FLIGHT MANUAL
F-104D
USAF SERIES AIRCRAFT

Commanders are responsible for bringing this manual to the attention of all personnel cleared for operation of affected aircraft.

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE.

This Publication replaces T.O. 1F-104D-1 dated 1 November 1958 and Safety of Flight Supplements -1CN through -1CQ, and -1CT. See Weekly Index, T.O. 0-1-1A, for current status of Safety of Flight Supplements.

This manual is incomplete without Confidential Supplement, T. O. 1F-104D-1A dated 1 January 1960.

AIR FORCE, Kerr Litho, Culver City, Cal., 11 March 60—1500 (Lockheed)

1 JANUARY 1960

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B
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SAFETY OF FLIGHT SUPPLEMENT SUMMARY

NOTE: This is a test page being included for your use and comments. If found desirable, it will become a standard item to be included in all USAF Flight Manuals.

Safety of Flight Supplements are numbered with Suffix letters after the -1. They start with -1C because the letters A and B are reserved for use with classified Supplements to the basic Dash One. The letters A, B, O and I will never appear in the numbering sequence. The Supplements you receive should follow in sequence and if you find you are missing one, check the publication index (T.O.0-1-1 and -1A) to see if it was issued and if it is still in effect. It may have been replaced or rescinded before you received your copy. If it is still active, see your Publication Distribution Officer and get your copy. It should be noted that a Supplement number will never be used more than once.

SAFETY OF FLIGHT SUPPLEMENTS INCORPORATED IN THIS CHANGE

Number	Date	Short Title	Disposition

SAFETY OF FLIGHT SUPPLEMENTS OUTSTANDING

(This portion to be filled in by you when you receive your Flight Manual and to be added to as you receive additional Supplements. Refer to Publications Index (T.O. 0-1-1 and -1A) for latest information if any questions arise.)

Number	Date	Short Title	Disposition

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★ REFER TO CONFIDENTIAL SUPPLEMENT T.O. 1F-104D-1A

F-54-0-1-88

...the Key to your Safety!

F54-0-1-2

SCOPE. This manual contains all the information necessary for safe and efficient operation of the F-104D. These instructions do not teach basic flight principles, but are designed to provide you with a general knowledge of the airplane, its flight characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and elementary instructions have been avoided.

SOUND JUDGMENT. The instructions in this manual are designed to provide for the needs of a crew inexperienced in the operation of this aircraft. This book provides the best possible operating instructions under most circumstances, but it is a poor substitute for sound judgment. Multiple emergencies, adverse weather, terrain, etc., may require modification of the procedures contained herein.

PERMISSIBLE OPERATIONS. The Flight Manual takes a "positive approach" and normally tells you only what you can do. Any unusual operation or configuration (such as asymmetrical loading) is prohibited unless specifically covered in the Flight Manual. Clearance must be obtained from ARDC before any questionable operation is attempted which is not specifically covered in the Flight Manual.

STANDARDIZATION. Once you have learned to use one Flight Manual, you will know how to use them all—closely guarded standardization assures that the scope and arrangement of all Flight Manuals are identical.

ARRANGEMENT. The manual has been divided into 10 fairly independent sections, each with its own table of contents. The objective of this subdivision is to make it easy both to read the manual straight through when it is first received and thereafter to use it as a reference manual. The independence of these sections also makes it possible for the user to rearrange the book to satisfy his personal taste and requirements. The first 3 sections cover the minimum information required to safely get the airplane into the air and back down again. Before flying any new aircraft these 3 sections must be read thoroughly and fully understood. Section IV covers all equipment not essential to flight but which permits the aircraft to perform special functions. Sections V and VI are obvious. Section VII covers lengthy discussions on any technique or theory of operation which may be applicable to the particular aircraft in question. The experienced pilot will probably be aware of the information in this section but he should check it for any possible new information. The contents of the remaining sections are fairly obvious.

YOUR RESPONSIBILITY. These Flight Manuals are constantly maintained current through an extremely active revision program. Frequent conferences with operating personnel and constant review of UR's, accident reports, flight test reports, etc., assure inclusion of the latest data in these manuals. In this regard, it is essential that you do your part! If you find anything you don't like about the manual, let us know right away. We cannot correct an error whose existence is unknown to us.

PERSONAL COPIES, TABS AND BINDERS. In accordance with the provisions of AFR 5-13, flight crew members are entitled to have personal copies of the Flight Manuals. Flexible, loose leaf tabs and binders have been provided to hold your personal copy of the Flight Manual. These good-looking, simulated-leather binders will make it much easier for you to revise your manual as well as to keep it in good shape. These tabs and binders are secured through your local materiel staff and contracting officers.

HOW TO GET COPIES. If you want to be sure of getting your manuals on time, order them before you need them. Early ordering will assure that enough copies are printed to cover your requirements. Technical Order 00-5-2 explains how to order Flight Manuals, classified Supplements thereto and Safety of Flight Supplements so that you automatically will get all original issues, changes, and revisions. Basically, all you have to do is order the required quantities in the Publications Requirements Table (T. O. 0-3-1). Talk to your Senior Materiel Staff Officer — it is his job to fulfill your Technical Order requests and make sure to establish some system that will rapidly get the books and Safety of Flight Supplements to the flight crews once they are received on the base.

SAFETY OF FLIGHT SUPPLEMENTS. Safety of Flight Supplements are used to get information to you in a hurry. Safety of Flight Supplements use the same number as your Flight Manual, except for the addition of a suffix letter. Supplements covering loss of life will get to you in 48 hours; those concerning serious damage to equipment will make it in 10 days. You can determine the status of Safety of Flight Supplements by referring to the Numerical Index of Technical Publications — Safety of Flight Supplements (T. O. 0-1-1A). This is the only way you can determine whether a supplement has been rescinded. The title page of the Flight Manual and title block of each Safety of Flight Supplement should also be checked to determine the effect that these publications may have on existing Safety of Flight Supplements. It is critically important that you remain constantly aware of the status of all supplements — you must comply with all existing supplements but there is no point in restricting the operation of your aircraft by complying with a supplement that has been replaced or rescinded. Technical Order 00-5-1 covers some additional information regarding these supplements.

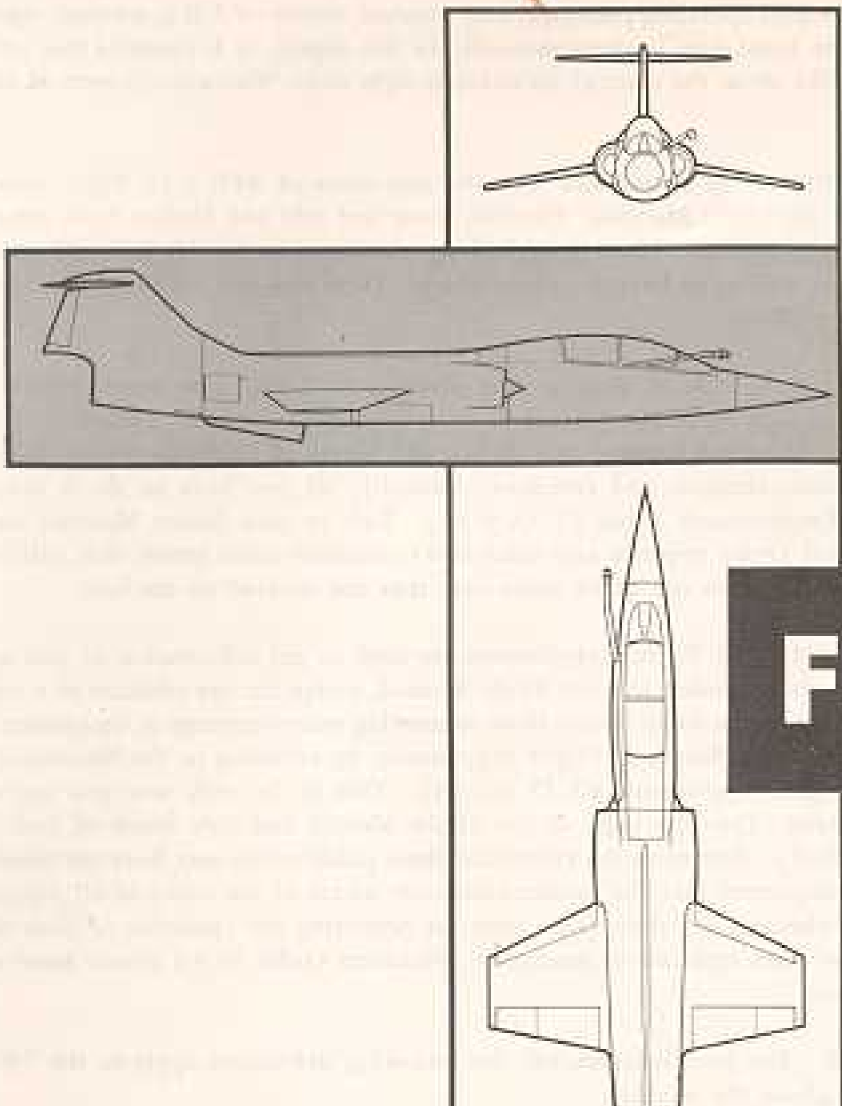
WARNINGS, CAUTIONS, AND NOTES. For your information, the following definitions apply to the "Warnings," "Cautions," and "Notes" found throughout the manual:

WARNING Operating procedures, practices, etc., which will result in personal injury or loss of life if not carefully followed.

CAUTION Operating procedures, practices, etc., which if not strictly observed will result in damage to equipment.

Note An operating procedure, condition, etc., which it is essential to emphasize.

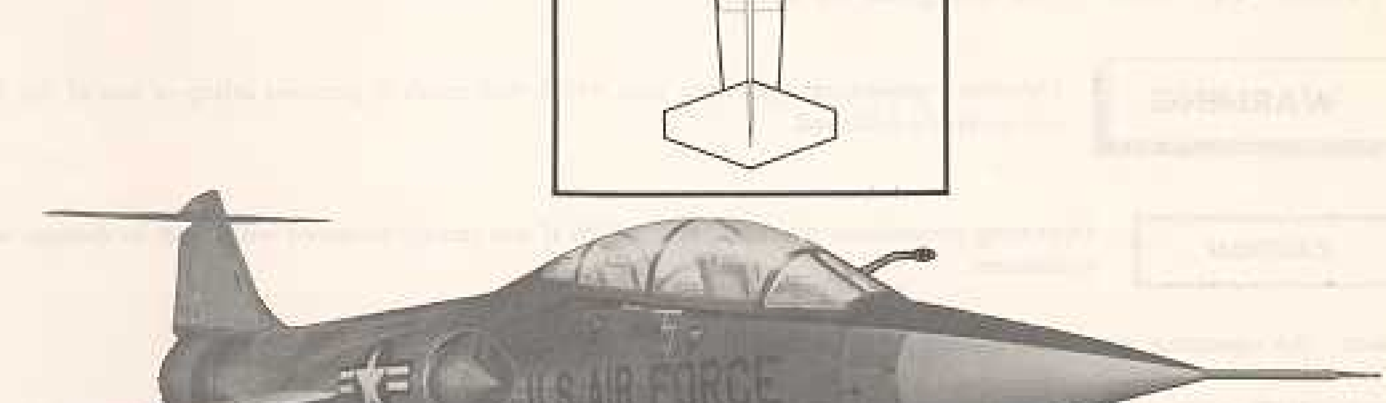
COMMENTS AND QUESTIONS. Comments and questions regarding any phase of the Flight Manual program are invited and should be forwarded through your command Headquarters to Directorate of Systems Management, Air Research and Development Command, Wright-Patterson AFB, Ohio, ATTN: RDZSPH.



USAF SERIES

F-104D

AIRCRAFT



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description

SECTION I

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THE AIRPLANE.

The F-104D is a two-place, high performance, day and night fighter powered by an axial flow turbojet engine with afterburner. The airplane, built by Lockheed Aircraft Corporation, is designed for high subsonic cruise, high supersonic combat and for use as a pilot trainer. The airplane features extremely thin flight surfaces, short straight wings with negative dihedral, irreversible hydraulically-powered ailerons, and a controllable horizontal stabilizer mounted at the top of the vertical stabilizer. The wings have leading and trailing edge flaps and a boundary layer control system used in conjunction with the trailing edge flaps to reduce landing speeds. Air escape is accomplished by means of downward ejection systems. Modified aircraft are equipped with upward ejection systems. A drag chute is installed to reduce landing roll. The forward and aft main fuel cells are filled from a single refueling well. The external fuel tanks are filled individually from their own refueling wells. AF Serials 57-1329 and subsequent also include a single point pressure and aerial refueling capability.

AIRPLANE DIMENSIONS.

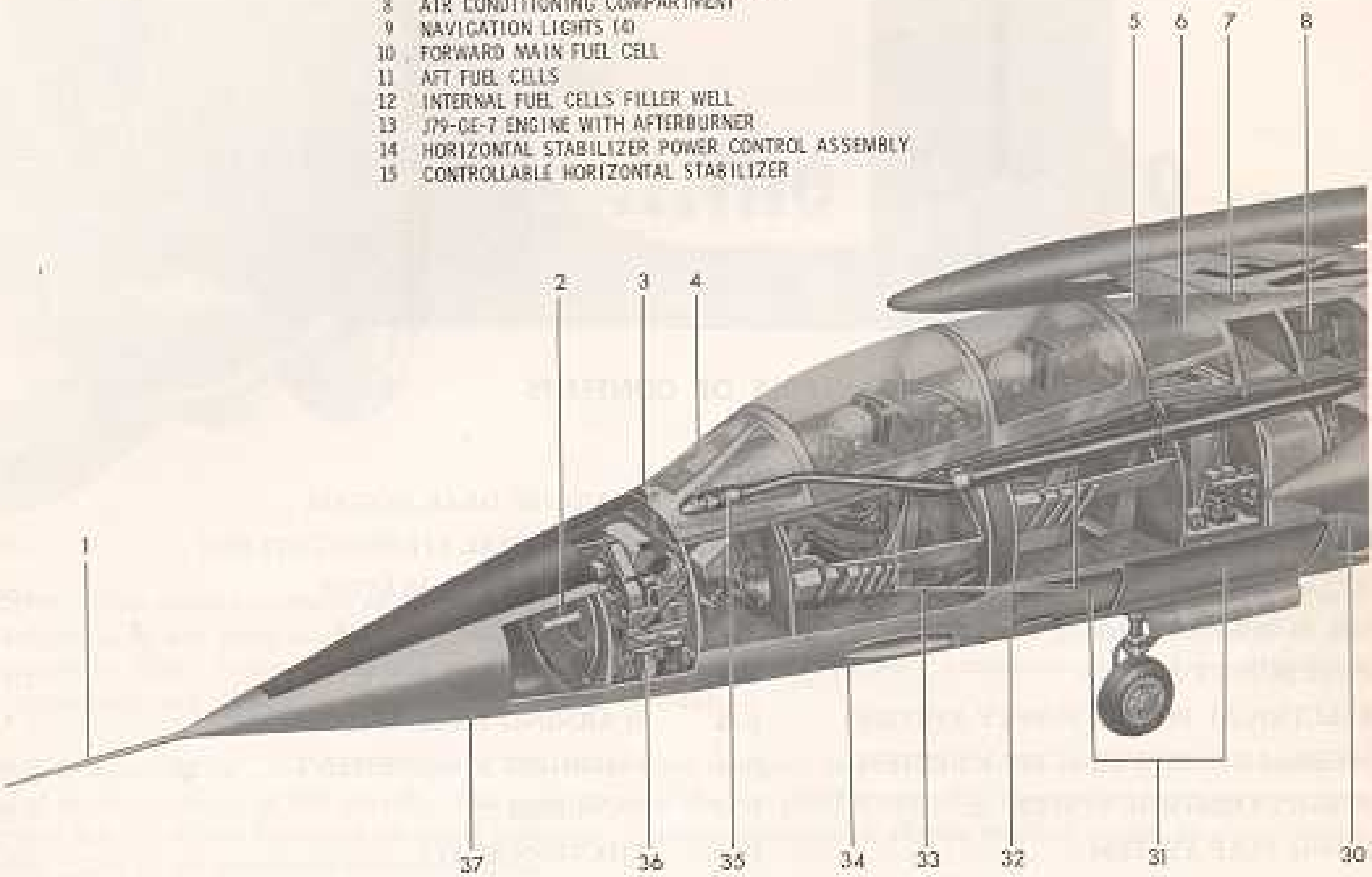
Overall dimensions of the airplane are as follows:

Wing Span	21.94 feet
Length	54.77 feet
Height (to top of vertical stabilizer)	13.49 feet
Tread	8.79 feet

Refer to figure 2-4 for minimum turning radius and ground clearances.

GENERAL ARRANGEMENT

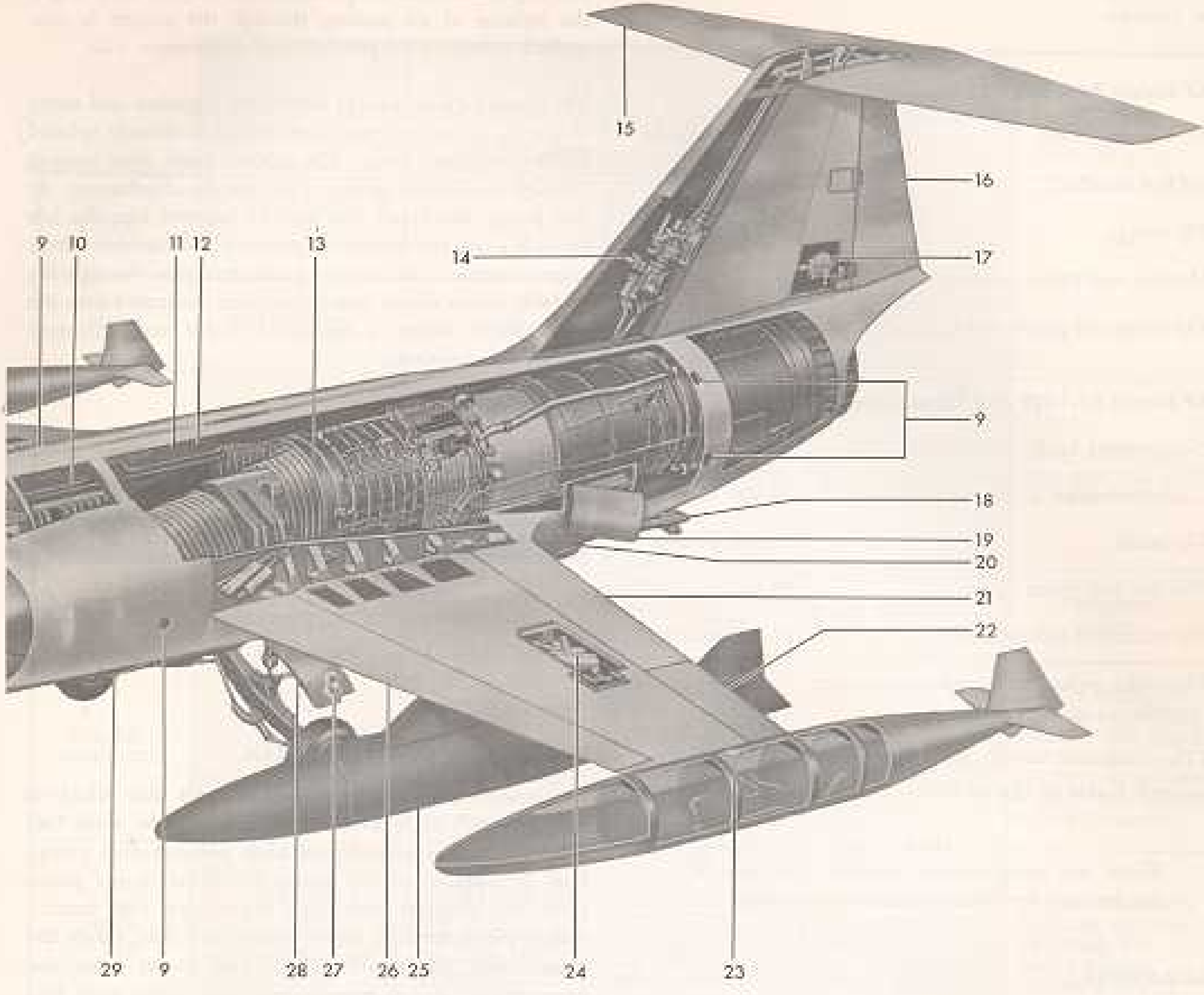
1 PITOT-STATIC BOOM
2 AN/ASG-14T1 RADAR ANTENNA
3 INFRA-RED SIGHT WINDOW
4 OPTICAL SIGHT, INFRA-RED SIGHT AND CAMERA
5 VOR ANTENNA
6 ELECTRONICS COMPARTMENT
7 AUXILIARY FUEL CELL AND FILLER WELL *
8 AIR CONDITIONING COMPARTMENT
9 NAVIGATION LIGHTS (4)
10 FORWARD MAIN FUEL CELL
11 AFT FUEL CELLS
12 INTERNAL FUEL CELLS FILLER WELL
13 J79-GE-7 ENGINE WITH AFTERBURNER
14 HORIZONTAL STABILIZER POWER CONTROL ASSEMBLY
15 CONTROLLABLE HORIZONTAL STABILIZER



16 RUDDER
17 RUDDER POWER CONTROL ASSEMBLY
18 DRAG CHUTE DOOR
19 SPEED BRAKE
20 VENTRAL FIN AND MARKER BEACON ANTENNA
21 TRAILING EDGE FLAP
22 AILERON
23 TIP TANK FILLER WELL
24 LEFT AILERON POWER CONTROL ASSEMBLY
25 PYLON TANK
26 LEADING EDGE FLAP
27 LANDING LIGHT

F54-1-1-4

Figure 1-1



28 LANDING GEAR AFT DOOR
29 LANDING GEAR FORWARD DOOR
30 ENGINE AIR INTAKE SCOOP
31 AUXILIARY FUEL CELLS *
32 UHF ANTENNA
33 EJECTION SEATS
34 IFF ANTENNA
35 AIR REFUELING PROBE *
36 AN/ASG-14-T1 RADAR
37 GLIDE SLOPE ANTENNA

* AF SERIALS 57-1329 AND SUBSEQUENT

F56-8-1-5

AIRPLANE GROSS WEIGHT.

The approximate take-off gross weight of the airplane (including full internal fuel and two crew members) is as follows:

AF Serials Prior to 57-1329.

No external load	18,100 pounds
GAR-8 missiles	18,500 pounds
Tip tanks	20,700 pounds
Missiles and pylon tanks	21,700 pounds
Tip tanks and pylon tanks	23,900 pounds

AF Serials 57-1329 and Subsequent.

No external load	18,900 pounds
GAR-8 missiles	19,300 pounds
Tip tanks	21,500 pounds
Missiles and pylon tanks	22,400 pounds
Tip tanks and pylon tanks	24,600 pounds
Tip tanks, pylon tanks and air refueling probe	24,700 pounds

(The increased weight on AF Serials 57-1329 and subsequent is due to the addition of auxiliary fuel.)

Note

These are approximate weights and should not be used for detailed mission planning.

ARMAMENT.

Basic armament consists of one GAR-8 air-to-air guided missile which may be carried at each wing tip in place of tip tanks.

ENGINE.

The airplane is powered by a General Electric J79-GE-7 turbojet engine (figure 1-2). Its sea level static thrust rating is approximately 15,800 pounds at Maximum Thrust (full afterburning) and approximately 10,000 pounds at Military Thrust (maximum thrust non-afterburning). A 17-stage, axial-flow compressor, driven by a three stage turbine, produces a compressor pressure ratio of 12 to 1. An anti-icing system and aerodynamic variable-area exhaust nozzles are provided. The vane angle of the inlet guide vanes and of the first six stages of stator blades is variable. Vane angle is established by engine fuel pressure and is automaticaly controlled by the engine fuel control unit as a function of engine speed and engine air inlet temperature. By varying vane angle, the volume of air passing through the engine is controlled, to reduce the possibility of compressor stall.

The three turbine wheels are bolted together and move as a unit on one common shaft which is directly splined to the compressor rotor. The exhaust gases, after passing through the turbine section, pass into the afterburner. At this point, additional fuel may be injected into the hot exhaust gases and burned to produce considerable thrust augmentation. The exhaust gases then pass through the variable area exhaust nozzles and are dissipated into the atmosphere. Refer to Section VII for supplementary engine information.

J79 TURBOJET ENGINE WITH AFTERBURNER

Refer to Confidential Supplement, T. O. 1F-104D-1A
Figure 1-2.

ENGINE FUEL CONTROL SYSTEM.

The system incorporates a fuel control unit which is supplied with high pressure fuel through the main fuel filter from an engine-driven high pressure fuel pump. Fuel is supplied to this pump at aircraft boost pump pressure. Metered fuel from the engine fuel control unit is piped through an oil cooler and then enters the pressurizing and drain valve. The outlet from the pressurizing valve is connected directly to the main fuel manifold. An afterburner fuel system also is provided. (Refer to Afterburner System in this Section for details of this system.)

Engine Fuel Pump. A three-element, engine-driven pump having a centrifugal boost element and two gear-type elements supplies the high fuel pressure required by the engine fuel system. The centrifugal boost element supplements fuel cell boost pump pressure. Failure of the centrifugal boost element does not affect engine operation except during high fuel demands required at low altitude high Mach number conditions. Either of the gear-type elements is capable of maintaining sufficient fuel flow to the engine fuel control unit if one element fails.

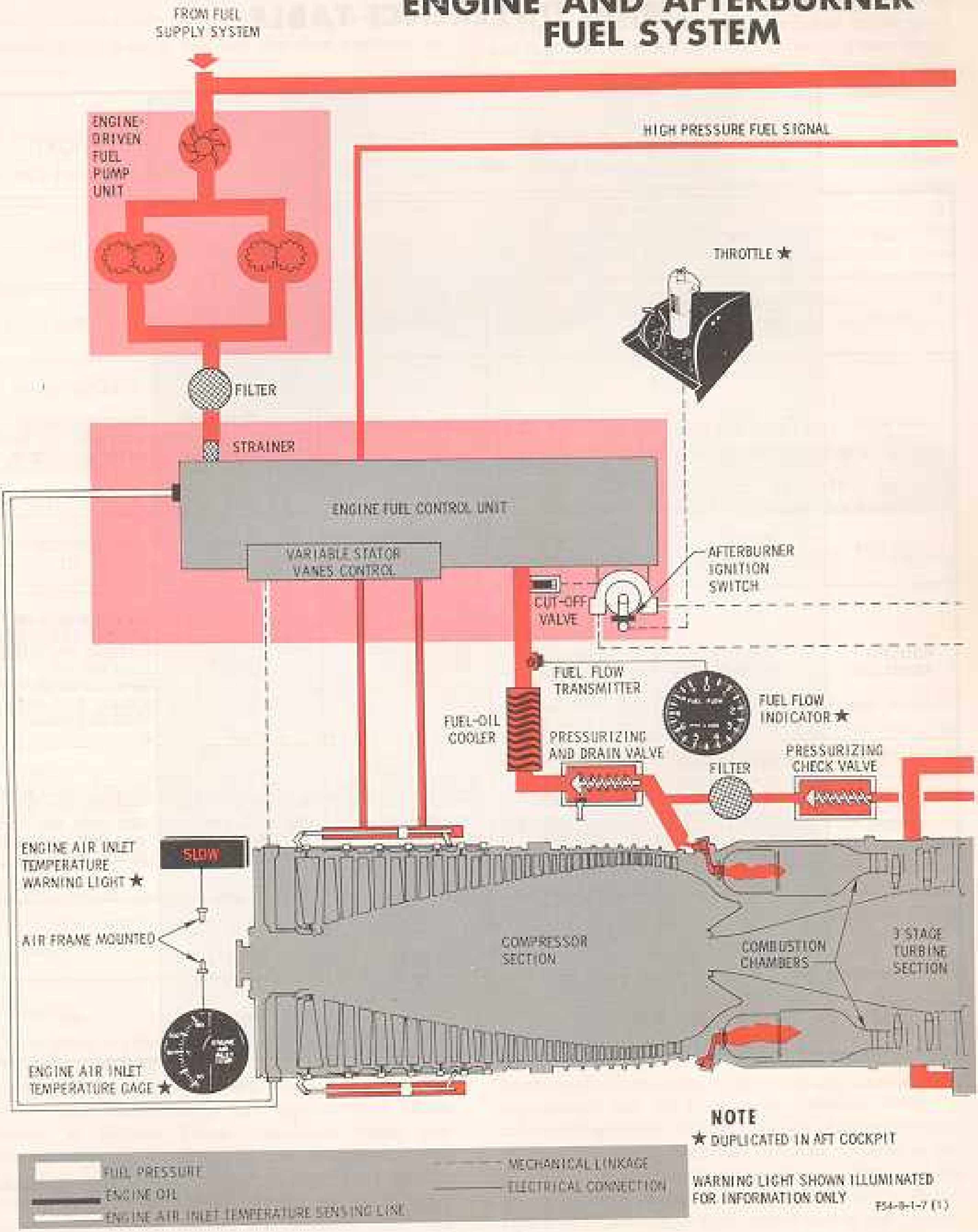
MAIN DIFFERENCE TABLE

	F-104A(1) (AF552955 THRU AF56-763)	F-104A (AF56-764 THRU 56-882)	F-104C (AF56-883 & SUBS.)	F-104B (AF56-3719 THRU 57-1313)	F-104D (AF57-1314 & SUBS.)
CREW	ONE	ONE	ONE	TWO	TWO
ENGINE	J79-GE-3 OR J79-GE-3A	J79-GE-3A	J79-GE-7	J79-GE-3A	J79-GE-7
NOSE WHEEL STEERING	TRAVEL UNRESTRICTED BY WING FLAP LEVER POSITION	TRAVEL UNRESTRICTED BY WING FLAP LEVER POSITION	TRAVEL UNRESTRICTED BY WING FLAP LEVER POSITION	TRAVEL RESTRICTED WITH WING FLAP LEVER IN THE UP POSITION	TRAVEL RESTRICTED WITH WING FLAP LEVER IN THE UP POSITION
NOSE GEAR	RETRACTS FORWARD	RETRACTS FORWARD	RETRACTS FORWARD	RETRACTS AFT	RETRACTS AFT
REFUELING PROVISIONS	GRAVITY FILLING	GRAVITY FILLING	PRESSURE TYPE SINGLE-POINT AND AIR REFUELING	GRAVITY FILLING	GRAVITY FILLING ON AF57-1314 THRU 57-1328 PRESSURE TYPE SINGLE POINT AND AIR REFUELING ON AF57-1329 & SUBS. PLUS EARLIER MODIFIED AIRCRAFT
OXYGEN SYSTEM	HIGH PRESSURE GASEOUS OR 5 LITER LIQUID WITH PRESSURE SUIT CONTROL PANEL AND MB-2, MD-1 OR MD-2 PRESSURE DEMAND REGULATOR	5 LITER LIQUID WITH PRESSURE SUIT CONTROL PANEL AND MD-1 PRESSURE DEMAND REGULATOR	5 LITER LIQUID WITH PRESSURE SUIT CONTROL PANEL AND MD-1 PRESSURE DEMAND REGULATOR	10 LITER LIQUID WITH PRESSURE SUIT CONTROL PANEL AND MD-1 PRESSURE DEMAND REGULATOR	10 LITER LIQUID WITH PRESSURE SUIT CONTROL PANEL AND MD-1 PRESSURE DEMAND REGULATOR
20 MM GUN	NO (SOME TEST AIRCRAFT - YES)	NO	YES	NO	NO
POWER RUDDER	NO	NO	NO	YES	YES

F-34-2-1-d

Figure 1-3

ENGINE AND AFTERBURNER FUEL SYSTEM



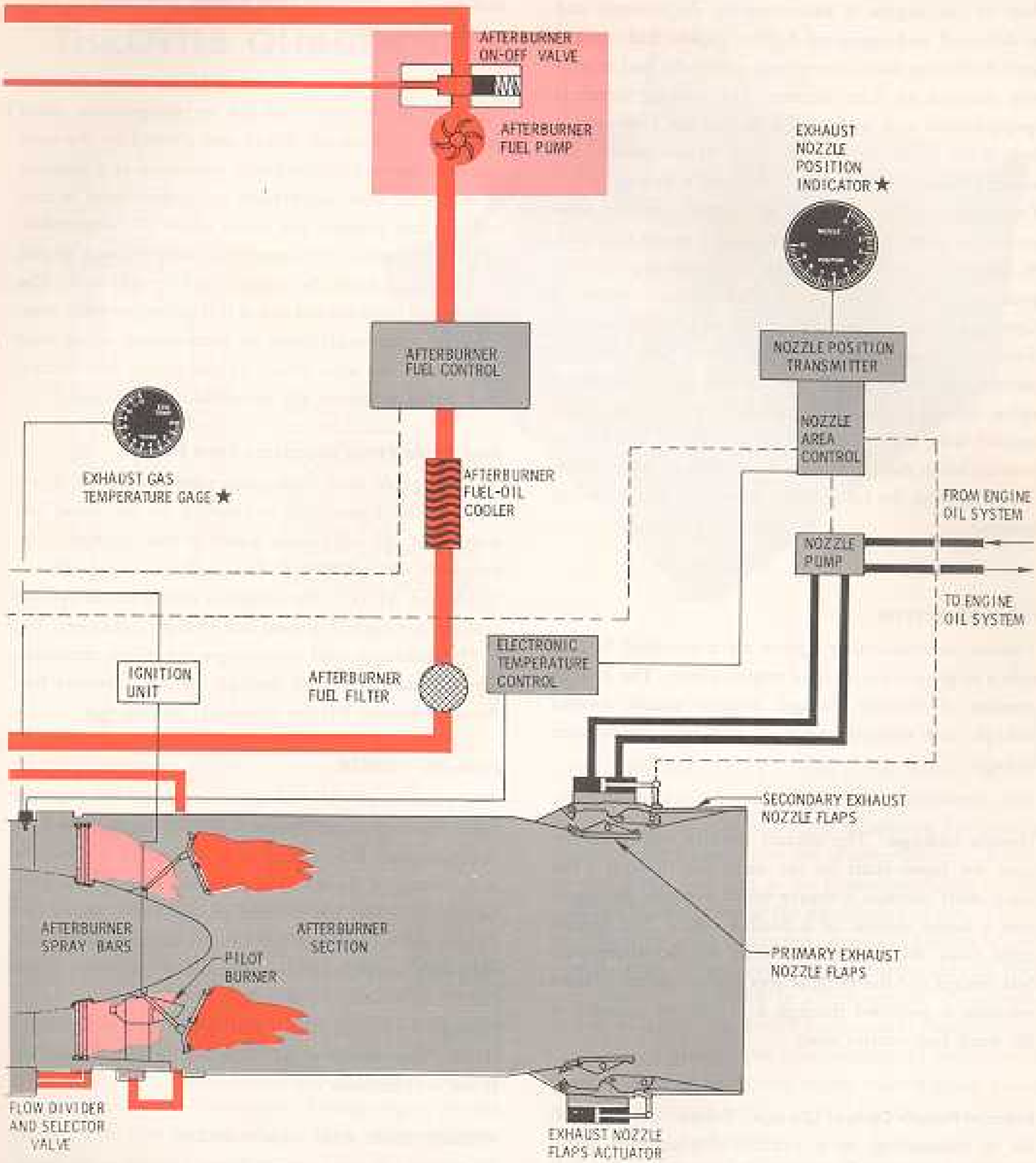
NOTE

★ DUPLICATED IN AFT COCKPIT

WARNING LIGHT SHOWN ILLUMINATED FOR INFORMATION ONLY

F54-0-1-7 (1)

Figure 1-4


AFTERBURNER ON-OFF VALVE
AFTERBURNER FUEL PUMP
EXHAUST NOZZLE POSITION INDICATOR ★
AFTERBURNER FUEL CONTROL
NOZZLE POSITION TRANSMITTER
NOZZLE AREA CONTROL
EXHAUST GAS TEMPERATURE GAGE ★
AFTERBURNER FUEL-OIL COOLER
FROM ENGINE OIL SYSTEM
NOZZLE PUMP
TO ENGINE OIL SYSTEM
IGNITION UNIT
AFTERBURNER FUEL FILTER
ELECTRONIC TEMPERATURE CONTROL
SECONDARY EXHAUST NOZZLE FLAPS
AFTERBURNER SPRAY BARS
AFTERBURNER SECTION
PILOT BURNER
PRIMARY EXHAUST NOZZLE FLAPS
FLOW DIVIDER AND SELECTOR VALVE
EXHAUST NOZZLE FLAPS ACTUATOR

F04-0-1-7 (2)

Engine Fuel Control Unit.

