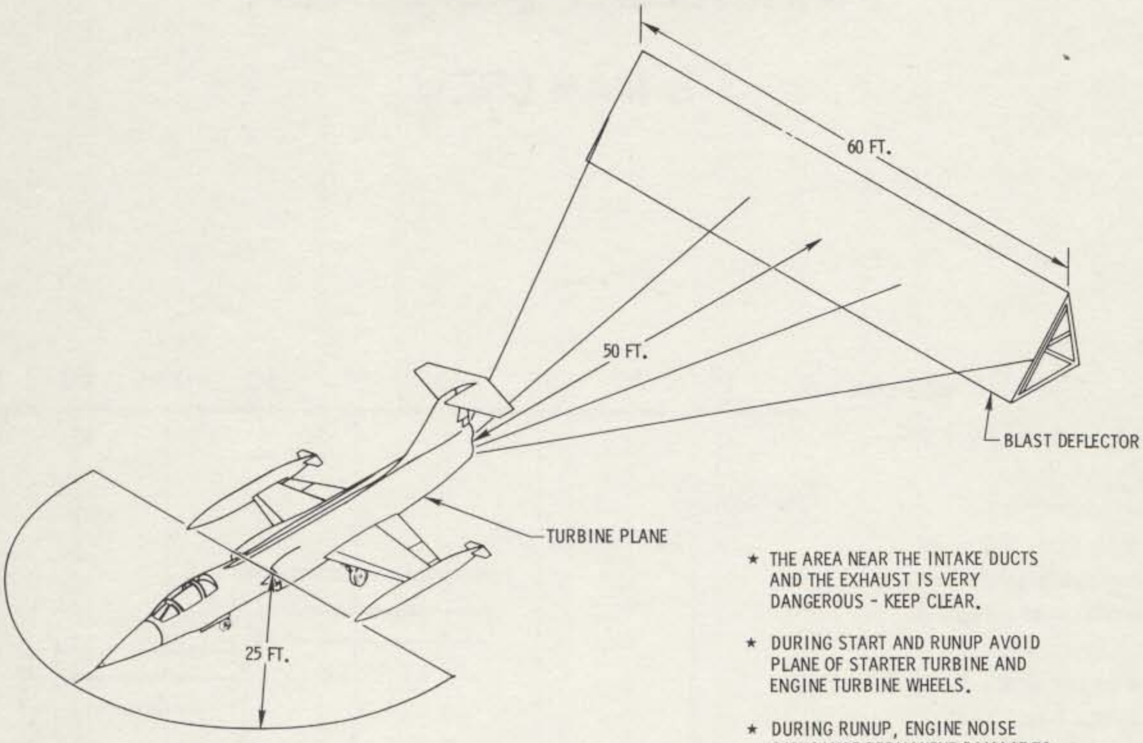
6 MAN CREW



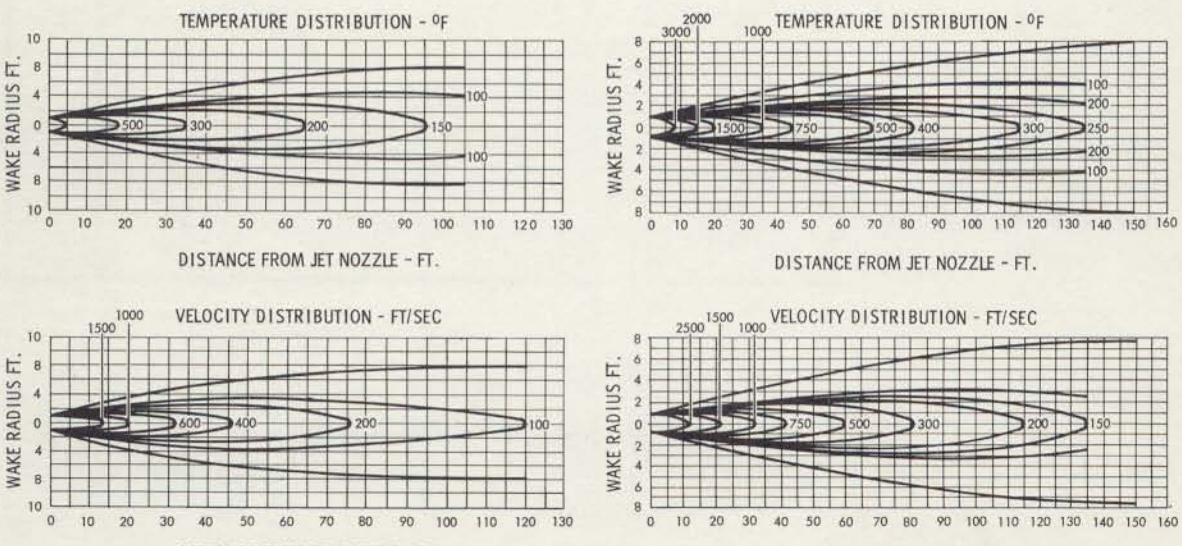
Note: 9:39 man hours
1:38 hours elapsed time

Figure 2-30

DANGER AREAS



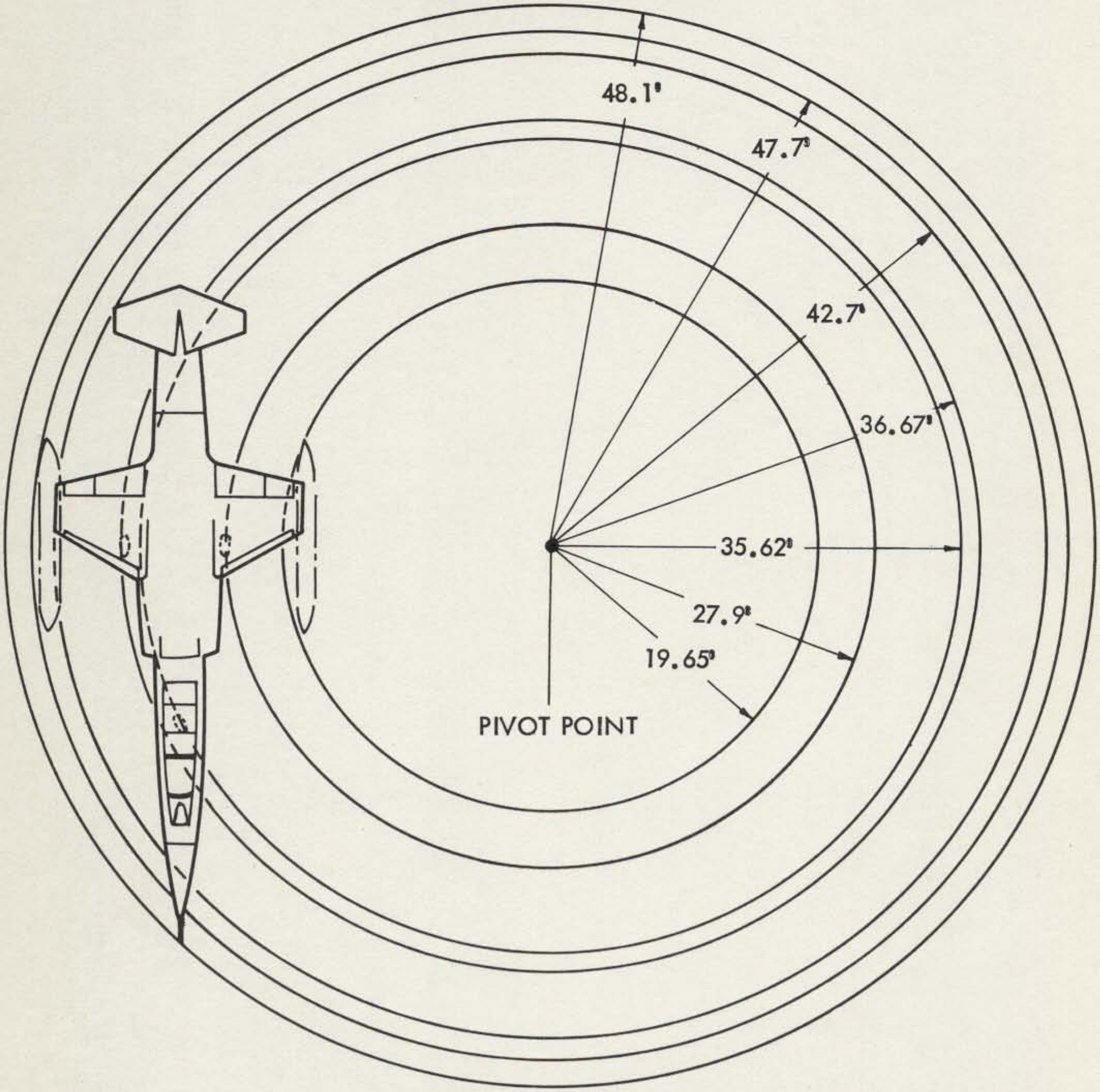
- ★ THE AREA NEAR THE INTAKE DUCTS AND THE EXHAUST IS VERY DANGEROUS - KEEP CLEAR.
- ★ DURING START AND RUNUP AVOID PLANE OF STARTER TURBINE AND ENGINE TURBINE WHEELS.
- ★ DURING RUNUP, ENGINE NOISE CAN CAUSE PERMANENT DAMAGE TO EARS. WITHIN 100 FT. USE EAR PLUGS. WITHIN 50 FT. USE EAR PLUGS AND PROTECTIVE COVERS.
- ★ IF BLAST DEFLECTOR IS NOT AVAILABLE, CLEAR AREA FOR 250 FEET.



MILITARY OPERATION **MAXIMUM AFTERBURNER OPERATION**

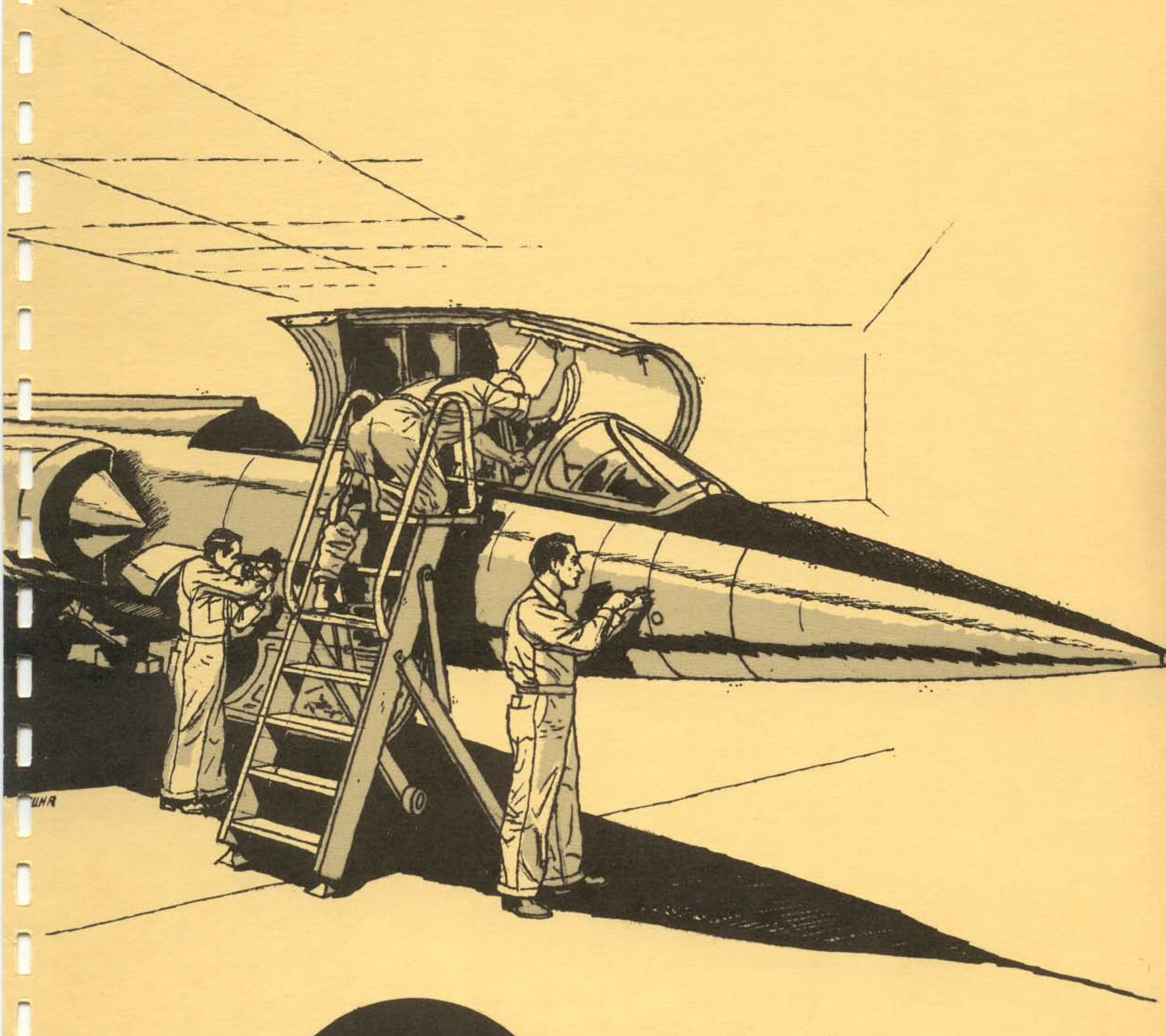
Figure 2-31

TURNING RADIUS



VERTICAL CLEARANCES	
VERTICAL STABILIZER TIP	13.5 FT.
HORIZONTAL STABILIZER	12.6 FT.
NOSE BOOM	4.13 FT.
TIP TANKS	2.07 FT.

Figure 2-32



MAINTENANCE

CONTENTS

MAINTENANCE

The Air Force is progressively acquiring equipment and weapon systems of higher precision and performance to carry out its assigned mission. Maintenance of this equipment in proper operating condition is a function of commanders at all echelons. To perform this work, three categories of maintenance (organization, field, and depot) are established to promote the maximum effectiveness and economy in the performance of maintenance. The scope of maintenance accomplished by each of these three categories is established for each new item of equipment or weapon system planned for Air Force use.

To assure that adequate numbers of the prime weapon will be available to meet the Air Defense requirements, the maintenance program of each squadron must maintain:

1. A schedule of inspections that will allow no more than seven aircraft out of a 25-aircraft squadron to be non-operational at any one time.
2. Close coordination with operations to insure that adequate flying time is available on each assigned operational-ready aircraft to meet any alert condition.
3. A duty roster of inspection and repair personnel for a sustained maintenance operation conducted on a 24-hour, 7-day basis (this is in addition to the normally designated alert crews).
4. Teams of specialists to perform normal maintenance functions.

Following the basic concepts under which the air war will be executed, maintenance will have no advanced warning to prepare for the fulfillment of the operational requirement for aircraft. It will be required to schedule continuous 24-hour readiness of aircraft. Maintenance will be confronted with an uneven work load and will not be able to schedule servicing and repair intervals on an even-flow basis. To counteract this uneven scheduling, a team can be drawn from the normal maintenance teams of specialists for use in the reservice area.

AIRCRAFT UTILIZATION

Present planning is that the monthly flying hours of the F-104A will average 40 hours per aircraft.

An Air Defense Command interceptor squadron, consisting of 21 F-104A and four F-104B aircraft to comply with the latest operational plan, must maintain a minimum operational-ready rate of 75 percent. This rate will permit assignment of four aircraft to the 5-minute alert condition and fourteen aircraft to the 15-minute alert condition.

Utilization under combat conditions is expected to be:

1. First month: 36 sorties.
2. Second through thirteenth month: 9 sorties per month.
3. Average sortie duration will be 1.3 hours with a fuel consumption rate of 760 gallons per hour.
4. Expected armament storage requirements for war use (exclusive of training requirements); 195 Sidewinders IA (GAR 8), 27,000 rounds of 20 mm ammunition.

Utilization of F-104A airplanes under peace time conditions, is based upon a yearly training program which provides each aircrew with a minimum of 240 hours flying time per year, not to include active Air Defense missions.

ORGANIZATIONAL MAINTENANCE

Organizational maintenance shall be performed in accordance with current applicable ADC Directives and Technical Orders.

FIELD MAINTENANCE

Field maintenance shall be performed in accordance with current applicable ADC Directives and Technical Orders.

DEPOT MAINTENANCE

Depot maintenance is that maintenance performed on Air Force materiel requiring major overhaul or a complete rebuild of parts, assemblies, subassemblies, and end items, including the manufacture of parts, modification, testing, and reclamation as required. Depot maintenance serves to support lower categories of maintenance by providing technical assistance and performing that maintenance beyond their responsibility. Depot maintenance provides stocks of serviceable equipment by the use of more extensive facilities for repair than are available in organizational or field level maintenance activities.

The prime maintenance engineering overhaul depot for the aircraft is SMAMA. The specialized engine overhaul depot is OCAMA.

The prime and specialized depot for the fire control systems is WRAMA.

Airport equipment and accessories will be overhauled by the appropriate AMA as specified in T. O. 00-25-11.

The prime and specialized depot for radar and communications electronics test equipment is Dayton AFD.

MAINTENANCE FEATURES

The F-104A aircraft is capable of obtaining extremely high speeds and, thus, will be subject to high G loadings. Although special training in system servicing and repair will be required, it is not anticipated that the skill level for field or organizational maintenance will exceed requirements established for subsonic and other "century-series" fighter aircraft. It will, however, be essential that each man in the maintenance team be adequately trained and exercise exceptional care in accomplishing maintenance work.

Airframe

The F-104A fuselage is of all metal, semi-monocoque construction utilizing aluminum alloy materials except for dielectric material for antenna covers and those areas where engine heat and/or fire protective measures dictate the use of heat resistant material, where titanium or stainless steel is used.

The wing is of multi-spar construction and incorporates a comparatively thick milled skin which is tapered to airfoil contour. The use of milled skin will limit, to some degree, the extent of repairs permissible by field and organizational level maintenance facilities. Present information indicates that it is necessary to maintain extremely close tolerances between the wing and the leading edge flap. It is anticipated that equipment and techniques will be developed which will facilitate obtaining the required fit; however, in all probability such equipment would not be made available below field level. Replacement of an entire wing panel, including a fitted leading edge, will be possible at field level. It should be noted that the extremely sharp leading and trailing edges will require considerable care to maintain a smooth profile and to protect personnel from injury.

Construction of the tail surfaces is very similar to the wing. Replacement of an entire surface by organizational maintenance facilities will be possible. However, many of the removable panels are stressed and fitted; therefore, replacement of such panels may require the greater facilities available at field level.

Several new structural fasteners are used in the F-104A. These include Jo-Bolt blind fasteners, Deutsch blind rivets, Hi-Torque bolts, Hi-Shear rivets and Cherry rivets. Installation of these fasteners and the required special tools are covered in the Structural Repair Handbook.

Cockpit Pressurization and Air Conditioning

The pressurizing and air conditioning systems are very similar to the installations in similar jet fighter aircraft. A water cooler has been incorporated into the system to provide adequate cockpit cooling during afterburner operation. The cooler contains approximately a 10-minute water supply, consequently it will be necessary to check and possibly replenish the water supply between missions. The water filler unit will have an integral filter as the air conditioning system requires purified water. The refrigeration package is a sealed unit which will not require lubrication or other servicing but will have a 250-hour replacement period. Reconditioning the unit will be accomplished at depot level. Trouble-shooting can be accomplished with the use of the HS-6950 tester.

Instrumentation

The instrumentation of the F-104A is quite similar to comparable jet fighter aircraft with the exception of a master warning panel which provides instant indication of malfunction of the systems listed thereon. Maintenance procedures presently established will be followed.

It will be necessary that maintenance personnel exercise care when working on the aircraft to avoid damaging the actuating vane for the angle of attack transmitter which is located on the right side fuselage centerline just forward of fuselage station 184.

Control System

Conventional type rudder pedals, control stick, and throttle are installed. The ailerons and controllable stabilizer are operated by the control stick through irreversible hydraulic actuating systems. The hydraulic power units for the flight controls are located within the surfaces as closely as possible to the control surfaces. Conventional type trim tabs are not installed as trim is provided by adjustment of the follow-up system and is controlled by switches on the B-8A stick grip. The rudder is controlled through a conventional cable system which is locked in neutral until the rudder pedals are operated. Roll, pitch, and yaw dampers are installed to assure a steady gun platform. Hydraulically-operated dive flaps, located on the sides of the aft fuselage, are controlled by a switch on the throttle grip. Leading and trailing edge wing flaps are provided and are simultaneously operated by a single three-position ("UP," "TAKE-OFF," "LAND") toggle switch located adjacent to the throttle. The throttle is of the conventional type for jet engines with afterburner. A drag chute similar to that installed in the F-94C is provided.

Replacement of the aileron actuator unit should not be attempted below field level since the actuator, when installed, becomes a portion of the wing structure. However, each actuator unit contains ten individual cylinders; replacing cylinder seals will be possible at organizational level.

Replacement of the stabilizer actuating cylinder, aileron actuator control valve (including the integral roll damper), and the pitch damper will be possible at organizational level.

Yaw damping is accomplished by a hydraulically-powered surface located below the rudder. Replacement at organizational level will be possible.

Replacement of the rate gyros in the damping system will be possible at organizational level. Information presently available indicates that any repair of the units will require depot facilities.

Replacement of the damper system amplifiers can be accomplished at organizational level; in addition, it will be possible to isolate and replace defective tubes by trouble-shooting with a portable analyzer, LT-3173. Minor repair of the amplifiers should be possible at field level; however, major repair will require depot facilities.

Hydraulic System

The hydraulic installation consists of two separate 3000 psi systems and a wind-driven auxiliary pump. The normal systems are composed of engine-driven pumps with separate accumulators, reservoirs, and lines. The No. 1 system operates one cylinder of the elevator servo unit and half of the cylinders in the aileron servo units. The No. 2 system operates the other cylinder of the elevator servo unit, the remaining cylinders of the aileron servo units, the landing gear, and the dive flaps. The wind-driven auxiliary pump, when extended, provides pressure for emergency operation of the aileron and stabilizer cylinders. The landing gear can be extended without the use of hydraulic power. Although the system is functionally dissimilar to the systems in comparable aircraft, the majority of the components are conventional and the usual repair and replacement criteria will apply.

A feature which should be noted is the use of a Teflon bellows within the hydraulic reservoir. The purpose of the bellows is to maintain a zero air system by absorbing the space provided by depletion of hydraulic fluid. Replacement of the bellows will be possible at organizational level; however, engine removal is necessary to gain access to the reservoirs.

Another noteworthy feature is the engine access door on the lower side of the fuselage between stations 520 and 572. Most of the hydraulic units, with the exception of pumps, actuators, and reservoirs, are located on this panel. Since the ground test fittings are located on the door, it becomes a virtual test panel. Reservice of the hydraulic system can be made with a standard C-1 pressure pot but requires an adapter.

The hydraulic reservoir sight gauges are located at the forward edge of the door opening. Refilling the reservoirs with a pressure refiller unit is accomplished through a fitting provided for this purpose.

Landing Gear

The tricycle landing gear is fully retractable hydraulically. A hydraulically-powered steering system is included on the oleo-pneumatic nose gear. The main landing gear is of the articulated suspension type with a liquid spring shock strut and is supported by, and retracted into, the fuselage. The liquid spring strut is smaller and lighter than an oleo-pneumatic strut of equivalent capacity. A landing gear warning device is provided to produce a signal in the pilot's earphones when the landing gear is not down and locked and the throttle is retarded. A master cylinder type hydraulic brake system is controlled by the rudder pedals. Nose gear tire size is 18 x 5.5, while the main gear mounts 26 x 6.6 tires.

The nose gear and steering units are conventional; no departure from established maintenance procedures is anticipated.

Replacement of a complete gear, the liquid spring, or other components can be accomplished at organizational level; however, replacement of connecting links and similar components will necessitate an alignment check, thus requiring the increased capabilities of field maintenance facilities.

Electrical System

The electrical system is a 115/208 volt variable-frequency three-phase installation. Two engine-driven 20 KVA A.C. generators constitute the normal A.C. power source. Twenty-eight volt D.C. power is normally provided by a 100 ampere transformer rectifier unit. Instrument A.C. power is provided by a 250 VA inverter. The ram air turbine operates a 5.5 KVA, 200 volt A.C., three-phase fixed-frequency generator for emergency use. A single 24-volt four ampere-hour battery provides D.C. power for air start ignition, external tank jettison, and fire warning in the event of loss of the emergency power supply.

The electrical system presents no special maintenance problems. Presently established levels of maintenance for components will apply. However, the transition from 28-volt D.C. power to 115/208 volt three-phase variable frequency A.C. power will require some additional training of personnel.

Electronic Equipment

The following electronic equipment is presently installed in the F-104A.

Radio Set (UHF Command)	AN/ARC-34
*Navigation Set	AN/ARN-14
Radar Set (IFF)	AN/APX-6

*NOTE: AN/ARN-14 installed in aircraft. Structural provisions are being incorporated to permit installation of AN/ARN-21 (TACAN) when operationally available.