This control is a hydro-mechanical device which uses engine fuel as the hydraulic controlling medium. Fuel flow to the engine is controlled by the throttle and is delivered and regulated by the engine fuel control unit. Fuel from the engine pump, enters the fuel control unit through an inlet strainer. The strainer screen is spring-loaded and will by-pass fuel to the fuel control unit if the screen becomes clogged. Major control elements consist of a metering valve and a by-pass valve. The by-pass valve maintains a constant pressure head across the metering valve by by-passing excess fuel back to the engine fuel pump inlet. The metering valve is positioned in response to various internal operating signals, and meters fuel to the engine as a function of these integrated signals. Interconnected with the fuel control unit is the nozzle area control system. A cut-off valve, located in the fuel outlet port of the engine fuel control unit, shuts off the fuel supply to the engine burners when either throttle is retarded to OFF. Interconnected with the fuel control is the nozzle area control system.

LINKAGE SYSTEM.

Various interconnecting signals are transmitted to provide a single-point control of engine thrust. The linkage consists of throttle linkage, exhaust nozzle control linkage, and variable stator — and inlet guide vane linkage.

Throttle Linkage. The aircraft throttle mechanism rotates the input shaft of the main fuel control. The input shaft contains a sheave which converts the signal into a linear motion of a flexible cable. The flexible cable links the main fuel control to the afterburner fuel control and the variable area nozzle control. Thrust selection is provided through a 113 degree rotation of the main fuel control shaft.

Exhaust Nozzle Control Linkage. Exhaust nozzle schedule is transmitted to a variable displacement pump through a mechanical linkage. The nozzle position is transmitted to the exhaust nozzle by linear motion of a flexible cable. This motion indicates to the control that the nozzle has produced the area that was scheduled.

Inlet Guide Vane and Variable Stator Linkage. The position of the vanes is transmitted by a linear motion of a flexible cable to the main fuel control. This signal indicates that the vanes have become positioned to their scheduled angles.

Inlet Guide Vanes and Variable Stator Vanes Control.

The inlet guide vanes and the variable-position stator vanes are mechanically linked and affected by the same control. They are hydraulically positioned as a function of engine air inlet temperature and engine speed to control air flow through the initial stages of compression. The two actuators of this system are supplied with engine fuel pressure from the engine fuel control unit. The mechanical feedback linkage of this system prevents overtravel or vane angle error by transmitting actual vane position to the servo piston in the engine fuel control unit. Refer to Section VII for additional information.

Inlet Guide Vanes Emergency Reset Switch.

An inlet guide vanes emergency reset switch (34, figure 1-6, and 33, figure 1-7) is installed on the lower left portion of the instrument panel in each cockpit. The switch is labeled IGV CONT and has two positions, MAN and AUTO. The switch is placed in the AUTO position for normal ground and in-flight operation. The MAN position is used for emergency in-flight operation. The system is energized through the No. 1 battery bus. Refer to Section VII for additional information.

FUEL-OIL COOLER.

The purpose of the fuel-oil cooler is to remove heat from the engine oil system. This is accomplished by the main fuel flow acting as a coolant to control the temperature of the oil. The assembly consists of a fuel-oil cooler, a fuel temperature control valve, and a fuel by-pass valve. The fuel temperature control valve senses oil outlet temperature and controls the routing of the fuel. The by-pass valve will not allow cool oil to go through the cooler; also, it will by-pass fuel to the cooler if fuel flow becomes too high and it will by-pass oil if the fuel becomes too hot.

PRESSURIZING AND DRAIN VALVE.

The pressurizing and drain valve maintains back pressure to the engine fuel control system in order to provide an acceptable fuel pressure level for servo operation. The valve opens to allow fuel flow to the engine when

THROTTLE QUADRANT

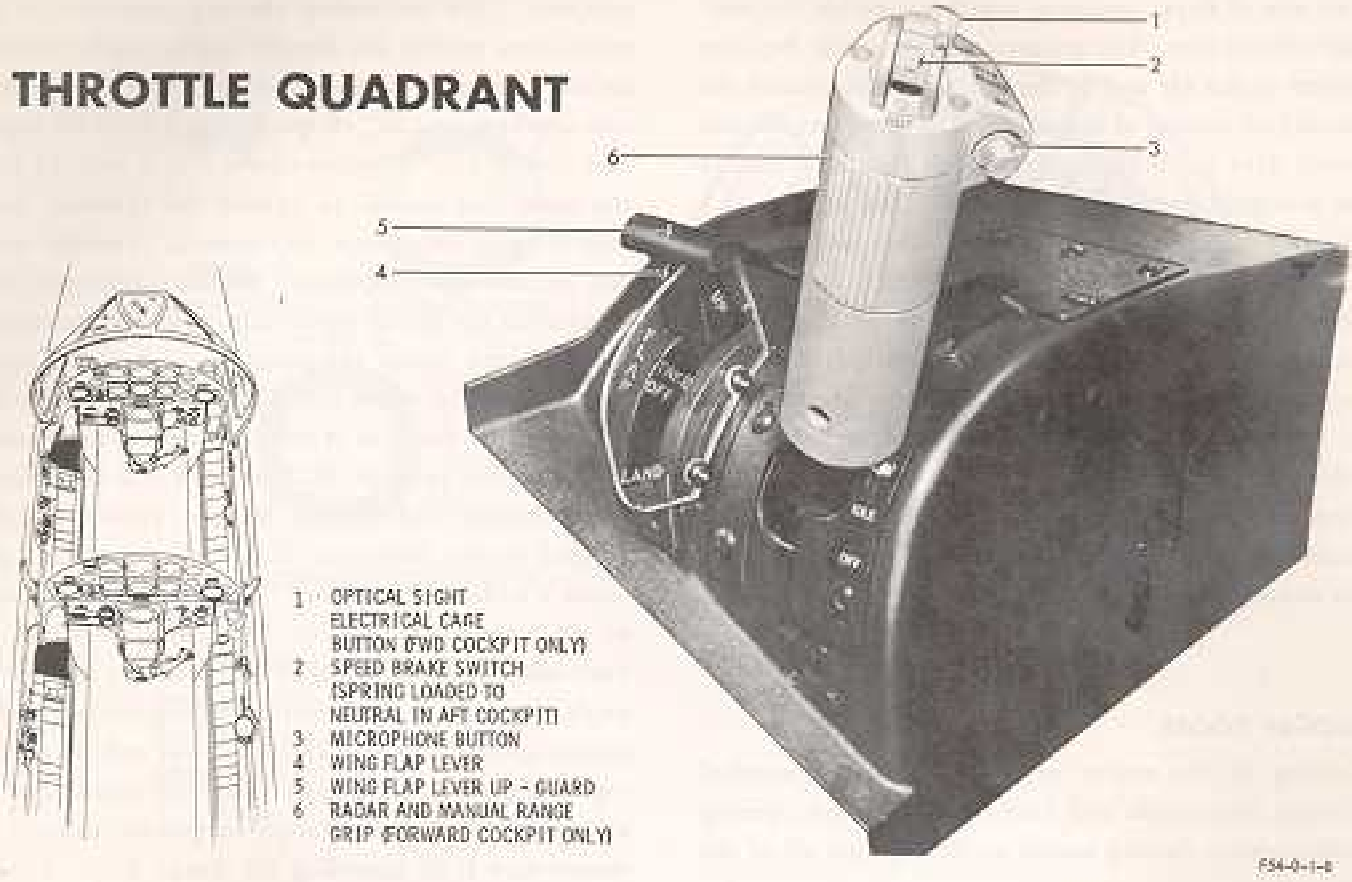


Figure 1-5

discharge pressure exceeds a preset value. The drain valve in the unit is used to drain the engine fuel manifold when the engine is shut down.

THROTTLES.

The forward and aft throttle quadrants are mechanically interconnected and are identical, except that the aft quadrants (figure 1-5) are labeled OFF, IDLE, and FULL. The throttles are spring-loaded in the inboard direction so that forward motion from OFF will cause them to drop into IDLE without forcing. Full travel from IDLE to the point where Military Thrust is reached is by straight forward movement. During engine ground starts the throttle is moved from OFF to IDLE position which opens the fuel cut-off valve. After the engine has started, throttle advancement increases engine speed until 100% rpm is reached. At this point, maximum engine speed is attained and is governed at this rpm throughout the remainder of throttle travel including maximum afterburner. Afterburning is initiated by moving the throttle outboard and forward into the afterburner slot. A substantial thrust variation in the afterburner range can be obtained by movement of the throttle in this slot. Throttle linkage provides the correct amount of friction to prevent the lever from creeping, so no separate throttle friction control is provided in either cockpit. A potentiometer with a built-in switch for gunsight manual range control is installed in the grip assembly of the forward throttle. Each throttle also incorporates a speed brake switch and a push-button switch for the microphone. An electrical gunsight cage button is installed on the forward throttle only. Throttle-actuated switches for the landing gear warning signal circuits are installed in both throttle quadrants.

AERODYNAMIC VARIABLE AREA EXHAUST NOZZLE.

Two sets of flaps, operating together, provide the variable exhaust area. The primary exhaust nozzle flaps are hinged to the aft end of the tail pipe, and control the convergent portion of the nozzle. The secondary exhaust nozzle flaps are hinged to a support ring, and control the divergent portion of the nozzle. (See figure 1-12.) The two sets of flaps are linked together and maintain a scheduled area-and-spacing ratio which is infinitely variable between extremes. Movement of the flaps is accomplished automatically by four synchronized hydraulic actuators. The exhaust gases leave the primary flaps at sonic velocity, and are accelerated to supersonic velocity by the controlled expansion of the gases. This expansion is controlled by the cushioning effect of the secondary airflow through the annular passage between the two sets of flaps.

SUCK-IN DOORS.

Cooling air for engine ground operation is supplied through four single and four double inboard opening suck-in doors (spring loaded to closed) just aft of the firewall.

BY-PASS FLAPS.

During flight, secondary airflow is supplied through automatically-operated engine air by-pass flaps installed at the joint between the main duct and the engine. Electrically operated valves, actuated by the main landing gear door uplock switches, allow No. 2 hydraulic pressure to open the two lower by-pass flaps when the landing gear is retracted. This allows excessive ram air to by-pass the engine. When the landing gear is extended, the two lower flaps are closed. Electrical power for operation of the by-pass flap valves is derived from the d.c. monitored bus.

EMERGENCY BLOW-OUT PANEL.

An emergency blow-out panel is installed on the bottom of the airplane forward of the hydraulic panel to relieve excessively high pressures which could build up in the aft fuselage.

NOZZLE AREA CONTROL SYSTEM.

The nozzle area control is an electro-hydromechanical computer. The parameters affecting operation of the nozzle area control are throttle angle, nozzle position, an electrical overtemperature signal from the temperature amplifier, and an "off-speed" signal from the engine fuel control unit. Regulated servo fuel is received from the main fuel control to operate the hydraulic force amplifiers in the nozzle area control. Throttle angle and exhaust gas temperature are the parameters used to schedule the correct nozzle area. The two parameters are combined within the nozzle area control. During engine operation in the sub-Military region, nozzle area is primarily a function of throttle angle. The nozzle is scheduled full open at IDLE and the area is decreased as the throttle is advanced to Military. However, during a rapid throttle burst, the main fuel control unit generates a hydraulic "off-speed" signal which is delivered to the nozzle area control. The signal overrides the mechanical nozzle schedule as established by the throttle angle, permitting a rapid increase in engine rpm. During engine operation in the Military Thrust and afterburner region it becomes necessary to limit the nozzle schedule as established by throttle angle to prohibit exhaust gas temperature from exceeding the design limits. Exhaust gas temperature is sensed by twelve dual loop thermocouples and the resulting signal is transmitted to the temperature amplifier. The amplifier, which receives its power supply from the engine driven control alternator, compares the thermocouple signal to a pre-set reference voltage representing desired engine temperature. The difference is amplified and transmitted to the nozzle area control which overrides the mechanical schedule in the open direction.

Temperature Amplifier.

The temperature amplifier provides an electrical signal to the nozzle area control. This signal overrides the mechanical schedule of the primary nozzle, preventing overtemperature operation of the engine. The amplifier receives power from the control alternator and an electrical signal representing actual exhaust gas temperature from the thermocouples.

The thermocouple generated signal is compared to a signal representing desired exhaust gas temperature. The difference voltage is amplified and delivered to the torque motor of the nozzle area control.

Nozzle Pump. The nozzle hydraulic pump is a variable pressure, variable displacement pump driven by a single engine shaft. The amount and direction of flow are determined by a mechanical push-pull signal from the nozzle area control.

Exhaust Nozzle Flap Actuators. There are four exhaust nozzle flap hydraulic actuators which are supplied with high pressure engine oil from the nozzle hydraulic pump. The four actuators are equally spaced and are located on the tailpipe. The nozzle actuators mechanically open and close the nozzles automatically through a series of rods and levers.

Exhaust Nozzle Control Switch.

An exhaust nozzle control switch (10, figure 1-8 and 9, figure 1-10) is located on the left side panel in each cockpit just forward of the throttle quadrant. The switch is labeled NOZZLE CONTROL and has two positions, MANUAL and AUTO. The temperature amplifier control of the nozzle area control system is energized with the switch in the AUTO position. If the temperature amplifier system malfunctions, the pilot may override the automatic feature and close the exhaust nozzle to the mechanical schedule by placing the switch in MANUAL. With the switch in MANUAL, there is no automatic temperature modulation.

Note

A failure of the hydromechanical portion of the nozzle area control system is also a possibility. Under this condition, control of the exhaust nozzle may not be possible.

Exhaust Nozzle Position Indicators.

An indicator, (15, figure 1-6 and 14, figure 1-7) located on the right side of each instrument panel, shows the exit area of the exhaust nozzle. The instruments are placarded "NOZZLE POSITION" and are calibrated from 0 through 10. Power for the instruments is derived from the instrument a.c. bus.

ENGINE STARTER AND IGNITION SYSTEMS.

Engine Starter System.

The engine is equipped with an air driven starter which requires air from a ground turbine compressor. The receptacle for connecting the air supply line is located in the right main wheel well. A special electrical receptacle located adjacent to this air connector is provided to permit electrical connection from the start switches to the electrically controlled air valve on the ground starting unit. If this electrical connection is made, the pilot has control of the start; starting air to the engine starter is provided through electrical operation of the valve by the pilot. A centrifugal switch closes the air valve to disengage the starter automatically between 42 and 47% engine rpm. If this electrical connection is not made, the ground crew manually positions the valve open and close on signal from the pilot.

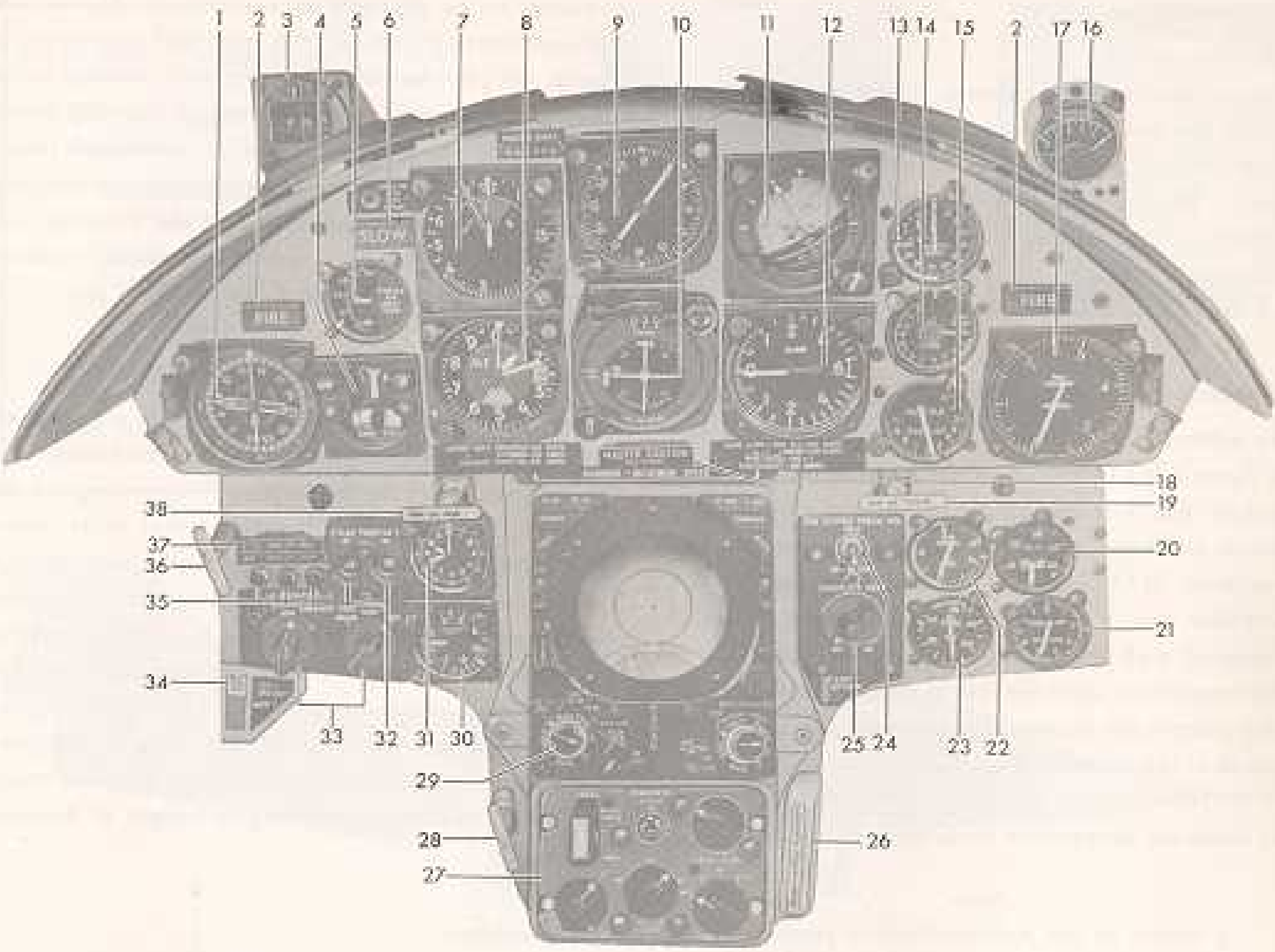
Engine Ignition System.

Dual ignition systems are provided for air start reliability. Each system has an individual battery and battery bus, switch and spark plug. When energized, the ignition circuit selected will supply power to its respective spark plug for 45 seconds or until the start switch is moved to the STOP-START position. The spark plug will ignite the fuel-air mixture in its vicinity. Ignition is propagated through combustion chamber cross-fire tubes. During gun firing, the ignition circuit is energized when the trigger is depressed and remains energized for 10 to 15 seconds after release. This provides standby ignition for immediate engine relight if flameout occurs.

Start Switches.

Two start switches in each cockpit (figure 1-13) are located on the left forward panel and are labeled No. 1 and No. 2. The switches have a START, STOP-START and a center NEUTRAL position. The switches are spring-loaded from the START and STOP-START position to NEUTRAL. By momentarily placing either start switch to START, battery bus power is supplied to energize the ignition circuit and begin the 45 second ignition cycle. During the ignition cycle, the start switches may be used to begin a completely new 45 second cycle. Placing the start switch in the STOP-START position discontinues ignition. Both switches may be used simultaneously to energize the ignition systems during air starts. This provides dual airstart reliability. When the special electrical connection is made between the airplane and the control valve, the start switch also controls starting air.

FORWARD COCKPIT INSTRUMENT PANEL
(TYPICAL)



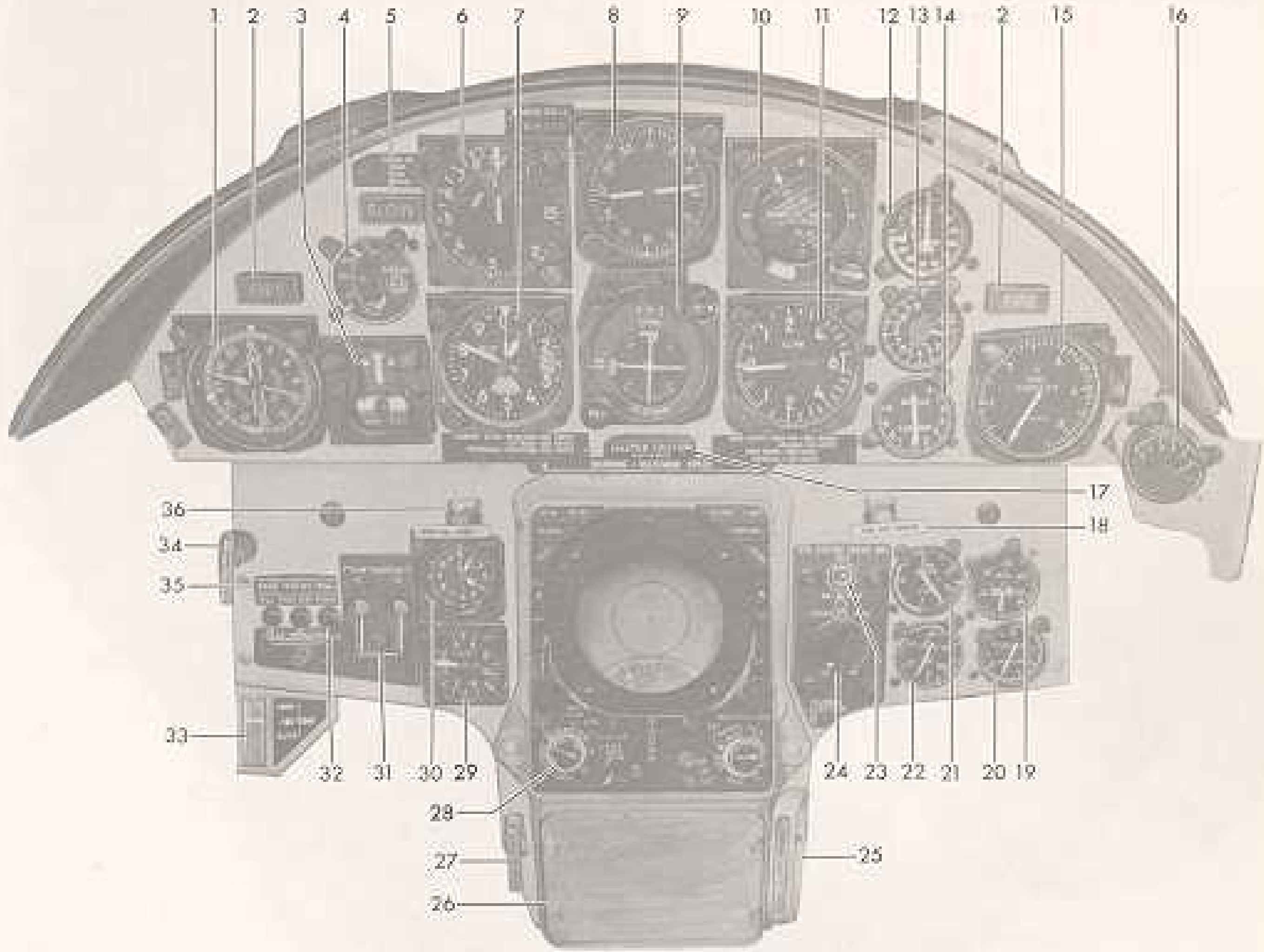
1 RADIO MAGNETIC INDICATOR
2 FIRE WARNING LIGHT (2)
3 STAND-BY COMPASS
4 TURN AND SLIP INDICATOR
5 ENGINE AIR INLET TEMPERATURE GAGE
6 ENGINE AIR INLET TEMPERATURE WARNING LIGHT
7 AIRSPEED AND MACH NUMBER INDICATOR
8 ALTIMETER
9 DIRECTIONAL INDICATOR
10 COURSE INDICATOR
11 ATTITUDE INDICATOR
12 VERTICAL VELOCITY INDICATOR
13 TACHOMETER
14 EXHAUST GAS TEMPERATURE GAGE
15 EXHAUST NOZZLE POSITION INDICATOR
16 AUTO-PITCH CONTROL INDICATOR
17 FUEL QUANTITY INDICATOR
18 MASTER CAUTION LIGHT AND RESET BAR
19 RAM AIR TURBINE EXTENSION HANDLE
20 CABIN ALTIMETER
21 FUEL FLOW INDICATOR
22 HYDRAULIC SYSTEMS PRESSURE GAGE
23 OIL PRESSURE GAGE
24 HYDRAULIC SYSTEMS PRESSURE SELECTOR SWITCH
25 FACE PLATE HEAT RHEOSTAT
26 ESCAPE HATCH JETTISON HANDLE (UNMODIFIED AIRCRAFT) CANOPY JETTISON HANDLE (MODIFIED AIRCRAFT)
27 ARMAMENT CONTROL PANEL
28 RUDDER PEDAL ADJUSTMENT HANDLE
29 RADAR SCOPE AND CONTROL PANEL
30 ACCELEROMETER
31 CLOCK
32 WING FLAP POSITION INDICATORS
33 GUNSIGHT CONTROL SWITCHES
34 INLET GUIDE VANES EMERGENCY RESET SWITCH
35 LANDING GEAR POSITION INDICATOR LIGHTS
36 DRAG CHUTE HANDLE
37 STABILIZER AND AILERON TAKE-OFF TRIM INDICATOR LIGHTS
38 MANUAL LANDING GEAR RELEASE HANDLE

F54-9-1-9

Figure 1-6

AFT COCKPIT INSTRUMENT PANEL

(TYPICAL)



1 RADIO MAGNETIC INDICATOR
2 FIRE WARNING LIGHT (2)
3 TURN AND SLIP INDICATOR
4 ENGINE AIR INLET TEMPERATURE GAGE
5 ENGINE AIR INLET TEMPERATURE WARNING LIGHT
6 AIRSPEED AND MARCH NUMBER INDICATOR
7 ALTIMETER
8 DIRECTIONAL INDICATOR
9 COURSE INDICATOR
10 ATTITUDE INDICATOR
11 VERTICAL VELOCITY INDICATOR
12 TACHOMETER
13 EXHAUST GAS TEMPERATURE GAGE
14 EXHAUST NOZZLE POSITION INDICATOR
15 FUEL QUANTITY INDICATOR
16 AUTO-PITCH CONTROL INDICATOR
17 MASTER CAUTION LIGHT AND RESET BAR
18 RAM AIR TURBINE EXTENSION HANDLE
19 CABIN ALTIMETER
20 FUEL FLOW INDICATOR
21 HYDRAULIC SYSTEMS PRESSURE GAGE
22 OIL PRESSURE GAGE
23 HYDRAULIC SYSTEM PRESSURE SELECTOR SWITCH
24 FACE PLATE HEAT RHEOSTAT
25 ESCAPE HATCH JETTISON HANDLE (UNMODIFIED AIRCRAFT)
CANOPY JETTISON HANDLE (MODIFIED AIRCRAFT)
26 RADAR CONTROL TRANSFER PANEL (DELETED)
27 RUDDER PEDAL ADJUSTMENT HANDLE
28 RADAR SCOPE AND CONTROL PANEL
29 ACCELEROMETER
30 CLOCK
31 WING FLAP POSITION INDICATORS
32 LANDING GEAR POSITION INDICATOR LIGHTS
33 INLET GUIDE VANE EMERGENCY RESET SWITCH
34 DRAG CHUTE HANDLE
35 STABILIZER AND AILERON TAKE-OFF TRIM INDICATOR LIGHTS
36 MANUAL LANDING GEAR RELEASE HANDLE

F54-8-1-10

Figure 1-7

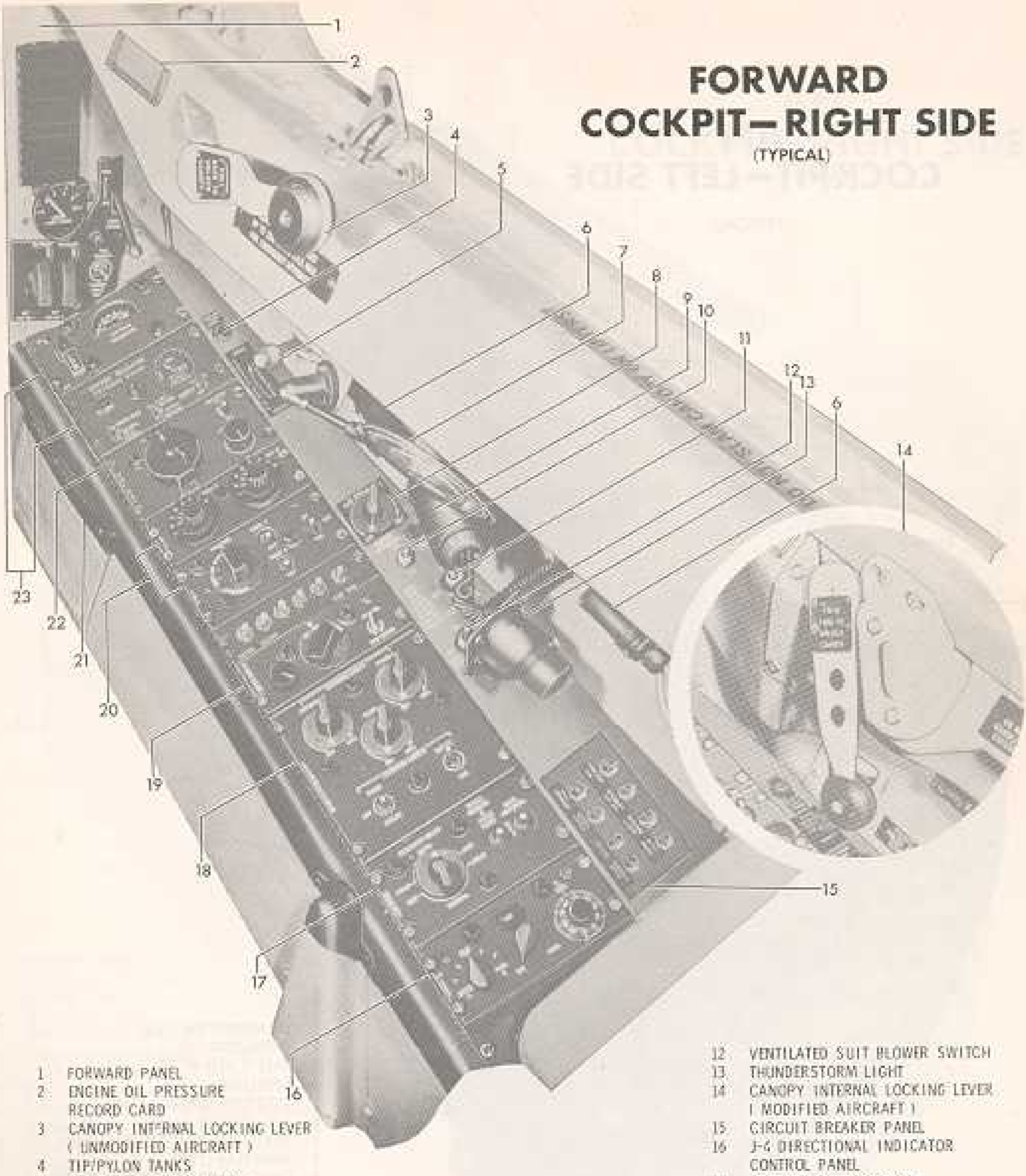
FORWARD COCKPIT—LEFT SIDE
(TYPICAL)

1 THUNDERSTORM LIGHT
2 ANTI-G-SUIT VALVE
3 FLOODLIGHT (2)
4 SPOTLIGHT
5 TRIM AND STABILITY CONTROL PANEL
6 FUEL CONTROL PANEL
7 STANDBY COMPASS CORRECTION CARD HOLDER
8 AUXILIARY TRIM CONTROL PANEL
9 WING FLAP LEVER
10 EXHAUST NOZZLE CONTROL SWITCH
11 THROTTLE
12 FORWARD PANEL
13 UHF COMMAND RADIO CONTROL PANEL
14 CIRCUIT BREAKER PANEL
15 MISSILE CONTROL PANEL
16 AUTO-PITCH CONTROL SYSTEM CUT-OUT SWITCH
17 VHF AND UHF CONTROL TRANSFER PANEL
18 GROUND TEST PANEL

F04-8-T-11

Figure 1-8

FORWARD COCKPIT—RIGHT SIDE
(TYPICAL)



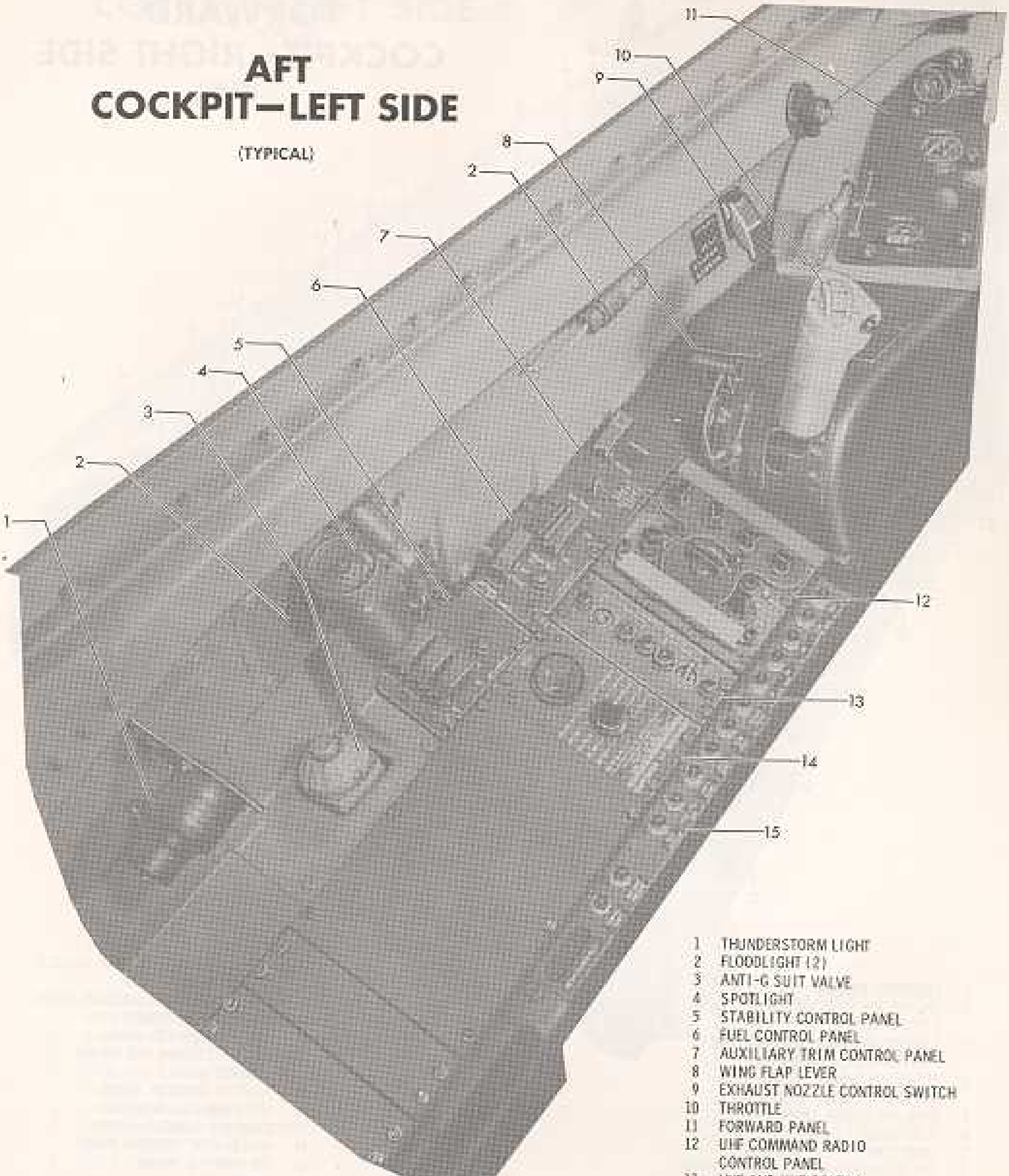
1 FORWARD PANEL
2 ENGINE OIL PRESSURE RECORD CARD
3 CANOPY INTERNAL LOCKING LEVER (UNMODIFIED AIRCRAFT)
4 TIP/PYLON TANKS EMPTY INDICATOR LIGHT
5 RAM AIR SCOOP LEVER
6 FLOODLIGHT (2)
7 COMPUTER
8 AIR REFUELING PROBE LIGHT SWITCH
9 SPOTLIGHT
10 ENGINE MOTORING SWITCH
11 THUNDERSTORM LIGHTS SWITCH
12 VENTILATED SUIT BLOWER SWITCH
13 THUNDERSTORM LIGHT
14 CANOPY INTERNAL LOCKING LEVER (MODIFIED AIRCRAFT)
15 CIRCUIT BREAKER PANEL
16 J-4 DIRECTIONAL INDICATOR CONTROL PANEL
17 HEATING CONTROL PANEL
18 INTERIOR AND EXTERIOR LIGHTING CONTROL PANEL
19 INTERPHONE CONTROL PANEL
20 IFF CONTROL PANEL
21 CHECK LIST
22 VHF NAVIGATION CONTROL PANEL
23 OXYGEN PANELS