All electronic components located in the electronics compartment aft of the pilot are readily accessible through the electronics hatch, and are of standard type and configuration; however, it has been proposed that all components be repackaged into tailored units. This procedure will permit weight and space saving and the use of a plug-in concept. Regardless of the configuration of the units, maintenance will follow presently established criteria as established in T. O. 00-25-156, "Maintenance of Communications, Electronics and Meteorological Equipment."

Component repackaging, as cited above, will provide sufficient space for the following items (also to be repackaged):

Data Link	AN/ARR-44
BROFICON	AN/ARR-47
ILS (Glide Slope)	AN/ARN-31
ILS (Localizer)	AN/ARN-32
Marker Beacon Receiver	

Armament Equipment

The armament installation consists of one type T-171E-3 20 mm A.C.-operated firing mechanism.

Maintenance of the firing mechanism presents no anticipated departure from present procedure; however, special training and some special tools will be required.

The construction of the gun requires a boresighting procedure somewhat different from standard. This procedure will be outlined fully in the aircraft T. O.'s and suitable equipment provided as GSE.

The firing mechanism weighs approximately 300 pounds and the unit must be raised approximately 30 inches above ground level to install in the aircraft. However, a special hoist will be provided for this purpose; therefore, no handling problems, because of the gun's size or weight, are anticipated.

Information presently available indicates that the construction of the gun and method of sealing the muzzle at the blast tube eliminates much of the gun compartment residue, thus decreasing maintenance requirements.

The ammunition loading 750 rounds (F-104A) and 535 rounds (F-104B) is carried in a compartment aft of the electronics compartment.

Access is through a separate hatch. Because of the height above the ground, special equipment will be required to load ammunition.

F-104A aircraft subsequent to number 36 and F-104B aircraft will be equipped to carry and deliver a Sidewinder IA (GAR 8) from each wing tip. Appropriate loading equipment will be provided as ground support equipment.

Photographic Equipment

An N-9 gun camera mounted on the sight head is used for strike recording. Established maintenance procedures will apply.

Fire Control System

The ASG-14 (F-104A) or ASG-14T1 (F-104B) fire control system consists of a General Electric gyro stabilized computing gunsight, a light-weight search and ranging radar set manufactured by RCA, and an Aero-Jet infrared detector to provide an aiming signal at night or during haze conditions. Major components of the sighting system are the sight head, amplifier, gravity drop unit, pressure sensing unit, and the infrared unit. Major components of the radar set are the antenna, control indicator, and the receiver-transmitter group.

Very little data relative to the maintenance requirements for the fire control system are available to date. However, component replacement and minor repair will be permissible at organizational level similar to the procedures for maintenance of other fighter aircraft fire control systems. The concept of plug-in electronic components will expedite aircraft turn-around. Tube change or other component maintenance may then be accomplished by organizational or field maintenance as appropriate.

With the exception of the sight head, infrared unit, and control-indicator all fire control system components are located on the forward side of the bulkhead at fuselage station 184 and are readily accessible by sliding the nose section forward on tracks.

Fuel System

The normal internal fuel load of 763 gallons of JP-4 fuel is carried in nylon bladder-type fuselage fuel tanks. Provisions are included for two 165-gallon wing tip tanks and two 200-gallon pylon tanks. Fuel is supplied to the engine by electrically-driven booster pumps. Fuel quantity gauges are installed for all tanks and include provisions for density compensation. Refueling is accomplished at a single filler cap in the fuselage and separate filler units on each external tank.

A 145-gallon internal auxiliary fuel cell is fitted forward of the main tank. Fuel from this cell will be transferred into the main cell by means of an electric transfer pump. A separate filler cap will be provided.

The nylon bladder fuel cells are repairable at depot level only. Replacement of the tanks will be possible at either organizational or field level. No special tools will be required to handle the cells; however, extreme care must be exercised to avoid damaging the relatively light material. In addition, the tanks follow stringer and skin contour and are laced in place; therefore, it will be necessary to exercise extreme care to fit the tanks in place. All other fuel system components will be maintained in accordance with presently established procedures.

Oxygen System

A high pressure demand oxygen system is presently installed. System capacity on early aircraft is sufficient for full flight duration at 100 percent oxygen using a mask. Aircraft 15 to 51 include a higher capacity system which will provide sufficient oxygen for two hours using a MC-1 partial pressure suit. Subsequent aircraft will incorporate a liquid oxygen system with sufficient oxygen for four hours. Retrofit of early aircraft with the liquid oxygen system is being contemplated.

Presently established maintenance procedures will apply to either system. Adequate support equipment will be provided for either system.

Emergency Escape System

The downward ejection seat is equipped with an automatic opening safety belt, shoulder harness, and a crotch belt. The system is actuated by a single "D" ring located between the pilot's legs on the forward edge of the seat. The single handle initiates stick stowing, shoulder harness locking, hatch release, seat ejection, and other associated action. The ejection system presently installed is considered subsonic; however, several modified systems are being considered which will permit safe supersonic escape.

The incorporation of a downward ejection seat presents some peculiarities which will require special attention. However, maintenance of the system and components will be conventional and in accordance with established procedures.

The escape hatch is removed by mechanical linkage actuated by initial movement of the catapult. While removing the door presents no problem, it is essential that caution be exercised to assure that the door is fully latched and locked prior to flight. The access to cockpit components provided by removing the hatch and seat is a noteworthy feature. A guard, to protect the hatch seal when the hatch is removed, will be provided.

The F-104B rear hatch contains some of the electronics equipment displaced by the rear seat. The weight of the hatch will require careful handling during installation and removal. A hoist will be provided for assisting this operation.

Engine

The F-104A is designed for the General Electric J79-GE-3 axial flow turbojet engine with afterburner which is introduced into Air Force service with this aircraft. The developmental status of the engine will result in several configuration changes prior to delivery to tactical units and at least one major change subsequent to delivery. The engine is contained within the fuselage and is accessible for removal by removing the aft fuselage section. Engine-driven units include two 20 KVA A.C. generators, two hydraulic pumps, a tachometer generator, and fuel system components. A pneumatic type engine starter is provided. The engine oil system is self-contained.

The use of stressed skin type construction has permitted reducing engine weight to nearly half that of engines of comparable power output. However, the extremely light-weight construction presents handling problems not previously encountered. In addition, the use of variable compressor stators and controllable afterburning complicate the controls used on the engine. A hydromechanical fuel control system is installed.

Initial engine design required that engine maintenance be performed in a vertical position, requiring unstacking of components beginning with the turbine frame. While this technique is practical for depot overhaul, it is not compatible with the maintenance concepts of the using commands. Organizational and field maintenance requirements are that inspection and JEFM be performed in a horizontal position from relatively simple maintenance stands with hand tools. Equipment developed to date accepts the engine in a horizontal position and permits unstacking the engine horizontally. Engine configuration, however, requires such extensive disassembly to accomplish a periodic inspection that the task is considered a field maintenance function. An engine incorporating provisions to permit inspection without major disassembly will not be available in the foreseeable future.

Access to engine and accessories, while installed in the aircraft, through the large engine access door is a noteworthy feature. The size of the door provides a vast improvement over the limited access provided by other jet fighter aircraft.

Engine, afterburner, and aft fuselage handling and maintenance requirements will be fulfilled by the Air Logistics, model 3000 and 4000A trailers, model 4500 rollover adapter assembly, model 3100A and B workstands, model 4600 monorail hoist, and the appropriate component adapters. Pending development of the model 4500 adapter, engine removal and primary support for maintenance will be provided by LAC 764636 adapter kit and engine rollover by the Air Logistics model 5000 trailer. In both cases complete maintenance support will be provided by the applicable G.E. adapters.

Prior to engine start, danger areas around the aircraft must be clear of all personnel, vehicles and other aircraft, as suction at the air intake is sufficient to kill or seriously injure personnel. The high temperature and velocity of the jet exhaust is also extremely dangerous. Antipersonnel screens and boundary layer run-up screens must be installed to prevent foreign material from being drawn into the intake ducts.

Because of the high thrust to weight ration, the airplane will be secured to an anchor with the engine run-up sling. (See Section VI for details of F-104A test anchor installation.)

Start and run-up should be made with the aircraft on a clean concrete or other paved surface. Make sure engine inlet and exhaust areas are free of obstructions including ice.

During ground run-up, when either the hydraulic panel is open or the aft fuselage is removed, the air conditioning package shut-off valve must be closed because no cooling air is circulated through the primary heat exchanger. This can be accomplished by opening the pilot's fresh air scoop. Also, the electronics compartment cover must be open because no cooling air is provided for the equipment when the air conditioning system is not operating.

Towing, Jacking, and Mooring Provisions

Provisions are included for forward towing from the nose gear and both forward and backward towing from the main gear. A special light-weight collapsible tow bar will be provided for forward towing by the nose gear and a cable sling provided for forward or backward towing from the main gear. The latter device is stressed to be suitable for mooring the aircraft for run-up purposes.

Jack points are located forward of the nose gear well and approximately in the center of each wing panel. Suitable adapters will be provided as will an adapter for nose gear axle jacking. Provisions for main gear axle jacking are built into the landing gear legs, and an adapter will be provided for nose gear axle jacking.

Provisions are made for mooring and hoisting at the jack points. Suitable adapters and slings will be provided.

Ground Power Equipment

The 115/208 volt A.C. electrical system of the F-104A requires a source of ground electrical power which may not readily be available at appropriate air bases at present. A suitable unit has been included in the Tentative Table of Equipment (TTE); however, all activities must closely scrutinize any substitute equipment because of the load requirements for gun check-out.

Starting Power

The starting system installed in the F-104A requires a source of low pressure — high volume air. This requirement is common to comparable jet fighter aircraft; consequently, no particular problems are envisioned. The MA-1A compressor is programmed for Air Defense Command units. Interim support with MA-1 units may be required for ADC pending availability of MA-1A compressors.

Special Store Handling Equipment

It is anticipated that special stores handling will be accomplished with the Air Logistics model 3900 stores handling adapter in conjunction with the model 4000A trailer. With the proper adapters the same combination should prove adequate for tip and pylon tank and missile handling.

MAINTENANCE SUPPORT

Early in the F-104A program, Lockheed Aircraft Corporation made certain recommendations to Headquarters ADC for indoctrination of flight and maintenance personnel prior to and during the initial exposure to the F-104A aircraft, and for service assistance for the operational support extending to such time as continued assistance is deemed unwarranted.

To support these areas, Lockheed will provide representatives from its Field Service, Spare Parts and Flying Operations Divisions. Two phases of support have been developed using contractor supplied personnel; Permanent Team and Conversion Team. A time-reference point of "D" Day is utilized in establishing a reference date from which arrivals of various support personnel will be determined. "D" Day is the date of receipt of the first F-104A aircraft.

D-60

Permanently assigned electronics and supply technical representatives will arrive. This will include a Spare Parts Representative, Electronic Technical Representatives (qualified on AN/ASG-14 FCS), Electronics Instructors (qualified on AN/ASG-14 FCS), and Electronic Technicians.

D-30

Permanently assigned Technical Representatives will arrive. These will include F-104A Aircraft Technical Representatives, J-79 Engine Technical Representatives, Ground Power Technicians, and Gas Turbine Technician.

"D" Day

The Maintenance Conversion Team will arrive concurrently with the first aircraft delivery and will consist of additional Aircraft Technical Representatives, J-79 Engine Technical Representatives, Aircraft Technicians, FCS Technicians, and Ground Power Equipment Technicians.

The Maintenance Conversion Team will remain with each squadron for approximately 180 days. The Maintenance Conversion Team will actively engage in the teaching of maintenance by classroom instruction, working with maintenance personnel, and will be under the direct control of the Materiel Officer through the Squadron Commander.


FG-78
FUHR
PERSONNEL
AND TRAINING

CONTENTS

ILLUSTRATIONS

PERSONNEL AND TRAINING

The complexity of new aircraft and associated equipment placed in the Air Defense Command requires skilled personnel for both maintenance of the equipment and effective operational employment of the weapon system. With the development of new equipment peculiar to supersonic and high altitude flight, an extensive training and retraining program is required. In considering personnel problems and the training involved to bring personnel up to a skill level required by new equipment, three points should be of primary concern:

1. The quality of personnel assigned to the various factory and service schools should be experienced people of the five or seven level. The equipment is of such a nature that much of the training is wasted unless the personnel receiving the training have a sound basic background in their specialty field.
2. Economical utilization of the training invested requires that the personnel trained and assigned to tactical units must be retained so that their knowledge may be utilized over a period of at least two years. (This is essential in such specialty fields as radar and fire control systems, where the required training approaches three months for five and seven level personnel and six months for inexperienced personnel.) Pilots should have one year retainability as of date of check-out.
3. Because of the very specialized training received by personnel in factory and other specialist schools, personnel trained should be assigned to some phase of the F-104A Weapon System and remain frozen in that assignment until such time as the maximum benefit has been obtained from their training.

The Technical Training Program has been developed in four parts and divided into Phases I, II, III, and IV. Technical training of instructor and maintenance personnel is accomplished in Phases I and II of the Technical Training Program.

PHASE I

Phase I, factory training, is conducted to assure a sound basis for expansion of the Technical Training Program and to provide key Air Force personnel with a sound background for maintenance.

A prerequisite for Air Force personnel to enter these courses and become qualified instructors or maintenance personnel, is the five or seven level in the

AFSC of the specialty field in which they will instruct or work. Phase I is in progress at Lockheed and should be concluded about June 1957.

The F-104A airplanes on the final assembly and the flight line are used to familiarize the student with unit location. In addition, classroom trainers and cutaways are provided to teach system operation, inspection, and the trouble-shooting techniques that will enable the student to diagnose system malfunctions.

Aircraft Mechanic Training

Courses for senior level aircraft mechanics have been in progress since 3 July 1956 and will conclude on 4 July 1957. There will be thirty-nine classes presented. Each course consists of 160 academic hours (four weeks).

The purpose of this course is to train qualified maintenance and instructor personnel for organizational maintenance of the F-104A aircraft in service. General airplane familiarization plus escape system, wing flaps, oxygen and pitot system and use of ground support equipment is given the first week. This is followed by the hydraulic system including the flight controls and landing gear system for the second week, airplane fuel system and power plant for the third week, and in the fourth week the air conditioning, pressurization and electrical systems will be covered.

Hydraulic Maintenance Specialist Training

Courses for senior level aircraft hydraulic repair technicians are scheduled for six classes with an average of seven students who will spend 80 hours (two weeks) at the new Lockheed school facilities located at Plant B-1 in Burbank, California.

The purpose of this course is to train qualified maintenance and instructor personnel for Air Force organizational maintenance of the F-104A airplane in service.

This course includes general aircraft familiarization, a detailed description of the various components that make up the F-104A hydraulic systems and their function during actuation of the units.

Electrical Maintenance Specialist Training

Courses for the senior level aircraft electrical repair technicians are scheduled for eight classes. The duration of each course is 120 academic hours (three weeks).

The purpose of this course is to train qualified maintenance and instructor personnel for organizational maintenance on the F-104A aircraft in service. General airplane familiarization, use of ground support equipment, plus a detailed description of the entire electrical system will be covered.

Mechanical Accessories and Equipment Specialist Training

Courses for senior level aircraft mechanical accessories and equipment repair technicians are scheduled for four classes. Each course consists of 40 academic hours (one week).

The purpose of this course is to train qualified maintenance and instructor personnel for organizational maintenance on the F-104A aircraft. General airplane familiarization plus a complete description of the operation of air conditioning, pressurization, and auxiliary air systems will be covered.

Fire Control System Specialist Training

A course has been designed to train qualified personnel who will in turn either instruct or maintain the ASG-14 fire control system. Nine classes are scheduled with an average of six students per class, consisting of Air Force technicians and Civil Service instructors. Small classes enable the students to receive more individual attention, thus more knowledge gained. One complete course is six weeks or 240 academic hours. During this time the student is taught the radar, optical, infrared gunsight, and associated equipment. Besides covering a block diagram of the system, the course will include circuit analysis, trouble-shooting, and alignment procedure. The greater amount of time is devoted to the more complex or unusual circuitry. To complete an eight-hour school day, time is allotted for classroom instruction, lab work, and study hall period. With this arrangement, the student applies the theory of operation learned in classroom to practical experience in the lab. Also, lab period enables the class to check waveforms and voltages throughout the system with necessary equipment. The final lab periods of the course are used for trouble-shooting malfunctions which the instructor induces into the system. Study hall periods aid students to review the day's lesson or prepare for the next day's lesson.

Supervisors and Planners Training

Courses for supervisors and planners are scheduled for four classes. Each course consists of 60 academic hours (one and one-half weeks).

The purpose of this course is to provide familiarization training for supervisory personnel who will be responsible for maintenance, operation and/or training programs on the F-104A aircraft in service. General airplane familiarization, Spares support problems, and a brief description of the different aircraft systems will be covered.

Pilots Ground School Training

Ground school courses for pilots who will fly the F-104A were scheduled for ten classes. Each class consisted of 80 academic hours (two weeks).

The purpose of this course was to bring the pilot up to a standard where, after a check-out by a qualified F-104A pilot, he would be able to fly this airplane. His first flight must be within a reasonable length of time after completion of the course. This course outlined a description of airplane systems, auxiliary systems, normal and emergency procedures, flight characteristics and aircraft limitations. The students performed an actual walk-around inspection of the aircraft. There were familiarization trips to the final assembly and flight line.

Engine Mechanic Training

Courses for senior level jet engine mechanics were scheduled at General Electric's Evendale, Ohio plant. A total of 59 spaces have been received by ADC and will support both the organizational and field maintenance of the J-79 engine.

The purpose of this course is to train qualified maintenance and instructor personnel for field and organizational maintenance on the J79-GE-3 engine. This course will consist of basic engine indoctrination, engine integrated control systems, inspection and trouble-shooting procedures, test cell operation, field disassembly and assembly, and the use of ground support equipment supplied for the engine. An engine will be provided for tear down and component location.

PHASE II

Phase II is the training which will be taught entirely by Air Force instructors. The Phase I and Phase II training programs are very close in scope and may overlap to insure continuity and quality of training throughout the expanding program.

General airplane familiarization will be given to all mechanics at the beginning of each course. This will be followed by the detailed instruction on the system and operational components. Class 26 trainers are used to augment such standard classroom equipment as visual aids, animated panels, wall charts, and other training material.

Aircraft Mechanic Training

Phase II aircraft mechanic training will be conducted at Chanute Air Force Base, Illinois. This course consists of an overlapping series of classes for aircraft mechanics, electricians, hydraulics mechanics, and mechanical accessory mechanics. The capacity of the Chanute facility is considered adequate for Air Force requirements.

Fire Control System Specialist Training

Courses in the ASG-14 fire control system will be conducted for Air Force personnel at Lowry Air Force Base. It will start during the latter part of the 1st quarter or at the beginning of the 2nd quarter of 1957. The Air Force will plan the course with assistance of Lockheed through contracts. Instructors will be Air Force and Civil Service personnel trained at the Lockheed school in Burbank, California. Students will be additional instructors or maintenance personnel for Air Defense Command. Training aids will be furnished by Lockheed through Air Force contracts with Spare Parts Division of Lockheed.

OPERATING PERSONNEL

Under the concept of a short but intensive war at the outbreak of hostilities, only experienced personnel assigned and in place at the squadron will be of any benefit in the active air defense of the country. Unless these personnel have been properly trained to maintain the weapon system, the prime weapon will be useless shortly after the start of combat operations.

Replacement or augmentation of squadrons will be very slow, and it is questionable whether ground crews or aircrews can be trained after war starts.

Because of the complexity of equipment, training must be a joint effort between the manufacturers and the Air Force.

The initial training program for each squadron should be completed, with the exception of replacements for attrition, by the time the squadron is declared operational.

Flying personnel will be transitioned to the new aircraft within the Air Defense Command. Upon completion of the transition in the F-104A, the training of experienced aircrews will proceed on a proficiency basis as directed by the Squadron Commander in accordance with Air Defense Command Regulations. The current flying requirement considered necessary to maintain proficiency is 240 hours per year, not including active Air Defense missions.

To implement the transition of experienced pilots, a mobile training unit will be available which will enable the completion of aircrew instruction courses prior to arrival of the tactical aircraft. Four F-104B's are programmed for each squadron. These aircraft have all the characteristics of the F-104A including speed and altitude and will give pilots a sound basis in the operation and handling of the F-104A.

The training version of ASG-14 fire control system has two radar scopes and both instruction on the fire control system and proficiency checks can be given to insure a high degree of effectiveness of the pilots.

In converting to this aircraft, the flying training program will be conducted by the Air Defense Command with replacement pilots supplied by the Crew Training Air Force. This program will be in addition to the pilot ground school conducted by Lockheed Aircraft Corporation at Burbank, California.

Training Within the Converting Unit

On-the-job training as defined in ADCM 52-1, will be used to the fullest extent possible in converting airmen AFSC's to those required by new equipment. Special training programs will be conducted by OJT methods to convert airmen to the new equipment within their awarded AFS's. This type of training must be started as soon as practicable and the services of Maintenance Conversion Teams, Technical Representatives, and graduates of formal training courses will be used to insure its success.