F54-8-1-12

Figure 1-9

AFT COCKPIT—LEFT SIDE

(TYPICAL)



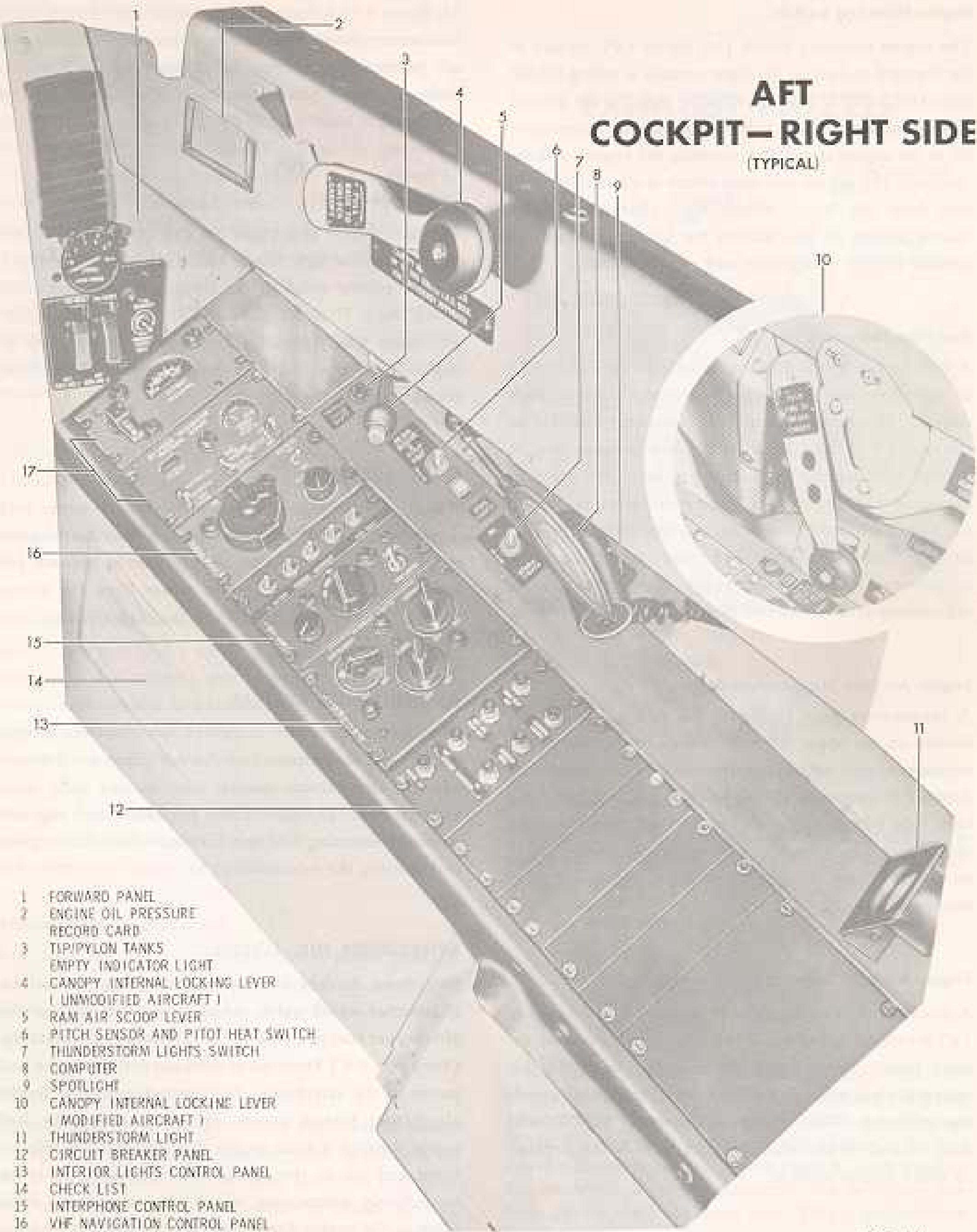
1 THUNDERSTORM LIGHT
2 FLOODLIGHT (2)
3 ANTI-G SUIT VALVE
4 SPOTLIGHT
5 STABILITY CONTROL PANEL
6 FUEL CONTROL PANEL
7 AUXILIARY TRIM CONTROL PANEL
8 WING FLAP LEVER
9 EXHAUST NOZZLE CONTROL SWITCH
10 THROTTLE
11 FORWARD PANEL
12 UHF COMMAND RADIO CONTROL PANEL
13 VHF AND UHF CONTROL TRANSFER PANEL
14 FIRE CONTROL SYSTEM TEST PANEL
15 CIRCUIT BREAKER PANEL

Figure 1-10

T54-9-1-13

AFT COCKPIT—RIGHT SIDE

(TYPICAL)



1 FORWARD PANEL
2 ENGINE OIL PRESSURE RECORD CARD
3 TIP/PYLON TANKS EMPTY INDICATOR LIGHT
4 CANOPY INTERNAL LOCKING LEVER (UNMODIFIED AIRCRAFT)
5 RAM AIR SCOOP LEVER
6 PITCH SENSOR AND PITOT HEAT SWITCH
7 THUNDERSTORM LIGHTS SWITCH
8 COMPUTER
9 SPOTLIGHT
10 CANOPY INTERNAL LOCKING LEVER (MODIFIED AIRCRAFT)
11 THUNDERSTORM LIGHT
12 CIRCUIT BREAKER PANEL
13 INTERIOR LIGHTS CONTROL PANEL
14 CHECK LIST
15 INTERPHONE CONTROL PANEL
16 VHF NAVIGATION CONTROL PANEL
17 OXYGEN PANELS

T34-8-1-14

Figure 1-11

Engine Motoring Switch.

The engine motoring switch (10, figure 1-9), located in the forward cockpit on the right console, is spring loaded from ON to OFF. It is provided to energize the ground turbine compressor air valve which directs compressor air to the engine starter for motoring the engine without ignition. The engine motoring switch is electrically powered from the No. 1 battery bus. (Refer to Engine Starter System in this Section for information on the ground turbine compressor and engine starter.)

Fuel Flow Indicators.

A fuel flow indicator (21, figure 1-6 and 20, figure 1-7) is located on the lower right instrument panel in each cockpit. They are operated by a flowmeter installed in the engine fuel line. These instruments indicate the rate of fuel consumption in pounds per hour and are calibrated to 12,000 pounds. The system receives 26-volt a.c. power from the instrument a.c. bus through the instrument auto-transformer and fuses on the electronic compartment circuit breaker panel. The instruments do not indicate afterburner fuel flow.

Engine Air Inlet Temperature Gages.

A temperature gage (5, figure 1-6 and 4, figure 1-7), located on the upper left side of each instrument panel, measures engine air inlet temperature. The temperature detector is located in the right 20 KVA, a.c. generator blast tube which carries engine inlet air from the right intake duct. The instruments are calibrated from —70° C to +150°C and receive power from the 28-volt d.c. monitored bus.

Engine Air Inlet Temperature Warning Lights.

A placard-type warning light (6, figure 1-6 and 5, figure 1-7) is located on the upper left side of each main instrument panel. These lights are energized from the d.c. emergency bus when engine air inlet temperature exceeds the limitation. When energized the word "SLOW" will flash on and off and alert the pilot to slow the airplane to avoid engine damage.

Exhaust Gas Temperature Gages.

An exhaust gas temperature gage (14, figure 1-6, and 13, figure 1-7) is located on the right side of each main instrument panel. The units are operated electrically by self-generating thermocouples and provide visual indications of exhaust gas temperature. They are calibrated from 0° C to 1000° C.

Tachometers.

The tachometers (13, figure 1-6 and 12, figure 1-7), one mounted on the right side of each main instrument panel, register engine speed in percentage of maximum rated rpm (7460). The instruments are powered by tachometer generators which generate a frequency proportional to engine speed and therefore do not require power from the airplane electrical system.

Oil Pressure Gages.

An oil pressure gage (23, figure 1-6; and 22, figure 1-7) is mounted on the right side of each lower instrument panel. The gages register oil pressure in pounds per square inch. The gages receive power from the instrument a.c. bus through the 26-volt auto-transformer.

AFTERBURNER SYSTEM.

The afterburner section is located just aft of the turbine section and is comprised of the tail pipe, aerodynamic variable area exhaust nozzle, pilot burner, spray bars, and manifold. The afterburner provides thrust augmentation by injecting addition fuel into the exhaust gases and igniting the mixture.

AFTERBURNER FUEL SYSTEM.

Fuel from the aircraft fuel tanks is admitted to the afterburner on-off valve, which passes the fuel to the afterburner fuel pump when the afterburner is operating. (See figure 1-4.) From the afterburner fuel pump the fuel passes to the afterburner fuel control and then to the afterburner fuel-oil cooler. From the cooler the fuel passes through a filter to the flow divider and selector valve and on to the spray bars. Fuel flow is taken immediately downstream of the pressurizing and drain valve in the engine fuel system and is used for ignition purposes. The ignition system receives power from the No. 2 a.c. bus.

Afterburner On-Off Valves.

The afterburner on-off valve is an integral part of the afterburner fuel pump. It is located on the inlet of the pump and allows fuel to pass into the afterburner fuel pump upon receipt of a high pressure fuel signal from the engine fuel control unit. This signal is controlled first by throttle position and second by engine speed. If either throttle is advanced into the afterburner region, the high pressure fuel signal will be applied to the engine speed control valve in the engine fuel control unit. If engine speed is high enough the signal will pass through this valve and into the afterburner on-off valve, thereby actuating it. If there is no signal the valve will remain closed and no fuel will enter the afterburner pump.

Afterburner Fuel Pumps.

The afterburner fuel pump is an engine-driven centrifugal pump. Although it operates continuously, it discharges fuel to the afterburner fuel system only when the afterburner on-off valve is open.

Afterburner Fuel Control.

The afterburner fuel control is linked mechanically to the engine fuel control unit. Fuel entering the afterburner fuel control is metered by the fuel control in response to throttle movement and changes in compressor discharge pressure (optimum fuel-air ratio). The afterburner fuel control is made to hold a constant pressure drop across an orifice while the area of that orifice is varied in accordance wtih throttle position and compressor discharge pressure.

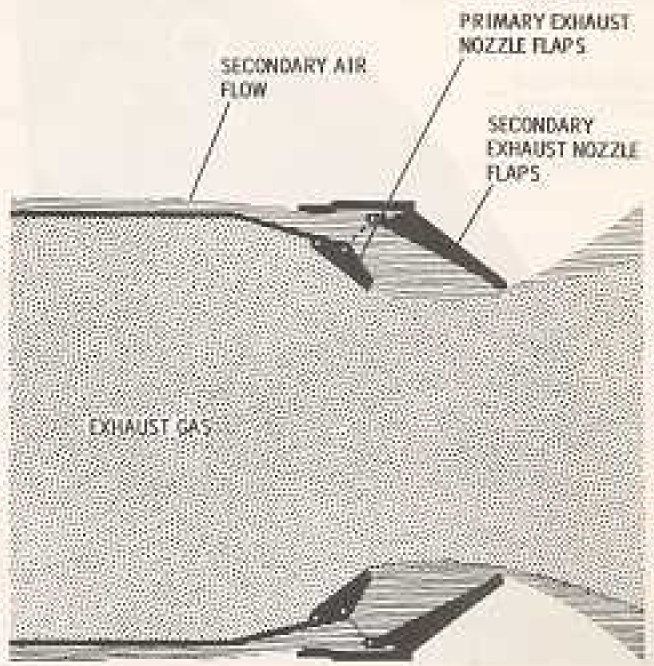
Afterburner Fuel-Oil Cooler.

Fuel from the afterburner fuel control passes through the fuel-oil cooler which removes heat from the engine oil in much the same manner as the fuel-oil cooler in the engine fuel system.

Flow Divider and Selector Valve.

Metered fuel from the afterburner fuel control passes through the fuel-oil cooler and fuel filter to the inlet of the flow divider and selector valve. Here fuel is distributed to the various spray bar sectors to obtain the best spray pattern for the condition of afterburner required.

EXHAUST NOZZLE



F54-0-1-15

Figure 1-12

Afterburner Sector Light Up.

The flow divider and selector valve assembly distributes fuel to the spray bars in sequence (see figure 1-15). There are four stages of fuel flow:

1. Primary sector.
2. Secondary sector.
3. Primary uniform.
4. Secondary uniform.

When either throttle is first advanced into the afterburner position, the primary sector lights up. Further advancement causes the secondary sector to light up. When the throttle is advanced still further a distinct increase in thrust occurs. As the throttle is advanced to the maximum afterburner position, the secondary uniform (final) manifold flows fuel. This is full uniform burning.

LEFT AND RIGHT FORWARD PANELS

(MODIFIED AIRPLANES)

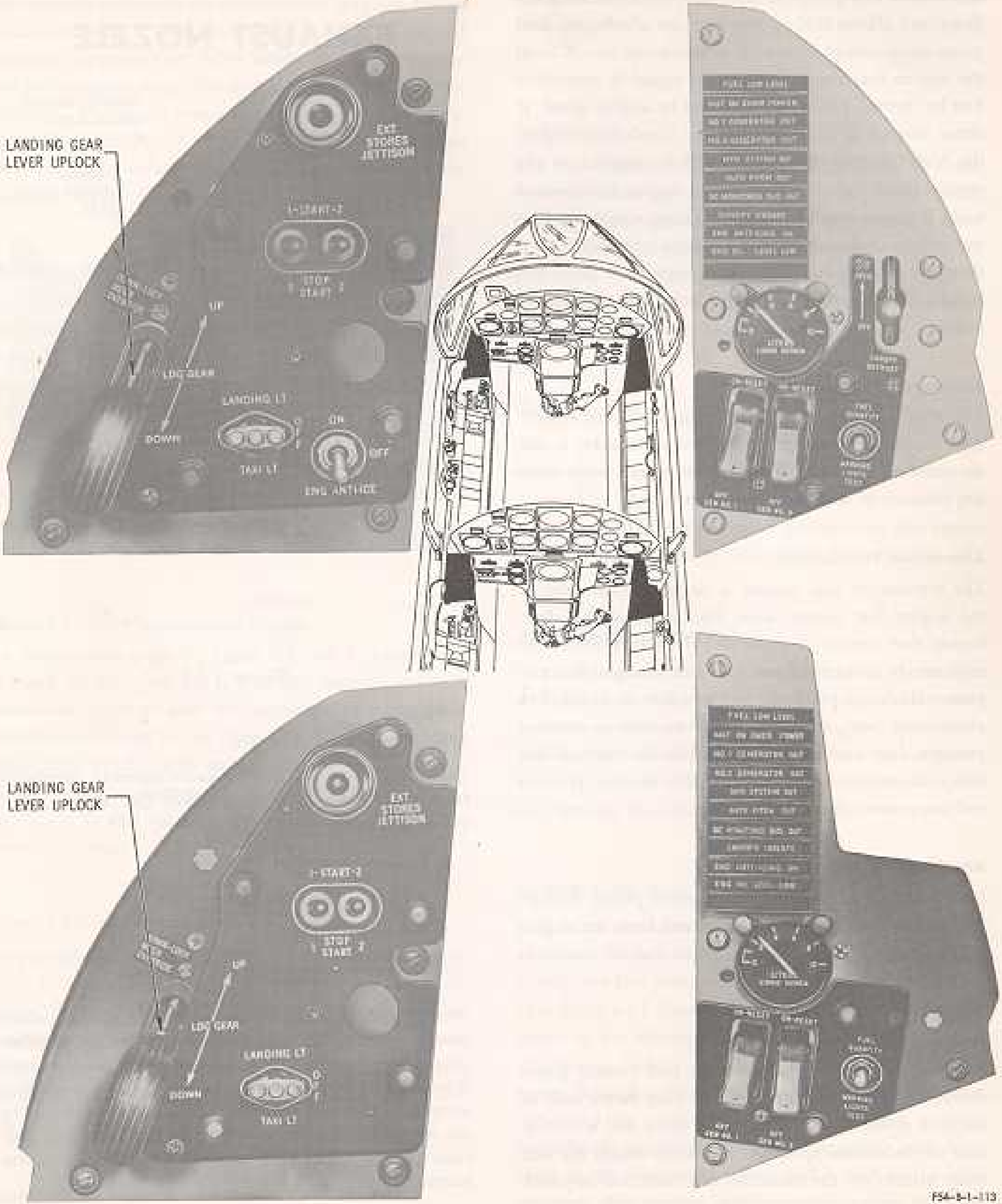


Figure 1-13

AFTERBURNER FUEL MANIFOLD

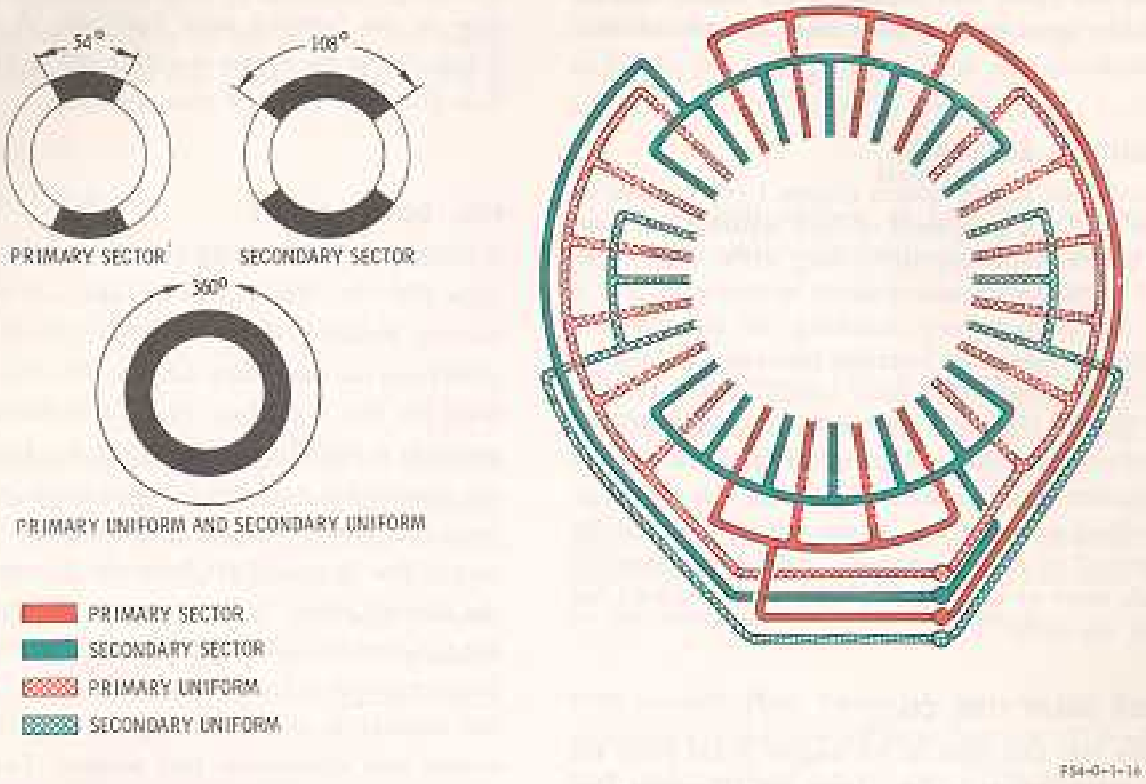


Figure 1-15

Afterburner Ignition System.

Afterburner ignition is controlled by a throttle actuated ignition switch. The afterburner ignition unit receives power from the No. 2 a.c. bus when the throttle is moved to any position in the afterburner range. A spark plug located within the pilot burner operates continuously during afterburning, assuring positive ignition of the pilot burner.

VARIATION OF ENGINE SPEED, TEMPERATURE AND NOZZLE AREA WITH THROTTLE POSITION

Refer to Confidential Supplement T. O. 1F-104D-1A Figure 1-14.

OIL SUPPLY SYSTEM.

The engine oil system is operated automatically. (Refer to figure 1-39 for oil grade and specification.) The system uses 4 US gallons of oil in a 5 US gallon tank (1 gallon expansion space). Necessary pressure and scavenge pumps and supply lines to those areas requiring lubrication are provided. Engine oil also is used to actuate the exhaust nozzles. The flow of engine oil for the exhaust nozzle actuators is controlled automatically by the nozzle area control system. Access to the oil quantity dip stick is provided on the top surface of the fuselage directly over the wing.

ENGINE OIL PRESSURE RECORD CARD.

An engine oil pressure record card (2, figures 1-9 and 1-11) is provided on the forward right side of both cockpits. This card lists the normal engine oil pressure at Military Thrust for each engine/airplane combination.

ENGINE OIL LEVEL LOW WARNING LIGHT.

On AF Serials 57-1329 and subsequent and modified aircraft an ENG. OIL LEVEL LOW warning light is installed on each warning light panel. The warning lights are actuated by a pressure switch in the engine hydraulic supply line. A reduction of oil level in the tank below the hydraulic supply line (approximately 0.8 gallons) will result in loss of engine hydraulic pressure thereby illuminating the warning lights. The lights do not directly measure oil quantity in the reservoir. Illumination of the lights also illuminate the master caution lights. Both lights are powered from the 28 volt d.c. emergency bus.

FUEL SUPPLY SYSTEMS.

The aircraft fuel supply system (figure 1-16) consists of one main fuel cell comprised of four separate interconnected, bladder-type non-self-sealing cells, four tank-mounted submerged boost pumps, a shut-off valve a strainer, and the necessary plumbing and electrical circuits. Flapper valves are installed between the forward main and aft center fuel cells which permit fuel to flow by gravity from the aft fuel cells to the forward main fuel cell. A filler well in the aft center fuel cell is used to service all four internal fuel cells. All the necessary plumbing and electrical circuits are provided for the installation of tip and pylon tanks. For fuel specification and grade refer to figure 1-39. Refer to figure 1-21 for fuel tank capacities.

FORWARD MAIN FUEL CELL.

All of the fuel that goes to the engine is fed from the forward main fuel cell. Fuel from the aft center fuel cell enters the forward main fuel cell through two flapper valves. Fuel from the external tanks enters the forward main fuel cell through a transfer float valve. A low level warning switch, quantity transmitter, four boost pumps, two vent valves, and a fuel manifold are located inside of the fuel cell. Drain valves are located in the four corners of the fuel cell and are accessible from outside of the airplane.

AFT CENTER FUEL CELL.

The aft center fuel cell is located between the engine inlet ducts. Two vent valves, a duel fuel level control valve, a quantity transmitter, and two drain valves are in the fuel cell. The drain valves are at the forward bottom end of the fuel cell and are accessible from the forward end of the wheel well.

AFT RIGHT AND LEFT FUEL CELLS.

The aft right and aft left fuel cells fit around the engine air inlet ducts outboard of the aft center fuel cell. Each fuel cell is connected by tubes, at the top and bottom, to the aft center fuel cell. Fuel flows to the aft center fuel cell through the bottom tube. The top tube serves as a vent connection. These fuel cells and the aft center fuel cell will hereafter be considered and referred to as the aft main fuel cell.

AUXILIARY FUEL CELLS.

On AF Serials 57-1329 and subsequent, three auxiliary fuel cells are installed. These interconnected cells have a combined capacity of 98 gallons and feed by gravity flow to the forward main fuel cell. A flapper valve is installed in the lowest auxiliary cell to prevent reverse flow from the forward main fuel cell.

FUEL BOOST PUMPS.

A boost pump is installed in each corner of the forward main fuel cell. The pumps are operated by 3 phase a.c. motors. Power to operate the No. 1 boost pump is supplied from the emergency a.c. bus. The No. 2 boost pump is on the No. 2 a.c. bus. No. 3 and No. 4 boost pump power is supplied from the No. 1 a.c. bus. The pumps are manifolded together through check valves into the main fuel supply line and to the engine. The main fuel supply line is routed aft from the forward fuel cell to the shut-off valve. A line connects the shut-off valve to the fuel strainer. A drain valve and an overboard drain line are plumbed from the strainer sump. The fuel from the strainer is routed through a flexible hose to the engine and afterburner fuel pumps. The boost pump circuits are energized any time the airplane electrical system and the circuit breakers are in. The pumps supply fuel at 35 psi. A fuel pressure switch located in the main fuel supply line, downstream of the boost pumps, is installed to check boost pump operation by ground maintenance personnel. No fuel pressure indicating system is provided in the cockpit.

FUEL TANK PRESSURIZATION AND VENT SYSTEM.

The vent system vents the internal fuel cells, provides self-pressurization of the fuel cells in a climb to prevent loss of fuel, and provides controlled pressurization of the fuel cells in a dive.

Vent Float Valves.

Four vent float valves are installed in the system. Two are in the forward main fuel cell, and two are in the aft center fuel cell. The valves are float-actuated and close the respective fuel cell vent in all attitudes of flight when the fuel reaches a predetermined level at the valve. This prevents fuel from flowing out of the vent.

Altitude Vent Valves.

An altitude-closing vent valve is provided. Its purpose is to provide self-pressurization of the fuel cells in a climb, reduce loss of fuel at high altitudes, allow for depressurization of fuel cells on the ground, and maintain some measure of fuel cell pressurization during a dive.

Auxiliary Relief Valve.

An auxiliary relief valve, which works in conjunction with the altitude vent valve, provides pressure and vacuum relief if the altitude vent valve fails.

Pressure Regulator.

A dual air pressure regulator maintains an air pressure differential between the fuel cell cavity and the inside of the fuel cell. Either side of the dual regulator is capable, by itself, of fulfilling the entire requirement. The regulator senses pressure within the fuel cells and pressure in the fuel cell cavity and closes when the pressure within the fuel cells exceeds the fuel cell cavity pressure by a preset value.

EXTERNAL TANKS.

Provisions are included for carrying tip tanks and pylon tanks, on each wing. (Refer to figure 1-21 for capacities.) A tip and pylon tank auto-drop system and a means for electrically jettisoning the tip tanks, pylon tanks and pylon racks are provided.

EXTERNAL FUEL TRANSFER SYSTEM.

The fuel transfer system provides a means of transferring fuel from the tip and pylon tanks to the forward main fuel cell. The fuel is transferred by using air pressure supplied by the engine compressor. Air is cooled by the primary heat exchanger and is controlled by a pressure regulator set to maintain a constant psi pressure. Fuel in the external tanks moves from the aft compartment to the forward compartment through a tube. A door at the forward end of the tube permits flow of fuel only in the forward direction. The fuel outlet to the transfer line and the forward main fuel cells is in the forward compartment of the external tanks. This compartment contains a low level float shut-off switch which automatically shuts off the transfer valve and pressurizing air when the tanks are empty or jettisoned. This prevents engine bleed air from entering the fuel transfer lines and internal cells. Sniffle valves are located in the tip tanks and in the pylons which support the pylon tanks. They act as relief valves if a regulator malfunctions. A failure in the regulator will cause it to fail in the open position. The unit is vented to the atmosphere by a line on the left side of the fuselage.

Note

A nominal amount of fuel may be vented overboard through the fuselage overboard vent at the time the tip tanks become empty.

Air Shut-Off Valves. The air shut-off valves are installed in the engine compartment on the left side. One valve shuts off the supply of engine compressor air to the tip tanks and the other shuts off air to the pylon tanks. The valves are motor-operated and are controlled by low level float switches and limit switches in the external tank jettisoning system.

Fuel Transfer Float Valve. A fuel transfer float valve is installed in the forward main fuel cell. The valve controls fuel transfer from the external tanks. The level of fuel in the forward main fuel cell is maintained by movement of a float valve inside the valve that opens and closes the valve by its movement until external fuel is exhausted.

External Stores Auto Drop System.

A tip and pylon auto-drop system is provided. If either a pylon or a tip tank becomes disengaged accidentally, the system will automatically jettison both the disengaged tank and the corresponding tank on the opposite wing, provided the airplane electrical system is in operation. The system is powered from the d.c. emergency bus. Safety pins are provided for the tip and pylon tanks to prevent the auto-drop system from operating when one tank is intentionally removed. The pins are inserted under each wing for the tip tanks and in the pylons for the pylon tanks.

Note

The auto-drop system is in operation when missiles are on the wing tip. Only in event of a missile launcher becoming disengaged will the auto-drop system function as described. Missile firing will not activate the system.

FUEL SUPPLY SYSTEM

(AF SERIALS PRIOR TO 57-1329)

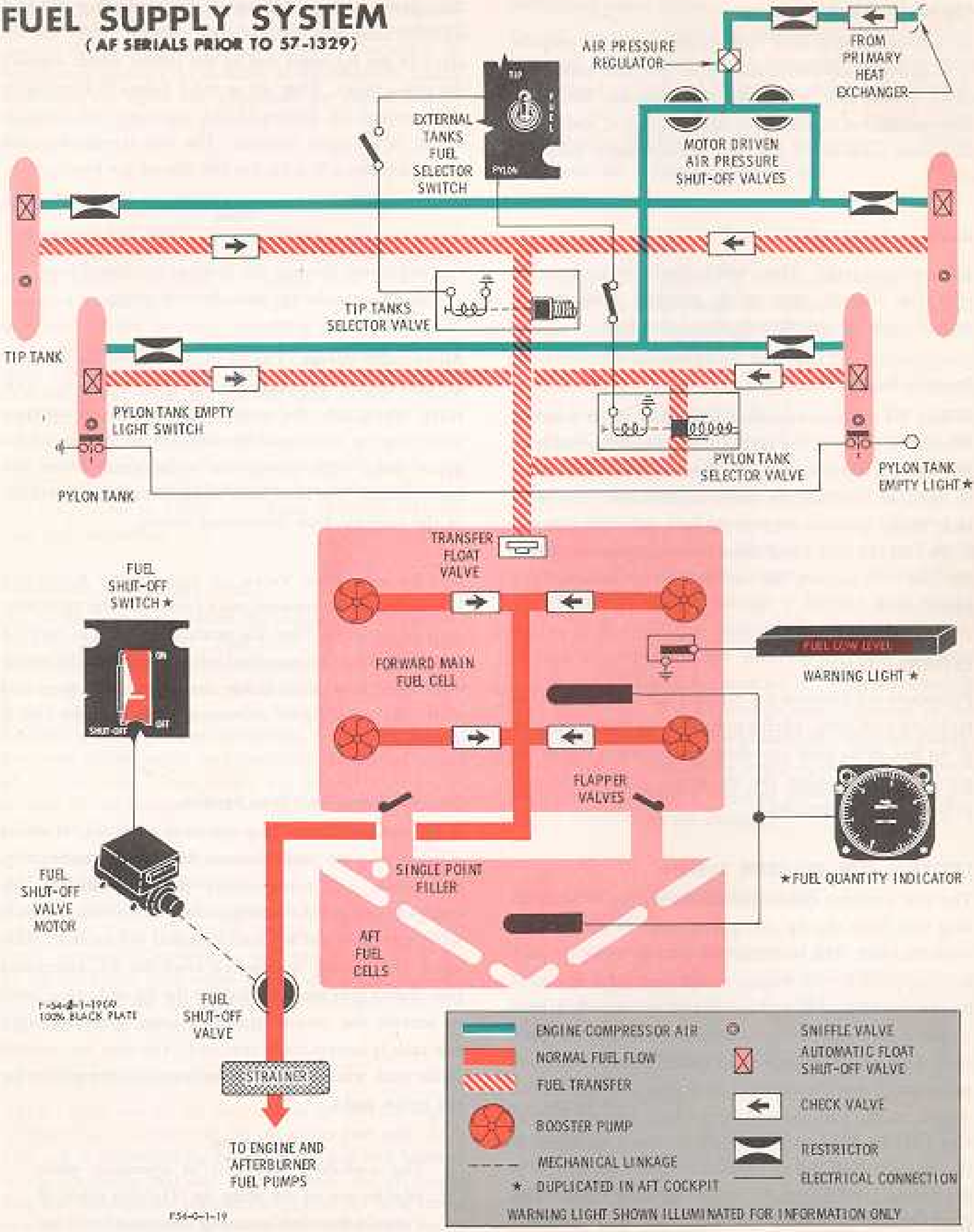


Figure 1-16

FUEL SUPPLY SYSTEM
(AF SERIALS 57-1329 AND SUBSEQUENT)

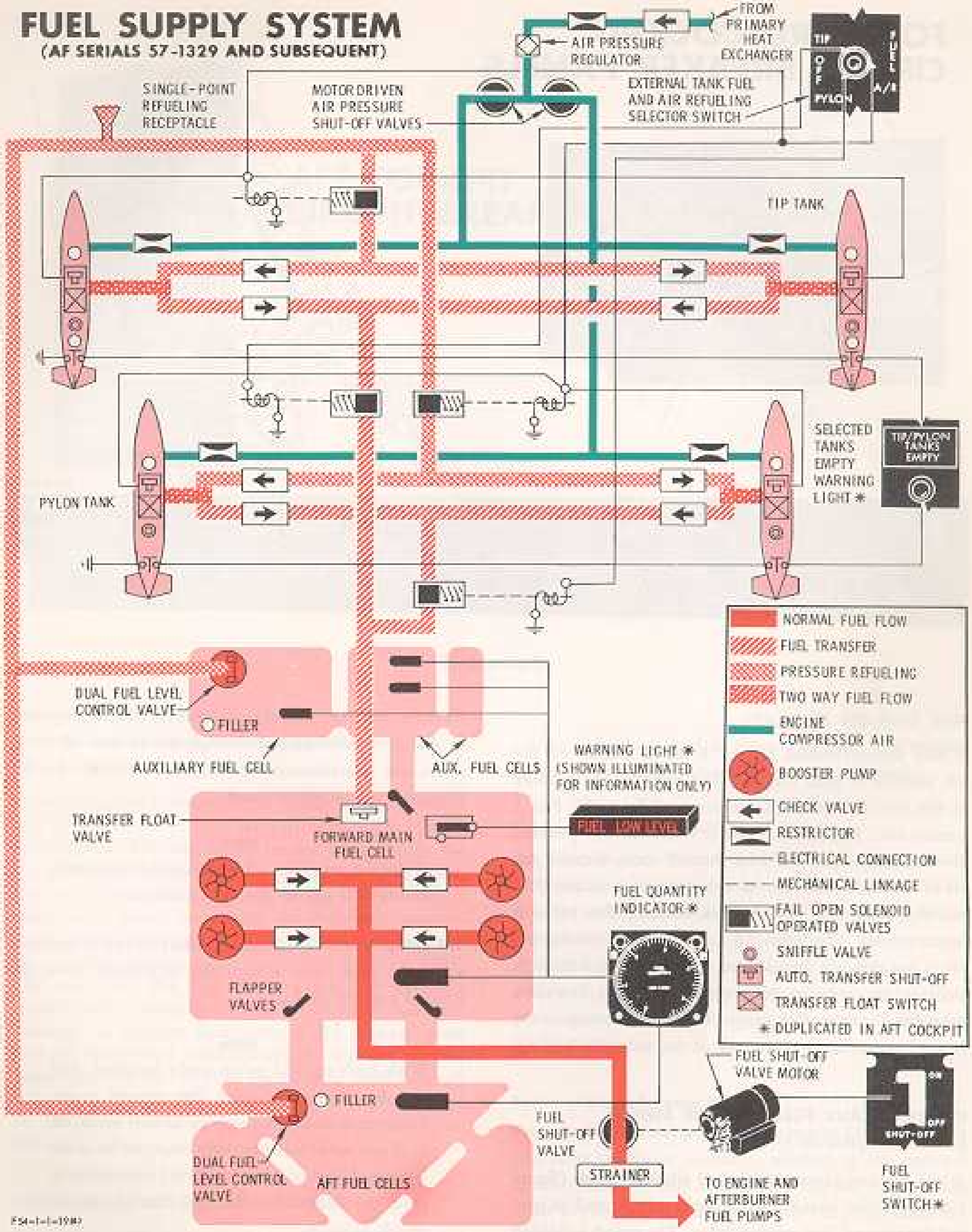


Figure 1-17

FORWARD COCKPIT CIRCUIT BREAKER PANELS

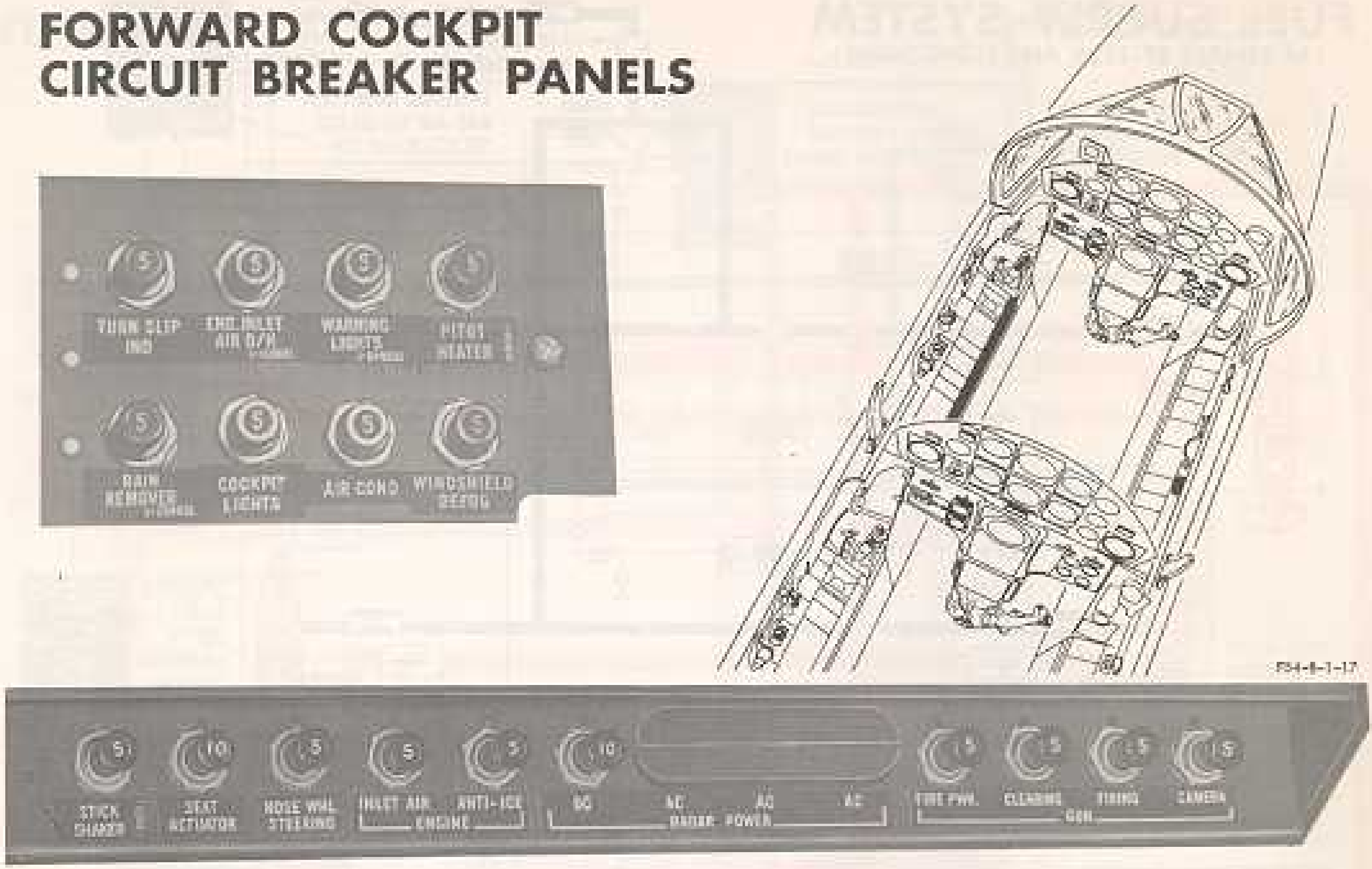


Figure 1-18

FUEL SHUT-OFF SWITCHES.

A fuel shut-off switch (figure 1-20) is located on the left console of each cockpit. The switches are guarded to the ON position and are powered from the No. 1 battery bus. Both switches must be in the ON position to electrically open the fuel shut-off valve located just aft of the main fuel cell. If either switch is in the OFF position, the valve will remain closed. The valve is motor-driven. The motor is connected to the battery No. 1 bus through the fuel shut-off switches and through a circuit breaker in the electronic compartment. The valve provides a means of shutting off fuel to the engine for ground maintenance or in case of fire or crash landing.

EXTERNAL TANK FUEL SELECTOR SWITCH.

(AF Serials prior to 57-1329)

A two-position external tank fuel selector switch (figure 1-20), installed in the front cockpit only, is used to control the external fuel selector valve. The switch is labeled PYLON and TIP. Power to operate the valve is supplied by the d.c. monitored bus through the air shut-off valve relays, the selector switch and a circuit breaker on the electronic compartment panel.

Note

If the d.c. monitored bus fails, the fuel selector valves will fail to the open position.

When fuel level in the forward main fuel cell is lowered, a transfer float valve allows fuel to transfer from the selected external tanks.

Note

With both tip and pylon tanks installed, fuel will be transferred from the selected tanks; however, with tip or pylon tanks only installed, or if one set of tanks become empty or has been jettisoned, fuel will be transferred automatically from the installed tanks regardless of selector switch position.

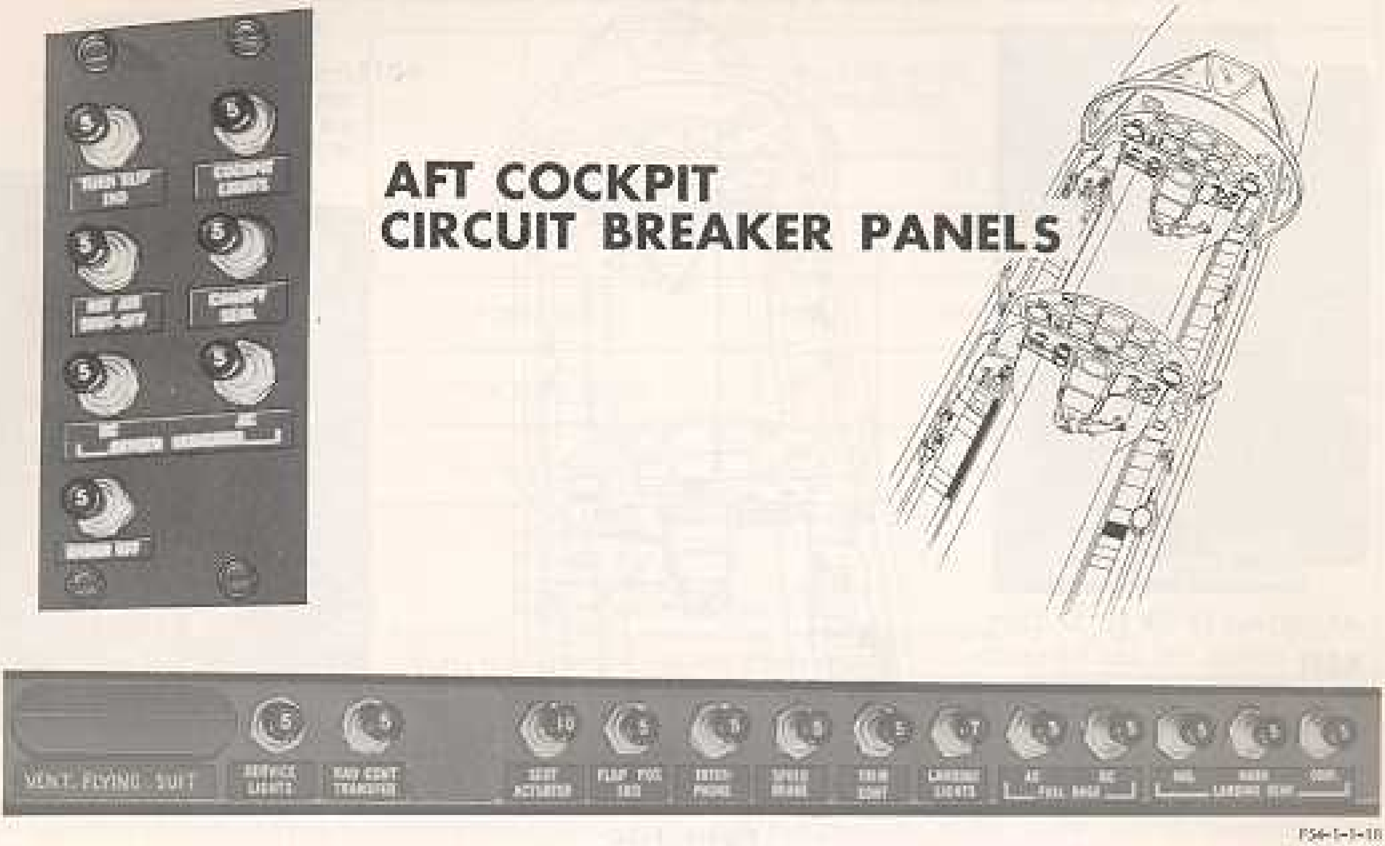


Figure 1-19

External Tank Fuel and Air Refueling Selector Switch.
(AF Serials 57-1329 and subsequent)

Solenoid-operated external fuel selector valves permit fuel to be transferred from both tip tanks or from both pylon tanks. The selector valves are connected to the d.c. monitored bus through the air shut-off valve relays, the fuel selector switch (figure 1-20) on the fuel control panel and a circuit breaker on the electronic compartment panel. The four-position external tank fuel and air refueling selector switch is labeled PYLON, OFF, TIP and A/R. The TIP, PYLON and OFF positions control valve operation as long as external tanks are installed. A transfer float valve in the forward main fuel cell allows fuel transfer from the selected external tanks when the fuel level in the forward main fuel cell is lowered. The A/R position is used for ground and air refueling. Refer to External Tank Fuel And Air Refueling Selector Switch in Section IV.

EXTERNAL STORES JETTISON SYSTEMS.

Two electrically independent systems for firing the external stores ejectors are installed. Forward cockpit controls are duplicated in the aft cockpit. No manual means of releasing external stores are provided.

External Stores Release Selector Switches.

An external stores release selector switch (figure 1-20) is located on the left console in each cockpit. This guarded switch is labeled PYLON, OFF and TIP. When any position other than OFF is selected, the electrical circuit to the ejectors is armed and the selected tanks (or stores) can be dropped by pressing the external stores release button. The system is powered from the No. 1 battery bus.

External Stores Release Buttons.

Pressing the external stores release button (2, figure 1-25) will close whichever circuit is selected by the external stores release selector switch and fire the ejectors. In order to release the pylon racks after the pylon tanks are released, the button must be released and pressed again. The button is powered from the No. 1 battery bus.

FORWARD AND AFT FUEL CONTROL PANELS

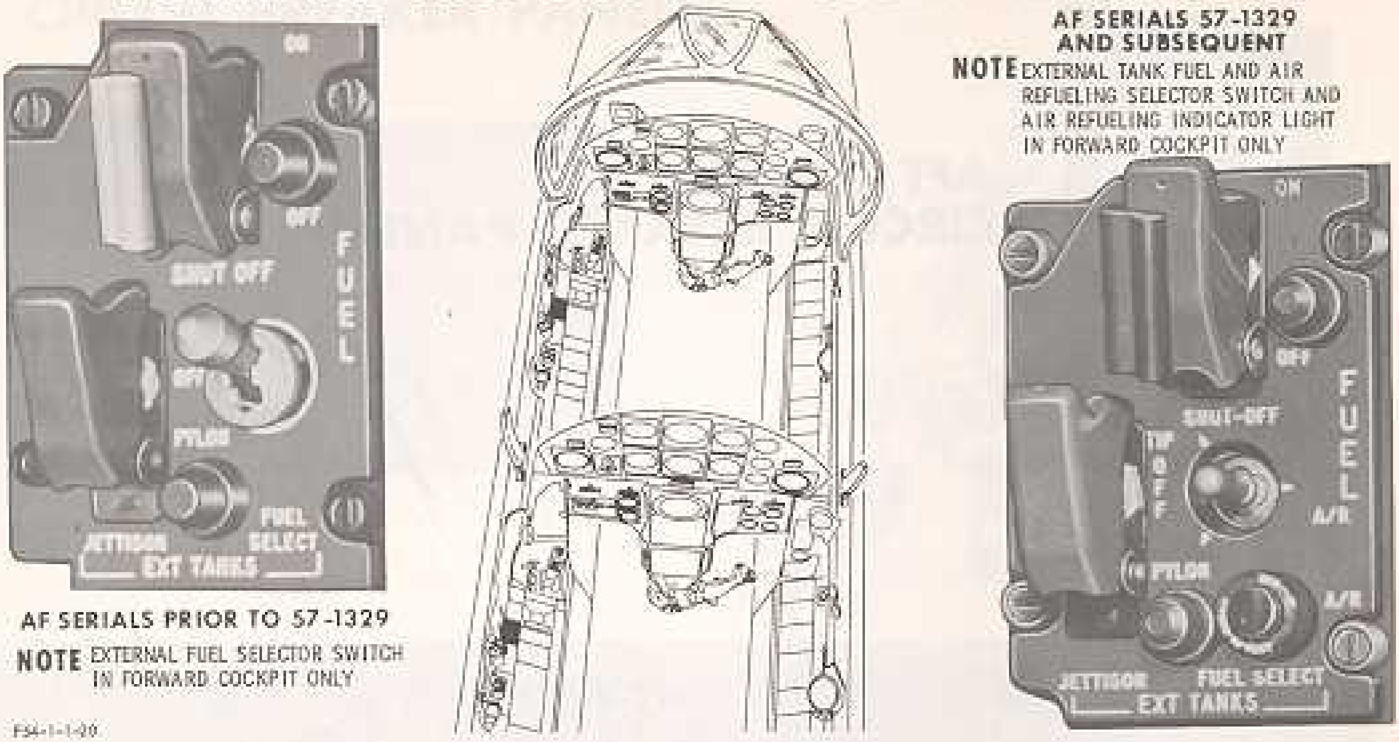


Figure 1-20

Note

The external stores release button will operate only in the cockpit in which the system has been armed by use of the external stores release switch.

External Stores Jettison Buttons.

A button (figure 1-13), located on the left forward panel in each cockpit, can be used to jettison all external stores in an emergency. The circuit is connected directly to the No. 1 battery bus through a circuit breaker in the electronic compartment and is "hot" when the circuit breaker is in and a battery installed. By pushing the button in either cockpit, both tip and pylon stores may be jettisoned. However, if it is desired to jettison the pylons, the external stores release selector switch and external stores release button must be used.

PYLON TANKS EMPTY LIGHT.

An amber light, (4, figure 1-9, and 3, figure 1-11) located on the right console in each cockpit, illuminates when the pylon tanks are empty. On AF Serials 57-1329 and subsequent the light is labeled TIP/PYLON TANKS EMPTY and illuminates when the selected external tanks are empty.

FUEL QUANTITY INDICATORS.

The fuel quantity indicating system indicates in pounds the fuel quantity remaining in the internal fuel cells.

CAUTION

The fuel quantity indicator does not indicate external fuel remaining.

The system consists of an indicator in each cockpit (17, figure 1-6 and 15, figure 1-7), located on the right side of the main instrument panel, and five fuel cell transmitters; one in the forward fuel cell, one in the aft fuel cell and three in the auxiliary fuel cells. The system receives power from the No. 2 a.c. bus and the d.c. emergency bus through circuit breakers on the left circuit breaker panel.

FUEL QUANTITY DATA

DATA BASIS:
GROUND TEST STANDARD DAY CONDITIONS WITH CONVERSIONS FACTOR 6.5 LBS/GAL

REMARKS:
LEVEL FLIGHT ATTITUDE - TOP OF FUSELAGE 3° NOSE UP, STATIC ATTITUDE - TOP OF FUSELAGE 0°

	USABLE FUEL IN LEVEL FLIGHT ATTITUDE		FULLY SERVICED IN STATIC ATTITUDE	
	U.S. GALS	LBS.	U.S. GALS	LBS.
INTERNAL FUEL	655	4257	662	4303
TIP TANKS (EACH)	170	1105	175	1137
PYLON TANKS (EACH)	195	1267	199	1293
AUXILIARY TANKS *	97	630	98	637

TOTAL USABLE FUEL IN LEVEL FLIGHT ATTITUDE
INTERNAL FUEL . . . . 655 GALS. - - 4257 LBS.
WITH TIP TANKS . . . . 995 GALS. - - 6467 LBS.
WITH PYLONS . . . . 1045 GALS. - - 6792 LBS.
WITH TIP AND PYLON TANKS . . . . 1385 GALS. - - 9002 LBS.

* AF Serials 57-1329 and subsequent have auxiliary tanks installed. Add 97 gallons or 630 lbs. to above figures to determine fuel capacities of these aircraft.

Figure 1-21

Fuel Quantity Indicating System Test Switches.

A system test switch (figure 1-13) is located on the right forward panel of each cockpit. When the airplane's electrical system is energized, placing either switch in the FUEL QUANTITY (up) position grounds the system power supply, which causes both fuel quantity gage indicating needles to go toward zero if the system is functioning properly. This will not activate the low level warning indication as the systems are independent. The switches also are used to check the warning lights circuits in the WARNING LIGHTS TEST (down) position.

FUEL LOW LEVEL WARNING LIGHTS.

A low level warning system is installed to indicate to the pilot that the fuel level in the forward main fuel cell has decreased to a critical value. The configuration of the fuel system is such that airplane attitudes and maneuvers affect the flow of fuel into the forward main fuel cell. Therefore, the warning light should not be used as an accurate indication of the fuel quantity remaining. The system includes a float-actuated switch installed in the forward main fuel cell, and a light on the warning panel. Under stabilized level flight conditions when the fuel level falls to approximately 1275 pounds ± 250 in level flight, the switch closes the circuit and energizes the FUEL LOW LEVEL warning light and the master caution light. The system receives electrical power from the d.c. emergency bus.

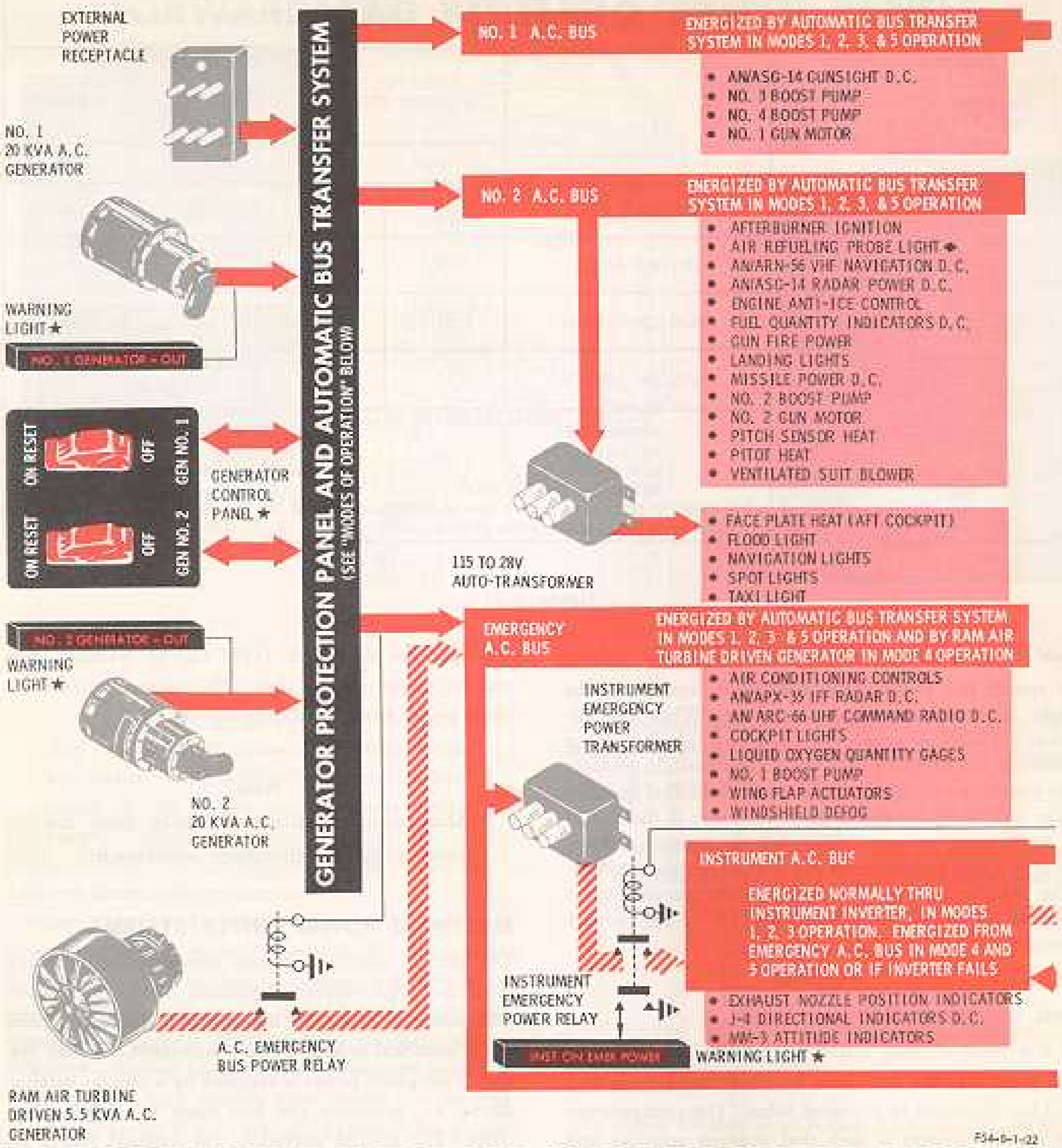
Note

Acceleration or deceleration may cause the warning light to illuminate momentarily.

ELECTRICAL POWER SUPPLY SYSTEMS.

The aircraft electrical systems obtain power primarily from two engine-driven alternating current generators. This power is utilized by the main a.c. electrical system, a d.c. electrical system and an instrument inverter system. Emergency power is supplied by a ram air turbine-driven a.c. generator and two small 3.6 amp/hr. batteries. For ground operation, the external power receptacle on the lower right side of the fuselage provides a means for connecting an external a.c. power source to the aircraft. Electrical power is distributed to the individual systems through an a.c. bus for each of the generators, an emergency a.c. bus, and a d.c. monitored bus. Power to the d.c. monitored bus is made available by the conversion of a.c. power in a 100 ampere transformer rectifier. The instrument inverter receives power

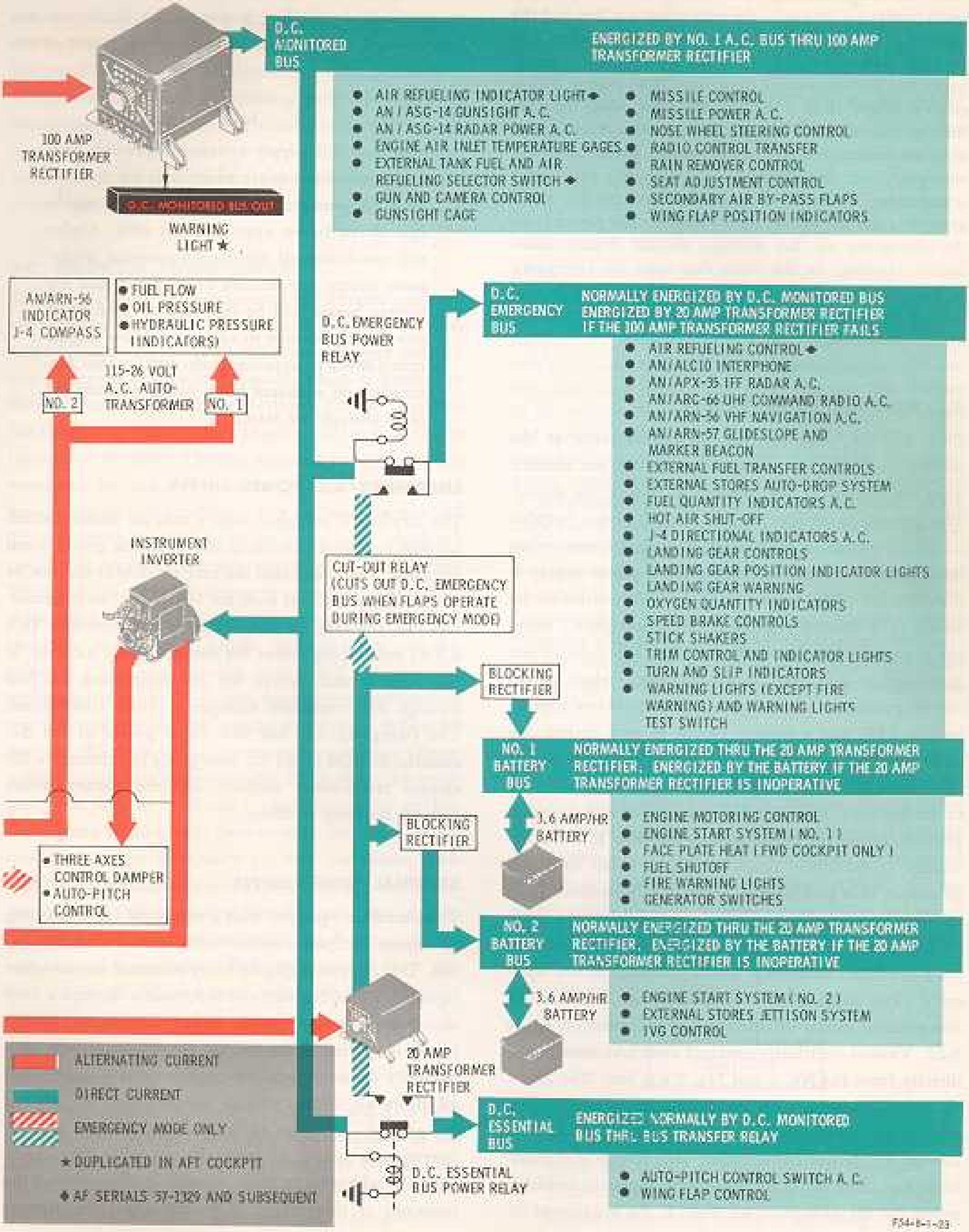
ELECTRICAL POWER DISTRIBUTION



MODES OF OPERATION

MODE 1 - NORMAL OPERATION	MODE 2 - NO. 1 GENERATOR OUT	MODE 3 - NO. 2 GENERATOR OUT	MODE 4 - EMERGENCY OPERATION	MODE 5 - GROUND POWER OPERATION
• NO. 1 GENERATOR ON NO. 1 A.C. BUS • NO. 2 GENERATOR ON NO. 2 A.C. BUS AND EMERGENCY BUS	• NO. 2 GENERATOR ON ALL BUSSES	• NO. 1 GENERATOR ON ALL BUSSES	• NO. 1 & 2 BUSSES OUT • NO. 1 & 2 GENERATORS OUT • EMERGENCY GENERATOR ON EMERGENCY A.C. BUS	• ALL BUSSES ENERGIZED BY EXTERNAL POWER SOURCE

Figure 1-22


D.C. MONITORED BUS
ENERGIZED BY NO. 1 A.C. BUS THRU 100 AMP TRANSFORMER RECTIFIER
AIR REFUELING INDICATOR LIGHT ◆
AN/ASG-14 GUNSIGHT A.C.
AN/ASG-14 RADAR POWER A.C.
ENGINE AIR INLET TEMPERATURE GAGES
EXTERNAL TANK FUEL AND AIR REFUELING SELECTOR SWITCH ◆
GUN AND CAMERA CONTROL
GUNSIGHT CAGE
MISSILE CONTROL
MISSILE POWER A.C.
NOSE WHEEL STEERING CONTROL
RADIO CONTROL TRANSFER
RAIN REMOVER CONTROL
SEAT ADJUSTMENT CONTROL
SECONDARY AIR BY-PASS FLAPS
WING FLAP POSITION INDICATORS
100 AMP TRANSFORMER RECTIFIER
D.C. MONITORED BUS OUT
WARNING LIGHT ★
AN/ARN-56 INDICATOR J-4 COMPASS
FUEL FLOW
OIL PRESSURE
HYDRAULIC PRESSURE (INDICATORS)
115-26 VOLT A.C. AUTO-TRANSFORMER
NO. 2
NO. 1
D.C. EMERGENCY BUS POWER RELAY
D.C. EMERGENCY BUS
NORMALLY ENERGIZED BY D.C. MONITORED BUS ENERGIZED BY 20 AMP TRANSFORMER RECTIFIER IF THE 100 AMP TRANSFORMER RECTIFIER FAILS
AIR REFUELING CONTROL ◆
AN/AIC-10 INTERPHONE
AN/APX-35 IFF RADAR A.C.
AN/ARC-66 UHF COMMAND RADIO A.C.
AN/ARN-56 VHF NAVIGATION A.C.
AN/ARN-57 GLIDESLOPE AND MARKER BEACON
EXTERNAL FUEL TRANSFER CONTROLS
EXTERNAL STORES AUTO-DROP SYSTEM
FUEL QUANTITY INDICATORS A.C.
HOT AIR SHUT-OFF
J-4 DIRECTIONAL INDICATORS A.C.
LANDING GEAR CONTROLS
LANDING GEAR POSITION INDICATOR LIGHTS
LANDING GEAR WARNING
OXYGEN QUANTITY INDICATORS
SPEED BRAKE CONTROLS
STICK SHAKERS
TRIM CONTROL AND INDICATOR LIGHTS
TURN AND SLIP INDICATORS
WARNING LIGHTS (EXCEPT FIRE WARNING) AND WARNING LIGHTS TEST SWITCH
INSTRUMENT INVERTER
CUT-OUT RELAY (CUTS OUT D.C. EMERGENCY BUS WHEN FLAPS OPERATE DURING EMERGENCY MODE)
BLOCKING RECTIFIER
NO. 1 BATTERY BUS
NORMALLY ENERGIZED THRU THE 20 AMP TRANSFORMER RECTIFIER. ENERGIZED BY THE BATTERY IF THE 20 AMP TRANSFORMER RECTIFIER IS INOPERATIVE
3.6 AMP/HR BATTERY
ENGINE MOTORING CONTROL
ENGINE START SYSTEM (NO. 1)
FACE PLATE HEAT (FWD COCKPIT ONLY)
FUEL SHUTOFF
FIRE WARNING LIGHTS
GENERATOR SWITCHES
THREE AXES CONTROL DAMPER
AUTO-PITCH CONTROL
BLOCKING RECTIFIER
NO. 2 BATTERY BUS
NORMALLY ENERGIZED THRU THE 20 AMP TRANSFORMER RECTIFIER. ENERGIZED BY THE BATTERY IF THE 20 AMP TRANSFORMER RECTIFIER IS INOPERATIVE
3.6 AMP/HR BATTERY
ENGINE START SYSTEM (NO. 2)
EXTERNAL STORES JETTISON SYSTEM
IVG CONTROL
ALTERNATING CURRENT
DIRECT CURRENT
EMERGENCY MODE ONLY
★ DUPLICATED IN AFT COCKPIT
◆ AF SERIALS 57-1329 AND SUBSEQUENT
20 AMP TRANSFORMER RECTIFIER
D.C. ESSENTIAL BUS
ENERGIZED NORMALLY BY D.C. MONITORED BUS THRU BUS TRANSFER RELAY
D.C. ESSENTIAL BUS POWER RELAY
AUTO-PITCH CONTROL SWITCH A.C.
WING FLAP CONTROL

from the d.c. monitored bus during normal operation and supplies a.c. power to the instrument a.c. bus and the three axes control damper. The d.c. monitored bus also supplies power to a d.c. essential bus and a d.c. emergency bus during normal operation. The battery busses receive power from a 20 ampere transformer rectifier through blocking rectifiers. During emergency operation, the instrument a.c. busses receive power from the emergency a.c. bus through an emergency instrument transformer, while the d.c. essential bus, the d.c. emergency bus and the battery busses receive their power from the emergency a.c. bus through the 20 ampere transformer rectifier. In the event that even the emergency power supply is lost, the 3.6 amp./hr. batteries will furnish sufficient power to operate those items on the battery busses for a limited period of time.

A.C. ELECTRICAL POWER SUPPLY.

Two 20-KVA, engine-driven generators serve as the primary source of a.c. electrical power for the aircraft. They are located on the accessory section of the engine. The generators supply 200/116 volt, 3-phase, variable frequency power to the aircraft electrical system when the engine is running and the ground power supply is disconnected. This generator output is controlled by means of a voltage regulator, protection panel, relays for automatic transfer of the two a.c. busses from one generator to the other, under-frequency relays to cut out the generators when engine rpm drops below approximately 65%, and a control switch in each cockpit for each generator. Normally, the No. 1 generator output goes to the No. 1 a.c. bus and the No. 2 generator output to the No. 2 a.c. bus. The No. 2 generator also normally provides power for the emergency a.c. bus. If an under-voltage or an over-voltage condition exists in either generator, that generator is automatically removed from its bus, the bus is automatically transferred to the other generator, and the warning light panels in the cockpits are illuminated indicating which generator is not operating. The automatic bus transfer system provides for five possible modes of operation as indicated on figure 1-22. Various electrically-operated units take their power directly from the No. 1 and No. 2 a.c. bus. The No. 1 a.c. bus also directs generator output to the 100 ampere transformer rectifier where the a.c. power is changed to 28-volt d.c. power before being sent to the d.c. monitored bus. The No. 2 a.c. generator normally furnishes power for the emergency a.c. bus. If the instrument inverter fails, the emergency a.c. bus will assume the load automatically by feeding power to the instrument a.c. bus through the instrument emergency power transformer.

Note

> The electrical supply system is equipped with under-frequency relays which will cut the two 20 KVA generators off the busses when engine rpm drops below approximately 65%. Under this condition all electrically-operated equipment except one aircraft boost pump and the battery busses will be inoperative. The boost pump will continue to operate at lower engine rpm (down to approximately 40%). This feature insures sufficient boost pump pressure for high altitude air starts.

EMERGENCY A.C. POWER SUPPLY.

The airplane is equipped with a ram air turbine which supplies emergency electrical and hydraulic power when extended. Once extended the ram air turbine can not be retracted in the air. If both the No. 1 and No. 2 generators fail, the ram air turbine-driven a.c. generator (5.5 KVA) will supply power for the emergency a.c. bus. It will also furnish power for the instrument a.c. bus through the instrument emergency power transformer. The emergency a.c. bus will direct power to the d.c. essential bus and to the d.c. emergency bus through a 20-ampere transformer rectifier, and the battery busses through blocking rectifiers.

EXTERNAL POWER SUPPLY.

The aircraft is equipped with a receptacle for connecting an external a.c. power source to the aircraft electrical system. This receptacle (figure 1-39) is located on the lower right side of the fuselage and is accessible through a door above the hydraulic panel. When the external power supply is applied to the aircraft, the generators are automatically disconnected from their respective busses, and all three a.c. busses receive power from the ground power unit. In order to prevent unnecessary inverter operation, a system of protective relays operates automatically whenever external power is applied. One of the functions of these relays is to disconnect the inverter from the d.c. monitored bus. Instrument bus power is then supplied automatically through the emergency a.c. bus and the emergency instrument power transformer. It is possible for ground personnel to test the operation of the instrument inverter by means of the inverter ground test switch located on the electronics compartment junction box. When the switch is held ON, the instrument bus is connected to the inverter through the instrument power relay.

D.C. ELECTRICAL POWER SUPPLY.

The direct current requirements of the aircraft normally are supplied from the No. 1 a.c. bus through a 100 ampere transformer rectifier. This unit changes 200/115 volt a.c. power to 28-volt d.c. power which is directed to the d.c. monitored bus. Power is drawn directly from this bus to operate various units (figure 1-22) including the instrument inverter. The d.c. essential bus and the d.c. emergency bus are also connected to the d.c. monitored bus during normal operation. The d.c. essential bus and d.c. emergency busses furnish power to units which are considered necessary for safe operation of the aircraft. Therefore, an alternate source of power to these busses is provided in the event that power from the d.c. monitored bus is disrupted. Under this condition, the d.c. emergency and d.c. essential busses will be connected automatically to the 20 ampere transformer rectifier unit which is connected to the emergency a.c. bus. When the ram air turbine-driven a.c. generator is operative (Emergency Mode), it is important that the load on the emergency a.c. bus be minimized when using the aircraft leading and trailing edge flaps because they are powered directly from the emergency a.c. bus. To reduce loads and insure maximum flap effectiveness, the d.c. emergency bus is automatically disconnected from the 20 ampere transformer rectifier while the flaps are in operation, and those units which are powered from this bus, including UHF command radio, will be inoperative during the period of flap operation.