FACTORY TRAINING

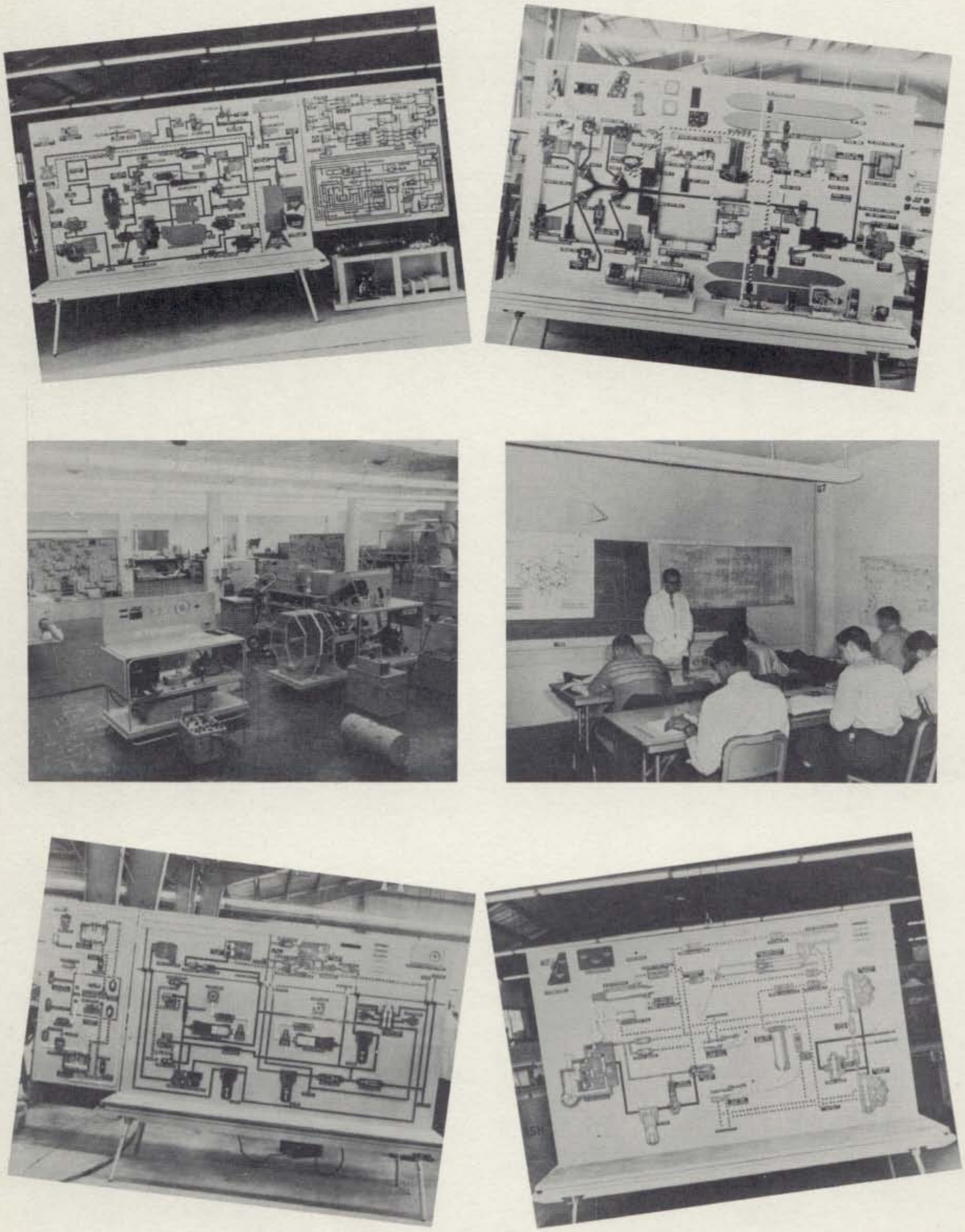
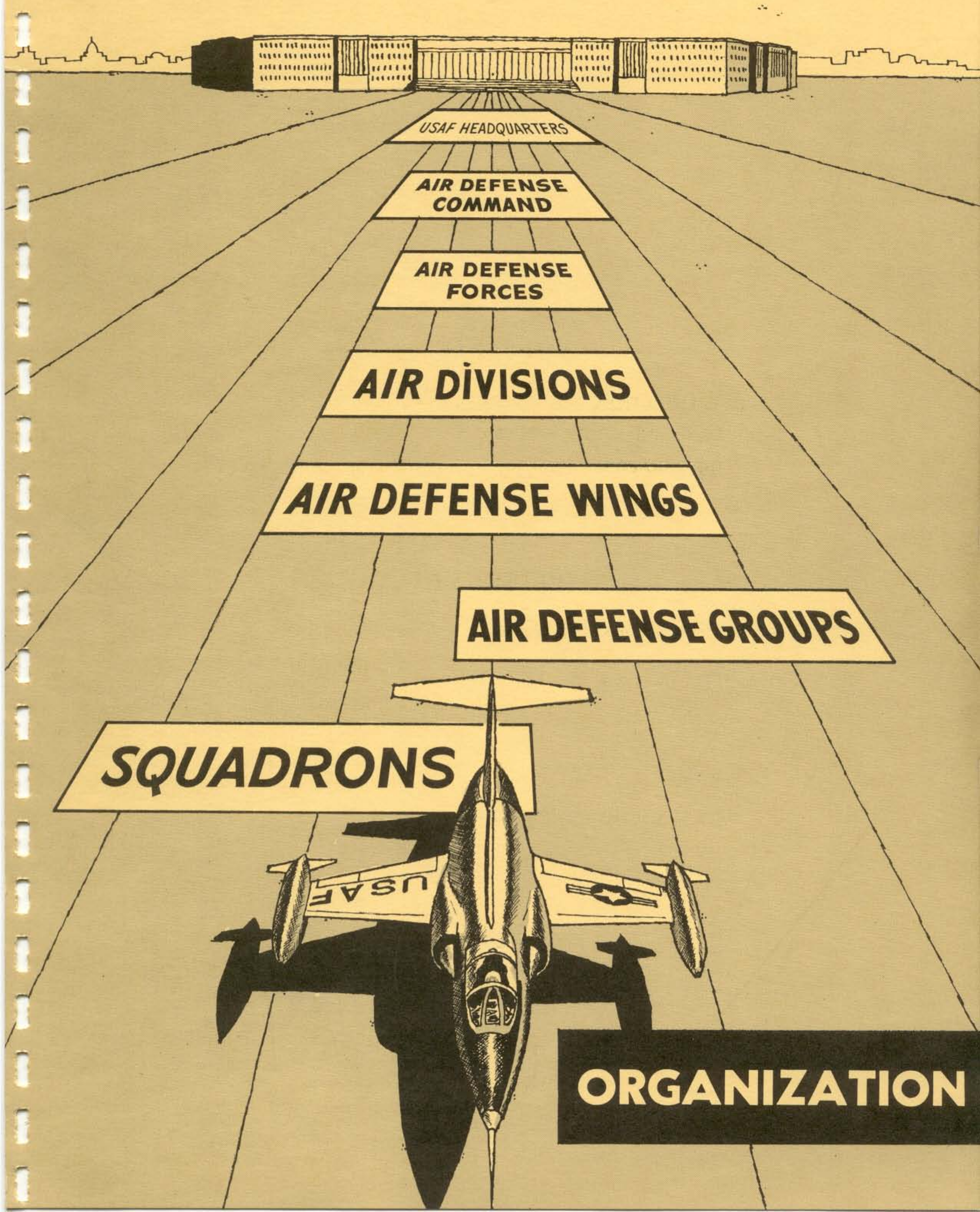


Figure 4-1



ORGANIZATION

CONTENTS

ILLUSTRATIONS

ORGANIZATION

COMMAND RELATIONSHIPS

The following Command relationships are outlined to clearly define the tactical mission and logistic support required (Figure 5-1). In general, the fighter squadrons and the control and warning squadrons are tactical organizations and their primary mission and interest is that of Air Defense operation. These squadrons will normally be supported logisitically from the Fighter Group (Air Defense) level.

Interceptor squadrons are basically complete tactical organizations. These squadrons will be normally based on airfields controlled by Air Defense Command, Strategic Air Command, or other military or civilian agencies. An interceptor squadron will normally have direct contact with the warning squadron which has been designated as the Air Defense Direction Center, and with the Continental Air Defense Division which is also designated as the Air Defense Control Center.

Aircraft Control and Warning Squadrons designated as Air Defense Direction Centers work directly with the squadrons and the Continental Air Defense Division, and normally have direct contact with these organizations as well as with the Early Warning Squadrons in the designated area of control. The Air Defense Direction Center has authority to scramble aircraft to intercept and identify unknown aircraft. Attack and destruction of unknown aircraft are covered by certain Rules of Engagement.

The Continental Air Defense Division is the Air Defense Control Center and is the direct over-all tactical coordination agency and combat director for all Interceptor Squadrons, Aircraft Control and Warning Squadrons, and anti-aircraft defense activity within a given area.

Where the squadron is a tenant organization on a SAC, TAC, or other major command air bases, logistic support for the squadron is the responsibility of the permanent organization on the base.

The Aircraft Control and Warning Squadrons usually receive logistic and electronics support from a support base. The degree of logistic support is dictated in each case by the location of the squadron or its proximity to a Fighter Group (Air Defense) or designated parent organization.

The Air Division will normally depend on the parent base organization (Air Base Group or Air Base Wing) for logistic support.

Materiel support will come through normal AMA channels in accordance with AFR 67-1; i.e., from the prime depot direct to the Fighter Group (Air Defense).

For conversion and activation of squadrons to the F-104A Weapon System, experienced personnel available within the Air Defense System will be used. Replacement pilots will be jet qualified by the Air Training Command and will undergo transition and combat crew training within the Air Defense Squadron. New maintenance personnel are expected to be three level and will be trained on fighter interceptor type aircraft. Transition to the F-104A aircraft must be accomplished through normal OJT.

THE SQUADRON

The fighter interceptor squadron will consist of twenty-one F-104A and four F-104B aircraft. It is anticipated that there will be three T-33A and one cargo type support aircraft per squadron. The squadron will function to maintain a state of readiness and execute assigned fighter interceptor missions. Assignment of squadrons will be to a Fighter Group (Air Defense), Air Defense Group, or Air Division (Defense), as required.

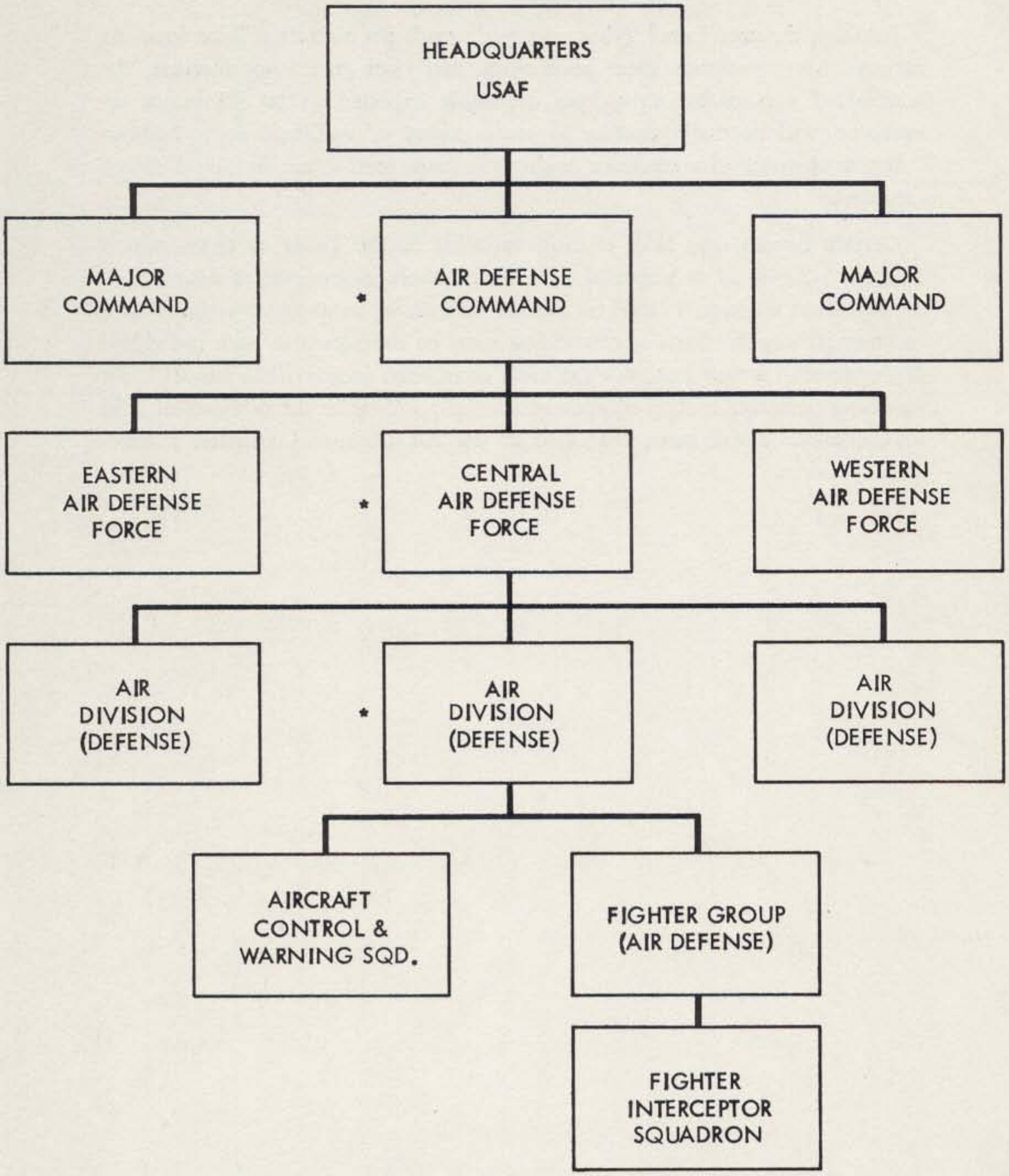
Considering that the squadron is 100 percent manned and equipped, it should encounter no difficulties in obtaining the following capabilities:

1. Performance of a continuous Air Defense alert mission.
2. An average flying rate of 40 hours per aircraft per month.
3. Performance of organizational maintenance on assigned aircraft, electronics equipment, and armament consisting of Sidewinder IA (GAR 8) missiles and T-171E-3 gun.
4. Repair, maintain and store in a live condition, armament as required.
5. Performance of organizational and field maintenance on the fire control system and associated electronics equipment as specified or directed.
6. Performance of organizational maintenance on assigned motorized equipment and towing vehicles.

Initially, the anticipated flying time per month per aircraft will be low. As maintenance experience, spare parts stock, and pilot proficiency increase, the anticipated non-combat flying per month is expected to be 30 hours. A squadron will normally operate in some degree of readiness on a 24-hour 7-day week basis in accordance with procedures established by Air Defense Command.

Certain factors may arise causing variation in the Table of Organization (Figure 5-2), such as a special field maintenance augmentation assigned to the squadron when it is based on remote airfields or temporarily assigned at a commercial airport. Such augmentation must be considered in each individual deployment of a squadron, but the areas considered most critical are all items requiring permament shop equipment normally falling in the category of field maintenance. These items are listed in the Air Defense Command maintenance concept.

COMMAND RELATIONS



* JOINT CONTINENTAL AIR DEFENSE HEADQUARTERS ARE ESTABLISHED AT EACH OF THESE ECHELOPS FOR EXERCISING OPERATIONAL CONTROL OF ALL WEAPONS MADE AVAILABLE FOR AIR DEFENSE.

Figure 5-1

INTERCEPTOR SQUADRON

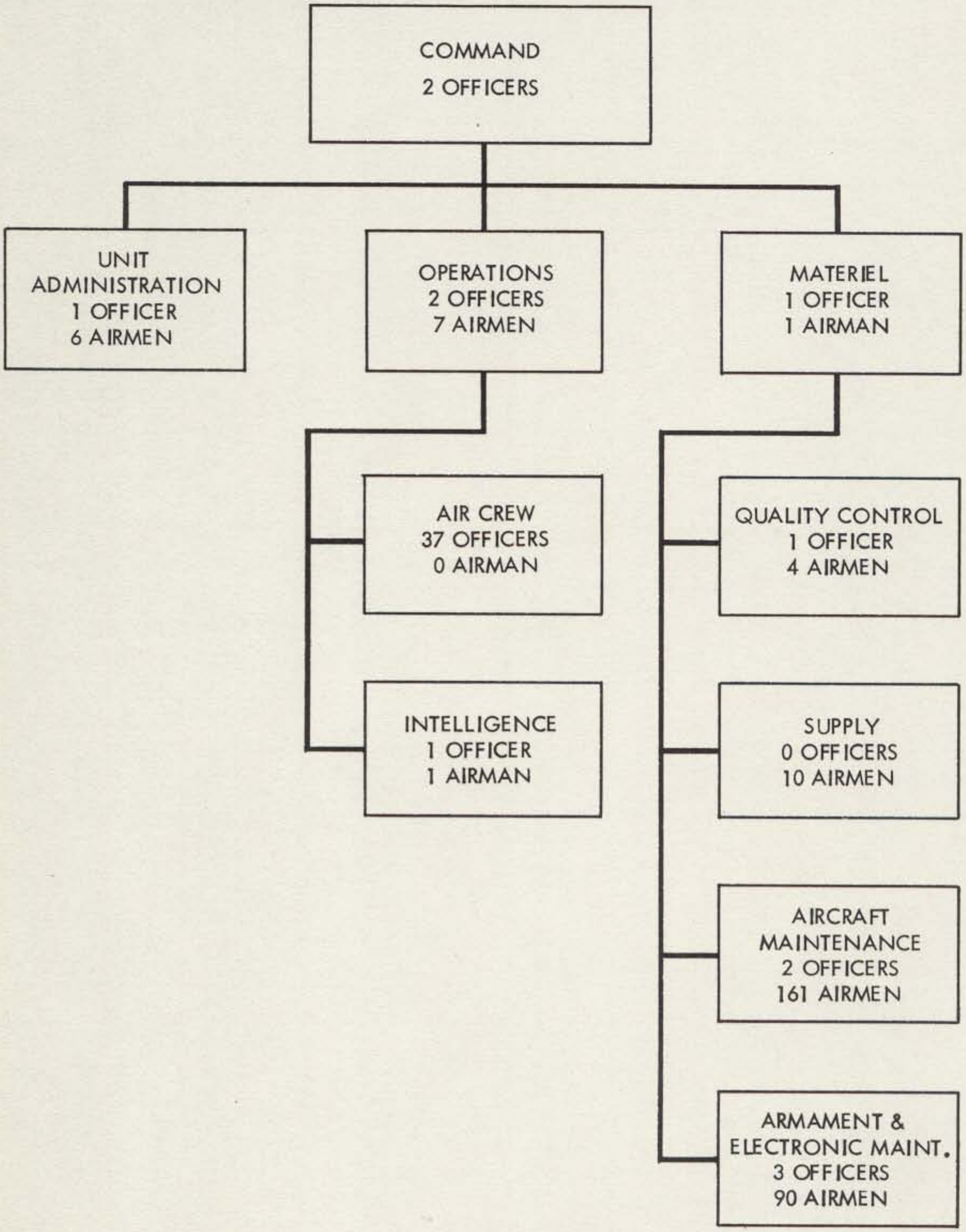
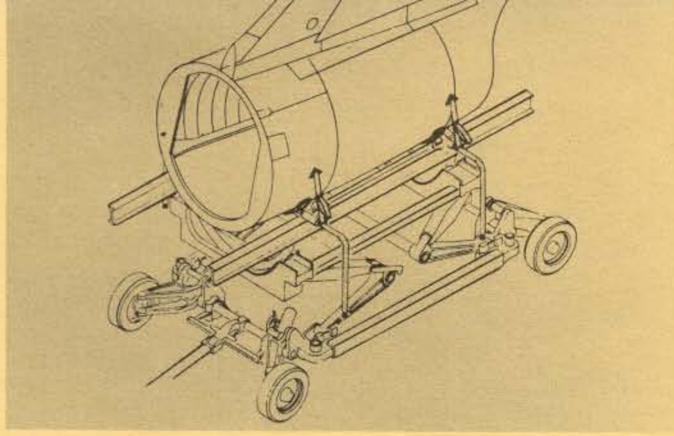
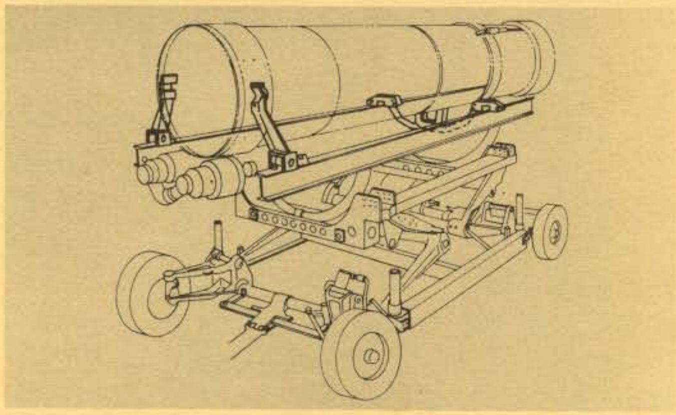
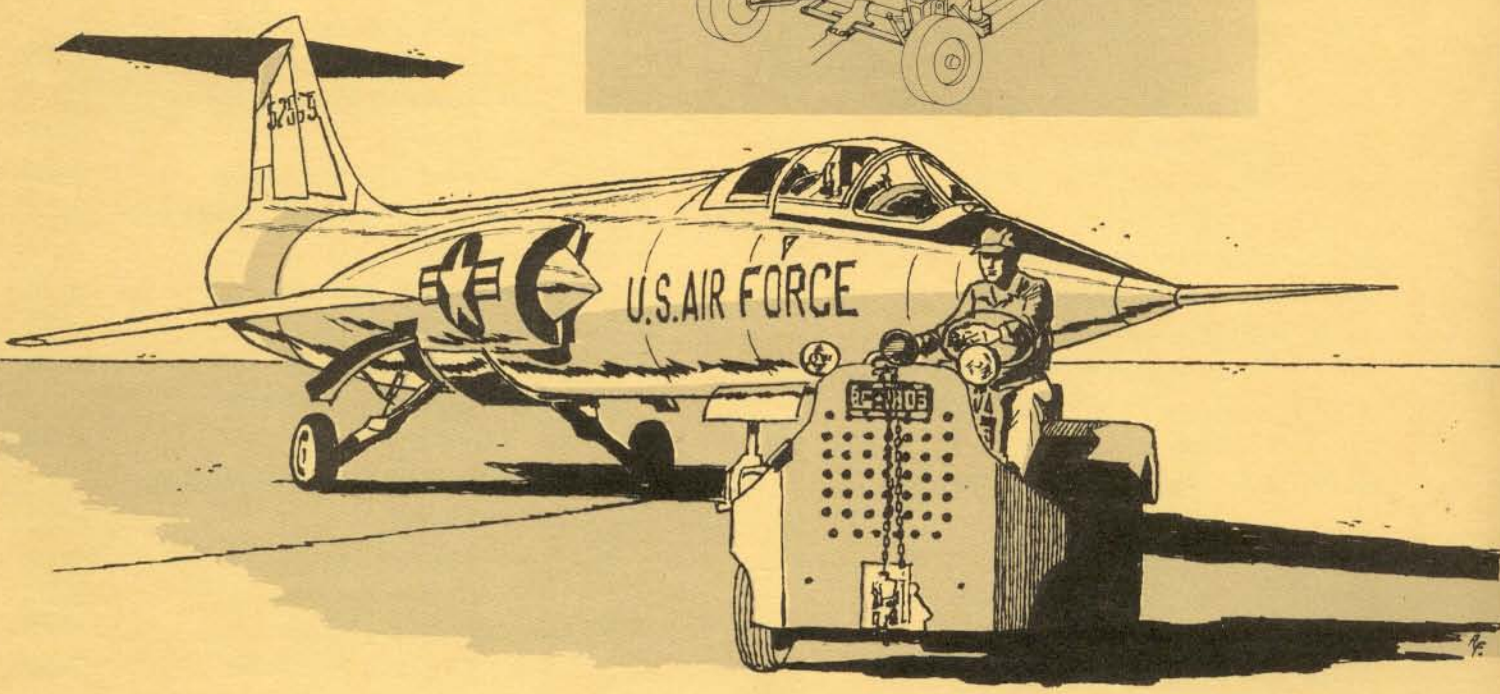


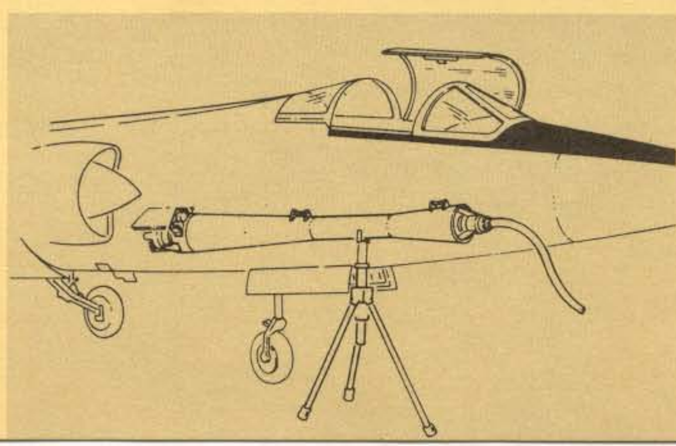
Figure 5-2



EQUIPMENT AND FACILITIES







CONTENTS

ILLUSTRATIONS

EQUIPMENT AND FACILITIES

It is the purpose of this section to cover equipment and facility requirements peculiar to utilization of the F-104A Weapon System with respect to previous weapon systems. Excluded in general is coverage of items which are standard within the Air Force system.

AUTHORIZATION

The Unit Authorization List (UAL) is a listing of specified equipment authorized and approved by a major air command for each unit and, within limitations, established by the Table of Allowances plus special authorizations and changes thereto. Equipment authorized by a UAL is tailored to the unit's mission, station location, and the existing fixed facilities, but does not include equipment normally deployed with a combat unit or task force element.

The Base Authorization List (BAL) is a consolidation of all Unit Authorization Lists for organizations being logistically supported by a particular Air Force base or installation.

PROCESSING

The F-104A Weapon System requires, in addition to common or universal items, certain special ground support equipment. Therefore, it is of the utmost importance that UAL/BAL documents be reviewed and processed at the earliest date, subsequent to issuance of a general order activating a new squadron or converting an existing squadron to the F-104A Weapon System. Particular emphasis should be placed on review of the Tentative Table of Equipment (TTE) to assure that all items required in support of the F-104A are accounted for and on hand prior to receipt of the aircraft. The Tentative Table of Equipment is a publication which prescribes the ground handling, tools and test equipment required to support a weapon system.

GROUND SUPPORT AND TEST EQUIPMENT

The following illustrations are intended to describe the function and depict the application of maintenance level special ground support equipment for the F-104A airplane.