EMERGENCY D.C. POWER SUPPLY.

If all three generators fail, (No. 1, No. 2 and RAT) the batteries will furnish a supply of direct current to the battery busses. The batteries are the only independent source of direct current in the aircraft electrical system. Normally, the batteries and battery busses are paralleled with the 20 ampere transformer rectifier, and the batteries thereby maintained in a fully charged condition. In emergency operation, battery output is prevented from discharging to the 20 ampere transformer rectifier by blocking rectifiers in order to conserve their power supply for those units connected directly to the battery busses. There is no battery control switch in either cockpit, and operation of the battery system is entirely automatic.

INSTRUMENT POWER SUPPLY.

Alternating current necessary for the operation of various flight instruments normally is furnished by an instrument inverter. The inverter is located in the electronics compartment of the aircraft. The inverter converts 28-volt d.c. power from the d.c. monitored bus to 115-volt, 400 cycle a.c. power for the instrument a.c. bus. Failure of the instrument inverter will actuate a transfer system and automatically connect the instrument a.c. bus to the emergency a.c. bus through the instrument emergency power transformer so that there will be no interruption of instrument operation. The inverter is disconnected from the d.c. monitored bus when an external power source is connected to the aircraft electrical system. However, it may be tested for proper operation by ground personnel by means of the inverter ground test switch in the electronics compartment. During external power operation, alternating current for the instruments is supplied by the ground power unit through the emergency a.c. bus and instrument emergency power transformer.

CIRCUIT BREAKERS.

The circuit breaker panels (figures 1-18 and 1-19) on the left and right consoles contain push-to-reset, pull-out type breakers for certain a.c. and d.c. circuits. All of the distribution circuits in the electrical system are protected by various types of circuit breakers. Circuit breaker panels which are not accessible during flight, but which should be inspected before flight, are located in the electronics compartment and in the electrical load center on the right side of the fuselage.

CAUTION

Circuit breakers should not be pulled or reset without a thorough understanding of all the effects and results. Pulling circuit breakers can eliminate from the system some related warning system, interlocking circuit, or canceling signal, which could result in an undesirable reaction.

GENERATOR SWITCHES.

A generator switch is provided in each cockpit for each of the 20 KVA generator systems. These switches (figure 1-13) are identical and are located on the right forward panels. The switches are powered from the battery bus. Each switch has three positions: ON RESET (up), OFF (down), and a center NEUTRAL position which is the normal postion for the switch when covered by the guard. The switches are spring-loaded to return to the NEUTRAL position. Placing either the forward or aft cockpit switch up to the ON-RESET position will return the generator to normal operation if it has been removed from the line for any reason other than complete generator failure. When placed down to the OFF position, either the forward or aft cockpit switch will energize the generator control relay which will remove the respective generator from its associated bus.

RAM AIR TURBINE EXTENSION HANDLES.

Emergency a.c. power is made available by extending the ram air turbine into the aircraft slip stream. This can be accomplished by pulling either yellow ram air turbine extension handle (19, figure 1-6; and 18, figure 1-7) located on the lower right side of each instrument panel. The handles require a firm pull of about 4 inches to the stop to extend the ram air turbine.

Note

There is no means of retracting the ram air turbine in the air.

GENERATOR OUT WARNING LIGHTS.

A No. 1 generator out warning light and a No. 2 generator out warning light are located in each cockpit on the warning light panels (figure 1-13). The lights are placarded NO. 1 GENERATOR OUT and No. 2 GENERATOR OUT. The lights are powered from the d.c. emergency bus and will glow whenever their respective generator is not generating voltage. The master caution light will also illuminate when either generator-out warning light illuminates.

D.C. MONITORING BUS OUT WARNING LIGHTS.

A d.c. monitored bus out warning light is located on the warning light panel (figure 1-13) in each cockpit. These warning lights are energized by the 28-volt d.c. emergency bus. The light is placarded D.C. MONITORED BUS OUT. The lights will illuminate when power to the d.c. monitored bus is discontinued during normal operation. The master caution light and the INSTRUMENTS ON EMERGENCY POWER warning light will also illuminate when the d.c. monitored bus-out warning light illuminates. (Refer to figure 1-22 for units which will be inoperative when the d.c. monitored bus-out warning light is on.)

INSTRUMENTS ON EMERGENCY POWER WARNING LIGHTS.

These lights (figure 1-13) are located on the warning light panel in each cockpit and are energized by the 28-volt d.c. emergency bus. The lights are placarded INST. ON EMER. POWER. The lights will illuminate any time power from the instrument inverter is discontinued and the instrument emergency power transformer is supplying power to the instrument a.c. bus. The master caution lights will also illuminate when the instruments on emergency power warning lights are illuminated.

HYDRAULIC POWER SUPPLY SYSTEMS.

Two completely independent hydraulic systems and an emergency system provide power to the various hydraulically-actuated units in the aircraft. (See figures 1-23 and 1-24.) The No. 1 and No. 2 systems are in simultaneous operation during all normal operating conditions and supply fluid at 3000 psi pressure to their respective hydraulically-actuated units. The No. 1 and No. 2 systems are provided with separte reservoirs which differ only in size and location, the No. 2 reservoir having the larger capacity. Both reservoirs are pressurized to prevent pump cavitation. In addition, each system includes an engine-driven pump, a cylindrical accumulator, a pressure transmitter, a pressure switch, and filters. In case of failure of either No. 1 or No. 2 system, the remaining system will maintain fluid pressure for flight control but at a reduced rate. If both No. 1 and No. 2 systems fail, the emergency ram air turbine-driven pump will furnish enough fluid pressure through the No. 1 system for flight control but at a reduced rate if sufficient hydraulic fluid is available in the No. 1 system.

Accumulators.

The cylindrical accumulators are charged with nitrogen at approximately 1000 psi and are provided with an air valve and an air pressure gage. The accumulators store a supply of high-pressure fluid and also act as surge chambers. The accumulators and pressure gages for both No. 1 and No. 2 systems are accessible upon opening a large engine access door (figure 1-39) on the under side of the fuselage below the engine. Graduations on the gage dial are in increments of 100, from 0 to 4000 psi. The pressure gage shows the initial nitrogen charge (1000 psi) in the accumulators only when hydraulic pressure is zero.

Hydraulic Panel.

Most of the hydraulic units are mounted directly onto a hydraulic panel on the inside face of the engine access door. Opening the door exposes the various units for servicing, testing and checking quantity indicators.

Ground Test Selector Valve.

The ground test selector valve on the hydraulic panel is the only link between the No. 1 and No. 2 systems and is manually controlled. A three-position lever extends from the top of the valve. Mechanical linkage from this lever to a fixed bracket inside the fuselage assures that the lever is placed and locked in the No. 2 position when the engine access door is closed.

NO. 1 HYDRAULIC POWER SUPPLY SYSTEM.

The No. 1 hydraulic system (figure 1-23) supplies fluid under regulated pressure exclusively to the flight controls. Power is supplied to the stabilizer aft cylinder, the five inboard cylinders for each aileron, the bottom rudder cylinder, the yaw damping control valve and the auto-pitch actuator. The system includes a reservoir, an engine-driven pump, a cylindrical accumulator, a pressure transmitter, a pressure switch, a pressure-regulating flow-control valve, and a filter. Fluid is supplied to the pump by the reservoir which is pressurized to prevent pump cavitation. Fluid from the pump is supplied under 3000 psi pressure, directly to the flight control components. The pressure-regulating flow-control valve is connected into the pressure line. This valve contains a relief valve which relieves system pressure to the return line in case of a pressure surge. When the emergency pump is in use, the pressure-regulating flow-control valve also regulates the pressure, maintaining a nearly constant flow of fluid from the emergency pump to the No. 1 system.

EMERGENCY HYDRAULIC POWER SUPPLY SYSTEM.

The emergency hydraulic system (figure 1-23) consists of a pump that is supplied fluid from the No. 1 system reservoir which it delivers under pressure to the No. 1 system through the pressure regulating flow-control valve. The pump is a constant-volume, piston-type, and is powered by the ram air turbine. The pressure-regulating flow-control valve diverts emergency pump fluid to return until the ram air turbine emergency has reached operating speed. Thus, a hydraulic load cannot be imposed on the turbine before it has reached a speed sufficient to handle the load. With the turbine and pump operating at the proper speed, fluid is then fed, upon demand, to the No. 1 system.

Note

- In addition to furnishing emergency hydraulic power, the ram air turbine will furnish emergency electrical power if necessary.
- Once extended, the ram air turbine cannot be retracted in the air.

NO. 2 HYDRAULIC POWER SUPPLY SYSTEM.

The No. 2 hydraulic system (figures 1-23 and 1-24) supplies fluid under regulated pressure to the flight controls, landing gear, nose wheel steering, engine air by-pass flaps, speed brakes, and roll and pitch dampers. The system includes a reservoir, an engine-driven pump, a cylindrical accumulator, a pressure transmitter, a pressure switch, a relief valve, a priority valve, and two filters. Fluid is supplied to the pump from the reservoir which is pressurized to prevent pump cavitation. Fluid from the pump is supplied under 3000 psi pressure, through a filter directly to the accumulator for each

HYDRAULIC SYSTEM

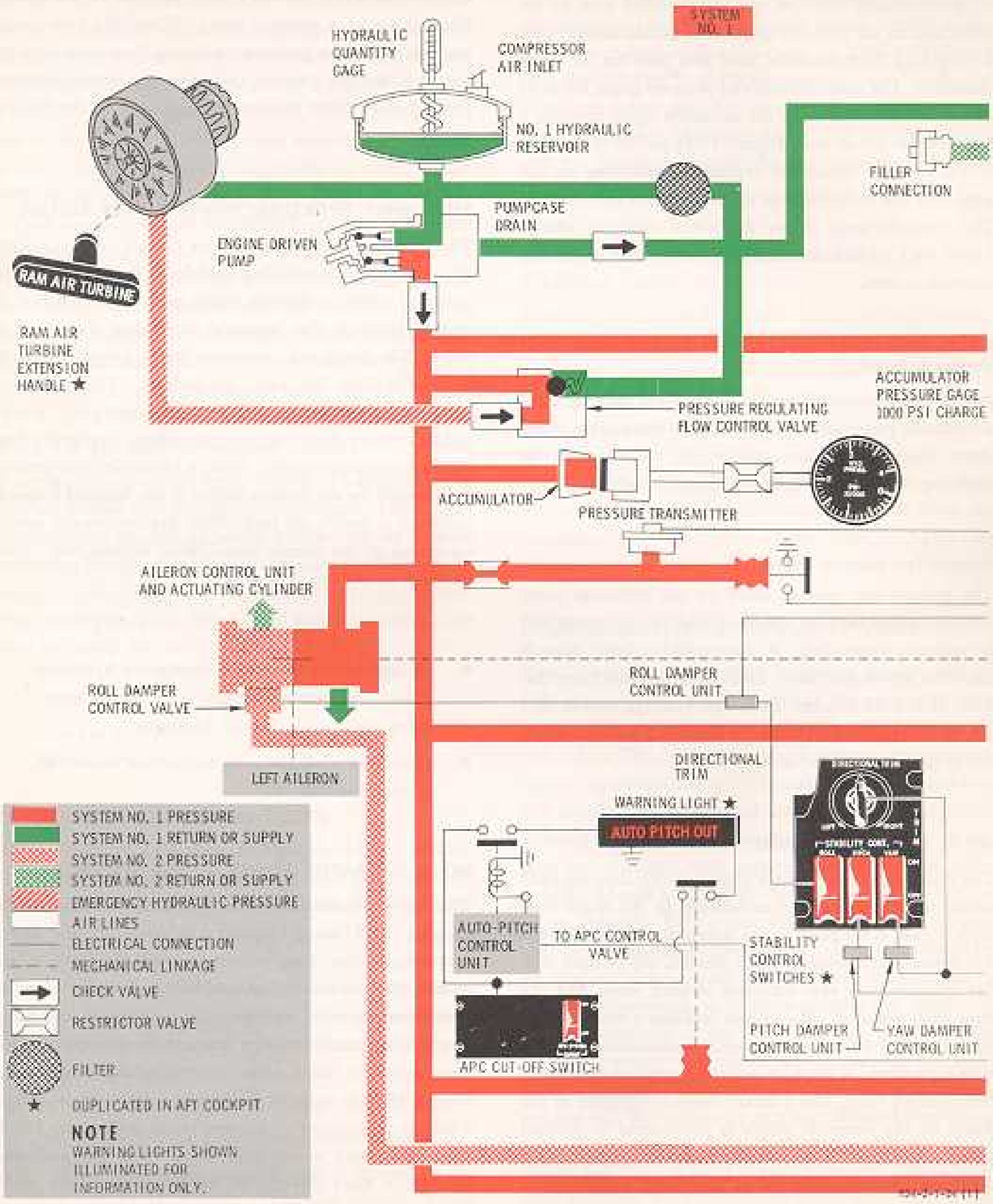
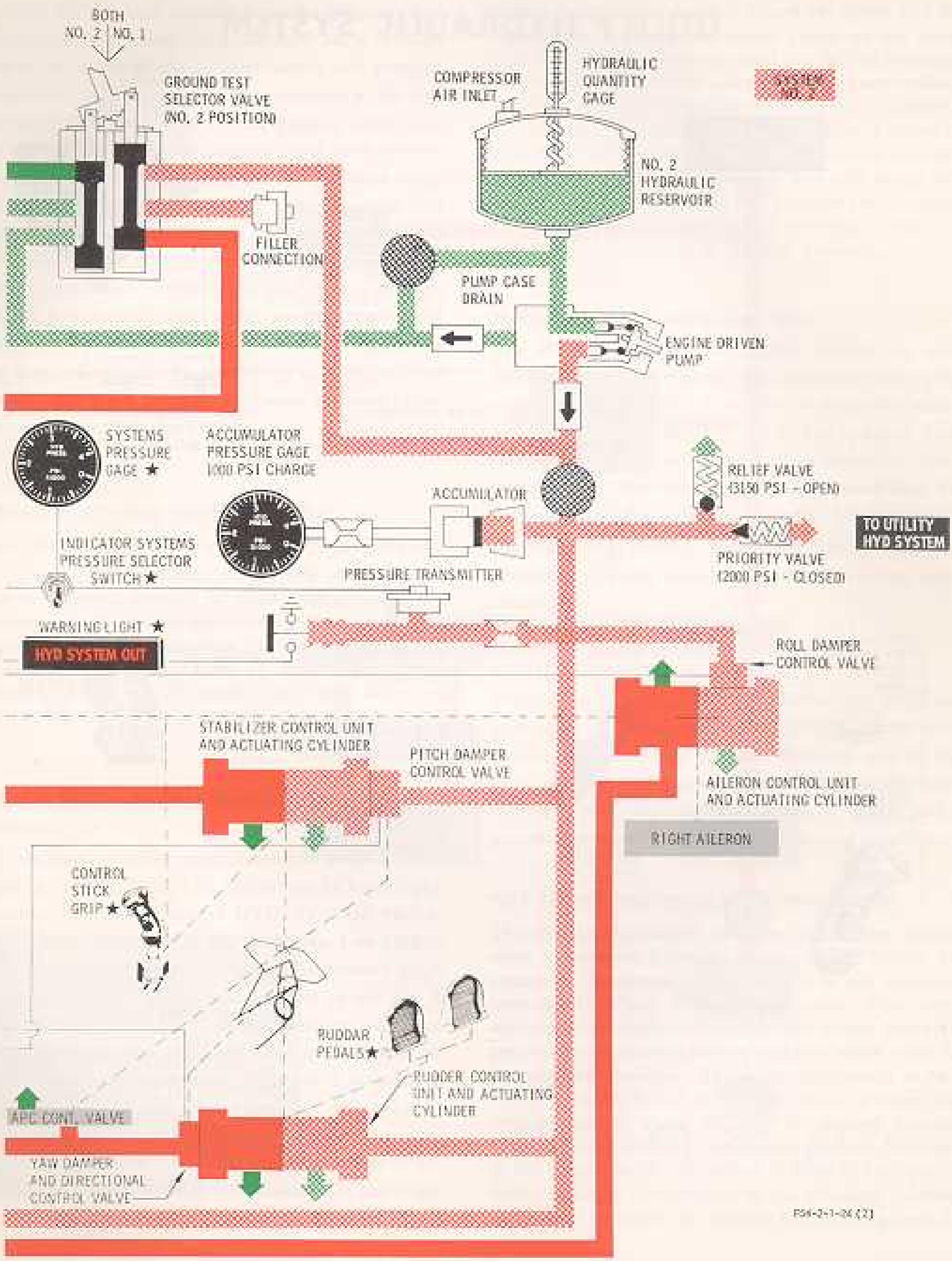


Figure 1-23


BOTH
NO. 2
NO. 1
GROUND TEST SELECTOR VALVE (NO. 2 POSITION)
COMPRESSOR AIR INLET
HYDRAULIC QUANTITY GAGE
NO. 2 HYDRAULIC RESERVOIR
FILLER CONNECTION
PUMP CASE DRAIN
ENGINE DRIVEN PUMP
SYSTEMS PRESSURE GAGE ★
ACCUMULATOR PRESSURE GAGE 1000 PSI CHARGE
ACCUMULATOR
RELIEF VALVE (3150 PSI - OPEN)
TO UTILITY HYD SYSTEM
PRIORITY VALVE (2000 PSI - CLOSED)
INDICATOR SYSTEMS PRESSURE SELECTOR SWITCH ★
PRESSURE TRANSMITTER
WARNING LIGHT ★
HYD SYSTEM OUT
ROLL DAMPER CONTROL VALVE
STABILIZER CONTROL UNIT AND ACTUATING CYLINDER
PITCH DAMPER CONTROL VALVE
AILERON CONTROL UNIT AND ACTUATING CYLINDER
RIGHT AILERON
CONTROL STICK GRIP ★
RUDDAR PEDALS ★
RUDDER CONTROL UNIT AND ACTUATING CYLINDER
APC CONT. VALVE
YAW DAMPER AND DIRECTIONAL CONTROL VALVE

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UTILITY HYDRAULIC SYSTEM

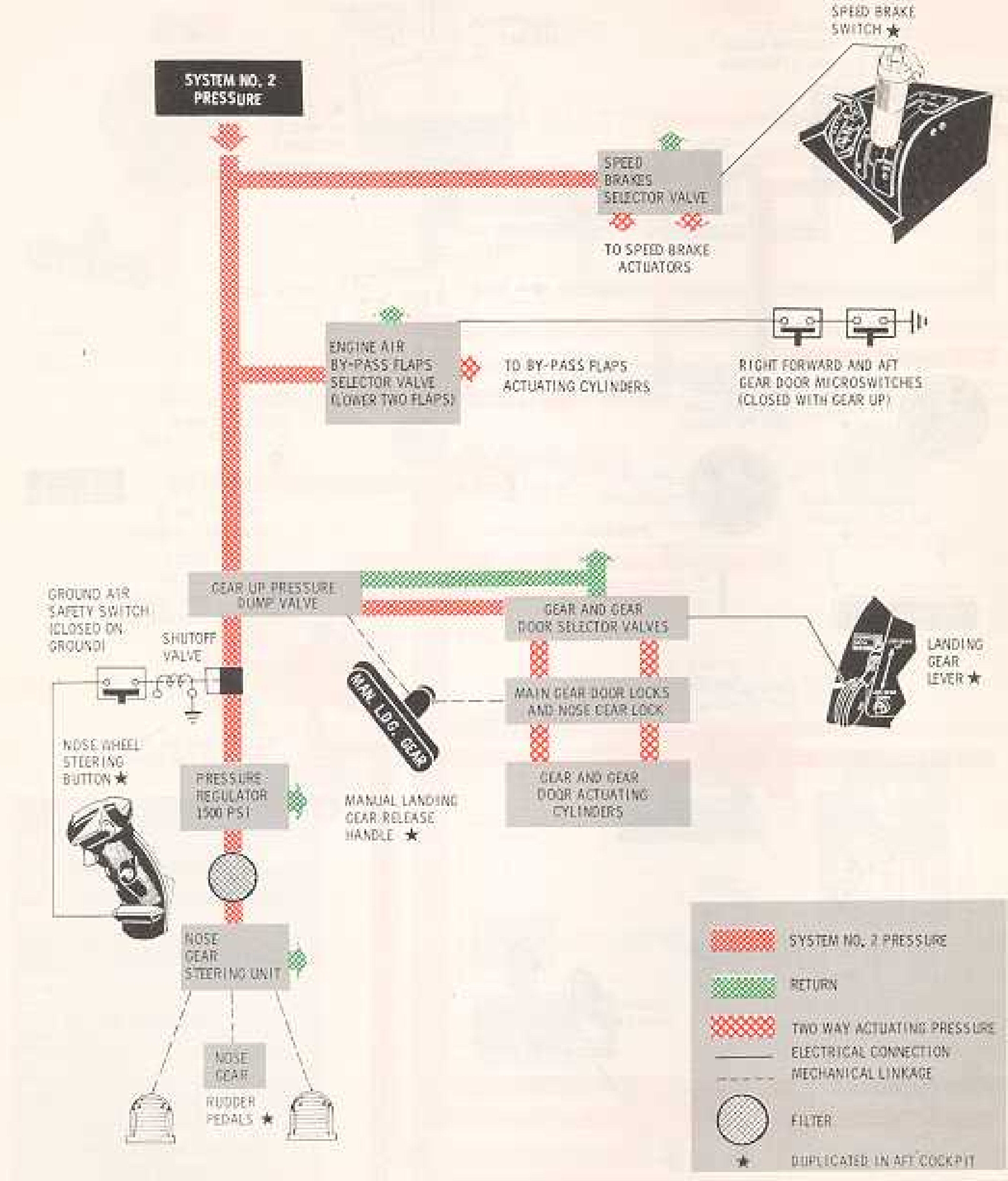

Figure 1-24

aileron, the stabilizer forward cylinder, and the rudder top cylinder. A line connected to the pressure line immediately downstream from the filter feeds through a restrictor valve to the pressure switch and pressure transmitter. Another pressure line connected to the outlet port of the filter is routed to the pressure relief valve and the priority valve. The pressure relief valve relieves system pressure to the return line if a pressure surge occurs in the system. The priority valve opens to full flow at 2350 psi. A pressure line from the priority valve outlet port carries fluid to the utility hydraulic system (figure 1-24) which includes the engine air by-pass flaps, landing gear system, nose wheel steering system and speed brake selector valve. The priority valve reseats to zero flow when system pressure drops to 2000 psi, thus retaining for flight controls all system pressure below this range.

HYDRAULIC SYSTEMS PRESSURE GAGE.

The hydraulic systems pressure gages (22, figure 1-6; and 21, figure 1-7), located on the right side of each lower instrument panel, provide a visual indication of the pressure available in the hydraulic systems. The gages receive 26-volt a.c. power from the instrument a.c. bus autotransformer through fuses on the electronic compartment circuit breaker panel. The gage dials are calibrated in increments of 1000, from 0 to 4000 psi.

Hydraulic Systems Pressure Gage Selector Switches.

The hydraulic systems pressure selector switches (24, figure 1-6; and 23, figure 1-7), located on the lower right instrument panels, are labeled HYD. SYSTEM PRESS. SEL. The two positions are No. 2 and No. 1 or EMER. The switches may be used to connect the pressure gages to either the No. 1 pressure transmitter or the No. 2 pressure transmitter. The No. 1 transmitter measures No. 1 hydraulic system pressure when the system is on normal or emergency operation. The No. 2 transmitter measures No. 2 hydraulic system pressure. A signal voltage is induced in the transmitter which varies in proportion to the amount of hydraulic pressure available in the system. This signal voltage is transmitted to the gages where it is converted to a scale reading of pressure in psi.

Ram Air Turbine Extension Handle.

Yellow handles (19, figure 1-6; and 18, figure 1-7) located below the main instrument panels on the lower right side of each instrument panel may be used to extend the ram air turbine which powers the emergency hydraulic pump. The handles are labeled RAM AIR TURBINE and require a firm pull to the stop of about 4 inches to extend the turbine. With the ram air turbine extended into the air stream, the emergency hydraulic pump will supply pressure through the No. 1 system for operation at about one-sixth normal rate of the various hydraulic units normally operated by the No. 1 system.

Hydraulic System Out Warning Lights.

The HYD. SYSTEM OUT lights, located on each warning light panel (figure 1-13), illuminate when pressure in either the No. 1 or No. 2 hydraulic system decreases to approximately 1250 psi. The hydraulic pressure indicating system can be used to determine which system is out. The warning lights are powered from the d.c. emergency bus through a circuit breaker in the electronics compartment. The master caution lights also illuminate when the hydraulic system out warning lights illuminate.

FLIGHT CONTROL SYSTEM.

Flight controls are comprised of conventional cable and push rod systems, mechanical and electro-hydraulic servo systems, electrical trim systems, electrical control systems, and hydraulic control systems. The primary flight control surfaces include the ailerons, a rudder and a pivoted, one piece, controllable horizontal stabilizer.

FULL POWER IRREVERSIBLE CONTROL SYSTEM.

The ailerons, horizontal stabilizer and rudder depend upon a complete hydraulic power control system for operation. Movement of the controls in any direction, immediately affects a servo mechanism. This servo mechanism immediately responds and directs hydraulic pressure to the control surface cylinders which move in the required direction. As soon as the control surface begins to move, follow-up linkage begins to cancel the original control signal to stop the control surfaces at the required deflection. When the required deflection of the control surface is reached it stops and is hydraulically locked in that position by the actuating cylinders and cannot be moved by external forces acting upon it.

CONTROL STICK GRIP

1 AILERON AND STABILIZER TRIM SWITCH

2 EXTERNAL STORES RELEASE BUTTON

3 CAMERA-ARMAMENT TRIGGER SWITCH (OPERATIVE IN FORWARD COCKPIT ONLY)

4 RADAR TRACK ACTION BUTTON

5 NOSE WHEEL STEERING BUTTON

6 STICK SHAKER

F54-0-1-26

Figure 1-25

Artificial Feel System.

The use of a full power, irreversible control system for actuation of the flight controls prevents air loads and resulting "feel" from reaching cockpit controls. Therefore, an artificial feel system is installed to provide a sense of control feel under all flight conditions. Normal control forces are simulated by a system of cams and centering springs. This system applies loads to the controls in proportion to the degree of control deflection or proportionally to the number of G's.

CONTROL STICK.

The control stick is mechanically connected (by means of control cables and push rods) to hydraulic control valves at the ailerons and to horizontal stabilizer hydraulic actuators. Movement of the stick positions these control valves so that power from the flight control hydraulic systems is directed to the control surface actuators to move the control surfaces. A follow-up system automatically closes off the flow of hydraulic fluid to the actuators when the desired control surface deflection is obtained. The control stick grip (figure 1-25) incorporates the primary aileron and horizontal stabilizer trim switch, nose wheel steering button, camera-armament trigger switch, external stores release button and radar track action button.

RUDDER PEDALS.

Primary control for the rudder consists of conventional rudder pedals which are mechanically connected to a hydraulic control valve at the rudder hydraulic actuator. Movement of the rudder pedals positions the valve so that power from the flight control hydraulic systems is directed to the control surface actuators to move the rudder. A Follow-up system automatically closes off the flow of hydraulic fluid to the actuators when the desired rudder deflection is obtained. The rudder pedals can be adjusted by use of rudder pedal adjustment handles (28, figure 1-6 and 27, figure 1-7) labeled PEDAL ADJ. which are located to the left of the center control panels. The wheel brakes are applied conventionally by toe action on the rudder pedals. Rudder pedal movement also controls nose wheel steering. (Refer to Nose Wheel Steering System in this Section.)

AILERON TRAVEL LIMITING SYSTEM.

A mechanical device is installed in the control stick mechanism which limits aileron travel to about 65% of normal when the wing flap levers are in the UP position. This installation reduces the roll rate of the airplane during normal flight, yet maintains full aileron deflection for landing and take-off. There is no cockpit control for this device other than the wing flap lever. (Refer to Section VI for additional information on this system.)

RUDDER TRAVEL LIMITING SYSTEM.

With the wing flap lever in TAKE-OFF or LAND position, rudder travel is 20° ±2 to either side of neutral. With the wing flap lever in the UP position, rudder travel is limited to 6° either side of neutral. Refer to Section VI for additional information on this system.)

Note

The rudder travel limiting system is linked mechanically to the wing flap lever. When the lever is moved to the TAKE-OFF or LAND position, maximum rudder travel and full nose wheel steering is available.

STABILITY AUGMENTATION CONTROL SYSTEM.

A three-axes stability augmentation control system compensates and corrects for small and rapid changes-of-rate in fundamental airplane stability due to speed or altitude change. Normal electric power is supplied from the d.c. monitored bus through the instrument inverter. Emergency electrical power is supplied from the emergency a.c. bus through the instrument emergency power transformer and instrument a.c. bus. The system measures the rate-of-change of airplane stability and generates an electrically-amplified signal. This signal moves a system of valves which in turn direct hydraulic pressure to the actuating cylinders to move the rudder, stabilizer or ailerons to a position relative to the amount of correction necessary. This operation does not move the normal surface control linkage or have any effect upon cockpit controls. The stability augmentation system also includes a "washout" circuit which allows the pilot to execute maneuvers without interference by the stability augmentation devices. The stability augmentation system causes the control surfaces to be deflected to correct for small, rapid disturbances. "The washout" circuit cancels these signals in favor of pilot-initiated signals. In order to decrease the possibility of excessive pitch rate changes with resultant high negative G forces, there is no washout circuit incorporated in the pitch axis.

Roll, Pitch and Yaw Damper Switches.

Three guarded switches (figure 1-28) placarded STABILITY CONTROL, YAW, PITCH AND ROLL are located on the left console in each cockpit. These switches are guarded to the ON position but may be used to disconnect the stability augmentation control system in any one or all three axes whenever it may be required by placing the switches in the OFF position. Any one of two of the systems may be disconnected without adversely affecting stability augmentation control of the remaining system. Refer to Section VI for flight characteristics with and without stability augmentation control.

Note

The forward and aft cockpit switches must both be ON to obtain system operation.

AUTO-PITCH CONTROL (KICKER)SYSTEM.

An auto-pitch actuator prevents inadvertent stalls by moving the control stick forward to neutral when either

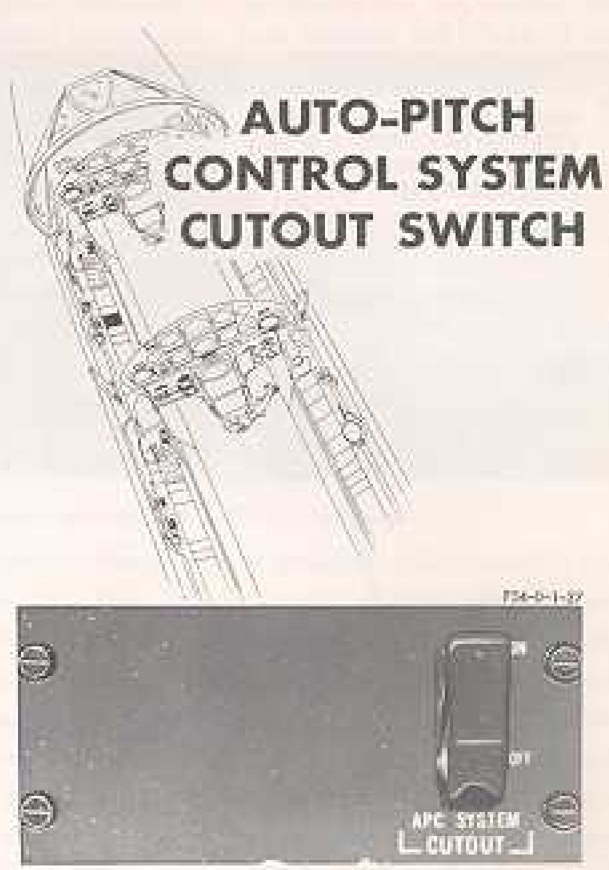

Figure 1-26

the pitching velocity or the angle of attack, or a combination of both reach a critical value. Signals to effect this action come from a rate gyro and/or a vane-actuated angle-of-attack detecting system (figure 1-27). These signals are amplified; when a critical value is reached, they trigger a solenoid valve and operate a small hydraulic cylinder; this in turn causes the stabilizer to asume an airplane-nose-down deflection and the control stick to move forward. This is the only control surface deflection that is transmitted back through the control system to the control stick. Thus, the pilot is immediately made aware of an approaching stall attitude of the aircraft. A force of approximately 32 pounds applied on the stick can override the automatic pitch system. Electrical power for the auto-pitch control system is supplied by the instrument inverter through the three-axes control damper. Hydraulic power is suppled from the No. 1 system. (Refer to Section VI for additional information on this system.)

Note

- To preclude an airplane nose-down deflection at low altitudes during take-off or landing, the auto-pitch control system is de-energized when the wing flaps are in any position except up.

AUTO-PITCH CONTROL AND STICK SHAKER SENSOR VANES

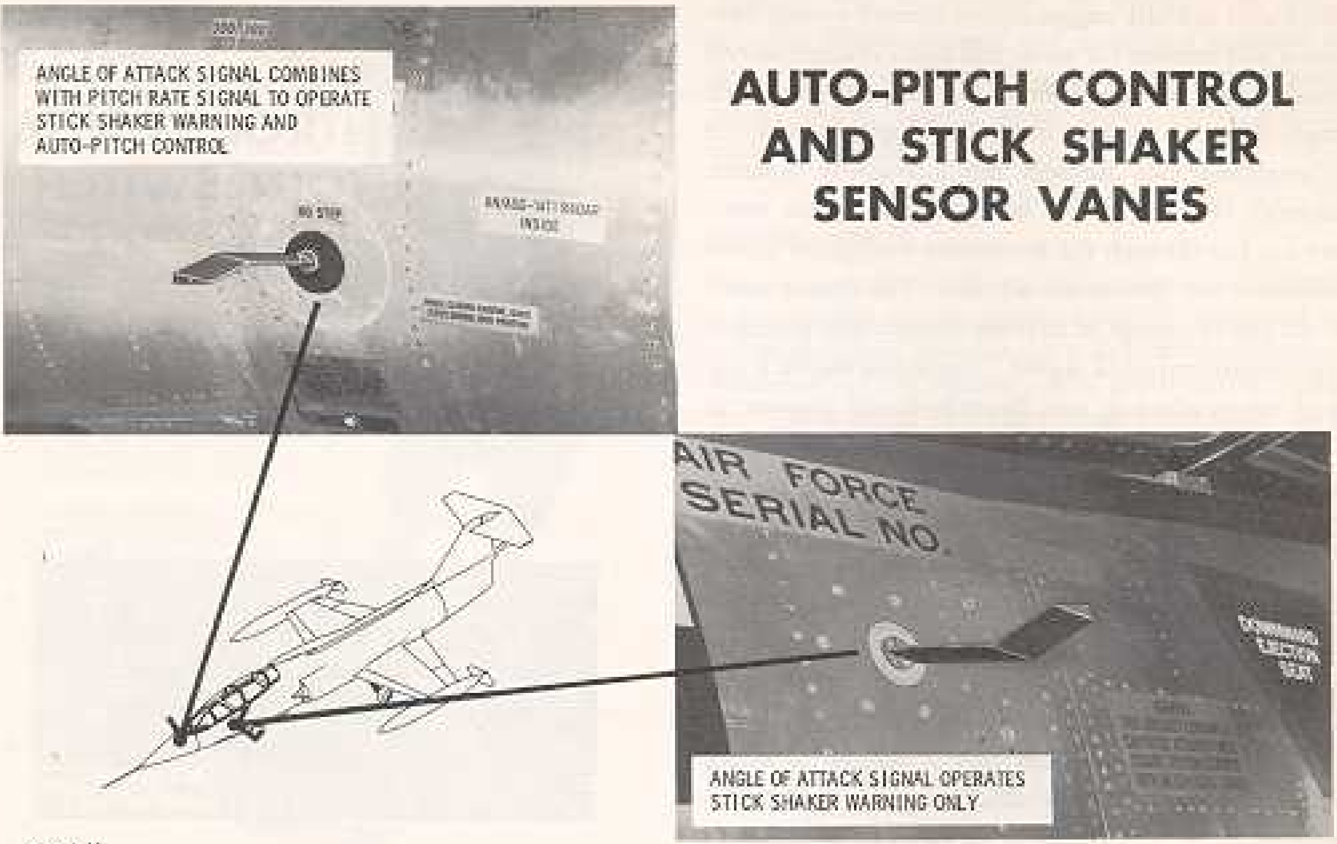

Figure 1-27

- On modified aircraft the APC system can operate with the flaps in the take-off position when the landing gear is up and locked. This modification allows the use of take-off flaps for increased maneuverability while retaining the stick kicker warning feature. Refer to Sections V and VI for additional information.