PROTECTIVE COVERS

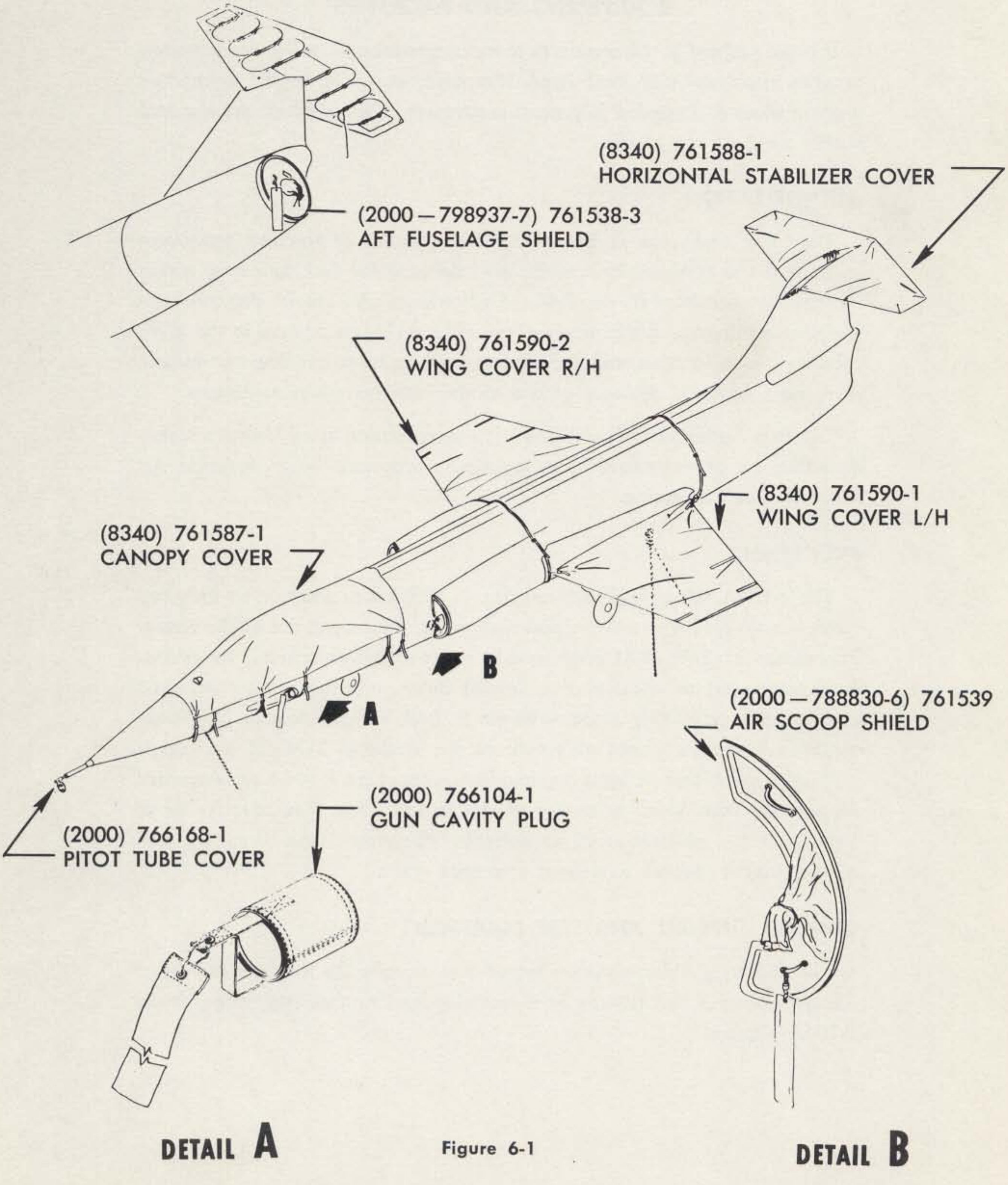


Figure 6-1

WING GUARDS

(2000 — 515100) 761541

Clip-on wing guards cover the wing leading and trailing edges to protect both the structure and ground personnel.

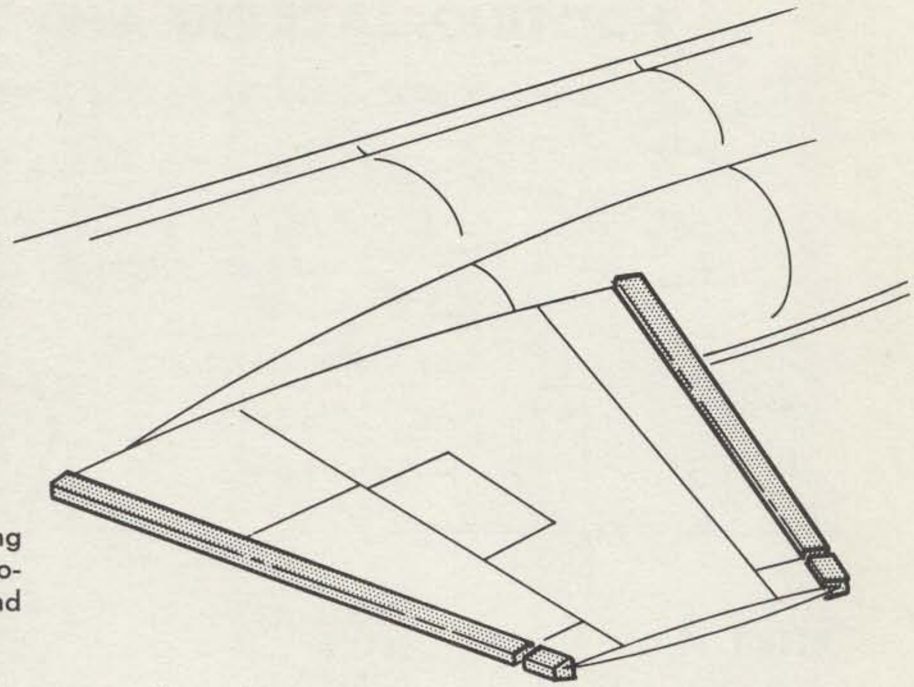
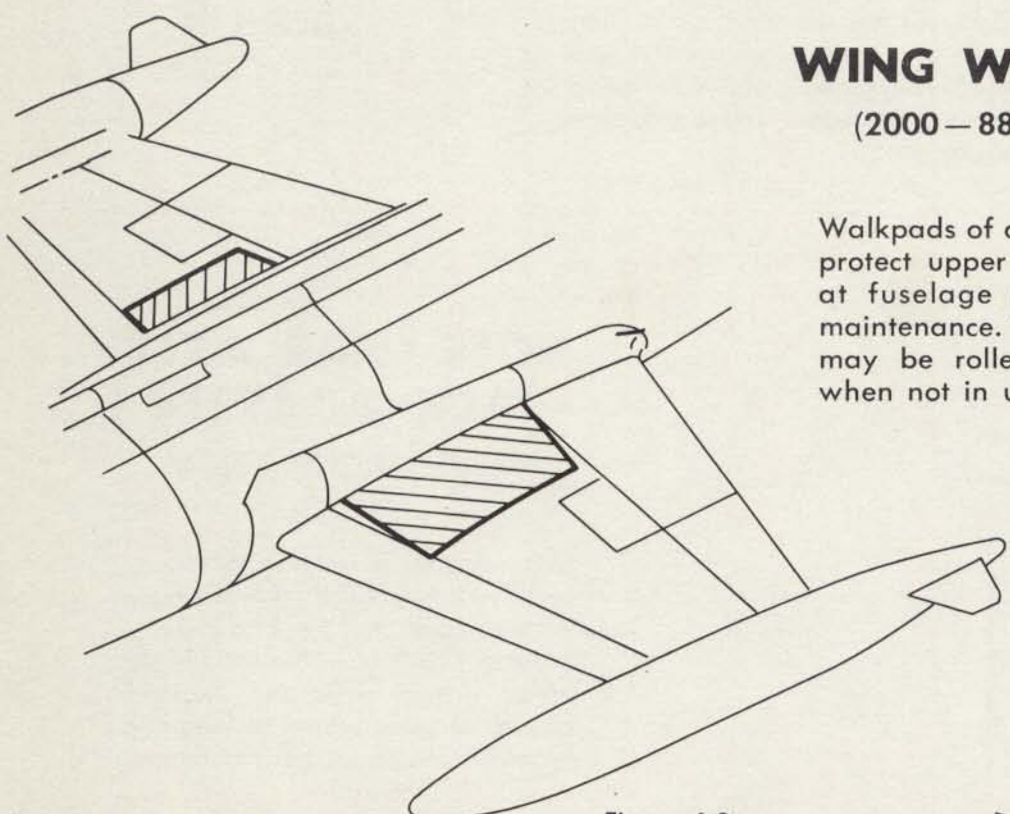


Figure 6-2



WING WALK PADS

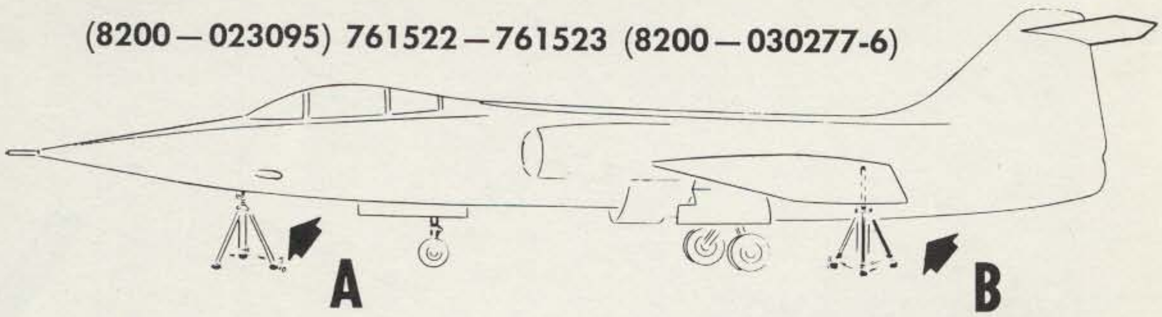
(2000 — 885025) 762254

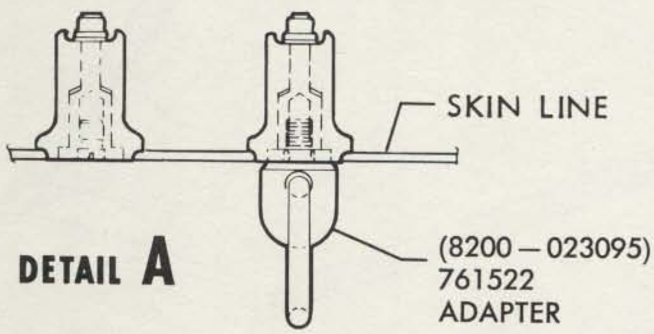
Walkpads of a non-skid material protect upper surfaces of wings at fuselage root area during maintenance. These flexible pads may be rolled up for storage when not in use.

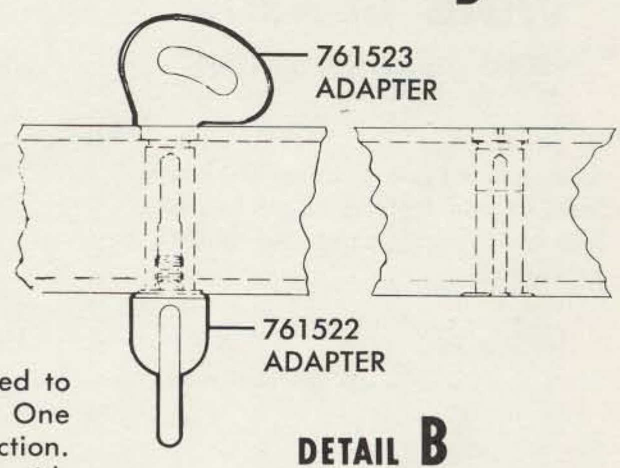
Figure 6-3

HOISTING, JACKING AND TIE DOWN

(8200—023095) 761522—761523 (8200—030277-6)







Three 761522 Jack and Tiedown Adapters are used to adapt Type B-5 Jacks to the aircraft jacking points. One adapter is threaded into the fitting on the nose section. The remaining two adapters are used in conjunction with 761523 hoisting adapters at wing jacking points for either hoisting, jacking or tiedown operations. These adapters are furnished as loose equipment.

Figure 6-4

NOSE GEAR AXLE JACK ADAPTER

(8200—030205) 762544

This adapter is used with standard Type A-2 Axle Jack for nose wheel jacking to provide a jacking point of sufficient height when tire is deflated. Jacking points for main wheel jacking are provided on main gear castings.

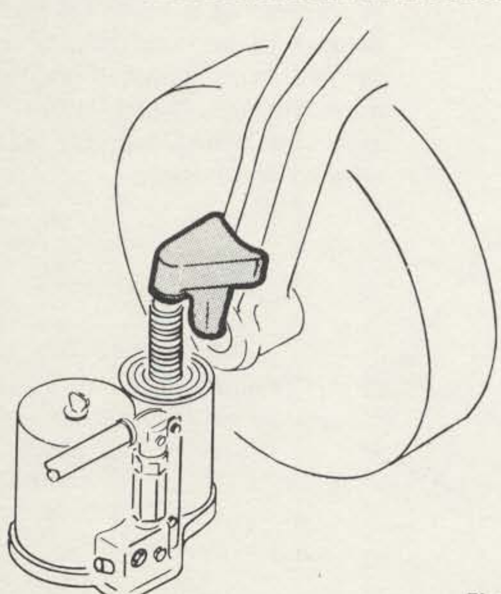
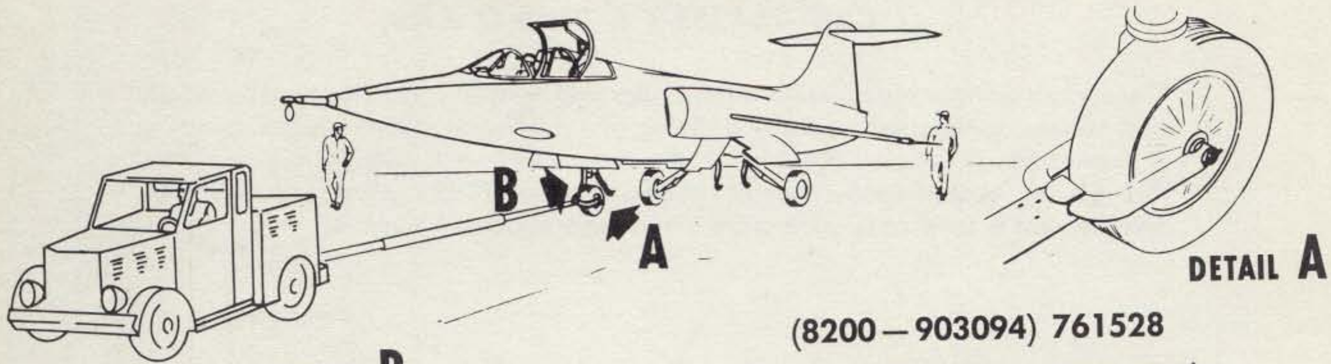
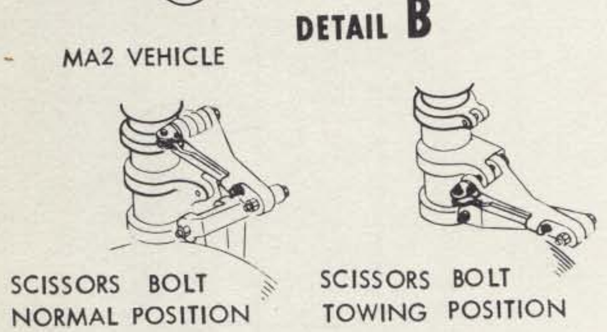


Figure 6-5

NOSE TOW BAR



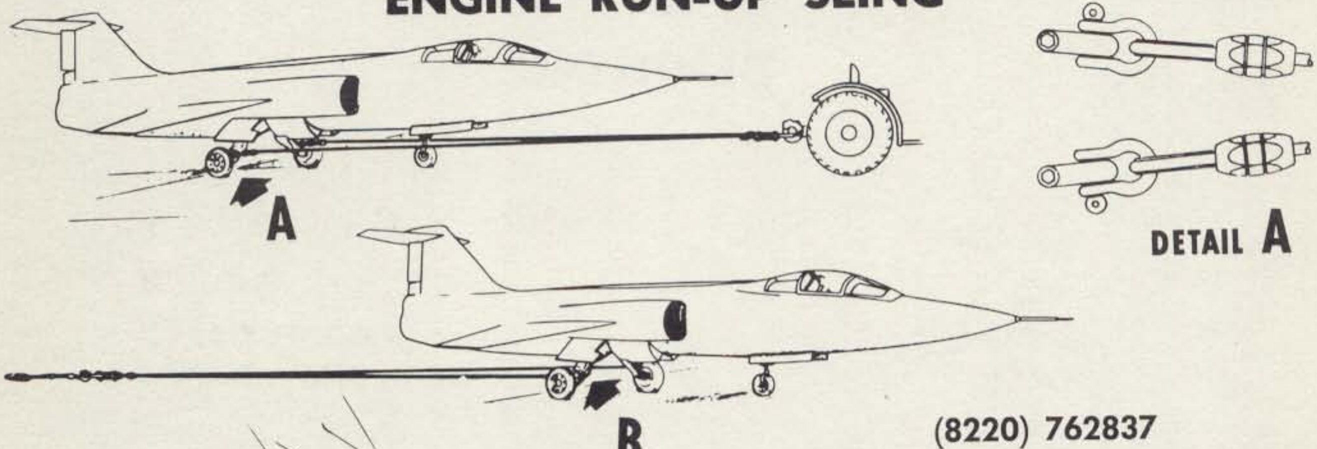


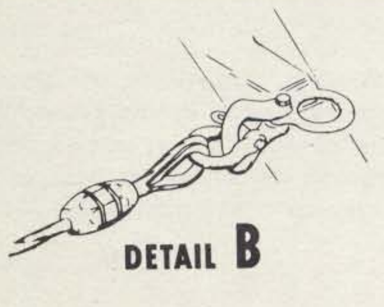
(8200—903094) 761528

The Nose Towbar connects to the nose landing gear axle. Telescoping construction allows length to be reduced to approximately 119" when not in use. Contains a shear pin to limit the maximum load to 6000 pounds to prevent inadvertent damage to gear installation. Total weight is 84 pounds. Nose gear steering mechanism must be disengaged for towing.

Figure 6-6

MAIN GEAR TOW AND ENGINE RUN-UP SLING





(8220) 762837

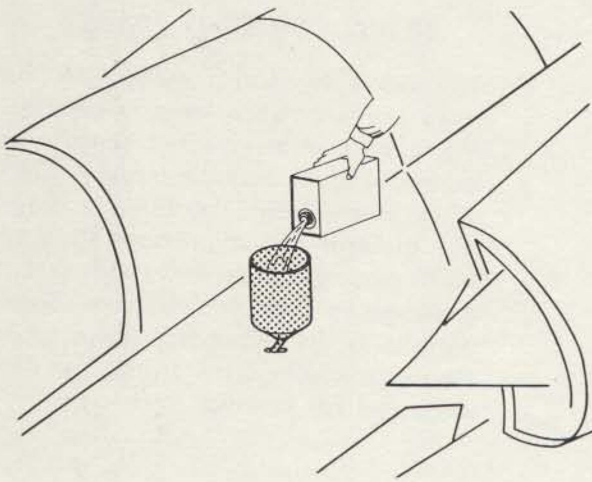
This sling attaches to lugs provided on the main gear using ball lock pins and shackle blocks. Large rings on gear are used for towing while the smaller eyes, aft of towing rings, are used to attach the tiedown cable during engine run-up.

Figure 6-7

DEMINERALIZER AND HOLDER

(7 CAB) 764365-1 & 212B (7 CAB)

The cockpit refrigeration system water boiler and reservoir is of two quart capacity and utilizes distilled water. Daily draining and refilling is recommended. Draining is made through a valve provided in the nose wheel well. Filling is accomplished through use of a 764365-1 funnel type holder and 212B replaceable cartridge. The element is used to demineralize water from available sources.



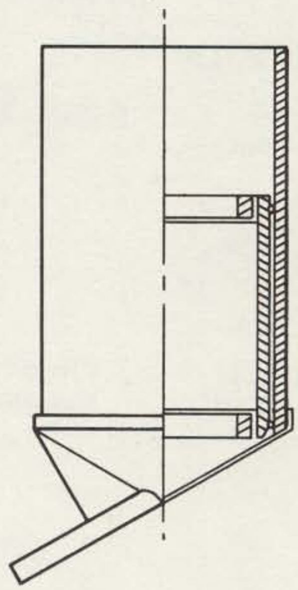
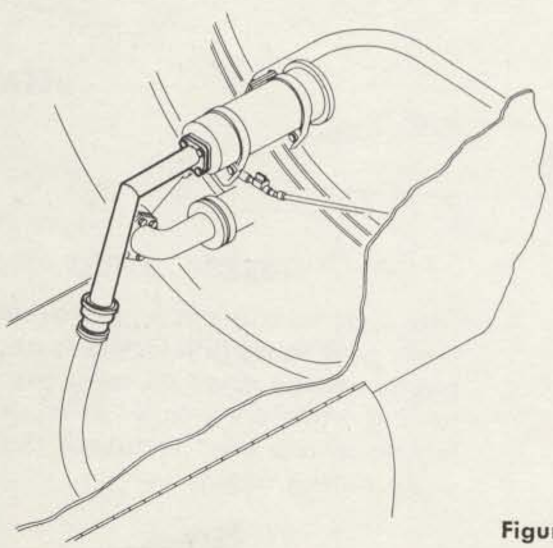


Figure 6-8

DEFUELING



(4930) 764732
DEFUELING ADAPTER

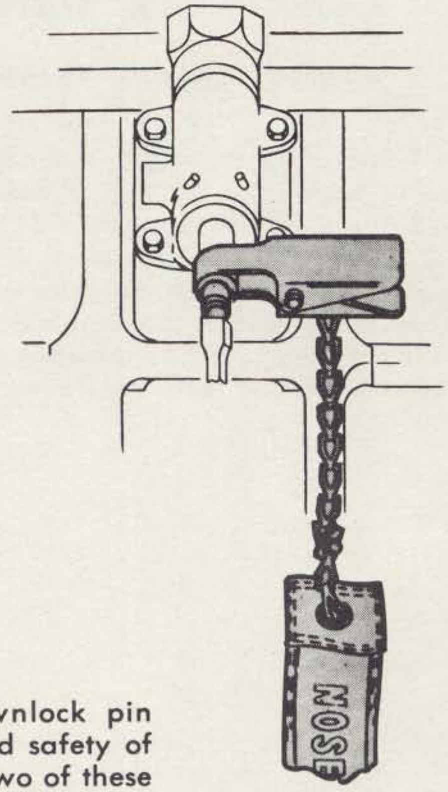
The defueling adapter is attached to the engine fuel filter and provides a connection for the fuel truck hose. The aircraft fuel tank pumps are used to pump fuel back to the fuel truck.

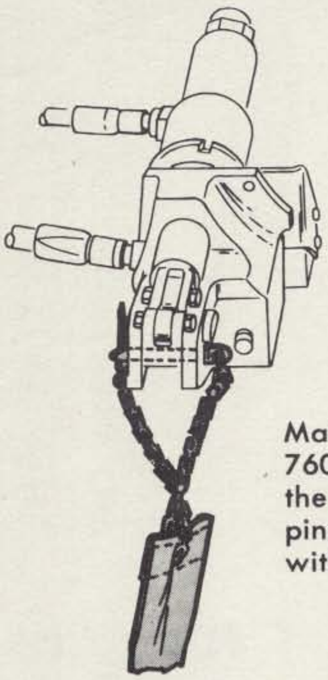
Figure 6-9

LANDING GEAR SAFETY PINS

760789—761521
(8200—691948-8) (8200—625334)

Nose landing gear downlock clamp 761521 is used for ground safety of the nose landing gear. One of these clamps is furnished as loose equipment with each aircraft.





Main landing gear downlock pin 760789 is used for ground safety of the main landing gear. Two of these pins are furnished as loose equipment with each aircraft.

Figure 6-10

TIP TANK EJECTOR SWITCH GUARD

(8220) 766707-1
(8220—439206-5) 761532

Each electrical tip tank ejector switch is covered by a switch guard during ground maintenance to prevent inadvertent firing and possible injury to ground personnel. These guards are installed over switch arms when access doors are removed.

Figure 6-11

AIRPLANE HOISTING COMPLETE SLING

(8220—602408) 761524

When hoisting the entire airplane, this sling is attached to each wing by use of hoisting adapters 761523 and jack pad adapters 761522. The nose belly band is secured to the nose jack point fitting by use of a special bolt provided with the sling. The sling spreader bar prevents side loads on the fuselage nose area. The hoisting link may be varied on chain for various "CG" conditions.

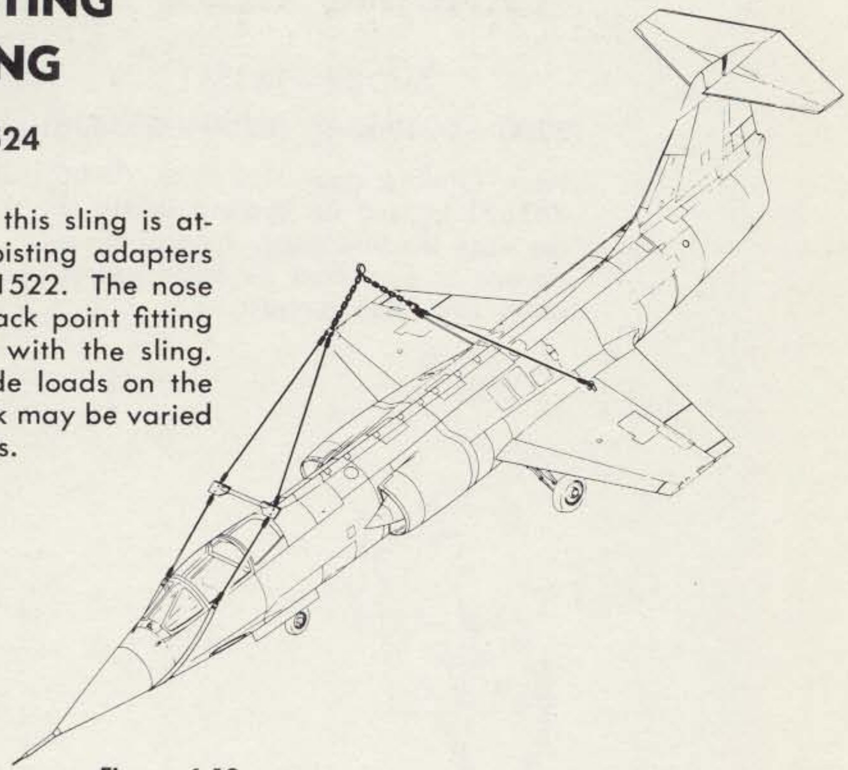


Figure 6-12

AFT FUSELAGE AND EMPENNAGE SLING

(8220—600323) 761530

This sling is used for hoisting either the horizontal stabilizer, the horizontal stabilizer and vertical fin, the aft fuselage structure or the complete aft fuselage and empennage structure. Attachment is made with sling retained bolts which replace existing screws at points of attachment marked on the outside surface of the airplane.

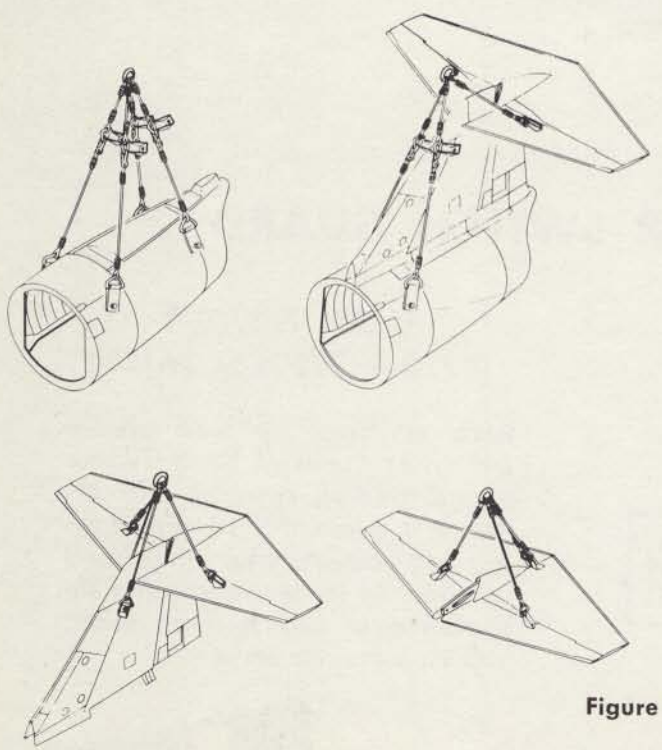


Figure 6-13

UTILITY LADDER

(8220—439206-5)

761532

Cockpit accessibility, fuel replenishment and electronics bay servicing are all facilitated by use of this utility ladder. It is lightweight, portable and may be folded to minimize storage space.

The standard B-4A platform provides accessibility to the upper empennage.

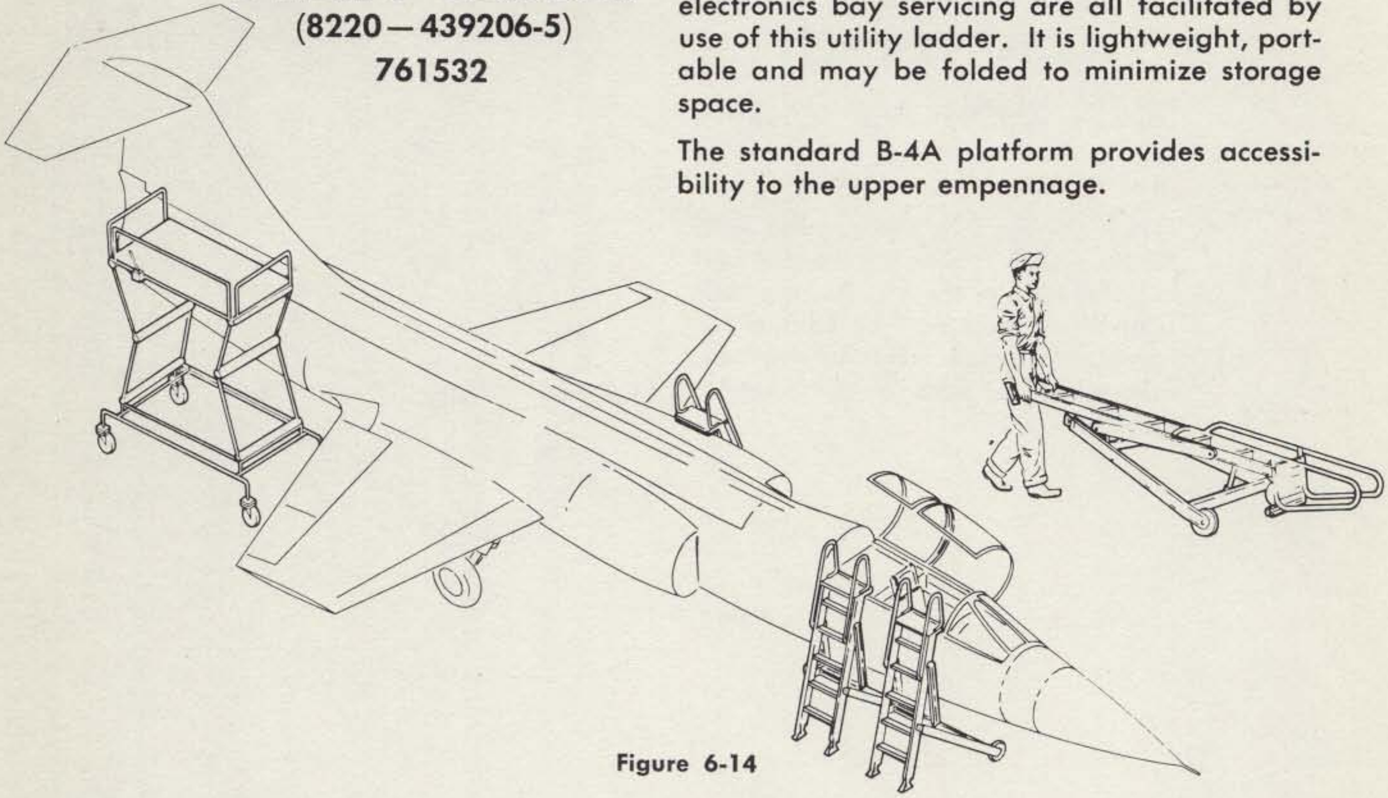


Figure 6-14

TIP TANK INSTALLATION AND STORAGE ADAPTER

(8220) 761534-1

The 761534-1 adapter is used with the Type MJ-1 Bomb Dolly to assist in the removal and installation of both the left and right wing.

Tip tanks may be stored in these racks when removed from the aircraft.

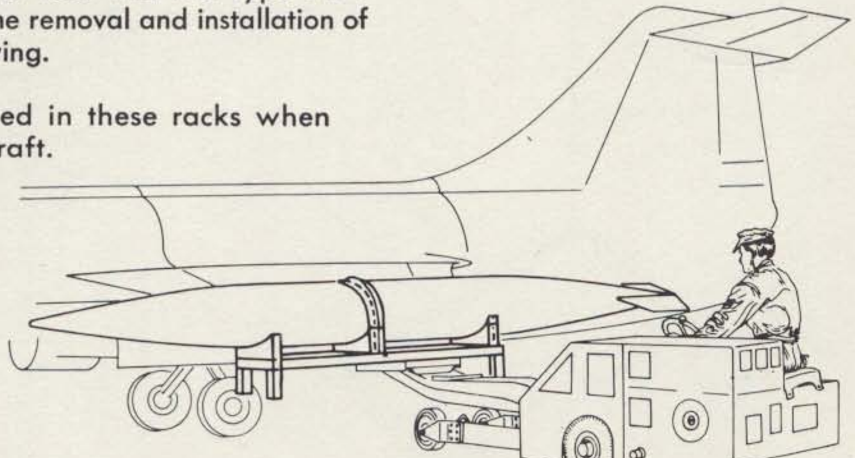


Figure 6-15

AFT FUSELAGE ADAPTER KIT

(8220—034201—93) 765189-1

This kit is used in conjunction with Model 4000A Trailer for removal and in installation of the aft fuselage. Self supporting legs can be folded for compact storage when not in use. Adjustable foot pads are provided for leveling.

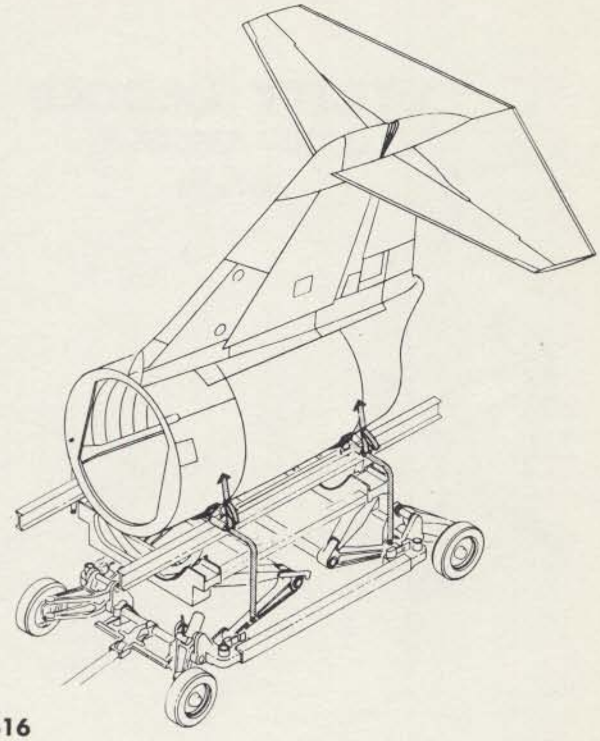


Figure 6-16

ESCAPE HATCH GUARD

(8200—298326) 761544

The escape hatch rubber seal is protected from possible damage by this guard when escape hatch is removed. It may be collapsed when not in use.

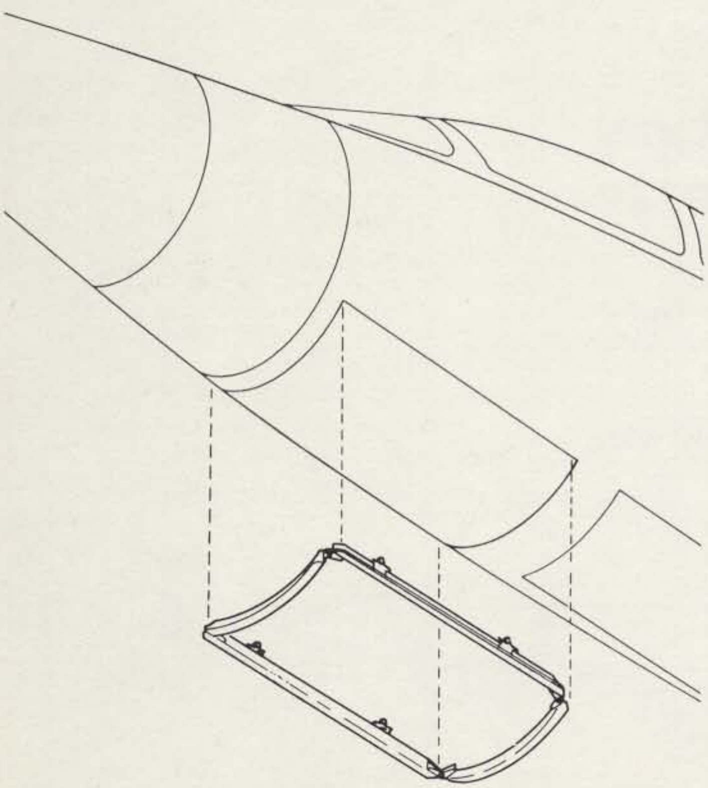


Figure 6-17

HYDRAULIC BEAD BREAKER

(8200 — 127105) 5033

This lightweight and portable tire tool is designed for use at deployed areas for breaking the bead on main and nose wheel tires. The bead breaker is adjustable for tires from 16" to 44" in diameter and 4" to 9" in width.

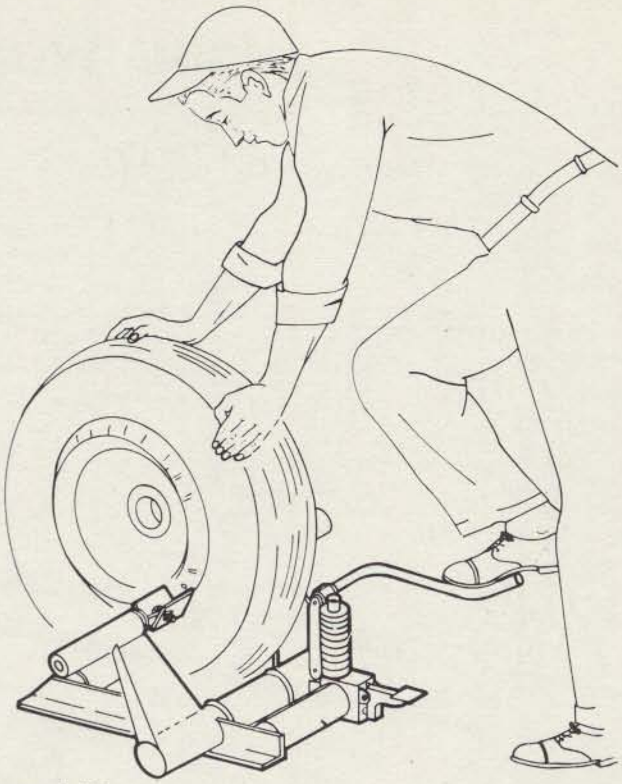
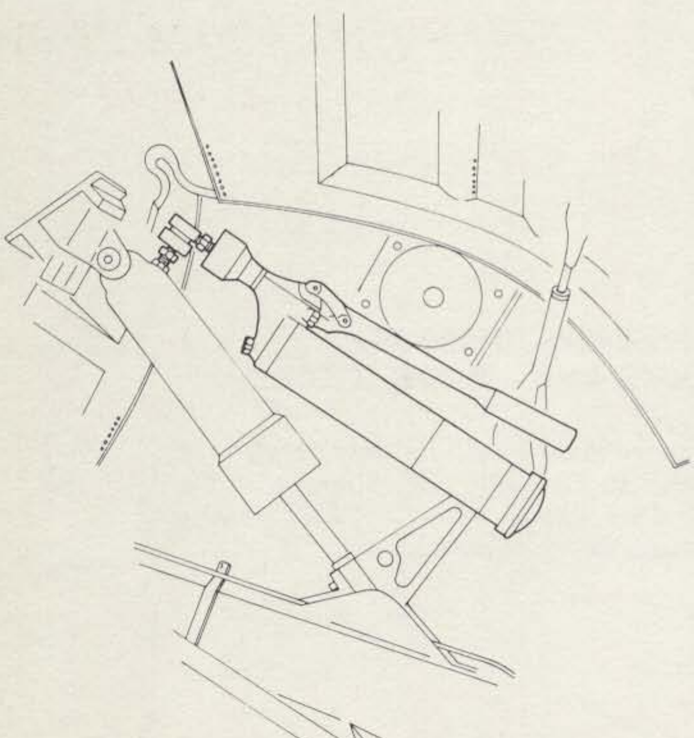


Figure 6-18



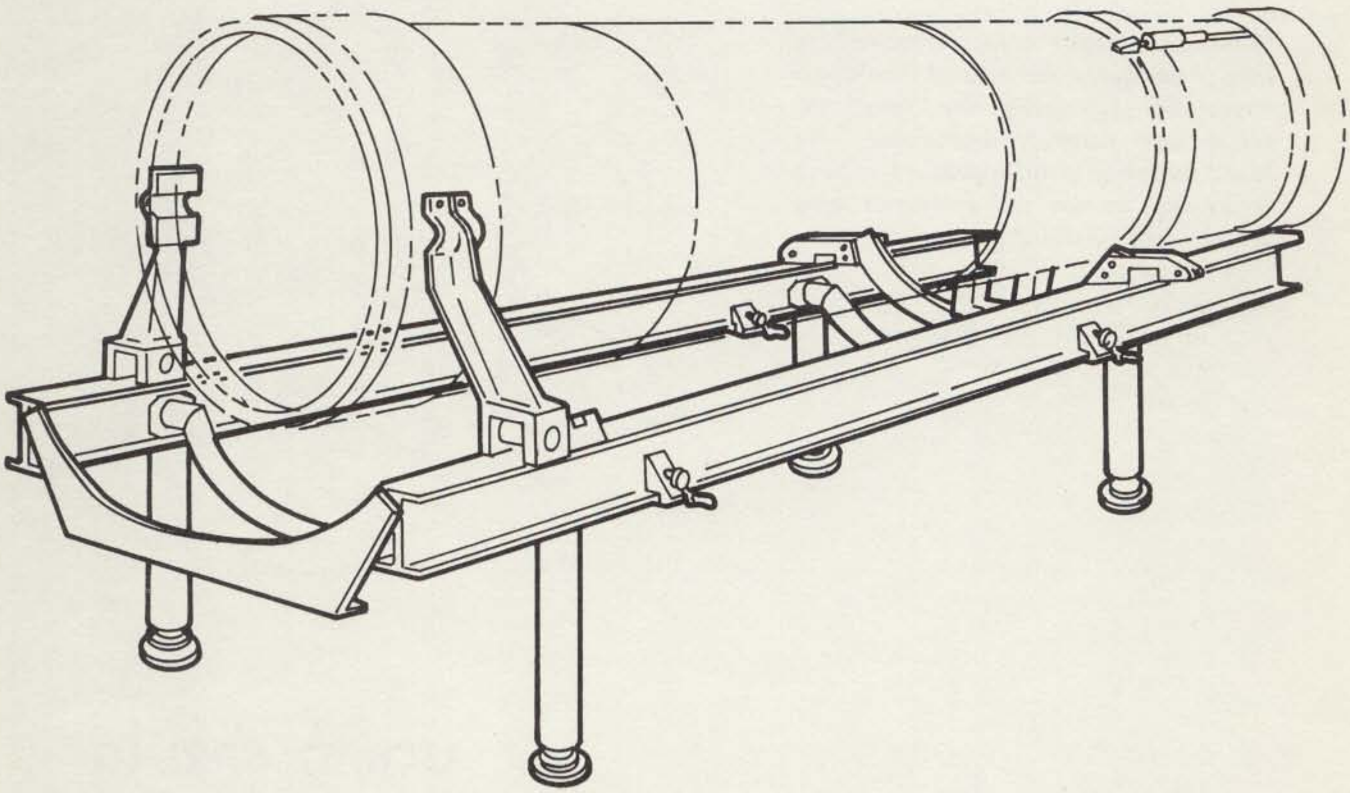
LIQUID SPRING GUN CHARGER

9365C

The gun assembly includes the 9365 gun and 9365-100 pressure gauge and adapter. The spring is to be recharged only when the A/C weight is not bearing on the landing gear.

Figure 6-19

ENGINE WORK STAND



(4920-293-8429) 101830-501
ENGINE WORKSTAND—MODEL 3100A

The J79 Engine maintenance stand is used for both storage and engine build up. Adapter kit 764636-1 adapts engine to this stand. Legs can be folded for storage. Wheel kit 764736-1 may be installed on legs to make the stand portable.

Figure 6-20

AFTERBURNER INSTALLATION KIT

(8220) 765188-1

Removal and installation of the afterburner with this stand is accomplished by means of the standard Model 4000 Trailer. The afterburner self-supporting installation stand may be used for storage of the J79 Engine Afterburner. Folding legs may be rotated to "up" position for storage when the stand is not in use.

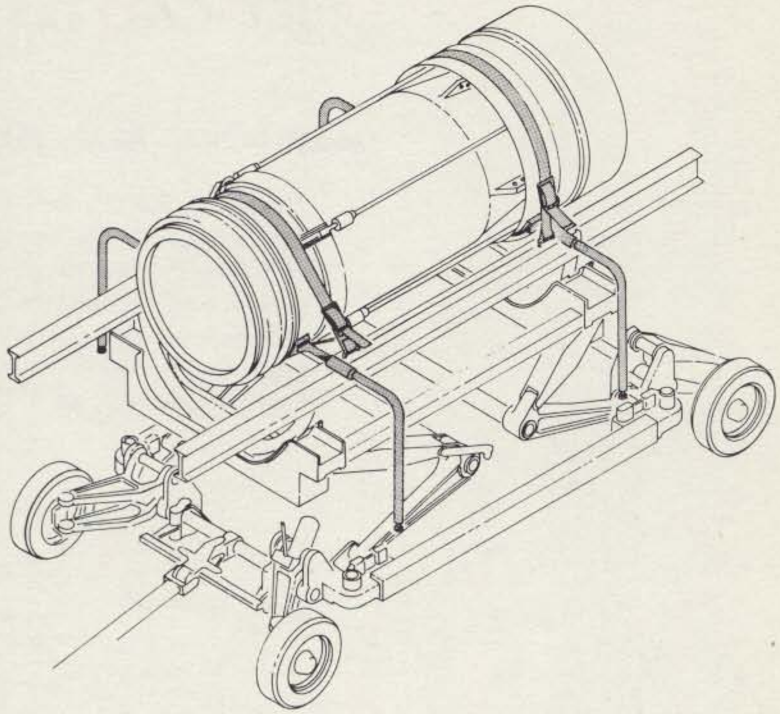


Figure 6-21

ENGINE ADAPTER KIT

(8220) 764636-1

This kit adapts the J79 Engine to Model 3000, 4000, and 5000 Trailers and the 761527 Engine Stand.

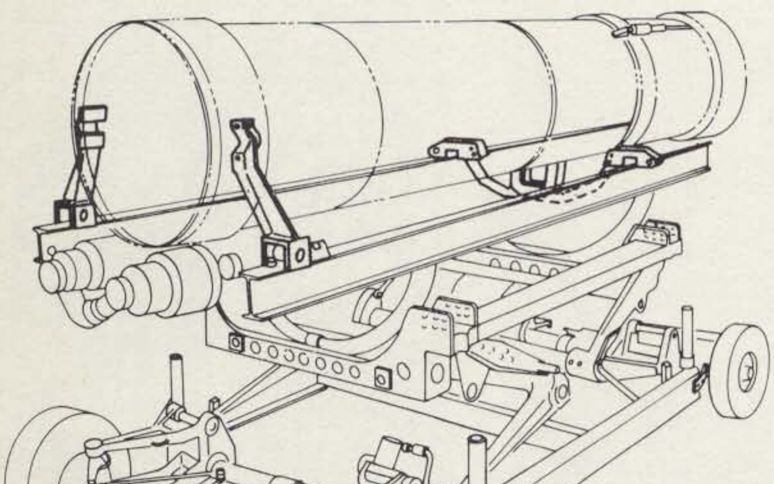


Figure 6-22

JET CAL TESTER

(4920—294—4328) BH112J-28T2

This analyzer is used for testing the Fenwal fire warning system switches, the engine temperature system and the engine RPM. The unit incorporates a potentiometer operating from Mallory Cells and has a readability of 1°C.