Auto-Pitch Control System (Kicker) Cut-Out Switch.

An auto-pitch control system cut-out switch (figure 1-26) is located on the left console in the forward cockpit only and is guarded and safety wired to the ON position. The OFF position may be used to de-energize the auto-pitch control system if necessary. When the switch is in the OFF position, the "AUTO-PITCH OUT" warning light illuminates. Power for the switch is received from the instrument inverter through the three-axes control damper. The switch energizes the "AUTO-PITCH OUT" warning light when turned to the OFF position.

Note

The auto-pitch control system (APC) cut-out switch does not de-activate the stick shaker.

WARNING

The auto-pitch control system cut-out switch is provided to de-energize the system because of malfunction or for ground maintenance only.

Auto-Pitch Control System (Kicker) Indicators. (Equivalent Angle of Attack Indicators).

Auto-pitch control (APC) system indicators (16, figure 1-6 and 16, figure 1-7) located in each cockpit are powered by the instrument inverter. The indicator which is actuated by the right vane only, may be used throughout the flight to ascertain that the auto-pitch control system is operating as well as to inform the pilot of the airplane's relation to the stall condition. The indicator dial is graduated in increments from 0 to 5 with a red area at 5 which is the point at which the "kicker" becomes effective. Since the stick shaker will be energized prior to kicker operation, experience with the indicator will aid the pilot in obtaining maximum performance from the aircraft.

Auto-pitch Out (Kicker) Warning Lights.

The d.c. emergency bus powered AUTO-PITCH OUT warning lights on the warning panels (figure 1-13) and the master caution lights illuminate if the auto-pitch control system malfunctions or the No. 1 hydraulic system becomes inoperative. This will warn the pilot to exercise caution to avoid pitch up during maneuvering flight or low airspeed. If the auto-pitch control cut-out switch is placed to the OFF position or the stick shaker circuit breaker is pulled out, the AUTO-PITCH OUT warning lights and MASTER CAUTION lights will illuminate.

Note

The lights may blink during normal operation when approaching the kicker range of operation.

STICK SHAKER SYSTEM.

A control stick shaker stall warning system has been incorporated into the flight control system. The system will be energized when pitching velocity or angle of attack, or a combination of both, reach a value which is less than the auto-pitch control system requires for actuation. When energized, electrical power from the d.c. emergency bus activates an eccentric motor on each control stick which agitates it in a forward and aft motion. This shaking is a warning of a stall and will commence before the auto-pitch control system is actuated. (Refer to Section VI for additional information on this system.)

Note

No switch is provided to de-activate the stick shaker; however, a circuit breaker (figure 1-18) on the left console in the forward cockpit can be used to de-activate the system if necessary.

TRIM CONTROL SYSTEM.

Aileron and Stabilizer.

The trim actuators are mechanically connected to the trim motors by flexible drive shafts and provide electrical trim of the control surfaces by movement of the servo valve assembly input linkage arms. This operation causes deflection of the control surfaces to a trimmed position but does not move cockpit controls. The trim motors are powered from the d.c. emergency bus and contain cam-actuated up-and-down limit switches and a take-off trim indicator light switch.

Rudder.

An electrical trim system for the rudder provides directional trim control of the airplane. The trim system for the rudder reacts in the same manner as the stability augmentation control system except that the electrical signals originate from a trim potentiometer located on the trim and stability control panel (figure 1-28) and are controlled by the pilot instead of by the yaw damper rate gyro.

Aileron and Stabilizer Trim Switches.

Normally, lateral and longitudinal trim control is provided by a spring-loaded, thumb-actuated switch located on top of each control stick grip (1, figure 1-25). The switch is used to control d.c. emergency bus powered trim motors. Lateral movement of the switch to the left causes a left aileron up, right aileron down operation of the trim motor and trim actuators. Lateral movement to the right causes a reverse operation. Forward movement of the switch causes a stabilizer leading edge up (aircraft nose down) operation of the trim motor and actuator. Aft movement causes reverse operation.

Note

A pressure switch in the No. 1 hydraulic system prevents operation of the aileron and stabilizer (Primary) trim system without No. 1 hydraulic system pressure. The auxiliary trim system bypasses this pressure switch making it possible to trim the aircraft without No. 1 hydraulic system pressure.

Auxiliary Trim Selector Switches.

A two-position, guarded trim selector switch (figure 1-28) is located in each cockpit on the left consoles and is labeled STICK TRIM and AUX. TRIM. The switches are powered from the d.c. emergency bus and may be used to override the control stick trim switch. If failure of the control stick trim switch occurs, the selector switch allows use of the auxiliary trim switch for control of the stabilizer and aileron trim circuits.

Auxiliary Trim Control Switches.

A spring-loaded toggle switch (figure 1-28) is located

FORWARD AND AFT TRIM AND STABILITY CONTROL PANELS

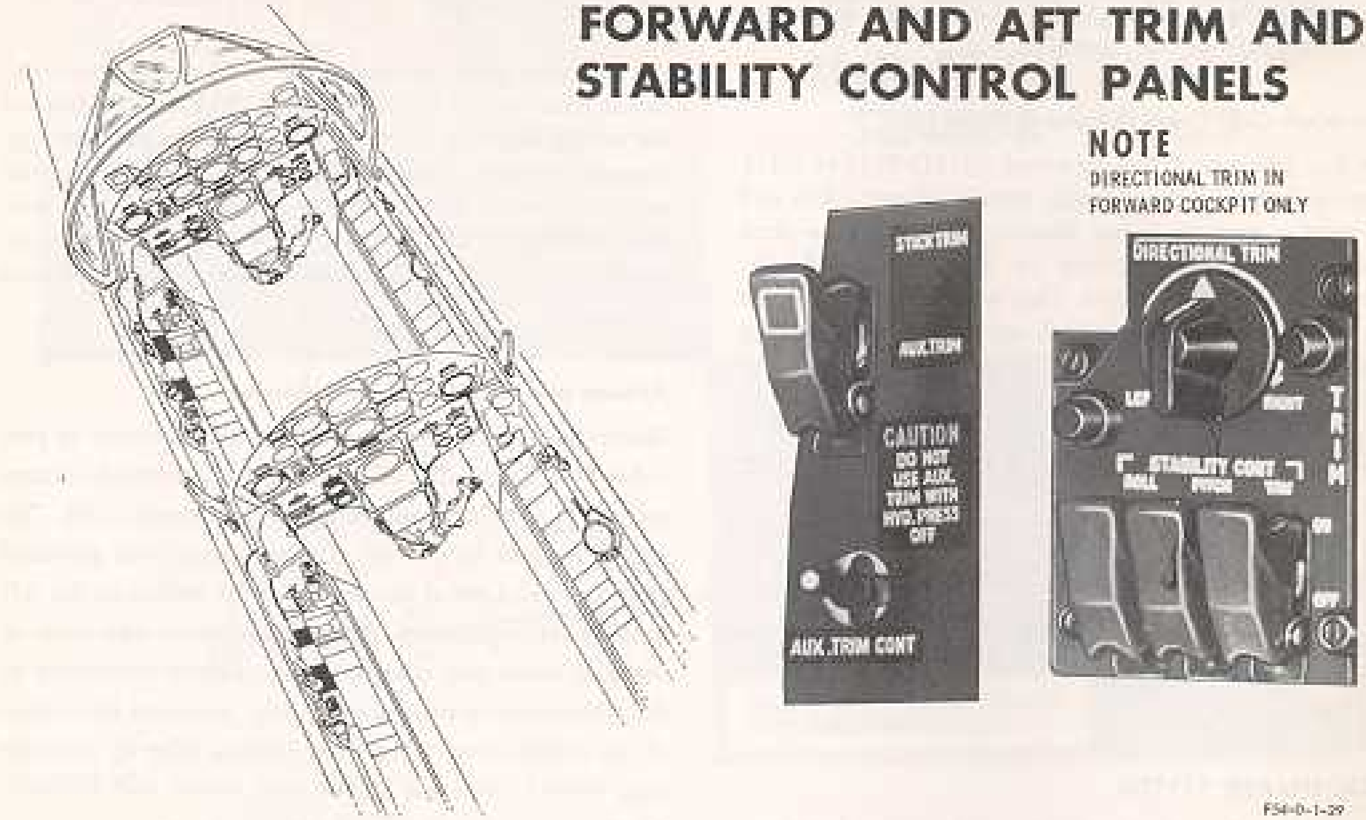

Figure 1-28

just aft of the auxiliary trim selector switch on each left console. This switch (d.c. emergency bus powered) produces the same effects as the control stick trim switch, provided the auxiliary trim selector switch is in AUX. TRIM position. The switch is labeled AUX. TRIM CONT. and functions as an auxiliary or standby switch which is used if the control stick trim switch fails.

Note

The forward and aft cockpit trim switches may be used independently; however, primary trim control is in the aft cockpit and will override any trim control operation in the forward cockpit.

Directional Trim Rheostat.

A rheostat (figure 1-28), (trim potentiometer) placarded DIRECTIONAL TRIM is located on the forward cockpit trim and stability control panel (left console). It provides electrical trim control of the airplane around the yaw axis. Electrical signals from the potentiometer are amplified and transmitted to the yaw damper servo valve assembly. The rudder trim mechanism reacts in the same manner as it does for stability augmentation control except that the trim potentiometer modifies signals in the yaw channel and is powered from the instrument a.c. bus. D.C. requirements are generated from this input by a magnetic amplifier power supply inside the 3-axes amplifier.

Stabilizer and Aileron Take-off Trim Indicator Lights.

Two d.c. emergency bus powered take-off trim indicator lights (37, figure 1-6 and 35, figure 1-7) are located in each cockpit on the left side of the lower instrument panel. With the airplane on the ground, the electrical system energized and hydraulic systems under pressure, the trim indicator lights can be energized either by use of

Figure 1-29

the control stick trim switch, the auxiliary trim control switch, or by the warning light system test switch (figure 1-13). The lights are provided to indicate aileron and stabilizer take-off trim position. When the lights are energized the words STAB. TAKE-OFF TRIM are illuminated on the upper light and AIL. TAKE-OFF TRIM is illuminated on the lower light. The lights illuminate whenever the trim motors are run through the take-off trim position of the aileron or stabilizer by action of the trim switches. The lights will not remain on after the trim switch is released. The stabilizer take-off trim light cannot operate once the airplane is airborne, due to a landing gear actuated ground-air safety switch. However, the aileron take-off trim indicator light may be energized in the air. This provides an additional means of checking a suspected asymetric tip tank fuel loading.

Stabilizer Trim Marker.

A black "T" (figure 1-29) painted on the right side of the vertical stabilizer is used as a take-off trim index. When trim is set for take-off, the leading edge of the horizontal stabilizer should be aligned with the index. The pilot should obtain ground personnel assurance that the stabilizer is within the correct tolerance.

WING FLAP SYSTEM.

The wing flap system consists of trailing edge flaps and leading edge flaps. A boundary layer control system is used with the trailing edge flaps and is automatically operated when the wing flaps are in the landing configuration. Both sets of flaps are used for take-off and landing. Each set is electrically interconnected by a control circuit and mechanically interconnected by flexible drive shafts. Although the trailing edge and leading edge flaps are electrically interconnected by the control circuit, they are not mechanically interconnected. Both sets of flaps are controlled by a single lever.

Wing Flap Sequencing System.

An automatic wing flap sequencing system operates automatically when the ram air turbine is extended to obtain electrical power, but only if the wing flap lever is placed to TAKE-OFF position. When the ram air turbine is extended and TAKE-OFF flaps position is selected, the system prevents electrical power from going to the trailing edge flaps until the leading edge flaps have moved to take-off position. This reduces the electrical load which can be applied to the ram air turbine-driven generator under these conditions. On AF Serials 57-1322 and subsequent and modified aircraft the flap sequencing is reversed, that is, electrical power is prevented from going to the leading edge flaps until the trailing edge flaps have moved to the take-off position.

TRAILING EDGE FLAP SYSTEM.

The trailing edge flaps are attached to the aft beam of each wing panel between the wing fillets and the inboard edge of the ailerons. The flaps are hinged at the forward lower edge. Movement of the flaps is controlled by two a.c. powered actuators, either of which will provide operation of both right and left trailing edge flaps if one actuator fails. If only one actuator is operative, the operating speed of the flaps will be reduced by approximately one-half the normal speed. The control circuit for the flaps is from the 28-volt d.c. essential bus and the power circuit is 200/115 volt, 3-phase, from the emergency a.c. bus.

LEADING EDGE FLAP SYSTEM.

The leading edge flaps form the leading edge of each wing between the fuselage and the wing tip fairings. The flaps are hinged at the aft lower edge. Flap movement is controlled by two a.c. powered actuators. The system is so designed that both right and left leading edge flaps will operate from a single actuator if one or the other fails. The control circuit for the flaps is from the 28-volt d.c. essential bus and the power circuit is 200/115-volt 3-phase, from the emergency a.c. bus.

Leading Edge Flap Lock System.

A leading edge flap lock system is provided to lock the flaps in the up position. Each flap is provided with a locking assembly and lock actuator. The left flap lock actuator only has a d.c. emergency bus powered motor. The right flap lock actuator is driven by the left lock actuator through an interconnecting flexible drive shaft. A warning system is installed to indicate when the flaps are in an unsafe position.

Wing Flap Levers.

The wing flap levers (4, figure 1-5) are located immediately to the left of the throttle in each cockpit and are mechanically interconnected. The positions are UP, TAKE-OFF, and LAND. Spring-loaded guards prevent G-loads from pulling the levers from the UP position. Both leading and trailing edge flaps are controlled by either flap lever. Selection of the TAKE-OFF position will extend the leading edge flaps 15 degrees from the faired position and trailing edge flaps 15 degrees from the faired position. In the LAND-position, the leading edge flaps extend 30 degrees from the faired position and the trailing edge flaps extend 45 degrees from the faired position. In the UP position both sets of flaps will retract to the UP (faired) position. On modified aircraft, when moving the flap lever from the LAND to the UP position, the lever will latch at the TAKE-OFF position during its travel. In order to release the latch, the lever must be pulled back (toward LAND) approximately ¼ inch. The lever can then be moved forward to the UP position.

CAUTION

Nose wheel steering is restricted when the wing flap lever is in the UP position; therefore, the lever must be placed in either TAKE-OFF or LAND position to obtain full nose wheel steering.

Wing Flap Position Indicators.

Position indicators (32, figure 1-6 and 31, figure 1-7) for the trailing and leading edge flaps are located on the left side of each lower instrument panel. The left indicator is for the trailing edge flaps and the right indicator is for the leading edge flaps. Two windows in each cockpit are provided and are labeled: FLAP POSITION, LE and TE. Flap position indicators for leading and trailing edge flaps are given in their respective window. UP, T.O. or LAND rotates into view in each window to correspond with flap deflection. The flap indicator will not indicate flaps UP until the leading edge flaps are fully retracted and locked. Cross-hatched indications will be given when the flaps are in any position other than that selected or when the electrical system is not energized. The indicators are powered by the 28-volt d.c. monitored bus.

BOUNDARY LAYER CONTROL SYSTEM.

Air is bled from the last compressor stage of the engine and ducted to the boundary layer control manifold which is located above the trailing edge flap hinge line (see figure 1-30). The boundary layer control manifold has a series of nozzles which direct this high pressure, high temperature air over the upper surface of the flap when the land position is used. The high velocity created by this jet of air causes it to adhere to the curved fairing and bend around and pass over the upper surface of the flap. This curving jet entrains the adjacent layer of air and causes it to bend through the flap deflection angle and thus flow separation is prevented. This results in a reduction of landing speed. The system is completely automatic in its operation.

BOUNDARY LAYER CONTROL DUCT SECTION

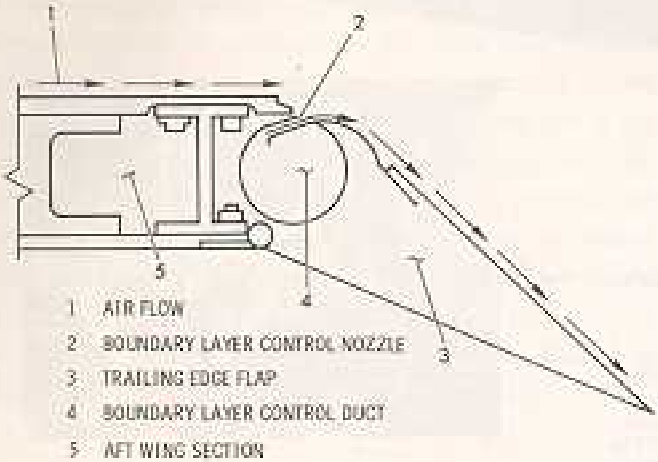

Figure 1-30

Boundary Layer Control Valve.

Since boundary layer control is used with a 45° flap setting only, there is no air flow for flap angles of 15° or less. This is accomplished by a valve which is mechanically driven by the flap actuator, thus the valve's position will always correspond to that of the flaps. The valve butterfly remains closed from 0° to 15° flap angle. For angles greater than 15° the valve modulates to full open at 45°.

SPEED BRAKE SYSTEM.

The speed brakes consist of two flaps, one on the left and one on the right side of the fuselage, just aft of the trailing edge of each wing. Total projected area of the speed brakes is approximately 8.25 square feet. The flaps move both outward and aft as they are extended by hydraulic cylinders. Maximum outward deflection is approximately 60 degrees from the retracted (faired) position. The speed brakes are electrically controlled from the d.c. emergency bus and hydraulically actuated by the No. 2 hydraulic system through the priority valve. The priority valve will close and prevent speed brake operation if the No. 2 hydraulic system pressure drops to below 2000 psi. No position indication is provided for the speed brakes.

Note

Modified aircraft incorporate provisions for automatically closing the speed brakes in the event of electrical power loss. The solenoid operated valve in the system fails to the closed position allowing normal hydraulic pressure or windmilling engine hydraulic pressure to close the speed brakes.

Speed Brake Switches.

Speed brake switches (2, figure 1-5) are thumb-actuated and are installed in the top of the throttle levers. The switches are d.c. emergency bus powered and provide incremental positioning of the speed brakes. The switches have three labeled positions: IN, NEUTRAL, and OUT. The aft cockpit switch is a momentary, spring loaded to NEUTRAL type switch and is the primary control for the speed brakes. However, the speed brakes will return to the position selected in the forward cockpit when the aft cockpit switch is released.

Note

Due to leakage in some speed brake control valves, the speed brakes may gradually extend when the switch is left in the NEUTRAL position. Inadvertent extension may be prevented by positioning the switch to the IN position whenever the speed brakes are not being used.

LANDING GEAR SYSTEM.

The aircraft is equipped with two main gear and a nose landing gear. Normally the landing gear system is hydraulically operated and electrically controlled by the d.c. emergency bus. Normal extension or retraction time of the landing gear is 4 to 5 seconds. A manual release system is provided for emergency extension of the gear which also requires 4 to 5 seconds. There is no emergency means of retracting the landing gear. The gear may be recycled if necessary, before reaching either the full up or full down position.

Figure 1-31

Main Landing Gear.

The main landing gear retracts forward and inward into the fuselage wheel wells. A linkage causes the wheels to rotate 90 degrees during retraction so that they fit into the wheel wells. Each main gear, when retracted, is enclosed by a forward and aft door. The forward door is hydraulically operated. The aft door is mechanically linked to the gear and travels up and down with the gear. The doors are locked in the closed position by four latches on the fuselage structure. The latches also serve as main gear uplocks because the doors support the gear in the closed position in event of hydraulic pressure loss. The forward door is held open by hydraulic pressure while the gear is being extended. During normal operation, the forward door is returned to within four inches of the fully closed position and held there by a mechanical detent after the gear is extended. The main gear is locked in the down position by the drag strut cylinder assembly. Barrier engagement fingers are located on the forward doors to retain the barrier cable during low speed engagements. When the gear is extended by the manual release, the forward doors remain in the open position. Ground safety pins are provided for manual installation in the downlock linkage at the forward end of the drag strut cylinder (1, figure 1-31) of each gear.

Nose Landing Gear.

The nose gear retracts aft into a wheel well. The nose gear incorporates a conventional air-oil shock strut. When the nose gear is retracted, it is enclosed by two doors that are mechanically operated through contact with the nose gear strut. When the gear is extended, a downlock mechanism serves to lock the knee joint in the extended position. Emergency extension of the nose gear is accomplished mechanically by a bungee spring. An uplock cylinder is mounted on the drag strut support beam and is linked to an uplock hook mounted on the upper drag strut pin. The uplock hook engages a lug on the nose wheel fork to lock the gear up. A static wire on the nose wheel fork electrically grounds the airplane when the wheel touches the ground. A ground safety lock pin is provided for manual installation on the downlock stop cartridge (2, figure 1-31). The nose gear is steerable through use of the rudder pedals. (Refer to Nose Wheel Steering System in this Section.)

LANDING GEAR LEVERS.

The landing gear levers (figure 1-13) are located on the left forward panel of each cockpit and are mechanically interconnected. The levers have two positions, LDG. GEAR DOWN and LDG. GEAR UP. They electrically control the landing gear and landing gear door hydraulic selector valves. When either lever is moved to the UP position, 28-volt d.c. emergency bus power is directed to selector valves which are electrically sequenced to direct hydraulic pressure to open the main gear forward doors, retract the nose gear and the main gear (and aft doors) and then reclose the main gear forward doors. When either lever is placed in the DOWN position, the same electrical power actuates the selector valves which sequence hydraulic pressure to lower the nose gear, open the main gear forward doors and lower the landing gear (which opens the aft main gear doors). When the gear reaches the down-and-locked position, hydraulic pressure is automatically selected to close the main forward doors to the mechanical detent position.

LANDING GEAR LEVER UPLOCK RELEASE.

Landing gear lever uplock mechanisms are provided. A trigger (figure 1-13) which extends upward from the top of the lever is used to release the lever uplock mechanisms. The locks prevent the landing gear levers from being inadvertently moved to the DOWN position.

LANDING GEAR LEVER DOWNLOCK MECHANICAL OVERRIDE BUTTONS.

Override buttons (figure 1-13) are located just above each landing gear lever. The button may be used in an emergency to override the lever downlock if it becomes necessary to raise the gear when the weight of the aircraft is on the landing gear. When the airplane is on the ground with the gear down-and-locked, solenoid-operated locking mechanisms lock the landing gear levers in the DOWN position. This locking mechanism is provided with a mechanical downlock by-pass that is operated by the push-button. When the weight of the aircraft is off the landing gear, 28-volt d.c. emergency bus power is directed to the control lock solenoids which cause the locks to retract so that the levers can be moved to the UP position.

MANUAL LANDING GEAR RELEASE HANDLES.

Yellow handles (38, figure 1-6 and 36, figure 1-7) located on the lower left side of each instrument panel and are labeled MAN LDG. GEAR. The handles are used to manually release the main landing gear door uplocks and the nose gear uplocks, allowing the main gear to lower and lock down by gravity and air load forces. The nose gear is forced down by a bungee spring. Approximately a 10-inch pull to the stop on either handle is required to release the gear. The landing gear cannot be retracted after being extended by means of the manual landing gear release handle. If the manual landing gear release handle has been used to extend the gear a notation should be made in Form 781 so that the valves will be repositioned prior to the next flight.

LANDING GEAR POSITION INDICATOR LIGHTS.

Three green lights (35, figure 1-6 and 32, figure 1-7) are installed on the left side of the lower instrument panel in each cockpit. When the lights are illuminated the landing gear is down-and-locked. The lights are labeled LH GEAR DOWN, NOSE GEAR DOWN, and RH GEAR DOWN. As each gear reaches the down-and-locked position, 28-volt d.c. power from the emergency bus is directed through the warning light dimming circuit to illuminate the indicator lights. The lights are off whenever the gear is not down and locked except when energized by the warning light test switch.

LANDING GEAR SYSTEM MALFUNCTION LIGHTS.

Red warning lights are installed in the transparent knob of each landing gear lever (figure 1-13). These lights provide the pilot with a visual signal whenever the landing gear is not up and locked or down and locked. The lights receive power from the 28-volt d.c. emergency bus.

LANDING GEAR WARNING SIGNAL.

An engine speed and pitot static operated landing gear warning signal is produced in the pilots' earphones through the interphone system when the landing gear is not in the down and locked position. When the throttle is retarded below 100%, the altitude is below 10,000 ±1,500 feet and the airspeed is below approximately 220 knots IAS, the warning signal will be energized. Power for the signal system is delivered from the d.c. emergency bus.

NOSE WHEEL STEERING SYSTEM.

The steering system provides power steering for the nose wheel when the airplane is on the ground. The nose wheel is steerable 25 degrees either side of center when the wing flap lever is in either TAKE-OFF or LAND position. Steering is accomplished by a steer-damper unit that is hydraulically powered and controlled through a cable system by the rudder pedals. No. 2 hydraulic system pressure from the landing gear-down line is routed to the steering system through a solenoid shut-off valve and a pressure reducing valve which reduces system pressure from 3000 psi to 1500 psi. The solenoid shut-off valve is controlled by switches on the control stick grips. The system is irreversible in that forces on the nose wheel cannot be transmitted back to the rudder pedals. Upon retraction, the nose wheel will automatically center itself.

Note

- The ground-air safety switch and relay are connected into the shut-off valve circuit in a way that renders the steering system inoperative unless the weight of the aircraft is on the main landing gear.
- If the manual landing gear release handle is used to lower the landing gear, hydraulic pressure for nose wheel steering is lost and the system becomes inoperative.

Steer-Damper Unit.

The steer-damper unit transforms hydraulic pressure into steering force when the unit is pressurized and nose wheel steering is engaged. When unpressurized, the unit absorbs shock loads and dampens nose wheel shimmy. When pressure is applied, an internal clutch engages the unit with the rudder cables through a control pulley.

Note

The clutch will engage only when the nose wheel and rudder pedals are in the same relative position.

NOSE WHEEL STEERING BUTTONS.

Push-buttons (5, figure 1-25) mounted on the control stick grips engage the nose wheel steering system. When either button is pressed and held, d.c. monitored bus power is directed to a shut-off valve which directs No. 2 hydraulic system pressure to the nose wheel steering unit. A clutch is then engaged hydraulically to link the rudder cables with the steering unit when the rudder pedals and nose wheel are in the same relative position.

CAUTION

The nose wheel steering button is operable only if d.c. monitored bus power is available and the weight of the aircraft is on the main landing gear.

WHEEL BRAKE SYSTEM.

Each main gear incorporates a hydraulic brake assembly. The brakes are self-adjusting, segmented rotor-type. The brake hydraulic system is independent of aircraft hydraulic systems. Each brake is operated conventionally by toe pressure on the rudder pedals which are linked to master brake cylinders. Fluid reservoirs are incorporated as part of each brake valve. Fluid quantity sight gages (figure 1-39) are mounted on the front of the pressure bulkhead and one on the bulkhead between cockpits. Both forward and aft master brake cylinders are serviced with hydraulic fluid through their respective sight gages. No parking brake system is provided.

DRAG CHUTE SYSTEM.

A 16-foot, ribbon-type drag chute is provided to reduce landing distances. The chute is packed in a deployment bag, and stowed in a compartment located in the lower surface of the aft fuselage. It is mechanically controlled from either cockpit. A shear link will release the drag chute if it is deployed at airspeeds in excess of the shear link structural limit.

DRAG CHUTE HANDLES.

The drag chute handles (36, figure 1-6 and 34, figure 1-7) are located at the left of the lower instrument panels. When pulled straight aft (about 2 inches) to the stop (without turning the handle) the spring-loaded drag chute door will open and a pilot chute will be deployed, the pilot chute deploys the drag chute. The drag chute can be released at any time by turning either drag chute handle 90 degrees clockwise and pulling it to the next stop (about four inches). The handle is under spring tension during the final pull to jettison the chute and when the handle is released it will retract to the first stop.

INSTRUMENTS.

Most of the instruments are powered by the a.c. and/or d.c. electrical systems.

Note

For information regarding instruments that are an integral part of a particular system, refer to applicable paragraphs in this Section and Section IV.

PITOT PRESSURE AND STATIC SYSTEMS.

The pitot pressure and static systems operate the airspeed indicators, altimeters, and vertical velocity indicators. The system is also connected to the gunsight pressure transmitters. The pitot-static head is mounted on a boom that extends forward from the nose radome. The head is electrically heated by an element in the head that is controlled by a switch on the right console in each cockpit (17, figure 1-9 and 6, figure 1-11). (Refer to Defrosting and Anti-Icing Systems, Section IV.)

AIRSPEED AND MACH NUMBER INDICATORS.

The indicators (figure 1-32) consist of a pitot-static operated indicated airspeed mechanism which drives a pointer to indicate airspeed on a fixed dial. The indicator also contains a static pressure operated altitude mechanism which drives a moving scale to indicate Mach number. The gearing between the moving scale and the altitude mechanism is such that Mach number is indicated by the pointer on the moving scale at any combination of indicated airspeed and altitude within range of the instrument. The indicator operates over a range of 80 to 850 knots indicated airspeed at altitudes up to 80,000 feet. The Mach number range is from 0.50 to 2.2. A third pointer functions as a maximum allowable speed pointer for a limiting equivalent airspeed of 600 to 800 knots.

Maximum Allowable Speed Pointer.

The maximum allowable speed pointer is positioned as a function of equivalent airspeed, and indicates in terms of indicated airspeed the specific value of equivalent airspeed which has been preset into the instrument.

Airspeed Setting Index.

An airspeed setting index is provided to assist the pilot in setting a speed reference marker. The setting of the index is controlled by a knob in the lower right corner. The index is adjustable over a range of 100 to 700 knots indicated airspeed.

ALTIMETERS.

In addition to the standard 1000 and 100-foot pointers, the altimeters (8, figure 1-6 and 7, figure 1-7) use a 10,000-foot pointer (segmented disk with an extension pointer) which serves as a warning indicator. The warning indicator is a striped section which appears through the segmented disk at altitudes below 16,000 feet. This altimeter offers improved readability and gives warning when an altitude of less than 16,000 feet is entered.

ACCELEROMETERS.

A three-pointer accelerometer (30, figure 1-6 and 29, figure 1-7) indicates positive and negative G-loads. In addition to the conventional indicating pointer there are two recording pointers (one for positive G-loads and one for negative G-loads) which follow the indicating pointer to its maximum travel. The recording pointers remain at the maximum travel positions reached by the indicated pointer, thus providing a record of maximum G-loads encountered. To return the recording pointers to the normal (1-G) position, press the knob on the lower left corner of the instrument.

STANDBY COMPASS.

A standby magnetic compass (3, figure 1-6) is provided in the forward cockpit only for navigation if the electrical system fails or to check the directional indicator. The compass is located on the left side above the instrument panel glareshield, and is hinged to fold forward when not in use. Illumination of the sight within the compass case is controlled by a rheostat on the right console interior lights panel (figure 4-12).

J-4 DIRECTIONAL INDICATOR.

Refer to Navigational Equipment in Section IV.

MM-3 (MODIFIED) ATTITUDE INDICATOR.

Modified MM-3 attitude indicators (11, figure 1-6 and 10, figure 1-7) provide the pilots with a pictorial presentation of aircraft attitude. The installation consists of

AIRSPEED AND MACH NUMBER INDICATOR

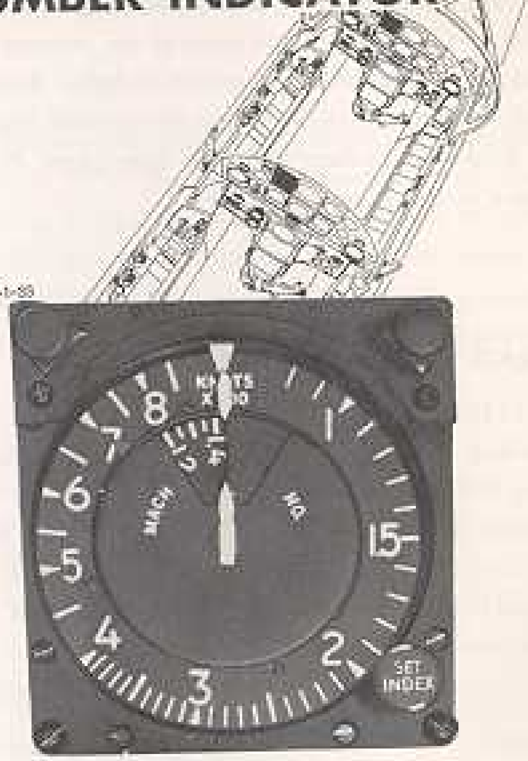

Figure 1-32

indicators mounted on the instrument panels, remotely located indicator amplifiers, an MD-1 gyro control and an MC-1 rate gyro. The indicators are operated independently by a common MC-1 gyro control and MD-1 rate gyro through individual indicator amplifiers. The MD-1 gyro senses pitch and bank angles and incorporates a pitch and bank erection system. The MC-1 rate gyro senses rate of turn. Any angular motion of the aircraft with respect to the vertical reference established by the gyro is detected by the MD-1 gyro control and electrically transmitted through the indicator amplifier to the universally mounted sphere on the indicator assembly. The gyro is mounted so that aircraft attitude is shown accurately through 360° of roll and plus or minus 82° of pitch. The pitch and bank erection system together with the rate of turn gyro, reduce turning errors to a minimum. Acceleration and deceleration will cause slight errors in pitch indications which will be most noticeable on take-off. Indications of aircraft attitude are presented by movement of the universally mounted sphere which serves as a background for a miniature reference airplane. The horizon is represented by a white line on the sphere and separates sky and earth presentations which are light grey and black, respectively. Both the sky and earth areas are marked with horizontal lines in five degree increments enabling the pilot to determine accurately his pitch attitude up to 82 degrees of climb or dive. The scale is expanded to amplify pitch displacement, providing quick readability within one degree of pitch attitude. Bank angles are indicated by the position of the pointer at the top of the sphere in relation to the semicircular bank scale around the upper half of the instrument. An adjustment knob located on the lower right side of the instrument permits alignment of the horizontal lines on the sphere with the miniature reference airplane. Turning the knob causes the sphere to be electrically rotated so that a relationship between reference lines and the miniature airplane may be established to provide greater ease in maintaining a desired pitch attitude. The OFF flag in the lower left corner of the instrument will be visible whenever a.c. power to the instrument is disrupted. The system starts operating as soon as 115-volt a.c. from the instrument bus is available, but the OFF flag will not retract until a warm-up period of approximately 1½ minutes has elasped. The OFF flag will appear in case of a complete a.c. power failure. However, a slight reduction in a.c. power, or failure of certain electrical or mechanical components within the system *will not cause* the OFF flag to appear, even though the system is not functioning properly.

WARNING

It is possible that a malfunction of the attitude gyro can be detected only by checking it with the directional indicator and the turn and slip indicator.

Gyro erection is accomplished automatically by the pitch and bank erection system thereby eliminating the necessity for manual caging provisions. If the pitch limit of 82° is exceeded, the sphere will roll 180 degrees, reversing the normal position of the sky and earth reference area, but still providing an accurate indication of aircraft attitude. As soon as the aircraft returns below the 82 degree limit, the sphere will roll back to its normal position without introducing any errors into the system.

TURN AND SLIP INDICATORS.

Conventional turn and slip indicators (4, figure 1-6 and 3, figure 1-7) are mounted on the main instrument panel. The instruments are electrically driven by 28-volt d.c. power from the d.c. emergency bus.

Note

Expect a momentary indication of a turn opposite to the direction of bank when originating a turn.

VERTICAL VELOCITY INDICATORS.

The vertical velocity indicators (12, figure 1-6 and 11, figure 1-7) are mounted on the main instrument panels. The indicators register the rate of climb or descent in feet per minute and are operated by the static air system.

WARNING LIGHTS SYSTEM.

WARNING PANEL LIGHTS SYSTEM.