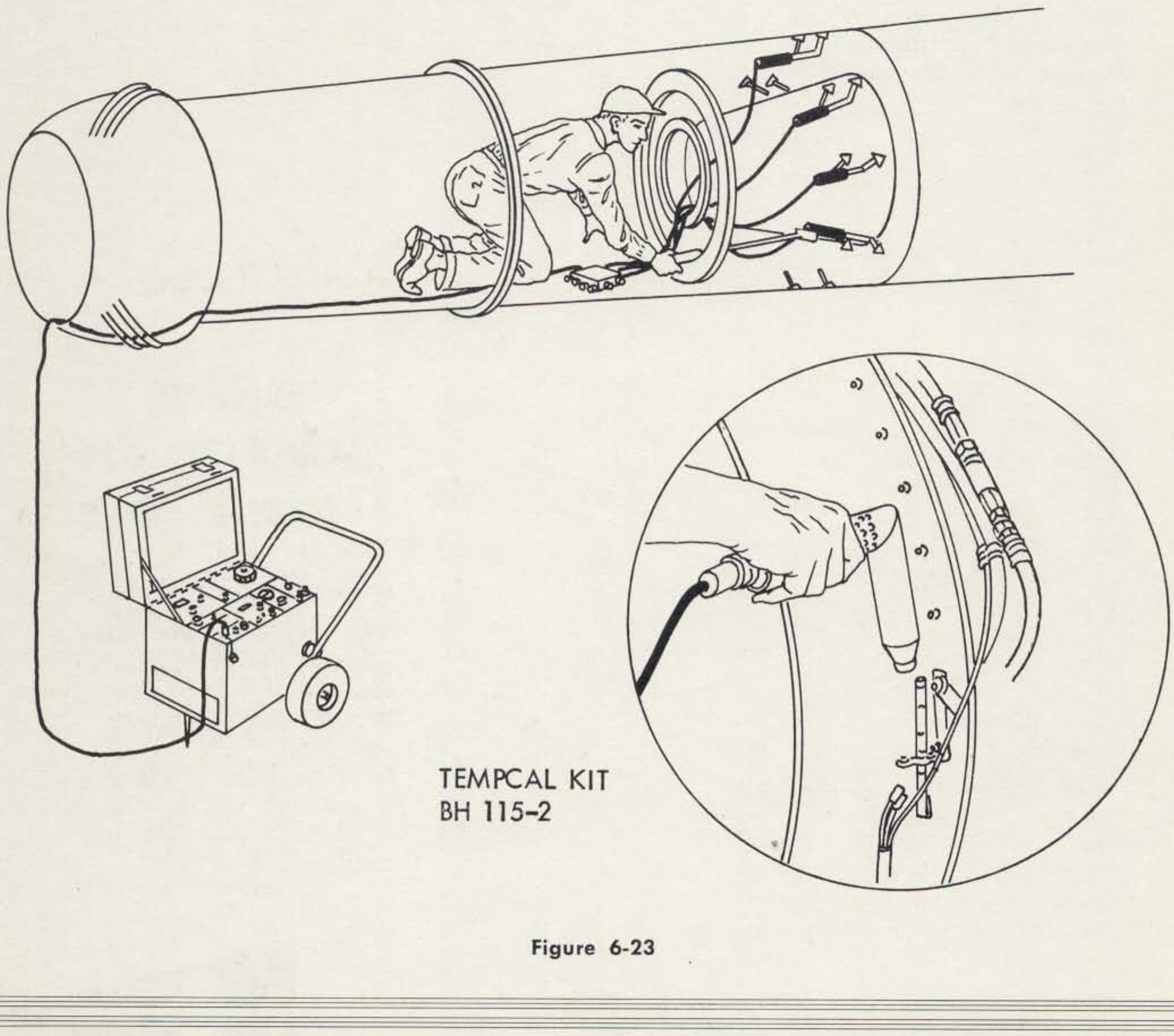


Figure 6-23

CABIN TEMPERATURE SYSTEM TESTER

(7 CHP) HS 6950

Cabin air conditioning temperature control system can be checked out while installed in the aircraft through the use of this tester.

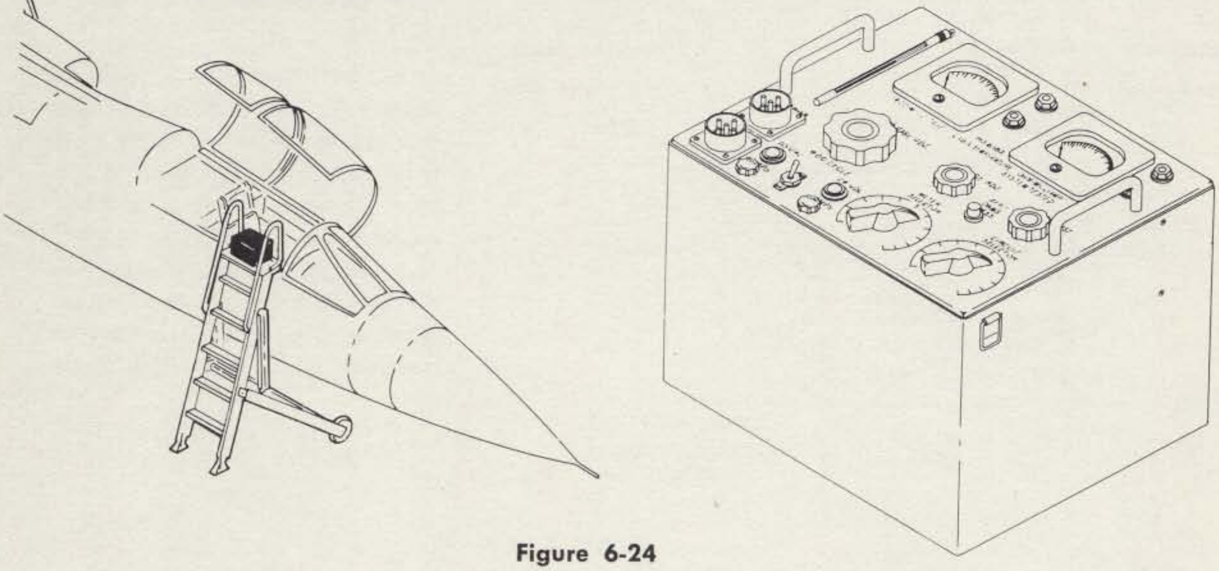
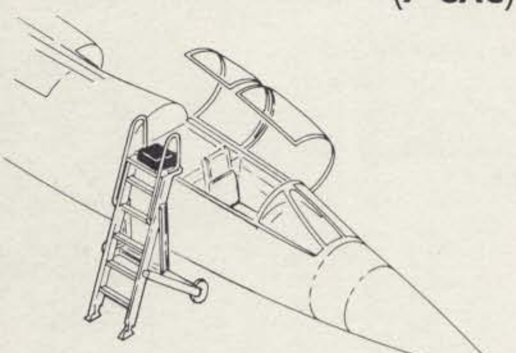
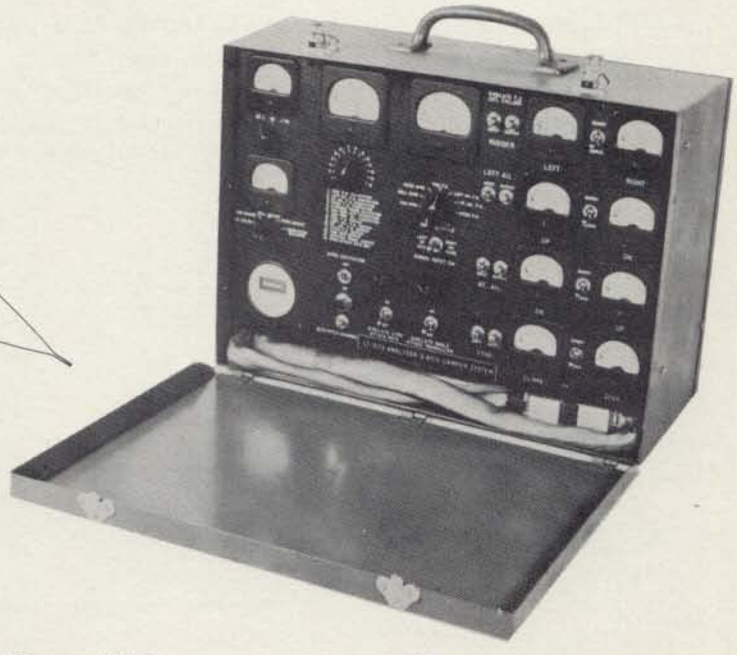


Figure 6-24

3-AXIS DAMPER AMPLIFIER ANALYZER

(7 CAC) LT 3173





This analyzer provides a means of analysis of the Stability Augmenter system through simulated signals. This analysis may be conducted without removing system components from the aircraft.

Figure 6-25

FUEL QUANTITY SYSTEM TEST HARNESS

(7 CAC—170270-158)

The fuel quantity circuit is tested for accuracy with the use of the MD-1 Tester and this Adapter Harness. One end of the harness is connected to the MD-1 Tester. The other end connects between the Indicator-Power Unit in the cockpit and the harness plug from the tank unit.

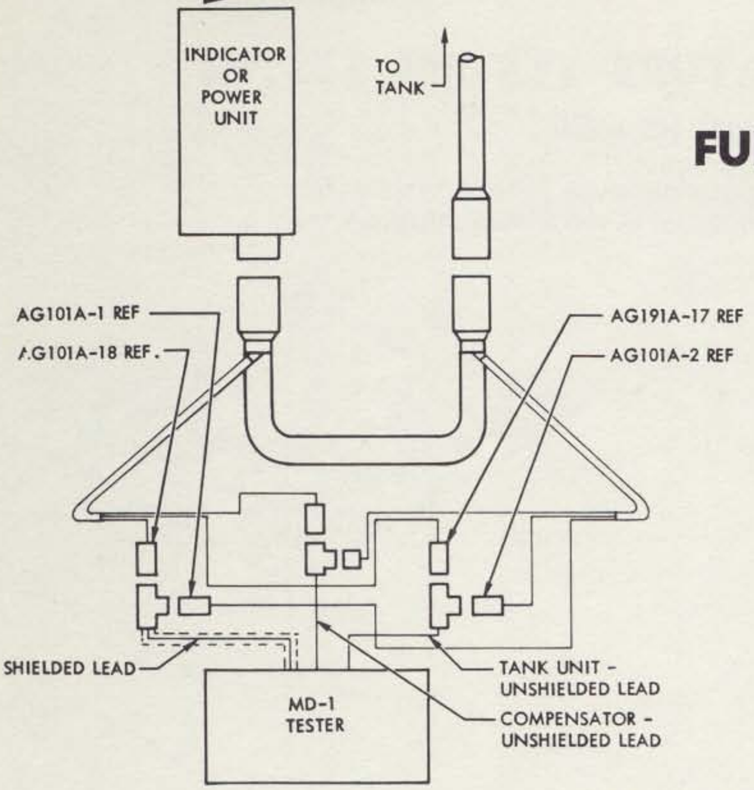


Figure 6-26

TIP TANK PRESSURE GAGE

(7 CAD) 765132-1

Two of these gages are used to test tip tank pressure feed system. One gage is installed in each top tip tank drain plug fitting. Gage readings may be taken by running engine or by introducing air into the tanks through the standard valves incorporated in each gage.

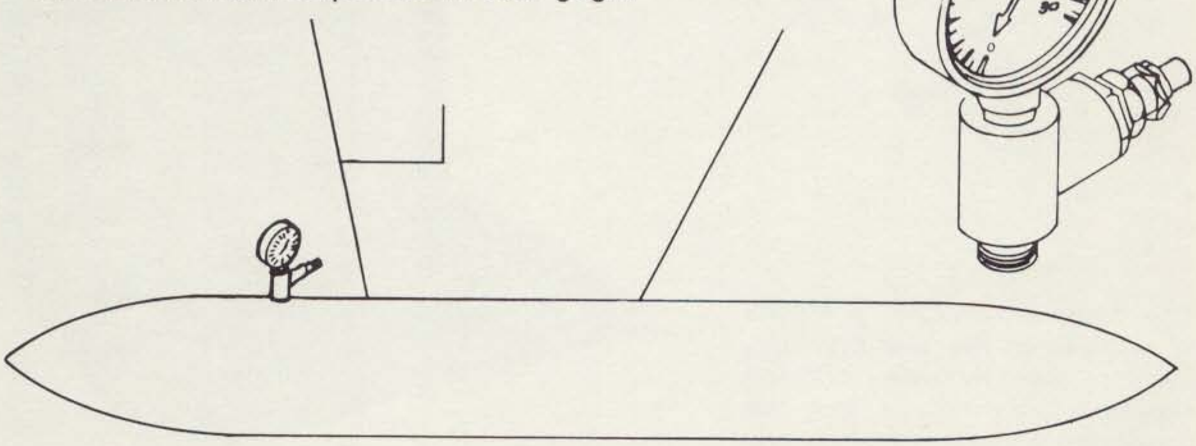
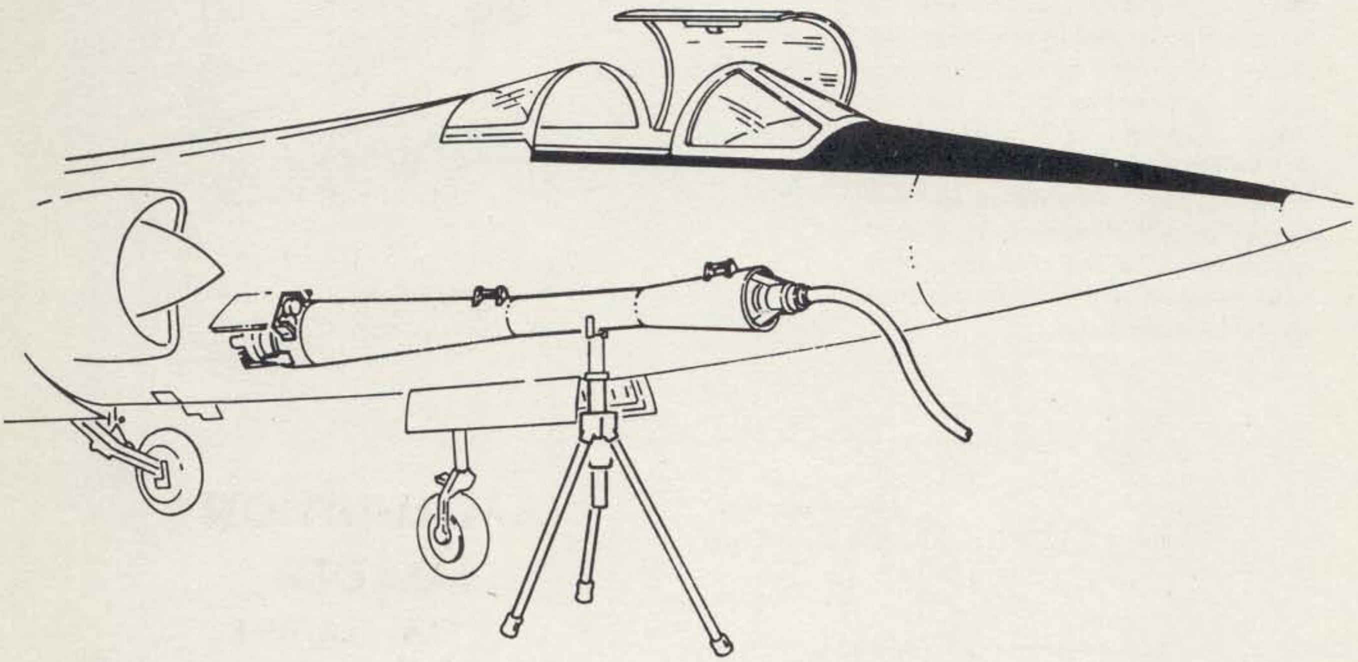


Figure 6-27

RAM AIR TURBINE TEST ADAPTER

(4920-341-8483) 700818



This adapter provides a means of ground testing the ram air turbine. Air speed and temperature gages are provided to insure proper air supply.

Figure 6-28

GUN HOIST

(8220-407398) 762655

This hoisting gear mechanism is operated by a hand crank to move the gun mechanism laterally into the armament compartment. The rail, attached to brackets provided in the compartment, protrudes at right angles, and is supported by a flexible cable attached to a screw hole on the fuselage structure. Ample mechanical advantage is designed into the crank gear mechanism to raise the gun and also hold it in any vertical position while being raised.

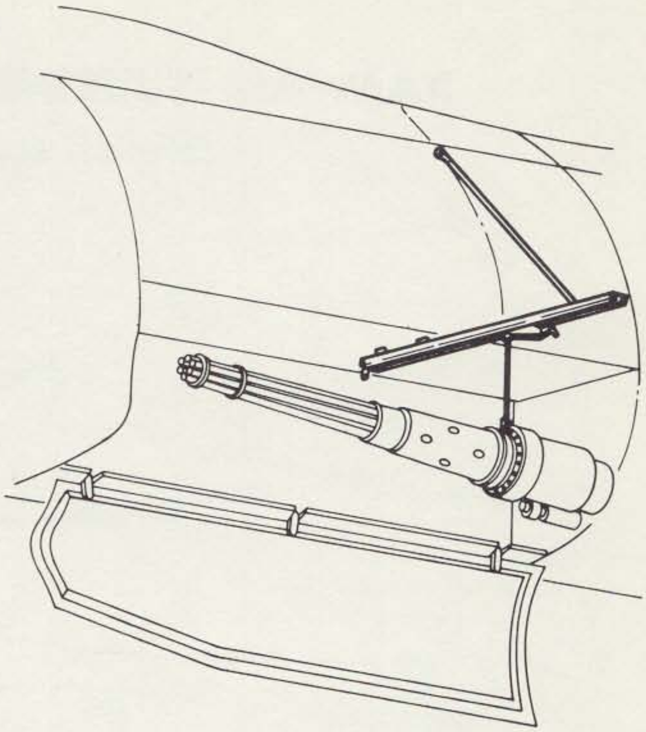


Figure 6-29

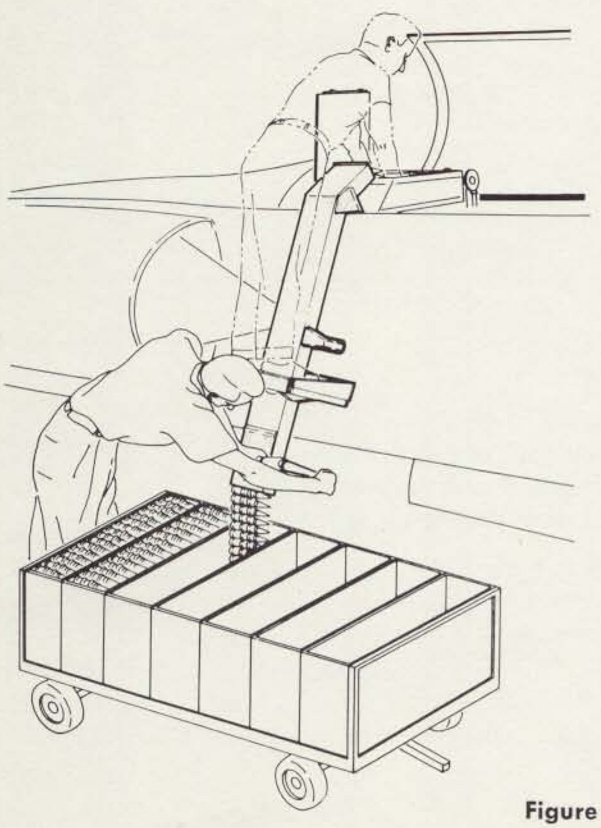


Figure 6-30

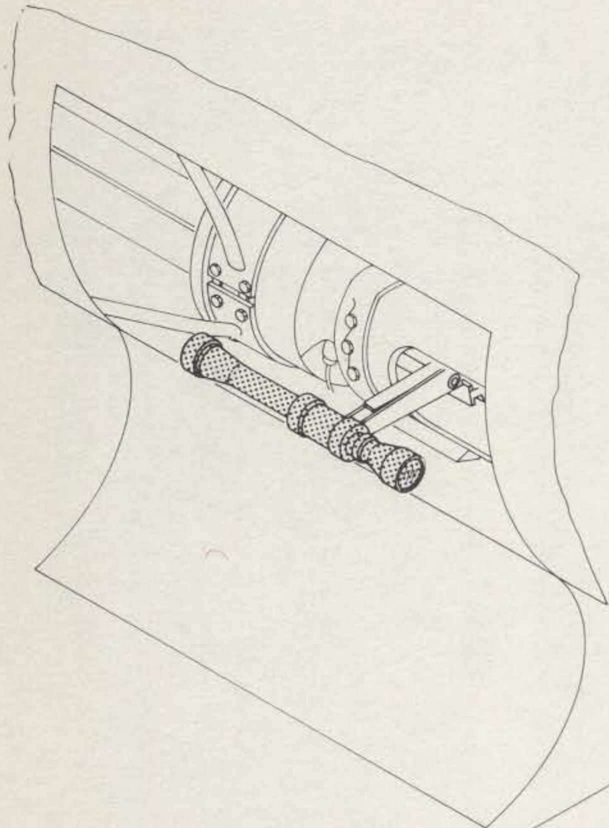
AMMUNITION LOADER

(9 CLA) 766705-1

Ammunition cans contained in early serial aircraft are reloaded without removal from aircraft. This is accomplished by means of this ammunition loader. A hand crank driven sprocket feeds the ammunition up the metal chute for proper feeding into the ammunition can. A self actuating linking device prevents the links from slipping back into the ammunition cart. The F2A Trailer transports the ammunition and loader to the aircraft. On later serial aircraft, pre-loaded ammunition can be hoisted into the aircraft by means of an overhead hoist mounted on the F2A Trailer.

GUN BORESIGHT KIT

(9 CLA—764532) 764532



A Weaver scope and adapter is used for boresighting the firing mechanism. A cross hair type peepsight, permanently mounted in the armament compartment, is used to position the target in relation to the aircraft. The scope is then mounted on the firing mechanism to boresight the gun barrels.

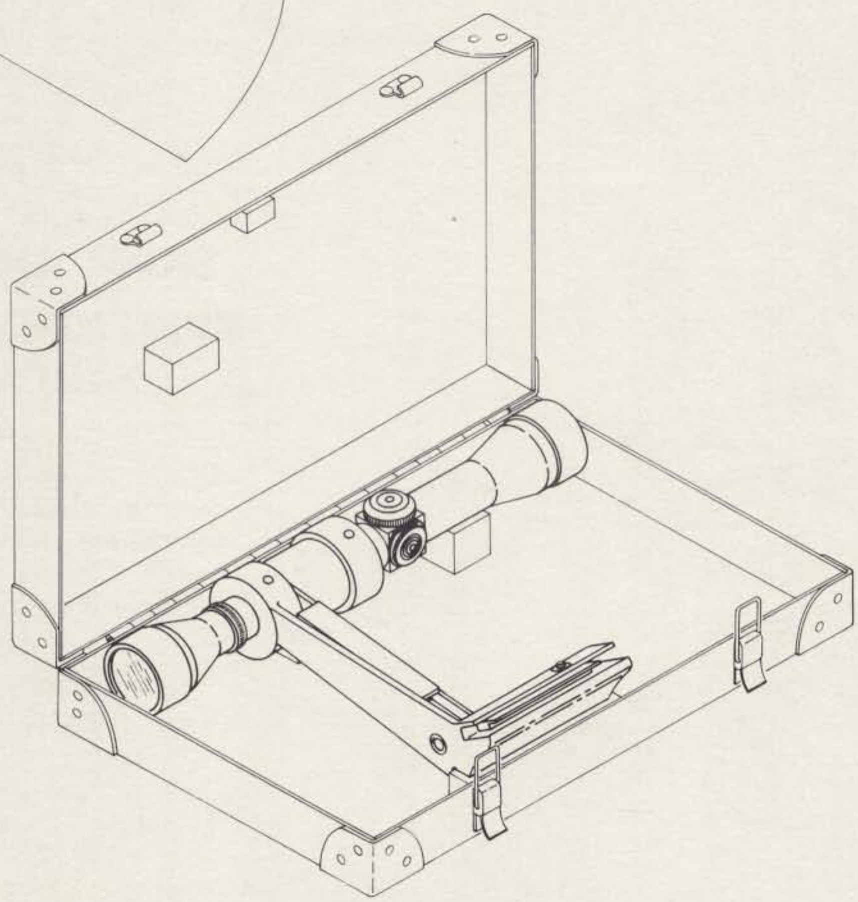


Figure 6-31

SIGHT COVER PLATE

(9 CGE) 196C341P1

This cover plate provides a small hole in the center of the sight head collimating to enable absolute accuracy during boresighting.

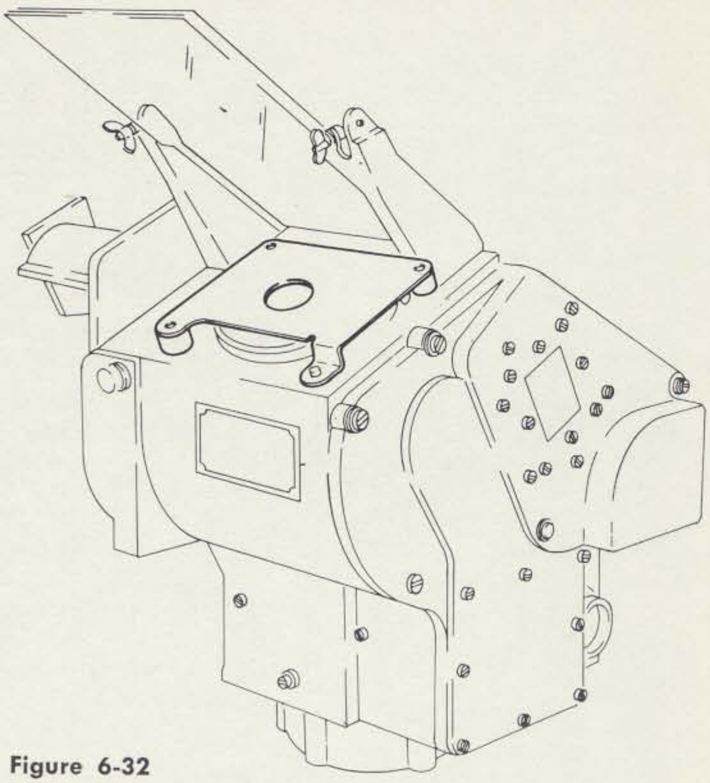


Figure 6-32

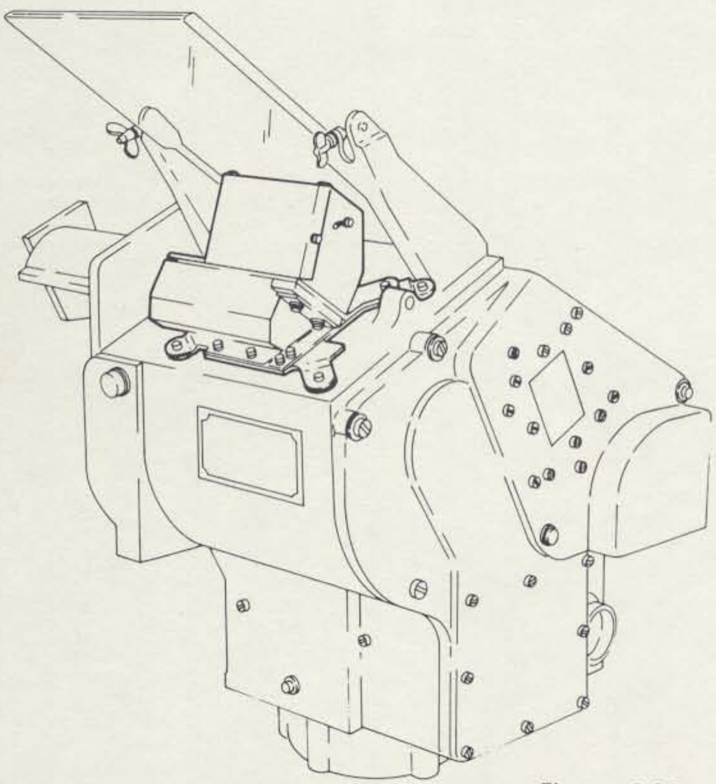


Figure 6-33

SIGHT UNIVERSAL PREFLIGHT CHECKER

(4920) 196C368G1

This unit provides a means of optically checking the sight system in the aircraft or on the test bench. The accuracy of range computation may also be checked.

PORTABLE OPTICAL SIGHT SYSTEM ANALYZER

(7 CAC—040240) 549E424G1

The analyzer is used to operate the Optical Sight System and to determine if the system is functioning properly. It is capable of locating and isolating any malfunction.

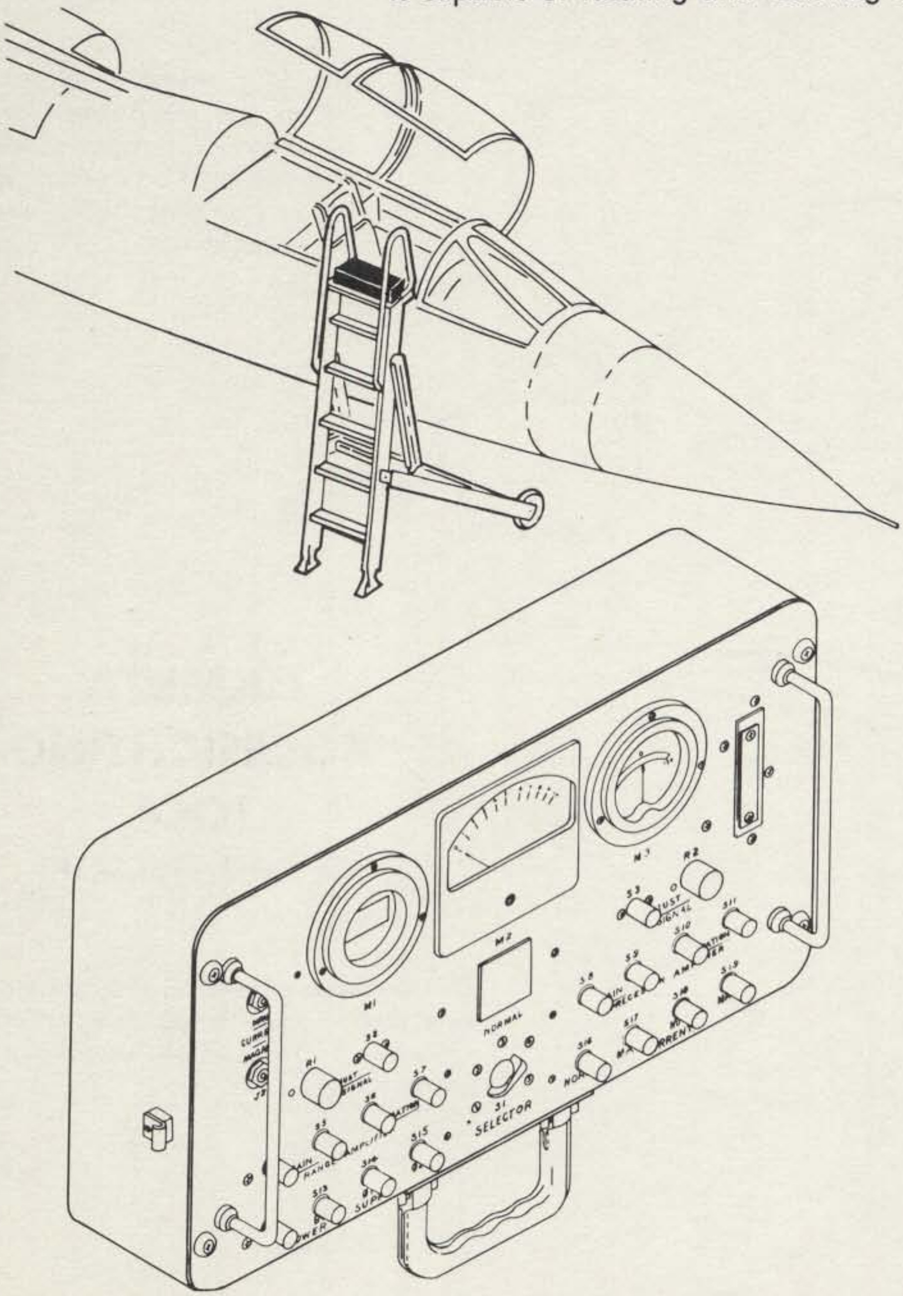
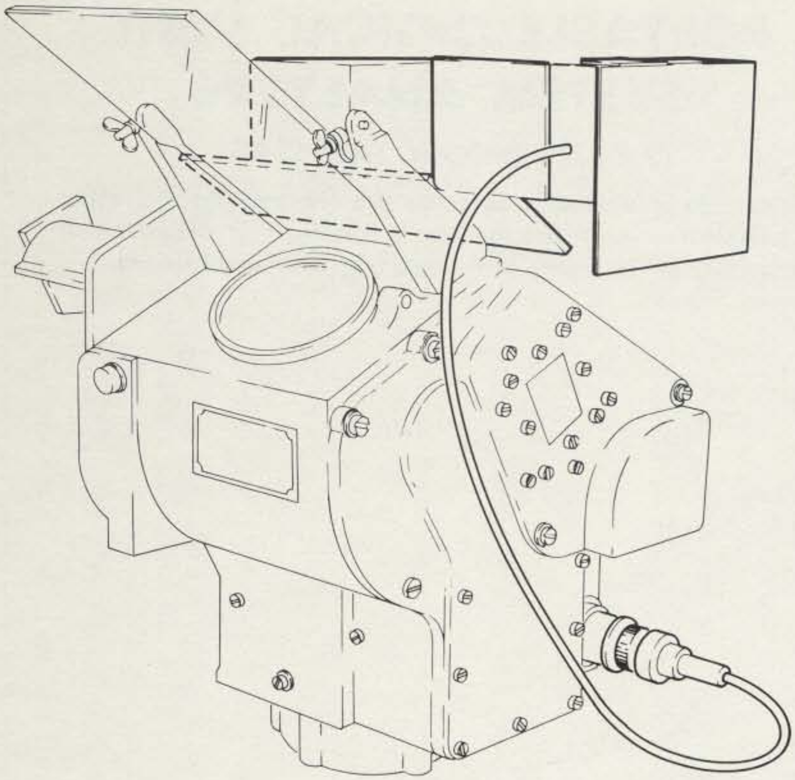


Figure 6-34

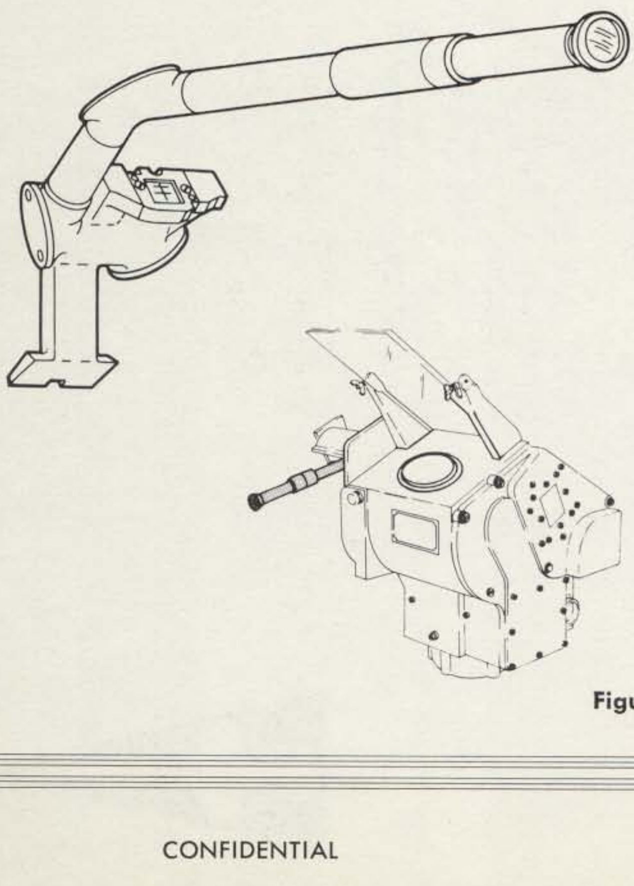


LEAD ANGLE CHECKING FIXTURE

(4920—509—5632) 147D264G1

The lead angle checking fixture aligns the mechanical and electrical caging positions, checks the function and balance of the gimbal system and checks lead angle and reticle size.

Figure 6-35



CAMERA BORESIGHTING TOOL

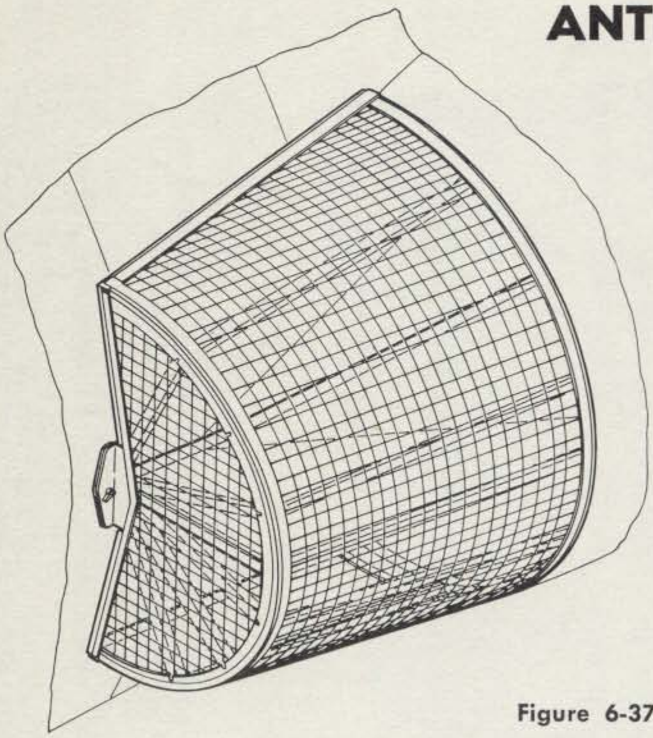
(9 CGE) 196C341P1

This scope is placed in the camera magazine section to boresight the camera to the sight head. The camera optics are utilized for sighting.

Figure 6-36

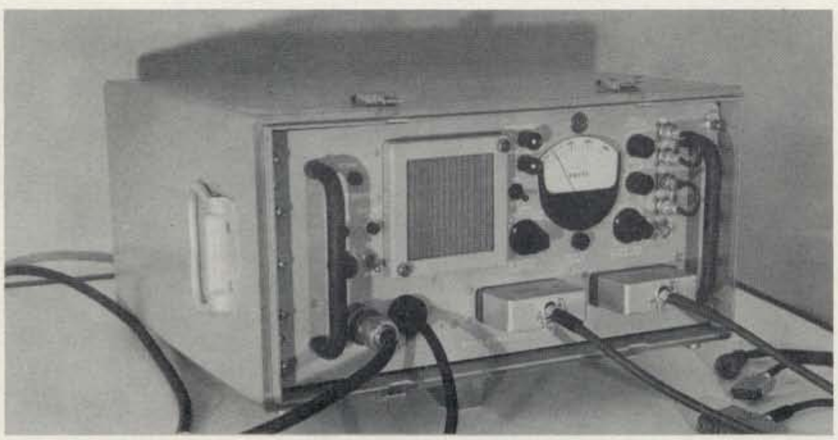
ANTI-PERSONNEL SCREEN

(2000) 766432-1



These screens are interchangeable on either right or left hand air scoop ducts. Meshed screen prevents entrance of foreign objects to engine and protects ground personnel during engine run-up. Each screen is held in place by a quick release fastener at forward end of screen.

Figure 6-37



ASG-14 RADAR SIMULATOR

(7 CAC—801319—22331) 8904691—502

This is a master test unit for testing individual assemblies independent of other components in the radar system. It provides all operating voltages, signals and controls for independent operation.

Figure 6-38

ASG-14 FCS MAINTENANCE TEST BENCH SET

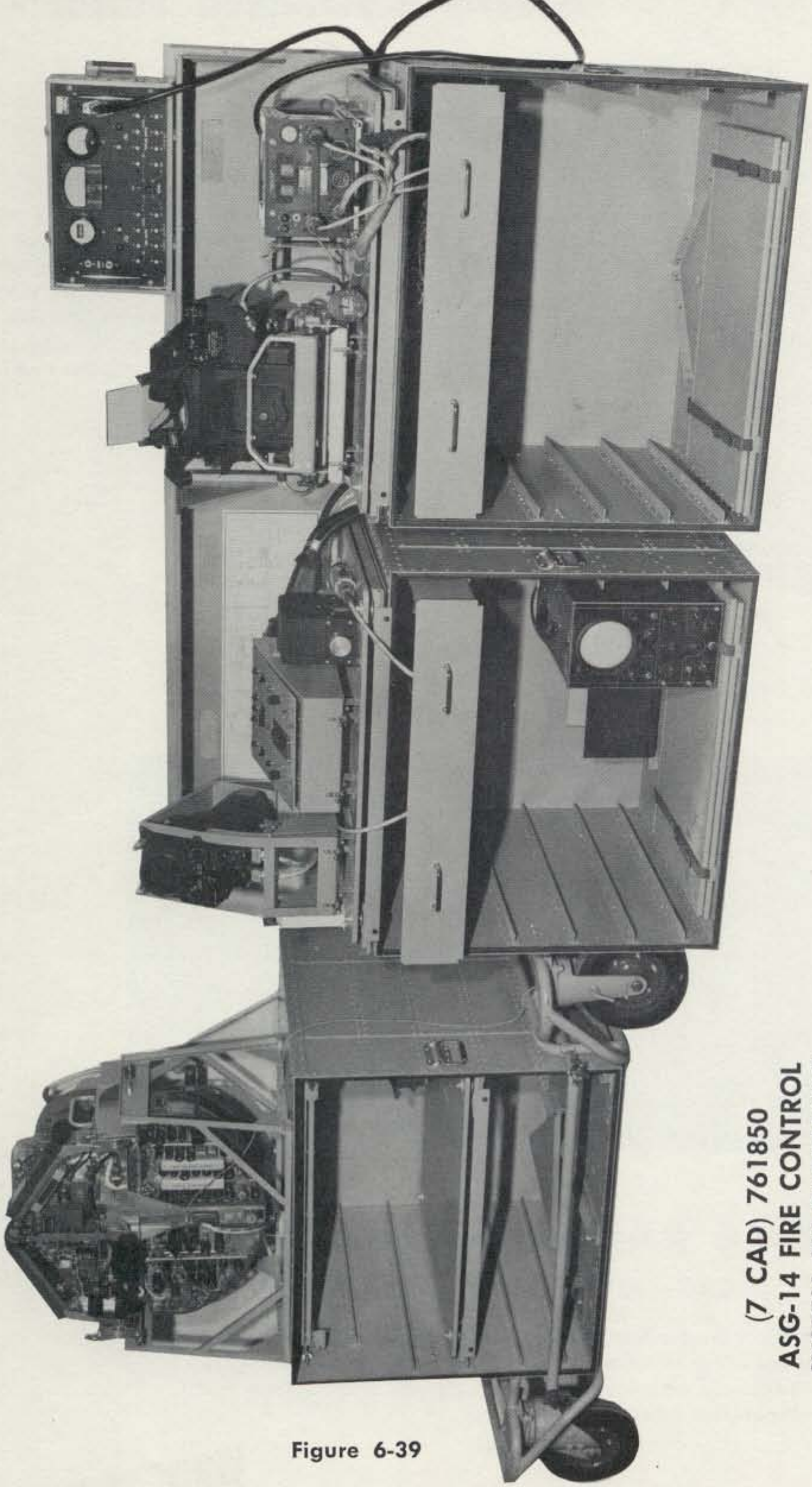


Figure 6-39

(7 CAD) 761850 ASG-14 FIRE CONTROL SYSTEM MAINTENANCE TEST BENCH SET

This bench set consists of three portable cabinets with detachable wheels. Wiring and bracketry are provided for mounting the complete MA-10 Fire Control System. This provides facilities for bench operation of the complete system and testing of individual components.

Benches contain storage space for test equipment, spare parts and operating manuals. This test facility requires 208 volt, 3 phase A. C. external power.

Portable storage cabinet 763994 is similar in design to the test benches and is utilized for additional storage space for test equipment and spare parts.

ENGINE TEST ANCHOR

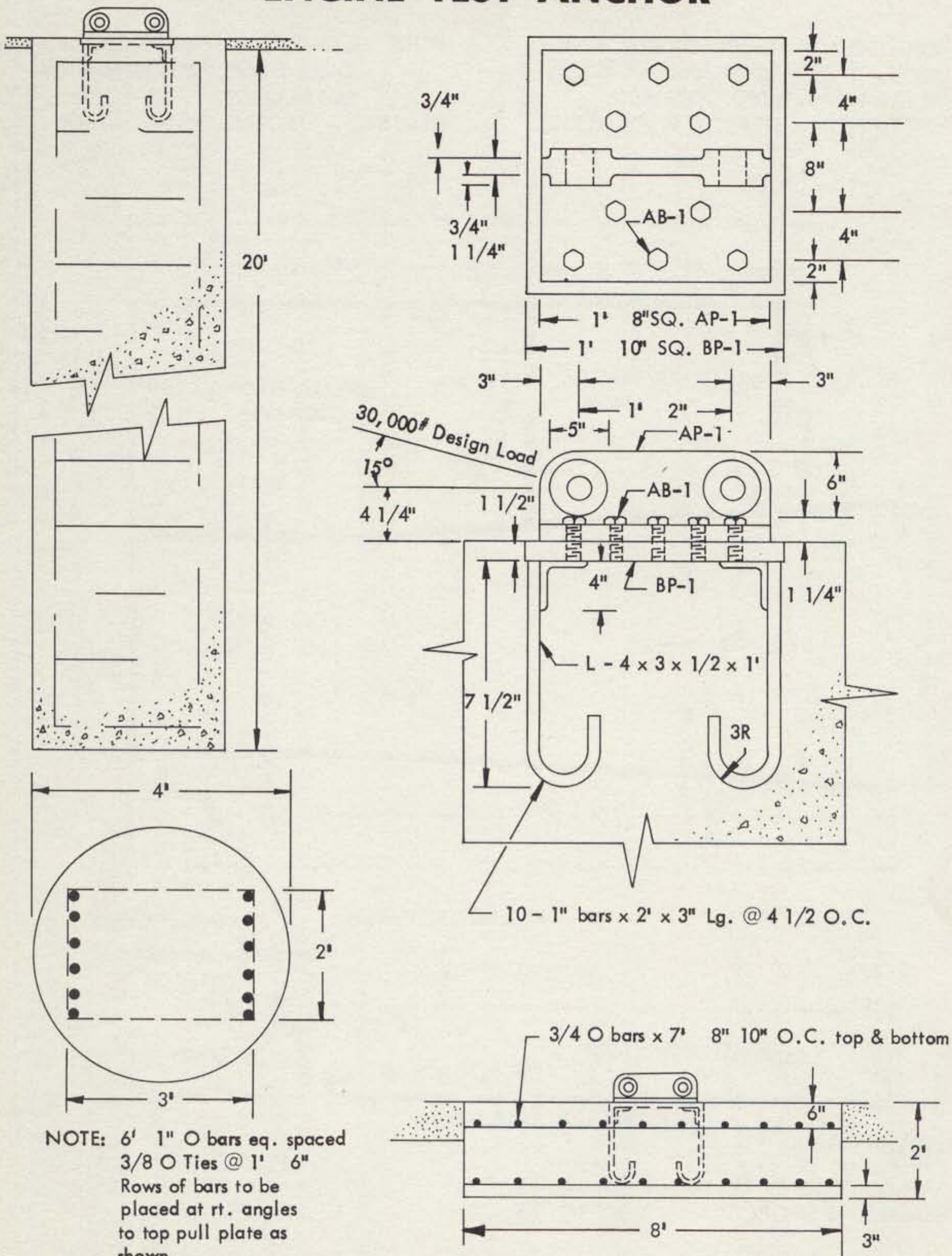
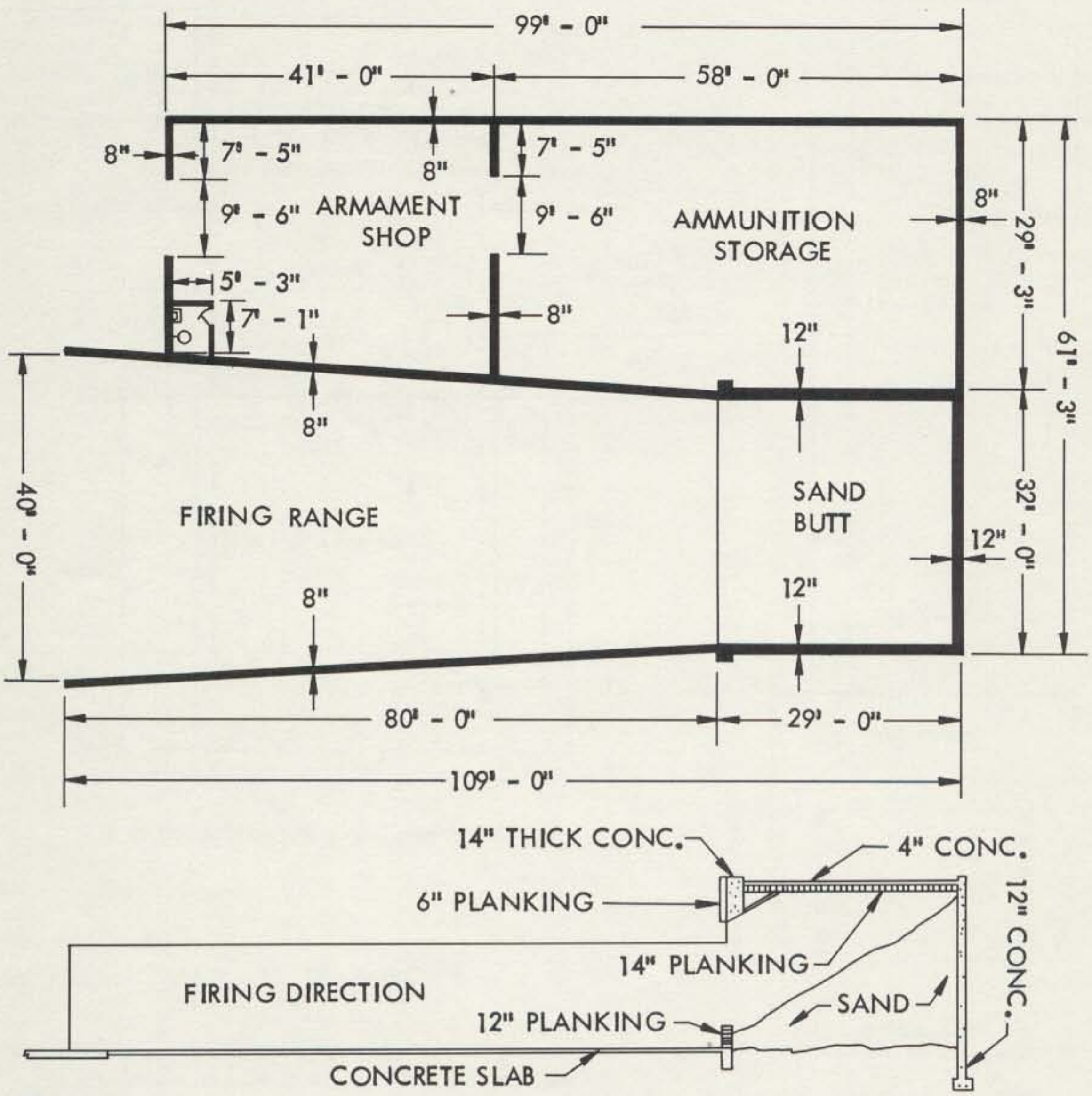


Figure 6-40

FIRING RANGE

STRUCTURE - REINFORCED CONCRETE
FLOOR - 5" REINFORCED CONCRETE
WALLS - REINFORCED CONCRETE
VENTILATION - GRAVITY ROOF VENTS

ROOF - COMP. AND GRAVEL ROOFING OVER 1 1/2" INSULATION ON METAL DECK
HEATING - ELECTRIC UNIT HEATERS



AREA:

AMMUNITION STORAGE: 1,608 SQ. FT.
ARMAMENT SHOP: 1,057 SQ. FT.