The warning panel lights system gives the pilots visual indications of failure or unsafe conditions of certain critical power equipment in cricital areas of aircraft. The system consists of warning light panel assemblies (figure 1-13), master caution lights and reset bars (18, figure 1-6 and 17, figure 1-7), and the associated equipment automatically operate amber placard-type lights on the warning panels and caution bars. The warning panels contain placard-type warning lights, each having its own operating circuit to indicate a particular condition in the aircraft. If a failure occurs in one of the systems, the warning light for that particular system remains on until the failure is corrected. The warning panel lights system is powered from the emergency d.c. bus through a circuit breaker on the right forward cockpit circuit breaker panel. (Refer to the particular system associated with each warning light in this Section.)

MASTER CAUTION LIGHTS.

The MASTER CAUTION (18, figure 1-6 and 17, figure 1-7) lights illuminate when any of the warning panel lights are energized. Reset bars on which the master caution lights are mounted, permit the pilot to push and de-energize the master caution lights even though a malfunction continues and the individual warning panel light stays on. This permits the master caution lights to indicate a second malfunction if one occurs while the first malfunction is still present.

WARNING PANEL LIGHTS.

The following placard type warning lights are contained on the warning panels: FUEL LOW LEVEL, INST. ON EMER. POWER, NO. 1 GENERATOR OUT, NO. 2 GENERATOR OUT, HYD. SYSTEM OUT, AUTO PITCH OUT, D.C. MONITORED BUS OUT, HATCH UNSAFE (or CANOPY UNSAFE on upward ejection aircraft), ENGINE ANTI-ICING ON and ENGINE OIL LEVEL LOW.

WARNING LIGHTS DIMMING SYSTEM.

The warning lights dimming circuit provides a means for reducing the brilliance of all warning lights from a single rheostat. The warning light dimming relay coil is connected to the emergency d.c. bus through the WARN LT. circuit breakers and the instrument lights dimming rheostat.

WARNING LIGHTS DIMMING RHEOSTAT (INSTRUMENT LIGHT DIMMING RHEOSTAT).

Rheostats on the right console lighting panels (figure 4-12) in each cockpit labeled INSTRUMENT, OFF and BRT. may be used to dim the warning lights. The rheostats control the warning lights in their respective cockpits only. When the rheostats are in the OFF position, as for daylight flying, full bus voltage is directed to the warning lights and they burn at maximum brilliance when energized. When the switch is moved from OFF, the warning lights dimming relay is energized and bus voltage is directed to the warning lights through a dimming resistor and the lights operate at a reduced brilliance. Once the airplane's electrical system has been de-energized the warning lights dimming relay automatically returns the warning lights to full brilliance, regardless of the position of the rheostat. To re-dim the warning lights the rheostat must be returned to the OFF position and again moved out of the OFF position. The fire warning lights, engine air inlet temperature warning light, landing gear warning and landing gear indicator lights, lights on the warning lights panel and the master caution light are dimmed by the use of this rheostat.

WARNING LIGHTS TEST SYSTEM.

The warning lights test circuit provides a means of checking warning light filaments. The warning lights test relay coils are tied to the d.c. emergency bus through circuit breaker and test switches. The fire warning lights are tested from battery bus.

WARNING LIGHTS SYSTEMS TEST SWITCHES.

Warning lights systems test switches (figure 1-13) are located on the right forward panel in each cockpit. (The switches are also used to check the fuel quantity indicating system.) The test switches operate independently to energize the warning lights in their respective cockpits. When moved to WARNING LIGHTS TEST position, the fire warning, engine air inlet temperature warning, landing gear warning, landing gear indicator, aileron and stabilizer take-off trim indicator, AN/ASG-14 system target lock-on, master caution and the warning panel lights are energized. The switches energize the lights through the d.c. emergency bus. On modified aircraft the fire warning lights are energized through the battery bus.

EMERGENCY EQUIPMENT.

ENGINE FIRE DETECTOR WARNING SYSTEM.

The aircraft is equipped with a system that gives visual warning in both cockpits of an overtemperature condition in the engine compartment or the tail section. The system consists of eleven temperature-sensing detectors in the engine compartment, four detectors in the tail section, and two fire warning lights in each cockpit. The system is powered from the battery bus through a circuit breaker in the electronics compartment.

FIRE WARNING LIGHTS.

Two fire warning lights (2, figures 1-6 and 1-7) are located on each main instrument panel. The word "FIRE" will be illuminated by these lights if any of the overtemperature detectors close. The detectors in the engine compartment close at 450°F and those in the tail section at 650°F. Because of the secondary air flow used with this engine installation it is impossible to install a secondary firewall between the hot and the cold ends of the engine. Due to the high compression ratio of the engine, the aft end of the compressor section is as hot as the combustion chamber of many engines. A secondary firewall would not effectively separate that portion of the engine containing fuel and oil system components from a high temperature region, therefore, no overheat warning lights have been provided.

ENGINE AIR INLET TEMPERATURE WARNING SYSTEM.

The aircraft is equipped with a system that gives visual warning in the cockpits when engine air inlet temperature increases to a critical value. The system consists of a temperature-sensing detector, a warning light in each cockpit, and two warning flashers. The detector is located in the left 20 KVA, a.c. generator blast tube which carries engine inlet air from the left duct.

ENGINE AIR INLET TEMPERATURE WARNING LIGHTS.

Warning lights (6, figure 1-6, and 5, figure 1-7) are located on the upper left of each main instrument panel. The lights are decaled ENGINE AIR INLET TEMPERATURE WARNING. The flashers are electrically connected in series with the detector and the warning lights. The flashers alternately open and close to flash the lights on and off whenever the detector is closed. When the lights are on, the word "SLOW" is illuminated. The detector closes when engine air inlet temperature reaches the allowable limit. The lights are powered from the d.c. emergency bus through a circuit breaker in the electronic compartment.

SURVIVAL KIT (DOWNWARD EJECTION SEAT).

A reinforced fiberglas survival kit (figure 1-33) container fits into the seat bucket. The container is divided into two main sections. The rear section contains two emergency oxygen bottles, a regulator, and associated oxygen equipment (refer to Section IV for information on the Oxygen System). A hinged door on the top of this section provides access to the components within. The rear section of the survival kit container also serves as a support for the backpack-type parachute. The front section of the container holds survival gear such as gun, food, and fishing kit, packed in a plastic bag tied to the bottom of the container with straps. The front section of the container is covered by a door which supports a sponge rubber cushion. The container is attached to the parachute, on each side, by a quick-release fitting. If an over-water flight is contemplated, a life raft may be stowed on the top of the plastic bag in the front section of the container. The survival kit release and life raft actuator handle, located near the right front corner of the container, provides a means for disconnecting the kit from the parachute harness, as well as inflating the life raft. Following ejection, the release handle should be pulled before hitting the ground. The survival kit gear and life raft will separate from the pilot but remain attached to him by a lanyard approximately 20 feet long. A life raft arming plunger located under the survival kit prevents life raft actuation when the survival kit is in the seat. This allows the survival kit release handle to be used as a quick disconnect without life raft actuation when a rapid abandonment of the aircraft is required on the ground. During rapid abandonment on the ground, the pilot must manually release his survival kit parachute attachments to free himself of the 20 foot lanyard attached to the survival kit.

SURVIVAL KIT (UPWARD EJECTION SEAT).

A reinforced fiberglas survival kit (figure 1-33) container fits into the seat bucket. The container is divided into two main sections. The aft section contains two emergency oxygen bottles, an oxygen regulator and associated oxygen equipment (refer to Section IV for information on the Oxygen System). A door on the top-back of this section provides access to the components within. The aft section of the survival kit container also serves as a support for the backpack-type parachute. The forward section of the container holds survival gear such as gun, food and fishing kit packed in a waterproof plastic bag attached to a 20 foot retention lanyard. If an over-water flight is anticipated, a life raft may be stowed on top of the plastic bag and attached to the 20 foot retention lanyard. During ejection, a ship to kit disconnect automatically actuates the emergency oxygen supply and arms the life raft inflating device. Following ejection, the survival kit release handle should be pulled before reaching the ground. This action separates the survival gear from the pilot and inflates the life raft. The survival gear and life raft remain attached to the parachute harness by the retention lanyard. During a rapid abandonment of the aircraft on the ground, the survival kit release handle may be used to free the pilot of the survival kit (including the lanyard) without inflating the life raft.

SURVIVAL KIT

1 OXYGEN AND RADIO CONNECTIONS
2 PRESSURE SUIT CONNECTION
3 MANUAL EMERGENCY OXYGEN SUPPLY ACTUATOR
4 EMERGENCY OXYGEN PRESSURE INDICATOR
5 SURVIVAL KIT CONTAINER
6 SURVIVAL GEAR (CONTENTS TO BE DETERMINED BY MISSION OR COMMAND)
7 LANYARD TO PILOTS PERSONAL GEAR
8 OXYGEN SYSTEM PRESSURE TEST BUTTON
9 SURVIVAL KIT RELEASE AND LIFE RAFT ACTUATION HANDLE
10 PARACHUTE ATTACHMENTS

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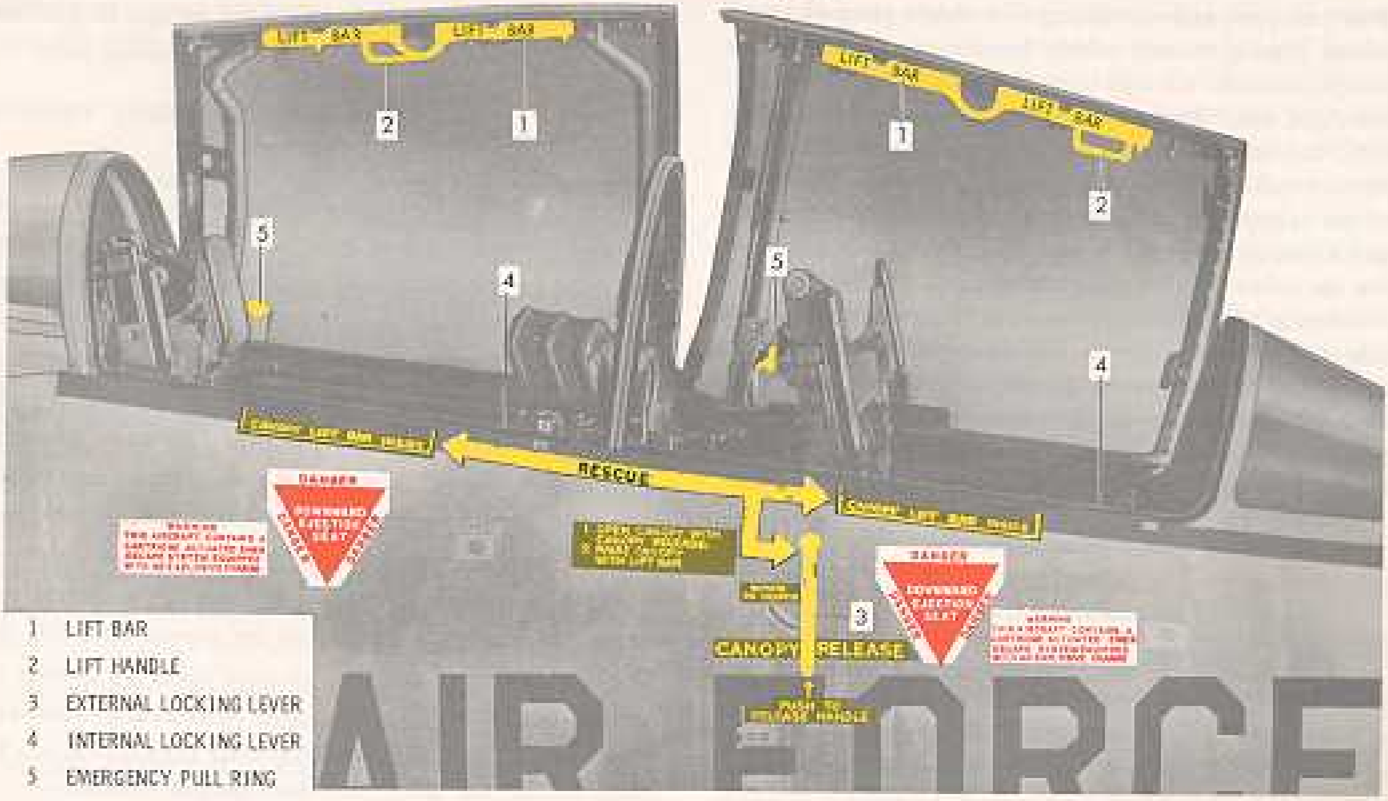
Figure 1-33

CANOPY CONTROLS

(UNMODIFIED AIRCRAFT)



(MODIFIED AIRCRAFT)

Figure 1-34

CANOPIES (NON-JETTISONABLE).

Two canopies, each consisting of a single piece of transparent plastic, secured within frames, are hinged to the cockpit left sill. Canopy operation is accomplished from the right side. Because the primary means of air escape is by the downward seat ejection system, no emergency jettison system for the canopies is provided. Operation of the canopies is completely manual by use of internal and external controls. A part-open position is provided for use when an emergency landing is imminent. This position is provided to prevent jamming of the canopies due to structural distortion upon impact. When either canopy is opened to the part-open position, sear pins automatically engage in the part-open tracks. Thus the canopy pins are locked between the ends of the grooves in the part-open tracks and the sears.

CAUTION

The canopy should not be opened in flight except when an emergency landing is imminent and then only to the part-open position at below canopy part-open structural limit speed.

CANOPY SEAL.

Inflatable rubber seals are installed in the edge of the canopy frame and seat against the mating surfaces when locked to provide sealing for cockpit pressurization. The seal pressurization switch is actuated by the forward center canopy latch when the canopy is closed and locked and by a landing gear actuated switch when the aircraft weight is off the gear. The switches operate a valve which allows engine compressor air to inflate the seal. Seal pressure will be dumped when the weight of the aircraft is on the landing gear, the canopy latching handle is in the unlocked position or when seat ejection is initiated. Electrical power is supplied by the d.c. emergency bus.

CANOPY LIFT HANDLES.

Black canopy lift handles (2, figure 1-34) are welded to yellow lift bars which are pivoted on the right canopy frame. These handles are designed for internal operation by the right hand. Movement of the handle toward the right unlocks the full-open latch and allows the canopy to begin closing. As the center of gravity of the canopy passes over the top-dead-center, the weight of the canopy will be felt increasingly until it comes to a rest on two lifter cams which protrude through the right canopy sill and hold the canopy approximately two inches from the sill. This places the canopy in position so that it can be locked by the internal locking lever.

CANOPY INTERNAL LOCKING LEVERS.

Levers (4, figure 1-34) located below the canopy sill on the right forward side of each cockpit are used to lock the canopies in the full-closed position or to unlock them from the full-closed position. After the canopies have been lowered so that they rest on the lifter cams, they may be fully locked by moving the canopy internal locking levers forward to the full-locked position which is indicated by the red sheet metal indicators located under the right forward canopy sills. This is the forward end of the canopy internal locking lever stroke. A very positive over center feel wil be noticed as levers are moved forward. As the levers are moved forward, the lifter cams retract and the canopies lower by gravity to the sill where three hooks engage three canopy brackets. These hooks are designed so that their engagement can be observed by the pilot to assure proper operation.

Note

The aft canopy must be closed and locked prior to closing and locking the forward canopy.

CAUTION

The canopy opening, and closing operation is designed to work smoothly and effortlessly. If the canopy is slammed shut or open, the system may be damaged. If any forcing is necessary to promote hook engagement, the canopy is either out of rig or improperly fitted, and corrective action must be taken before flight.

Canopy internal locking levers may also be used in flight to allow their respective canopies to go to the part-open position. This position is to be used only when an emergency landing is imminent. To place the canopy in the part-open position, the internal locking lever must be pulled to the full aft position. This action unlocks the engagement mechanism and extends the lifter cams. External negative air pressure will suck the canopy open until the part-open mechanism locks it about three inches from the canopy sill.

CANOPY EMERGENCY PULL RINGS.

If the right side of the cockpit is blocked it is possible for the pilot to escape or be removed from the left side. Yellow pull rings (5, figure 1-34) located on the left aft side of each canopy may be used to release the canopy full open lock. After the canopy has been raised to the full-open position, pulling the handle will allow the canopy to fall against the left side of the fuselage. The canopy frame and hinge will yield or fail completely when the canopy bottoms out on the fuselage. This provides a much larger exit area on the left side between the windshield frame and the forward end of the canopy. Since pulling this ring when the canopy is in the normal full-open position will damage the canopy and canopy hinges, it should be actuated only for emergency escape.

CANOPY EXTERNAL LOCKING LEVERS.

An external, flush-mounted yellow lever (3, figure 1-34) provides external control of the canopies identical to the internal locking levers in the cockpit. (Refer to Canopy Internal Locking Levers in this Section.) The external locking lever is placarded CANOPY RELEASE and is located on the right side of the fuselage below the windshield. The handle may be extended for use by pushing on the handle release at the lower end and stowed to the flush position by pushing on the opposite end.

CANOPY LIFT-BARS.

Yellow canopy lift-bars (1, figure 1-34) are attached to the right edge of the canopies. These bars are external controls and may be used to perform the same operations as the canopy-lift handles. (Refer to Canopy Lift Handles in this Section.) The only operational difference is that after the internal or external locking levers have been unlocked and the canopies are resting on the lifter cams or are in the part-open position, the hands are inserted under the canopy to lift the bar and raise the canopy. The lift-bars are placarded LIFT HERE where the hands should be inserted for lifting the canopy.

CANOPIES (JETTISONABLE).

Two canopies, each consisting of a single piece of transparent plastic, secured within frames, are hinged to the left cockpit sills. Normal operation of the canopies are completely manual. Cartridge type charges are provided for jettisoning the canopies in an emergency. When jettisoned, the canopies are released from both sides and are raised about two inches above the canopy sills by the canopy unlatching thrusters. The canopy unlatching thrusters in turn fire the canopy ejector thrusters on the forward canopy sills to insure upward rotation of the canopies. From this point the canopies are automatically hinged at the upper rear, allowing them to rotate upward and back. Each canopy is automatically jettisoned during the pilot escape ejection sequence by actuating the ejection ring on the respective seat.

CANOPY SEAL.

Inflatable rubber seals are installed in the edges of the canopy frames and seat against the mating surfaces of the canopy sills and windshield to provide sealing for cockpit pressurization. The seal pressurization switch is actuated by the center canopy latch when the canopy is down and locked and by a landing gear actuated switch when the aircraft weight is off the gear. The switches operate a valve which allows engine compressor air to inflate the seal. Seal pressure will be dumped when the weight of the aircraft is on the landing gear or when the canopy is in the unlocked position or when seat ejection is initiated. Electrical power is supplied to the switches from the d.c. emergency bus.

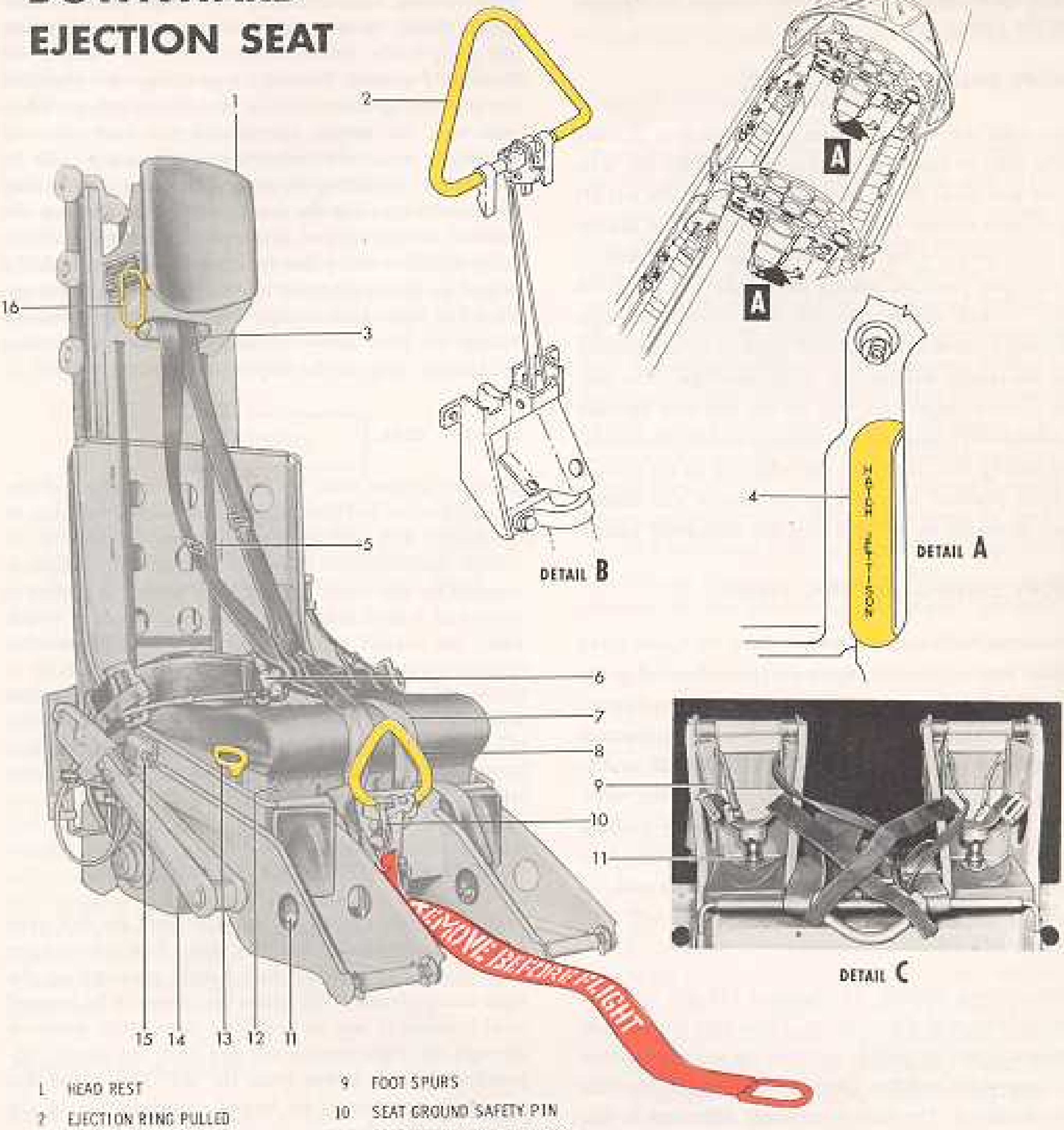
CANOPY FULL OPEN LOCK RELEASE LEVER.

Each canopy is released individually from the full open position by depressing a small canopy lock release lever (1, figure 1-34) attached to a handle mounted on the right canopy frame. This allows the canopy to be lowered until it comes to rest on two lifter cams which protrude through the right canopy sill and hold the canopy approximately two inches from the sill. This places the canopy in position to be locked closed by use of the internal locking lever.

CANOPY INTERNAL LOCKING LEVERS.

Levers (2, figure 1-34) located below the canopy sill on the right forward side of each cockpit are used to lock or unlock the canopies. After the canopies have been

DOWNWARD EJECTION SEAT



1. HEAD REST
2. EJECTION RING PULLED (SEAT FIRED)
3. SHOULDER HARNESS
4. ESCAPE HATCH JETTISON HANDLE
5. PILOT-SEAT SEPARATOR
6. AUTOMATIC OPENING SEAT BELT
7. TIE-DOWN STRAP
8. EJECTION RING
9. FOOT SPURS
10. SEAT GROUND SAFETY PIN
11. FOOT RETRACTOR FITTING (2)
12. OXYGEN SYSTEM PRESSURE TEST BUTTON
13. SURVIVAL KIT RELEASE AND LIFE RAFT ACTUATION HANDLE
14. KNEE GUARD
15. VERTICAL ADJUSTMENT SWITCH
16. MANUAL CABLE CUTTER RING

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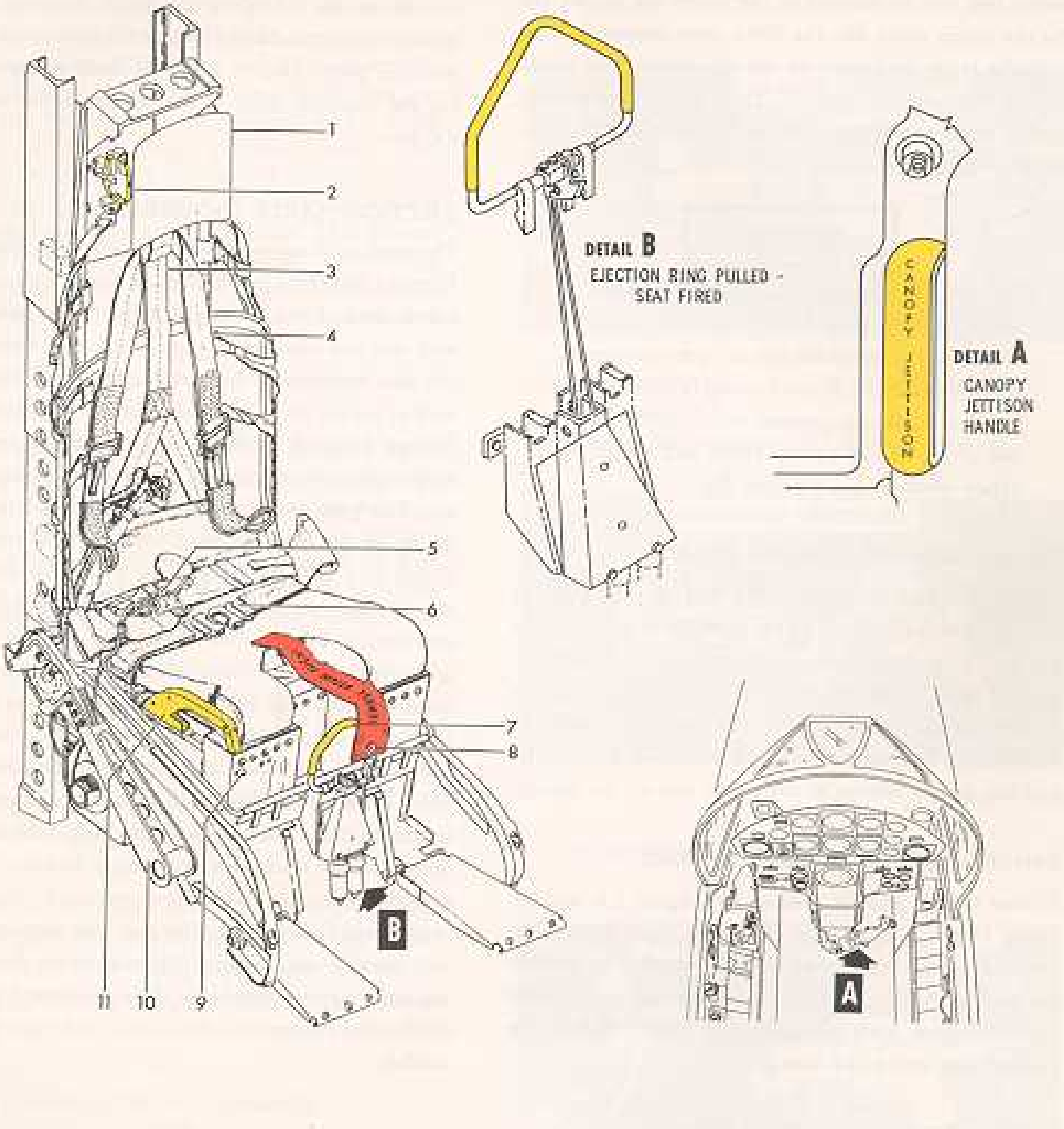
Figure 1-35

UPWARD EJECTION SEAT



1 HEAD REST
2 MANUAL CABLE CUTTER RING
3 PILOT-SEAT SEPARATOR
4 SHOULDER HARNESS
5 AUTOMATIC SEAT BELT
6 SURVIVAL KIT ATTACHMENT STRAP
7 EJECTION RING
8 SEAT GROUND SAFETY PIN
9 OXYGEN SYSTEM PRESSURE TEST BUTTON
10 KNEE GUARD (STOWED POSITION)
11 SURVIVAL KIT RELEASE HANDLE

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Figure 1-36

lowered so that they rest on the lifter cams, they may be fully locked by moving the canopy internal locking levers to the full locked position. A very positive over center feel will be noticed as the levers are moved aft. As the levers move aft, the lifter cams retract and the canopies lower by gravity to the sill where three hooks engage three canopy brackets. These hooks are designed so that their engagement can be observed by the pilot to assure proper operation.

CAUTION

The canopy opening and closing operation is designed to work smoothly and effortlessly. If the canopy is slammed shut or open, the system may be damaged. If any forcing is necessary to promote hook engagement, the canopy is either out of rig or improperly fitted, and corrective action must be taken before flight.

CANOPY EXTERNAL LOCKING LEVER.

An external flush-mounted yellow lever (3, figure 1-34) provides external control of the canopies identical to the internal locking levers in the cockpit. The external locking lever is placarded CANOPY RELEASE and is located on the right side of the fuselage below the windshield. The handle may be extended for use by pushing on the release at the lower end of the handle.

CANOPY INTERNAL JETTISON HANDLES.

Yellow canopy jettison handles (26, figure 1-6, and 25, figure 1-7) are located on the lower right instrument panels in each cockpit and allow each pilot to jettison his canopy independent of the automatic canopy-seat ejection system. Each canopy may be jettisoned with the ejection seat safety pin installed.

CANOPY EXTERNAL JETTISON HANDLE.

The canopy external jettison handle located on the left side of the fuselage permits ground rescue personnel to jettison the canopies for emergency entrance. The handle cover is labeled EMERGENCY CANOPY JETTISON ACCESS DOOR. The "T" handle and the canopy internal jettison handles use the same linkage system to fire the canopies. The linkage is designed so that the front canopy will fire first and the rear canopy will fire approximately 3 seconds later.

CANOPY UNSAFE WARNING LIGHT.

If a canopy is not properly locked, microswitches in the canopy locking mechanism and right canopy rail will illuminate the CANOPY UNSAFE warning light together with the MASTER CAUTION light on the warning panel (figure 1-13) of both cockpits. Power for the warning light is derived from the emergency d.c. bus.

EJECTION SEATS (DOWNWARD).

The airplane is equipped with catapult-type ejection seats (figure 1-35) that eject downward through escape hatches below the cockpits. A single catapult is mounted behind each seat and contains an explosive charge which propels the seat downward. Each seat assembly is mounted on rails to permit vertical seat adjustment. Quick disconnect fittings, installed on the aft left side of the seats permit single point disconnection for the microphones, headsets, face plate leads, and oxygen lines. Another similar fitting in the same location for each seat contains the G-Suit and ventilated suit hose quick disconnect. The seats incorporate head rests, tie down straps, knee guards, arm nets, automatic foot retractors, shoulder harnesses and inertia reel lock assemblies, initiator-operated automatic-opening seat belts, and thruster by-passes which provide a secondary means of firing the catapults. A yellow D-ring located to the right of the headrest provides a means for manually activating the cable cutter initiator. Below the seats and attached to the fuselage by quick release hooks are the escape hatches. Initiator-operated thrusters and initiator-operated catapults provide power for ejection. The seat rails support the seats and provide tracks which the seat slides down during ejection. As the seats begin their downward movement, mechanical connections disconnect and eject the escape hatches.

Note

The rigid seat style survival and oxygen kit container is contractor furnished equipment. No parachute support block is required because the aft section of the kit has a parachute support. If aircraft are furnished without kit containers, either the MC-2 seat cushion or the MD-1 contoured seat style survival kit container should be used. When the MD-1 container is used, the parachute support block is required.

PILOT SEAT SEPARATION.

The C-1 ejection seat is provided with a pilot-seat separation system which operates in conjunction with the automatic seat belt release system. The system consists of a wind-up reel mounted behind the headrest, a nylon webbing arrangement, an initiator and a gas generator. Two nylon webs (5, figure 1-35) are routed from the reel down the forward face of the seat back. From this point the nylon straps continue down, pass under the survival kit and are secured to the forward seat bucket lip. During ejection, the seat belt release initiator fires, energizing a gas generator. This generator actuates a wind-up reel which winds the webbing onto a cross shaft, pulls the webbing taut and causes the pilot to be separated from the seat with a sling-shot action.

AUTOMATIC SEAT BELTS.

The ejection seat belts are equipped with modified MA-6 automatic-opening seat belts (figure 1-37) which facilitate pilot separation from the seat following ejection. Belt opening is accomplished as part of the ejection sequence and requires no additional effort of the part of the pilot. As the seat travels down the rails during ejection a mechanical trip bar fires the seat belt initiator.

WARNING

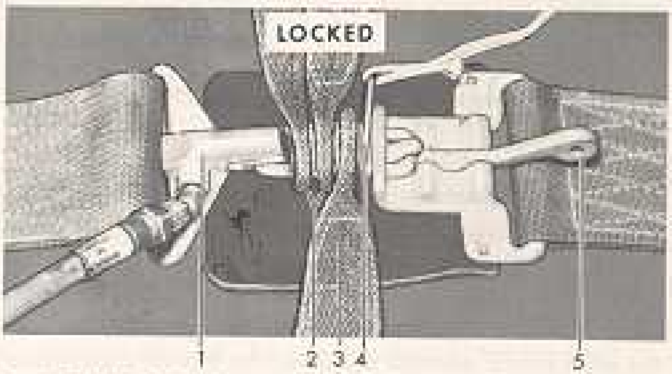
The initiators and the catapult contain explosive charges and should be handled by qualified personnel only.

This is a one second delay initiator which, upon firing, produces gas pressure which is directed to the belt buckle through a flexible hose. Gas pressure opens the buckle which releases the seat belt, shoulder harness and tie down strap.

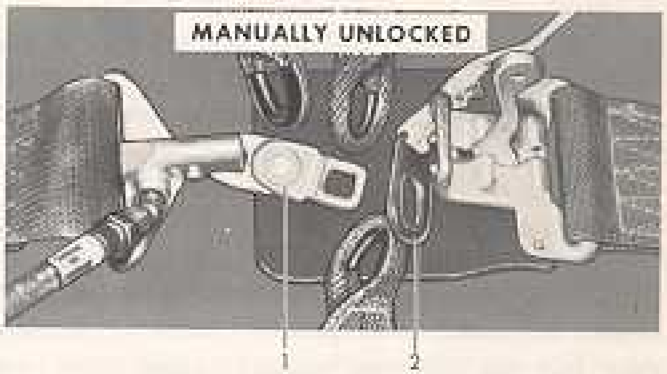
SEAT BELT — PARACHUTE ATTACHMENTS.

If the pilot is wearing an automatic-opening, aneroid-type parachute, the parachute lanyard anchor from the chute-opening device must be attached to the swivel link. As the pilot separates from the seat, the lanyard, which is anchored to the belt, serves as a static line to arm the chute-opening device. The parachute will then open at the preset time lapse or altitude. The automatic-opening seat belt is unlocked in the same manner as a conventional seat belt, and can be opened manually if automatic opening fails.

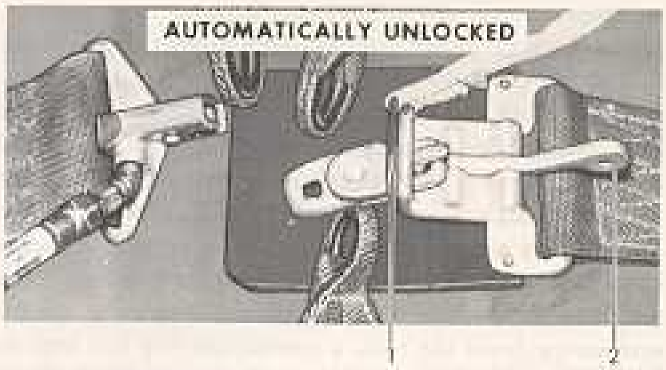
AUTOMATIC SEAT BELT



1. AUTOMATIC RELEASE
2. SHOULDER HARNESS
3. TIE-DOWN STRAP (DOWNWARD EJECTION AIRCRAFT ONLY)
4. PARACHUTE LANYARD ANCHOR
5. MANUAL RELEASE



1. SWIVEL LINK
2. PARACHUTE LANYARD ANCHOR



1. PARACHUTE LANYARD ANCHOR RETAINED BY SHOULDER ON SWIVEL LINK
2. MANUAL RELEASE LEVER LOCKED

Figure 1-37

SEAT VERTICAL ADJUSTMENT SWITCHES.

The seats are adjusted vertically by means of an electric actuator mounted on the lower end of each catapult. The switches (15, figure 1-35) are located on the right side of the seat buckles. Power for seat adjustment is derived from the 28-volt d.c. monitored bus.

SHOULDER HARNESS INERTIA REEL LOCK LEVERS.