TOTAL: 2,665 SQ. FT.

SCALE 1" 20'

Figure 6-41

TRAINING EQUIPMENT

The following information reflects the status of equipment that will be delivered to the Air Force for training purposes. Information relative to pilot training and factory training is contained in Section IV.

Cockpit Procedure Trainer

Procedure trainers are ground trainers used for teaching and familiarizing flight personnel with the general requirements for cockpit procedures. This trainer consists primarily of two sections; a cockpit and an instructor's console. The cockpit enclosure duplicates the appearance of the actual aircraft station, but contains nonoperable mock-up armament system controls, fire control, and flight and navigation instruments. No canopy is provided. Indicating lights and instruments for operating systems respond to the action taken by the student pilot. These instruments have a time lag that approximates the actual lag for ground operation of the aircraft where applicable, except when malfunction or failure is introduced.

The instructor's console is so constructed that placement adjacent to the cockpit enclosure permits the operator to observe the operations and procedures of the student pilot. The console is sufficiently mobile so that it may be placed on either side of the cockpit and at any distance up to twelve feet away. Sufficient controls are provided to enable the instructor to monitor the over-all cockpit procedure training problem.

The instructor is able to introduce malfunctions and failures for ground and airborne engine operation, electrical system, hydraulic system, landing gear, flight controls and emergency ecsape system. The instructor is also able to note, by indications of the console tell tale light system, repeater instruments, or other means, the corrective measures taken by the student pilot to overcome the emergency.

Flight Simulators

To date, the Contractor is not supplying data to any flight simulator manufacturer for the F-104A; however, full cooperation will be extended to any such program.

Mobile Training Unit (Crew Training and Operational Squadrons)

A mobile training unit is a mobile technical school complete with trained instructors, mock-ups, cutaways, films and technical literature, traveling by air from activity to activity as needed. Instructor personnel are carefully selected and trained for the mission assigned. Every effort is made to keep the units current by making changes as rapidly as they become known. Instruction is designed to transition qualified maintenance personnel from one type of equipment to another as quickly as possible.

Initial delivery of mobile training units was accomplished in the latter part of 1956. These units depict the following systems; electrical, hydraulic, canopy and ejection seat, armament, IFF radar, navigation radio, fuel, pressurization, damper, ASG-14 fire control, command radio, J-4 compass, instrument, drag chute, and engine fuel control.

Training Aids

A full complement of parts has been delivered to ATRC for use as training aids in the F-104A program at: Chanute Air Force Base, Rantoul, Illinois; Lowry Air Force Base, Denver, Colorado; Lockheed Aircraft Corporation, Field Service Training School, Burbank, California.

General

In addition to the ASG-14 fire control system panel, which is a component panel of the mobile training unit, the ASG-14 fire control system maintenance test bench set also may be used to train maintenance personnel in the operation, theory, and maintenance of the system. The bench consists of a complete ASG-14 system and an ASG-14 maintenance test bench. The test bench permits the operation of a system with all the components exposed and available.

Handbooks covering the operation, theory, and maintenance of the system may be used for instructional purposes at all training installations.

Maintenance training can be carried down to the squadron level inasmuch as the maintenance test bench is part of the operational equipment supplied to squadrons.

FACILITIES

Facilities, required to accommodate the operational and training programs of a new type weapon system, are determined by the characteristics of the weapon and associated equipment involved. Accordingly, changes to existing facilities will be required to varying degrees, depending upon similarity of old and new weapon systems. In any case, it will be necessary to program required modifications to existing facilities or to program new construction in sufficient time to allow its completion prior to assignment of the new weapon system.

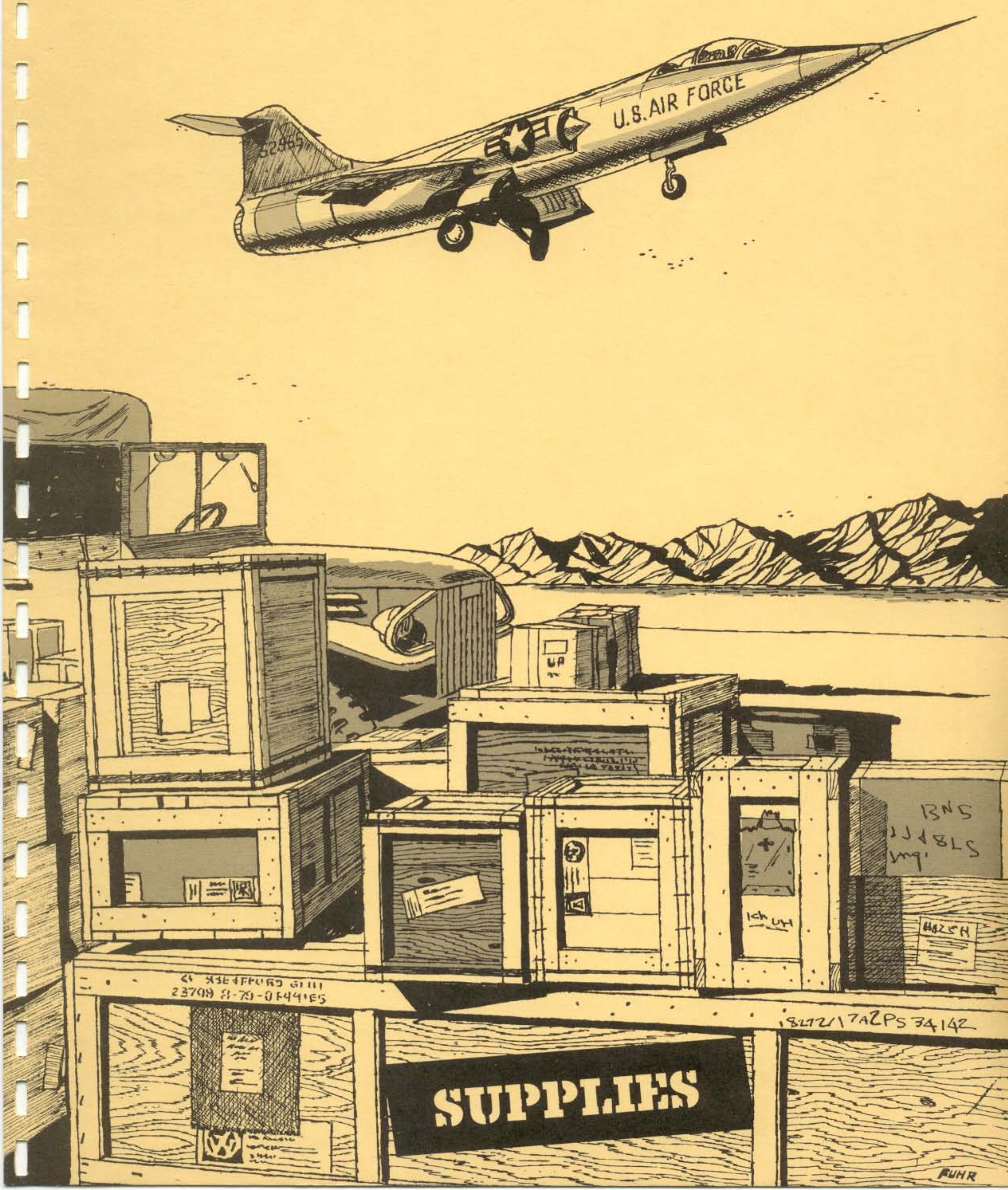
Planning

In keeping with the F-104A operational plan, the facilities plan must provide for suitable and adequate airfield pavements, liquid fuel storage, communications and navigational aids, operations, aircraft, maintenance, training, and storage facilities.

Because of the high thrust, low weight ratio of the F-104A, designated run-up areas with aircraft restraining facilities will be a requirement for maximum ground test operation of the engine (Figure 6-40).

A combined ammunition storage, shop and firing range for the T-171E-3 gun will be a requirement for test firing the gun (Figure 6-41).

Missile storage and build-up facilities will be required for the Sidewinder IA (GAR 8). Data is not currently available but will be provided as development progresses.


U.S. AIR FORCE
SUPPLIES
FUHR

CONTENTS

SUPPLIES AND MATERIAL

Supply support of commands and organizations assigned F-104A aircraft will be furnished through the F-104A Weapon System Supply Manager (WSSM) at the lead AMA, SMAMA, and the Weapon System Storage Sites (WSSS) established at selected locations. The F-104A WSSM will integrate the total AMC supply effort in support of the Weapon System.

The AMA's/AFD's responsible for supply support of the F-104A Weapon System are as follows:

WRAMA	T-171E-3 Gun ASG-14 FCS
OCAMA	J79-GE-3 Engine
SMAMA	Airframe Spares
MOAMA	Photographic Material
MAAMA	Instruments Sidewinder IA (GAR 8)
Gentile	Test Equipment Airborne Communications
Wilkins	Ground Handling Equipment
Topeka	Special Tools
Mallory	Vehicular Equipment

Complete prime commodity depot property class assignments are included in Section 3, Volume XV, AF Manual 67-1.

WEAPON SYSTEM SUPPLY MANAGER

The F-104A WSSM will develop and implement policies and procedures for assuring effective supply support of the F-104A program.

WEAPON SYSTEM STORAGE SITES

Weapon System Storage Sites will be established to store a 90-day level of peculiar and other selected items used in direct support of the Weapon System. F-104A WSSS have been established initially at Cheli AF Station, Maywood AF Depot, Maywood, California, and Mallory AF Station, Memphis

AF Depot, Memphis, Tennessee to support F-104A equipped organizations located in the west and east zones respectively with exception of spare parts peculiar to the J-79 engine.

Spare parts peculiar to the J-79 engine are stored at and issued from the bonded warehouse at the General Electric plant, Evendale, Ohio. This storage site was established for the purpose of storing a 90-day stock of engine spares to preclude manufacture of development-type items that would become excess or surplus to Air Force requirements upon stabilization of configuration of the engine. This applies primarily to Class 020.

Material in the following property classes will be accumulated at the Air Force WSSS: 01, 03, 04C, 04D, 05, 11, 16, 17C, 18A, 18C, 18D, 19A, 19F, 19G, and FCS Groups 26, 31, and 49. Stocks at the WSSS will include minimum quantities of insurance or random issue items not prepositioned at operating bases.

REQUISITIONING

Using commands and bases will normally submit requisitions directly to the F-104A WSSM for all materiel required in direct support of the Weapon System.

Aircraft spares and ground support equipment will be furnished to bases initially activating F-104A equipped organizations through AFSD supply action. Subsequent activations at bases of the same major command will be afforded initial support through the media of requisitioning by the base concerned or as otherwise determined through coordination between the lead AMA and the command concerned. The applicable supply tables and the G.E. listing of engine spare parts will be utilized as a requisitioning guide in event that usage or consumption data is not adequate on which to base initial operating requirement.

Requisitioning will be the standard procedure when aircraft have been in operation with the command a sufficient time to accumulate usage data (180 days after delivery of the first aircraft). In all cases, initial support action will be coordinated with the recipient major air command to insure support provided in agreement with command requirements. Follow-on support requirements will be obtained through requisitions submitted to the F-104A WSSM.

The -4 Tech Order and/or the applicable supply tables will be utilized by the using organizations as a media for identification of items in the event that the stock lists are not published and disseminated prior to the need for item identification. If after research of all available technical publications is made and items cannot be identified as to stock number or class code, these items will be forwarded to the F-104A WSSM for further research.

SUPPLY CONVERSION

To provide information so that an orderly maintenance and supply conversion from present squadron UE aircraft to the F-104A type aircraft can be accomplished, the following explanation is based upon the programmed conversion date being "D" Day with minus numbers being the number of days prior to receipt of the first aircraft and positive numbers being the number of days after receipt of the first aircraft.

Action to Be Taken

D-180

Representatives of the WSSM Sacramento Air Materiel Area will visit the base concerned and carry out a comparison check of F-104A spare parts and equipment in the Tables of Supply (TS) and in the Tentative Table of Equipment (TTE) against spare parts and equipment common to the F-104A and current UE aircraft presently available at the base. Immediately after the comparison check, the WSSM will advise the Base Commander of specific details of the TS and TTE parts and equipment which will be included in the AFSD. The required action will be initiated by the WSSM D-120. As items common to the F-104A and current UE aircraft revealed in the aforementioned comparison check will not be included in the AFSD, Air Defense Force Headquarters will insure that such quantities of parts and support equipment are maintained by the bases concerned in a serviceable condition available for support of the F-104A aircraft. Quantities of parts and equipment common to the F-104A and current UE aircraft, which are due in against outstanding base requisitions, will not be included in the AFSD's; however, the WSSM will assume the responsibility for follow-up of those requisitions to insure receipt at the base by D-60.

D-120

The WSSM will initiate AFSD action for each base for the TS and TTE and advise the Base Commander under the above procedure. All other items, not specifically mentioned previously in the Procedures Section will be requisitioned from the appropriate AMC Depot.

D-60

This is the target date established for the receipt at the base of all items required to support the F-104A aircraft. On this date, the base will review all parts and equipment not received by them against WSSM AFSD and/or base requisitions, which are considered essential to enable the F-104A aircraft to carry out their assigned mission. Follow-up action will be taken on all items for which the WSSM is responsible and all other supplying activities on which satisfactory delivery dates have not been received. If satisfactory delivery dates cannot be obtained, the matter should be considered for supply assistance action under ADCR 67-4.

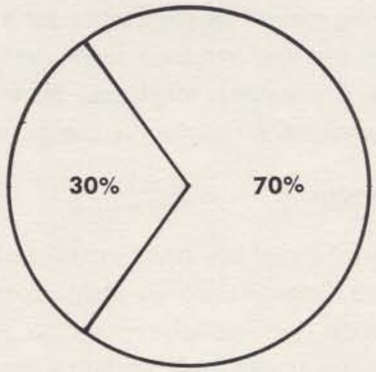
D-45

Preparation for, and initiation of, transfer inspections and transfer of present UE aircraft will commence on this date and will progress at an orderly rate so that by D-15 squadron strength will be six UE combat capable aircraft. As early as practicable, the base will initiate action to phase out materiel surplus to requirements in accordance with AFR 64-47 and Section 2, Volume II, AFM 67-1.

DISTRIBUTION OF SPARE PARTS

Spare parts deliveries support of F-104A aircraft is being accomplished in the following manner:

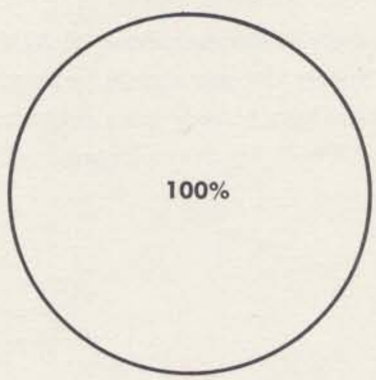
SPARE PARTS



Thirty percent (30%) of all spares for field and organizational maintenance and depot overhaul will be delivered to Cheli Air Force Depot (AFW 2042) Maywood, California.

Seventy percent (70%) of all spares for field and organizational maintenance and depot overhaul will be delivered to Mallory Air Force Depot (AFW 2042), Memphis, Tennessee.

HARDWARE



All hardware items are being delivered 100% to Topeka Air Force Depot, Topeka, Kansas.

DEPOT OVERHAUL CAPABILITIES

In order to realize continued capability of overhaul of development system components, until such time as the applicable Air Materiel Area Depot has received depot test equipment and is prepared to perform the overhaul functions, arrangements have been made by the Contractor to receive items requiring overhaul, and to arrange for this overhaul to be performed. This procedure is presently applicable to test support airplanes. However, it is expected that it will be applied to operational airplanes for the period deemed necessary.

SUPPLY SUPPORT GROUP

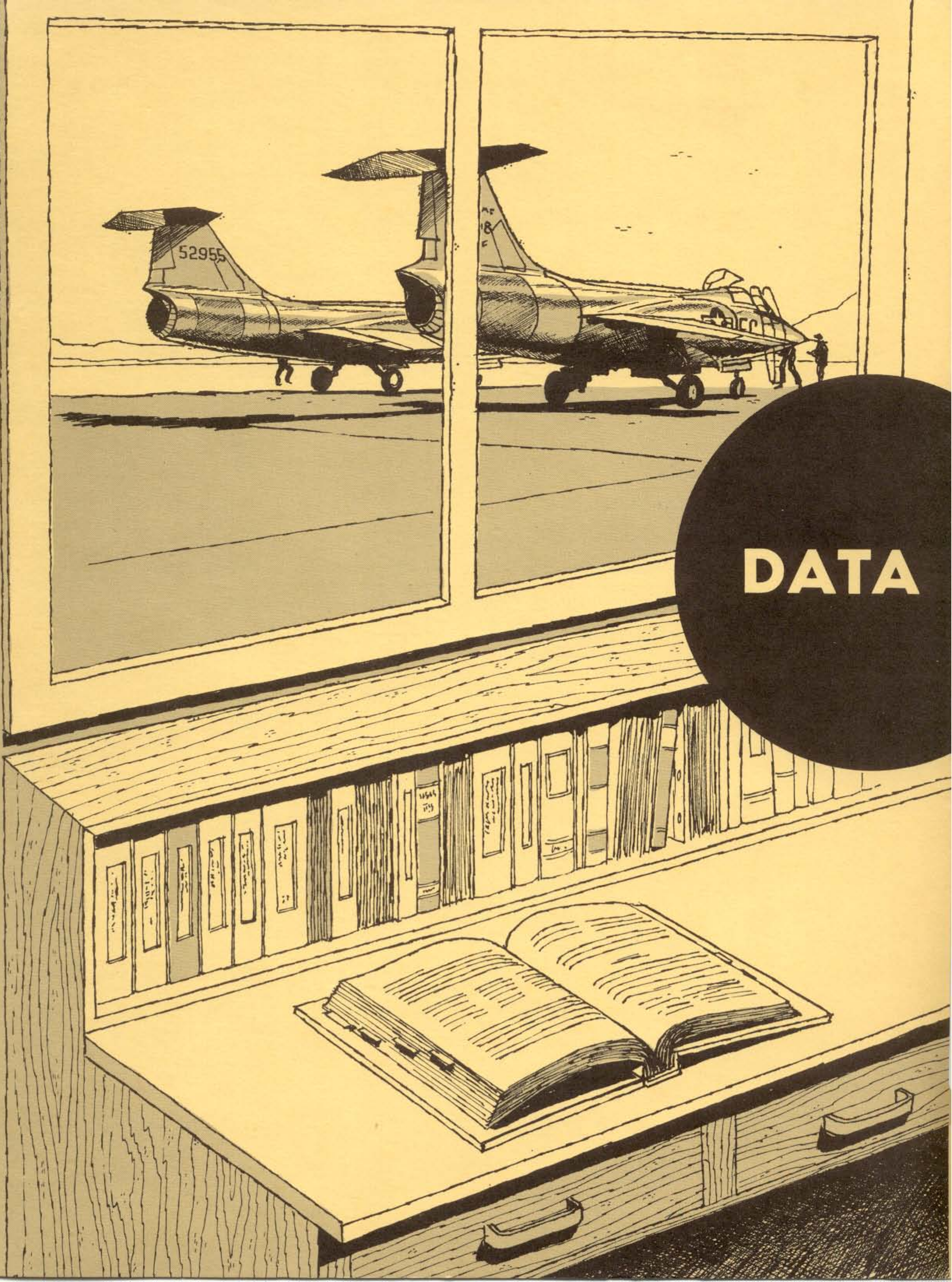
A Spare Parts Support Group has been established by Lockheed Aircraft Corporation's Spare Parts Organization to weld together a pattern of field support activity based upon previous experience on other models as well as F-104A experience at presently activated Air Force test sites.

Detailed procedures as they affect this field group are being negotiated with SMAMA to implement accelerated flow of material under the Vendor Depot Program for support of aircraft installations in the developmental stage.

A program for maintaining a supply of hard to get miscellaneous small parts and standards at ADC sites is currently under discussion.

Field-to-office, inter-office and intra-plant communication procedures have been established to insure rapid transmission of information back to traveling Spares Representatives at ADC activities.

Programming, with respect to the instruction of ADC Base Supply personnel in the use of Lockheed Spares documentation, is currently under way. Spare Parts Application Data Lists have already been delivered and instructions given to Air Force test sites and Cheli Air Force Depot.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DATA

CONTENTS

DATA

The prime Contractors (Lockheed and General Electric) are responsible for providing Technical Orders required for operations and maintenance of the F-104A Weapon System. Lockheed furnishes all T. O.'s for the airframe, fire control and armament systems, plus coverage for related accessory items and ground support equipment. General Electric provides T. O.'s for the engine and its accessories and items of ground support equipment.

OPERATIONS

Four categories of handbooks are provided for organizational maintenance. These handbooks contain operations data for:

1. Airplane
2. Engine
3. Fire Control System
4. Ground Support Equipment

Airplane Technical Orders (Basic)

The following is a list of all airplane T. O.'s considered essential for squadron level operations and maintenance:

Number	*Title*
1F-104A-1	Flight Handbook
1F-104A-2-1	Handbook Maintenance Instructions, Airplane General
1F-104A-3-1	Structural Repair Handbook, Secondary Structure Repair
1F-104A-3-2	Structural Repair Handbook, Primary Structure Repair
1F-104A-3-3	Structural Repair Handbook, Structural Maintenance
1F-104A-4	Illustrated Parts Breakdown
1F-104A-5	Handbook of Basic Weight Check List and Loading Data
1F-104A-6	Inspection Requirements Handbook

Airplane Technical Orders (For Systems)

An individual T. O. for each airplane system is supplied. The T. O.'s are designated as follows:

Number	*Title*
1F-104A-2-2	Handbook Maintenance Instructions, Airframe Group
1F-104A-2-3	Handbook Maintenance Instructions, Hydraulic and Pneumatic Power Systems
1F-104A-2-4	Handbook Maintenance Instructions
1F-104A-2-5	Handbook Maintenance Instructions, Fuel Supply System
1F-104A-2-6	Handbook Maintenance Instructions, Air Conditioning, Pressurization, and Anti-Ice Systems
1F-104A-2-7	Handbook Maintenance Instructions, Flight Control Systems
1F-104A-2-8	Handbook Maintenance Instructions, Landing Gear
1F-104A-2-9	Handbook Maintenance Instructions, Instruments
1F-104A-2-10	Handbook Maintenance Instructions, Electrical Systems
1F-104A-2-11	Handbook Maintenance Instructions, Radio, Communication, and Navigation Systems
1F-104A-2-12	Handbook Maintenance Instructions, Armament and Armament Electronics
1F-104A-2-13	Handbook Maintenance Instructions, Wiring Data

Engine Technical Orders

Handbooks provided for engine maintenance are:

Number	*Title*
2J-J79-3	Handbook Overhaul Instructions
2J-J79-6	Field Maintenance and Replacement

Fire Control and Armament System Technical Orders

Handbooks covering the assembly, inspection operations, maintenance of the missile, the missile assembly, and check-out equipment are currently unavailable. The missile handbooks will be delivered at the time missiles become available. Handbooks covering the operation, theory, and maintenance of the ASG-14 fire control system are available. Each item of special test equipment is covered by operations and maintenance handbooks. (Overhaul and illustrated parts breakdown handbooks covering all equipment will be supplied.)

Personal Equipment Technical Orders

Technical orders for each item of personal equipment are supplied. T. O.'s are not yet available for MC-4.

Ground Support Equipment Technical Orders

Technical Orders applicable to those items of ground support equipment requisitioned by the Air Force are in preparation. T. O. numbers will be published as this information becomes available.

Requisitioning of Technical Orders

Technical Orders should be requisitioned in accordance with procedures outlined in T. O. 00-5-2.