The shoulder harness inertia reel lock lever on the left side of each seat bucket, is a conventionally-operated device for locking and unlocking the shoulder harness. The lever has two positions: LOCKED and UNLOCKED. Each position is spring-loaded to hold the lever in the selected position. An inertia reel, located on the back of each seat, will maintain a constant tension on the shoulder straps to keep them from becoming slack upon backward movement. This inertia reel also incorporates a locking mechanism which will lock the shoulder harness when a 2- to 3-G body force is exerted in a forward direction. When the reel is locked in this manner, it will remain locked until the lock lever is moved to the LOCKED position and then returned to the UNLOCKED position.

EJECTION RING.

An ejection ring (8, figure 1-35) located on the front of each seat bucket is the primary control for ejection. Each seat has only one ejection system safety pin (10, figure 1-35) which is installed in the ejection ring housing bracket and which safeties both the ejection ring and primary initiator.

FOOT SPURS.

Foot spurs (9, figure 1-35) are attached to the pilot's feet and to the ejection seat by cables. Normal foot movement is in no way restricted as the cables are under a slight spring tension and reel in and out freely. When the ejection ring is pulled and the knee guards rotate from their stowed position, the cables to the foot spurs are reeled in, pulling the feet into the foot rests. As the seat moves down the rails, a mechanical trip bar fires an M-12 initiator which activates the automatic seat belt and one side of the foot retractor cable cutters. This will release the seat belt and both feet. A secondary cable cutter system also is activated by a separate trip bar which fires a second M-12 initiator. This initiator causes the other side of the cable cutters to operate, thus insuring foot release. Either side of the cable cutters, when activated, will completely release both feet.

MANUAL CABLE CUTTER D-RING.

All modified ejection seats incorporate an emergency means for cutting the foot retractor cables. A yellow D-ring (16, figure 1-35) located to the right of the seat head rest, has been connected to an initiator which operates the cable cutters. This provides a manual means for activating the cable cutter initiator should the automatic cable cutter system fail or if rapid abandonment from the aircraft is required on the ground.

ESCAPE HATCH JETTISON HANDLE.

A yellow handle (4, figure 1-35), located on the right of the center control stand in each cockpit, may be used to jettison the escape hatches in case the automatic ejection system fails. Manual release of the hatch and seat is accomplished by first pulling the hatch escape handle to the stop (about 7 inches). This action manually jettisons the hatch and pulls the pin on the catapult free-fall disconnect. The ejection ring must then be repulled. This action will cause the free-fall disconnect to revolve and the initiator-operated thruster to be bypassed. The catapult initiator will then fire the catapult and eject the seat or the seat will free fall clear of the aircraft. When this secondary means of escape is necessary, the automatic foot retractors, knee guards, tie-down strap tightening, inertia reel lock, and control stick stowage do not operate; however, if the feet are pulled back manually, they will be retained in that position and released in the normal manner upon ejection.

HATCH UNSAFE WARNING LIGHTS.

If either hatch is not properly locked, a mechanical indicator plus a microswitch will illuminate the HATCH UNSAFE warning light on the warning panel. Power for the warning light is derived from the emergency d.c. bus.

PRE-EJECTION SEQUENCE.

When the ejection ring is pulled, firing the initiator, the emitted gas pressure operates the thruster which causes the following: Raises the knee guards and deploys the arm nets, pulls the pilot's feet into the foot rests, tightens the tie down strap, locks the inertia reel, stows the control stick in the forward position and dumps the cabin pressure. The emergency oxygen supply is automatically actuated by the movement of the ejection seat during the ejection sequence. The ejection ring is connected to the initiator by a linkage having three inches of slack.

Note

- The slack assures that the initiator will not fire if the ejection ring is inadvertently knocked or pulled. Also, the slack in the system places the hands and arms in the most advantageous position for a safe ejection.
- The ejection ring cable is restrained by a spring-cartridge designed to absorb the sudden shock of the airloads which could cause the pilot to lose his grip on the ring.

FINAL EJECTION SEQUENCE.

The thruster fires the catapult initiator which, in turn, fires the seat catapult. One inch of downward travel of the seat releases and ejects the ecape hatch. As the seat continues downward, mechanical trip bars fire the initiators which open the seat belt and cut the foot retractor cables.

EJECTION SEAT (UPWARD).

The rocket propelled upward ejection system offers a substantial advantage over the earlier downward ejection system. This advantage is realized whenever low altitude ejections are attempted. The upward ejection system has reduced the minimum ejection altitude to ground elevation provided that any airspeed between 120 KIAS and 300 KIAS is achieved before ejecting. All upward ejection seats incorporate a pilot-seat separation device which eliminates the problem of "kicking free" of the seat after ejection. The seat also incorporates an ejection ring, headrest, knee guards, vertical seat adjustment, arm nets, automatic foot retractors, automatic foot retention separation, shoulder harness, inertia reel lock assembly, and an initiator-operated automatic opening seat belt. An initiator operated thruster and an initiator operated catapult provide initial power for ejection. The seat rails support the seat and provide tracks which the seat slides up during ejection. At a predetermined point in the upward travel of the seat, a rocket charge is ignited by the initial charge which provides additional upward thrust to the seat. Quick disconnect fittings installed on the bottom of the survival kit permit single point disconnection for the microphone, headrest, face plate lead and pressure suit oxygen line. A fitting on the left side of the seat contains the G-suit and ventilated suit hose quick disconnect. Another fitting on the right side of the seat contains the diluter demand system disconnect. A secondary backup system operated by the single pull of the ejection ring fires a one-second delay initiator into the catapult and a two-second delay initiator into the foot cable cutters. A yellow D ring located on the right side of the headrest provides a means for manually activating the cable cuter initiator.

Note

Use of incorrect seat cushions or kits increase the chances of back injury upon ejection or crash landing. The rigid seat-style survival and oxygen kit container is contractor furnished equipment. No parachute support block is required because the aft section of the kit has a parachute support. It aircraft are furnished without kit containers, either the MC-2 seat cushion or the MD-1 contoured seat style survival kit container should be used. When the MD-1 container is used, the parachute support block is required.

PILOT-SEAT SEPARATION SYSTEM.

The C-2 ejection seat is provided with a pilot-seat separation system which operates in conjunction with the automatic seat belt release system. The system consists of a wind-up reel mounted behind the headrest, a nylon webbing arrangement, an initiator and a gas generator. A single nylon web (3, figure 1-36) is routed from the reel half-way down the forward face of the seat back. From this point two separate nylon straps continue down, pass under the survival kit and are secured to the forward seat bucket lip. During ejection, the seat belt release initiator fires, energizing a gas generator. This generator actuates a wind-up reel which winds the webbing onto a cross shaft, pulls the webbing taut and causes the pilot to be separated from the seat with a sling-shot action.

AUTOMATIC SEAT BELT.

The ejection seat is equipped with a modified MA-6 automatic-opening seat belt (figure 1-37) which facilitates pilot separation from the seat following ejection. Belt opening is automatically accomplished as part of the normal ejection sequence and requires no additional effort on the part of the pilot. As the seat travels up the rails during ejection, a mechanical trip bar fires a one-second delay initiator which actuates the foot cable cutters. This initiator fires a second initiator which passes gas pressure to the seat belt buckle and releases the seat belt and shoulder harness. The second initiator also fires a gas generator in the pilot-seat separation system. (Refer to Pilot-Seat Separation System in this Section.) If the primary one-second delay initiator fails to fire, a secondary two-second delay initiator fires. The secondary initiator which fires when the ejection ring is pulled will only actuate the foot cable cutters. In this case there will be no automatic seat belt release, the pilot-seat separation will not operate, and the pilot will be required to manually release the seat belt and push free of the seat after ejection.

SEAT-BELT — PARACHUTE ATTACHMENTS.

If the pilot is wearing an automatic-opening aneroid type parachute, the parachute lanyard anchor from the chute-opening device must be attached to the swivel link of the lap belt. As the pilot separates from the seat, the lanyard which is attached to the belt serves as a static line to arm the chute-opening device. The parachute will then open at the preset time lapse or altitude.

SEAT VERTICAL ADJUSTMENT SWITCH.

The seat is adjusted vertically by means of an electric actuator mounted on the lower end of the catapult. The switch is located on the right side of the seat bucket. Power for seat adjustment is derived from the 28-volt d.c. monitored bus.

SHOULDER HARNESS INERTIA REEL LOCK LEVER.

The shoulder harness inertia reel lock lever, on the left side of the seat bucket, is a conventionally operated manual device for locking and unlocking the shoulder harness. The lever has two positions, LOCKED and UNLOCKED. Each position is spring-loaded to hold the lever in the selected position. An inertia reel, located on the back of the seat, will maintain a constant tension on the shoulder straps to keep them from becoming slack upon backward movement. This inertia reel also incorporates a locking mechanism which will lock the shoulder harness when a 2 or 3 G body force has been exerted on the harness in a forward direction. When the reel is locked in this manner, it will remain locked until the lock lever is moved to the LOCKED position and then returned to the UNLOCKED position.

EJECTION RING.

An ejection ring (7, figure 1-36) located on the front of the seat bucket is the primary control for ejection. The ejection system safety pin (8, figure 1-36) is installed in the ejection ring housing bracket.

FOOT SPURS.

Foot spurs attached to the pilot's shoes are attached to the ejection seat by cables. Normal foot movement is in no way restricted as the cables are under a slight spring tension and reel in and out freely. When the ejection ring is pulled and the knee guards rotate from their stowed position, the cables to the foot spurs are reeled in, pulling the feet into the foot rests. As the seat moves up the rails, a mechanical trip bar fires a one-second delay initiator which activates the foot cable cutters and actuates the pilot-seat separation system. A secondary back-up cable cutter system with a two-second delay initiator also fires automatically when the ejection ring is pulled.

MANUAL CABLE CUTTER RING.

All ejection seats incorporate an emergency means for cutting the foot retractor cables. A yellow D ring (2, figure 1-36) located to the right of the seat headrest has been connected to an initiator which operates the cable cutters. This provides a manual means for activating the cable cutters initiator if a rapid abandonment from the aircraft is required on the ground.

ONE-AND-ZERO SYSTEM.

In order to provide an improved low altitude escape capability, a system incorporating a one-second seat belt delay and a zero-second parachute delay (one-and-zero system) is provided for ejection seat escape systems. (This system is applicable for both upward and downward ejection seats.) This system makes use of a detachable lanyard that connects the parachute timer knob to the parachute D-ring. At very low altitudes and airspeeds this zero delay lanyard must be connected to provide parachute actuation immediately after separation of the pilot from the ejection seat. At other altitudes and airspeeds the lanyard MUST BE DISCONNECTED from the D-ring to allow the parachute timer to actuate the parachute below the critical parachute

ZERO-DELAY LANYARD

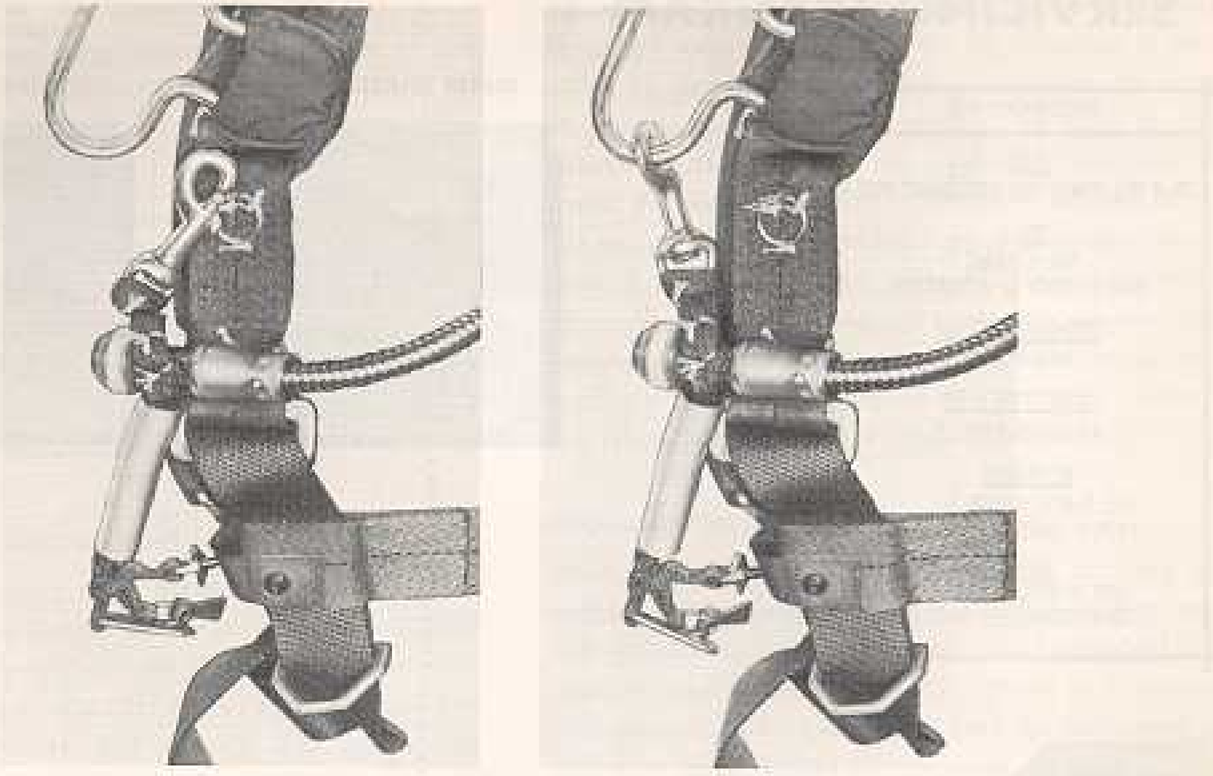


Figure 1-38

F54-8-3-51

opening speed and below the parachute timer altitude setting. A ring attached to the parachute harness is provided for stowage of the lanyard hook when it is not connected to the parachute D-ring. THIS *HOOK UP* and *UNHOOK* OF THE LANYARD MUST BE DONE MANUALLY BY THE PILOT. An illustration of the hook, figure 1-38, depicting the *hooked* and *unhooked* conditions, is provided for information purposes only. The lanyard configuration is one of several which will be in service use. Although each type lanyard differs in appearance, the hook and attaching positions are similar. *The following requirements are mandatory for use with the one-and-zero escape system:*

Before take-off, the lanyard must be hooked up to the D-ring. A check should be made as part of the pilot's cockpit check sequence prior to take-off, to insure that the lanyard is connected. After take-off the lanyard must be unhooked and stowed by the pilot, after passing through the minimum safe ejection altitude for his particular escape system. This minimum ejection altitude must be determined by the pilot from figure 3-5.

WARNING

The lanyard must be disconnected whenever operating at high alitudes or airspeeds in order that the safety-delay provided by the parachute timer-aneroid will not be overridden.

Before landing, the pilot must hook the lanyard prior to reaching the minimum safe ejection altitude for his particular escape system. When the pilot's flight duties necessitate hooking and unhooking the lanyard at altitudes higher than those specified in the preceding paragraphs, it should be noted that with the one-and-zero system the safe ejection speeds for the various parachute configurations are as shown in figure 3-6.

AUXILIARY EQUIPMENT.

Information concerning the following auxiliary equipment is supplied in Section IV; Air Conditioning and Pressurization System, Defrosting and Rain Removal System, Anti-Icing Systems, Communications and Associated Electornic Equipment, Lighting Equipment, Oxygen Supply System, Navigation Equipment, Armament Equipment, Pressure Refueling System, and Miscellaneous Equipment.

SERVICING DIAGRAM

SPECIFICATIONS

FUEL
JP-4 MIL-F5624 (NO ALTERNATE FUEL)

OIL
MIL-L-7808C
MIL-L-7808B-1, ALTERNATE

HYDRAULIC FLUID
MIL-H-5606

LIQUID OXYGEN
BB-O-925 TYPE II

NITROGEN
MIL-N-6011 GRADE A
TYPE 1 (WATER PUMPED)

WATER
USE DISTILLED OR
DEMINERALIZED WATER

Figure 1-39


AIR REFUELING PROBE★
HYDRAULIC BRAKE SIGHT GAGE AND FILLER FOR AFT COCKPIT
REFUELING WELLS★
OIL DIP STICK
U.S. AIR FORCE
★ AIR REFUELING PROBE, FORWARD REFUELING WELL AND REFUELING PRE-CHECK SWITCH PANEL ARE INSTALLED ON AF SERIALS 57-1329 AND SUBSEQUENT ONLY
REFUELING PRECHECK SWITCH PANEL★
HYDRAULIC SYSTEM QUANTITY GAGES AND BLEED LINES
OIL FILLER
HYDRAULIC SYSTEM FILLERS, ACCUMULATOR AND PRESSURE GAGES

normal procedures

SECTION II

TABLE OF CONTENTS

PREPARATION FOR FLIGHT

FLIGHT RESTRICTIONS.

Refer to Section V in Confidential Supplement, T. O. 1F-104D-1A for detailed airplane and engine limitations.

FLIGHT PLANNING.

Refer to Appendix I of Confidential Supplement T. O. 1F-104D-1A to determine the fuel quantity, engine settings and airspeeds that are required to complete the mission.

TAKE-OFF AND LANDING DATA CARDS.

Refer to Appendix I of Confidential Supplement T. O. 1F-104D-1A for the information necessary to fill out the Take-off and Landing Data Cards before each flight.

Figure 2-1

PREPARATION FOR FLIGHT CONTINUED

WEIGHT AND BALANCE.

Refer to Section V for weight limitations. For loading information, refer to Handbook of Weight and Balance Data, T. O. 1-1B-40.

PREFLIGHT CHECK

BEFORE EXTERIOR INSPECTION.

1. Check Form 781 for engineering status and servicing.

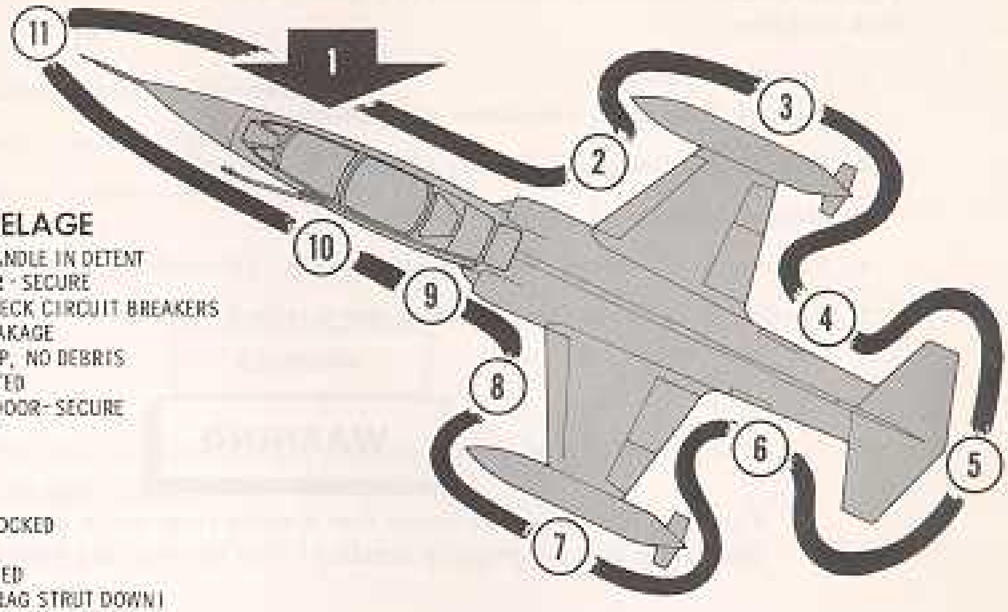
EXTERIOR INSPECTION.

CAUTION

Each tip tank has two fillers, one for each compartment. If a flight is necessary with partially filled tip tanks, the forward compartment must be filled first. Filling the aft compartment first would result in a tip tank aft center of gravity and the possibility of tip tank flutter.

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 AND COVERS
- REMOVAL OF GROUND SAFETY GUARDS AND COVERS
- WHEEL CHOCKS IN PLACE



1 RIGHT FORWARD FUSELAGE
- CANOPIES UNLOCKED, EXTERNAL HANDLE IN DETENT
- ELECTRONICS COMPARTMENT COVER - SECURE
- OPEN ELECTRICAL LOAD CENTER - CHECK CIRCUIT BREAKERS
- RAM AIR TURBINE - SECURE, NO LEAKAGE
- AIR CONDITIONING RAM AIR SCOOP, NO DEBRIS
- ENGINE INTAKE DUCT - UNOBSTRUCTED
- ENGINE INTAKE DUCT INSPECTION DOOR - SECURE
- NAVIGATION LIGHTS - UNDAMAGED

2 RIGHT MAIN GEAR
- LANDING GEAR DOORS UPLOCKS, COCKED
- GROUND SAFTY PINS - REMOVED
- LANDING GEAR DUMP VALVE-SAFETIED
- DOWNLOCKS IN PLACE (KNOB ON DRAG STRUT DOWN)
- SHOCK STRUTS EXTENDED (1 1/2 - 1 3/4")
- LANDING GEAR LIGHTS - SECURE AND UNDAMAGED
- CHECK FOR CLEARANCE BETWEEN WHEEL AND TIE ROD
- WHEEL BRAKE LINES SECURE, NO LEAKAGE, SELF ADJUSTER EXPOSED NOT LESS THAN 1/4"
- TIRES - INFLATION, CONDITION AND SLIPPAGE

3 RIGHT WING
- LEADING EDGE FLAP AND TIP - CONDITION, NO CRACKS OR DISTORTIONS
- ATTACHMENT OF EXTERNAL STORES SECURE, GENERAL CONDITION
- AILERON AND TRAILING EDGE FLAP - CONDITION, NO CRACKS OR DISTORTIONS
- SURFACE - CONDITION, NO CRACKS OR DISTORTION, PANEL SECURE
- VISUALLY CHECK RIGHT TIP AND PYLON TANKS, IF INSTALLED, FOR FUEL LEVEL AND AMOUNT

4 RIGHT AFT FUSELAGE
- BLOW OUT PANEL - SECURE
- SPEED BRAKE - CONDITION, CONNECTIONS, NO LEAKAGE
- NAVIGATION LIGHTS - UNDAMAGED
- DRAG CHUTE - INSTALLED
- VENTRAL FIN FOR ALIGNMENT

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 OR OIL LEAKS
- AFTERBURNER SPRAY BARS, FLAME HOLDER 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 - SAFTIED IN NUMBER 2 POSITION
- HYDRAULIC SYSTEM QUANTITY GAGES AT PROPER LEVEL
- HEAT EXCHANGER FOR CRACKS OR DISCOLORATION, CHECK
- ENGINE OIL DIPSTICK COVER - SECURE, FLAG DOWN

7 LEFT WING
(SAME AS STEP 3)

8 LEFT MAIN GEAR
(SAME AS STEP 2) EXCEPT:
- GROUND - AIR SAFETY SWITCH (LEFT GEAR ONLY) CLEAN, UNDAMAGED

9 LEFT FORWARD FUSELAGE
- FUEL FILLER CAPS - SECURE
- NAVIGATION LIGHT - UNDAMAGED
- ENGINE INTAKE DUCT INSPECTION DOOR - SECURE
- ENGINE INTAKE DUCT - UNOBSTRUCTED
- SINGLE POINT FILLER CAP - SECURE (AF SERIALS 57-1329 AND SUBSEQUENT)
- AIR REFUELING PROBE - SECURE (IF INSTALLED)
- REFUELING PRECHECK SWITCH COVER - SECURE

10 NOSE GEAR
- GROUND SAFETY PIN - REMOVED
- SCISSORS - PROPERLY CONNECTED
- DOWNLOCK - FULLY ENGAGED IN SLOT
- TAXI LIGHT - SECURE AND UNBROKEN
- SHOCK STRUT - EXTENDED 2 INCHES
- TIRE - INFLATION, CONDITION
- SEAT EJECTION HATCHES - PROPERLY SECURED (UNMODIFIED AIRCRAFT)

11 NOSE SECTION
- INFRA-RED SIGHT WINDOW - UNDAMAGED
- RADOME LATCHES - SECURE
- PITOT HEAD - SECURE, COVER REMOVED, OPENINGS CLEAN
- PITCH SENSOR VANES - FREE TO MOVE, GUARDS REMOVED

Figure 2-2

PREFLIGHT CHECK CONTINUED

Perform exterior inspection as outlined in Figure 2-2 and make the following additional checks in both cockpits:

1. Canopies — Check.
   Check for cracks, cleanliness and distortion.
2. Seat free fall linkages — Secure. (Unmodified aircraft.)
3. Manual cable cutter D-ring — Secure.
4. Ejection hatch release mechanisms — Secure. (Unmodified aircraft.)
5. Ejection rings in position and safety pins installed — Check.

WARNING

Care should be taken to insure that ejection rings are in proper position and that safety pins are properly installed in the ejection ring housing bracket.

6. Shoulder harness straps — Check.
7. Ejection seat and seat belt initiator hoses — Inspect general condition.
8. Survival kit emergency oxygen pressure — Check.
9. Flashlight, maps, reference books and personal gear — Check.

WARNING

- Do not stow items such as maps, navigation kits, flying clothes, etc., under the survival kit cushion and under and around the ejection seat. This practice can interfere with the normal operation of the escape system. This foreign material, in the event ejection becomes necessary, could restrict separation of the man and kit from the seat, or preclude proper ejection operation.
- If any safety wire is broken, do not fly aircraft until cleared by maintenance personnel.

10. Landing gear levers — Down.

AFT COCKPIT CHECK (SOLO FLIGHTS).

The following aft cockpit inspection must be made before solo flights.

1. Seat belt, tie-down strap, shoulder harness and all personal leads — Secured.
2. Circuit breakers — In.
3. Stability control switches — ON.

PREFLIGHT CHECK CONTINUED

4. External stores release selector switch — OFF.
5. Fuel shut-off switch — ON.
6. Radio control transfer switches — Forward.
7. Auxiliary trim control switch — NEUTRAL.
8. Auxiliary trim selector switch — STICK TRIM.

CAUTION

Do not use the auxiliary trim control without hydraulic pressure as this may damage the trim motors.

9. UHF command radio — OFF.
10. Wing flap lever — UP.
11. Throttle — OFF (Check).
12. Speed brake switch — NEUTRAL.
13. Exhaust nozzle control switch — AUTO (guard down).
14. Landing and taxi lights switch — OFF.
15. IGV switch — AUTO (guard down and safetied).
16. Drag chute handle — Stowed.
17. Manual landing gear release handle — Stowed.
18. Ram air turbine extension handle — Stowed.
19. Radar — STANDBY.
20. Escape hatch jettison handle — Stowed. (Unmodified aircraft.)
21. Canopy jettison handle — Stowed. (Modified aircraft.)
22. Face plate heat rheostat — OFF.
23. Generator switches — NEUTRAL (Guards down).
24. Survival kit oxygen supply lever — OFF.
25. Diluter demand oxygen supply lever — OFF.
26. VHF navigation radio — OFF.
27. Ram air scoop lever — CLOSED.
    Press the button on the lever and make sure lever is in the last detent.
28. Pitch sensor and pitot heat switch — OFF.
29. Thunderstorm lights switch — OFF.
30. Circuit breakers — IN.
31. Aft canopy — LOCKED.

PREFLIGHT CHECK CONTINUED

FORWARD COCKPIT CHECK (ALL FLIGHTS).

For dual flights, all items marked with an asterisk must be checked in the aft cockpit also.

* 1. Foot retractors — Attach.

* 2. Seat belt, shoulder harness, tie-down strap and parachute lanyard anchor — Fasten.

WARNING

Failure to attach the straps in the following proper sequence may prevent separation from the ejection seat after ejection.

a. Place the right and left shoulder harness loops over the manual release end of the swivel link.

b. Place the tie-down strap loop over the manual release end of the swivel link.

c. Place the automatic parachute lanyard anchor over the manual release end of the swivel link.

d. Fasten the seat belt by locking the manual release lever.

* 3. Zero-delay lanyard — Hook.

Note

The hooking of the zero-delay lanyard is at the pilot's discretion during afterburner take-off. It must be noted that if low altitude ejection is attempted with the zero-delay lanyard unhooked, an additional one second delay will be experienced before parachute deployment.

* 4. Oxygen hoses to face plate and pressure suit, other personal leads — Connect.

Connection of personal equipment should be done with the assistance of qualified personnel. Refer to Oxygen System in Section IV.

WARNING

Do not attach any personal equipment leads to the metal clips previously used to hold the arm restraining net. Such action may delay separation from the seat.

* 5. If pressure suit is not used, head set, oxygen mask, G-suit — Connect.

If the pressure suit is not used, the personal leads located on the right rear of the survival kit should be removed and stored in the kit.

6. MA-2 or MD-3 external power unit — Connected and ON.

Note

- The batteries can be used for electrical power during preflight checks and engine starting; however, if an external electrical power source is available it should be used. This will prolong battery life and provide fuel flow and oil pressure indications during engine start.
- MASTER CAUTION, INST ON EMER POWER, HYD SYSTEM OUT, AUTO PITCH OUT, NO. 1 AND NO. 2 GENERATOR OUT and ENG. OIL LEVEL LOW lights will illuminate until engine is started.

PREFLIGHT CHECK CONTINUED

7. Attitude indicator — Check.
   a. Warning OFF flag retracted within 2½ minutes.
   b. Horizon line for proper attitude and freedom from oscillation (energized).
   c. Horizon line for proper response to trim knob.

WARNING

If the warning OFF flag requires longer than 2½ minutes to retract, or if any oscillations are noted on the indicator after the OFF flag has retracted, a possible malfunction exists. Either of the above is cause for rejection of the indicator and should be entered in Form 781.

* 8. Left console circuit breakers — In.

* 9. Anti-G suit valve — As desired.

*10. Radio control transfer switches — As desired.

11. Auto-pitch control system cut-out switch — ON and safetied.

*12. Stability control switches (roll, pitch, and yaw) — ON.

13. Directional trim rheostat — Centered.

14. Missile firing selector switch — SAFE.

*15. External stores release selector switch — OFF.

16. External fuel tank selector switch — As required.

*17. Fuel shut-off switch — ON.

18. External tank fuel and air refueling selector switch (AF Serials 57-1329 and subsequent) — As required.

19. Air refueling indicator light (AF Serials 57-1329 and subsequent) — Push to test.

*20. Auxiliary trim control switch — NEUTRAL.

*21. Auxiliary trim selector switch — STICK TRIM.

CAUTION

- Do not use auxiliary trim control without hydraulic pressure as this may damage the trim motors.
- Do not attempt to move control stick without hydraulic pressure.

PREFLIGHT CHECK CONTINUED

*22. UHF command radio — As required.
*23. Exhaust nozzle control switch — AUTO. (guard down).
*24. Wing flap lever — UP (check indicator).
*25. Throttle — OFF (Check).
*26. Speed brake switch — NEUTRAL.
*27. Red landing gear warning light off — Check.
*28. Green landing gear indicator lights on — Check.
*29. Landing and taxi lights switch — OFF.
30. Engine anti-ice switch — OFF.
*31. IGV switch — AUTO (guard down and safetied).
*32. Drag chute handle — Stowed.
*33. Manual landing gear release handle — Stowed.
34. Gun sight target span selector switch — As desired.
35. Gun sight mechanical cage switch — CAGE.
*36. Accelerometer — Set.
*37. Clock — Check.
*38. Airspeed setting index — Set as desired.
*39. Altimeter — Set at field elevation.

WARNING

It is possible to rotate the barometric set knob through full travel so that the 10,000 foot pointer is 10,000 feet in error. Special attention should be given the altimeter to assure that the 10,000 foot pointer is reading correctly.

*40. Radar — Standby.
41. Arming switch — OFF.
*42. Armament panel security — Check.
*43. Weapons selector switch — GUN or as required. (AF Serials prior to 57-1321.)
44. Gun clearing switch — OFF. (AF Serials Prior to 57-1321.)
45. IR sight switch — OFF.
46. Reticle lights rheostat — Check (both lights).
47. Camera shutter selector switch — As desired.
*48. Hatch jettison handle — Stowed. (Unmodified aircraft.)
49. Canopy jettison handle — Stowed. (Modified aircraft.)
*50. Face plate heat rheostat — As required.
*51. Hydraulic systems pressure gage selector switch — No. 2.
*52. Ram air turbine extension handle — Stowed.
*53. No. 1 and No. 2 generator switches — NEUTRAL (guards down).
54. Canopy defrosting lever — As required.
*55. Fuel quantity and fuel indicating system — Check.

PREFLIGHT CHECK CONTINUED

*56. Warning light system test switch — WARNING LIGHTS TEST.

*57. Oxygen pressure gage — 295-315 psi.

*58. Liquid oxygen quantity gage — 9-10 liters.

*59. Oxygen system — Check.

Refer to Oxygen System Preflight Check in Section IV.

Note

If the diluter demand oxygen system is not to be used, the supply levers on the oxygen regulator panels must be placed in the OFF position. If left in the ON position, the regulators will automatically allow positive pressure oxygen flow above 25,000 feet cockpit altitude, which will rapidly deplete the oxygen supply.

*60. VHF navigation radio — OFF.

61. S.I.F. panel — As required.

62. IFF master switch —OFF.

*63. Interphone control panel — As desired.

*64. Ram air scoop lever — CLOSED (lever in last detent).

CAUTION

It is recommended that the ram air scoop lever be placed to CLOSED during the preflight check and be kept at CLOSED for all ground operation. This will provide sufficient cooling air for the electronic equipment. If the ram air scoop is opened on the ground, the supply of cooling air to the electronics compartment is shut-off and the electronic equipment may reach overtemperature limits.

65. Air refueling probe light switch — OFF. (AF Serials 57-1329 and subsequent.)

66. Engine motoring switch — OFF.

*67. Thunderstorm lights switch — OFF.

68. Ventilated suit blower switch — As desired.

*69. Interior lights rheostat — As desired.

70. Exterior lights switches — As desired.

71. Cockpit heat rheostat — AUTO (position as desired).

*72. Pitch sensor and pitot heat switch — OFF.

73. Rain removal switch — OFF.

74. Directional indicator function selector switch — MAG.

*75. Right console circuit breakers — IN.

BEFORE STARTING ENGINE

Before starting engine, make sure danger areas (figure 2-3) fore and aft of the airplane are clear of personnel, aircraft, and vehicles. The boundary layer control outlet for the intake ducts on each side of the lower fuselage will have a strong suction when the engine is started which may be strong enough to draw articles of clothing or loose equipment into the engine. Start engine with airplane heading into the wind when practicable. An external power source will be connected when starting the engine unless an emergency condition exists.

CAUTION

- The starter is limited to 1 minute of continuous operation, after which 2 minutes must be allowed for cooling before using the starter again.
- The auto-start control cable between the airplane and the auto-start control valve must be connected so that the start switches control starting air. If the auto-start control cable is not connected, the pilot has no control over starting air in the event of starter overspeed. Repeated exposure to overspeed conditions (above 40% rpm) will cause starter fatigue and subsequent disintegration of the starter. This can result in serious damage to the airplane.

STARTING ENGINE

Occasionally it may be necessary to start the engine without the recommended ground starting equipment. Basically there are three types of starts that can be made. The following chart is presented to show the difference between the AUTOMATIC, MANUAL and BATTERY start, and how existing equipment may be utilized to effect start.

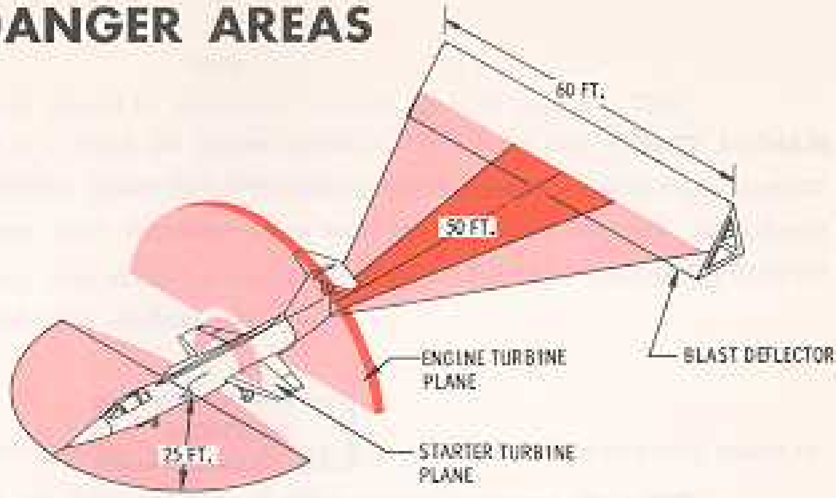
Type of Start	*Auto-Start Control Cable Connected*	*Air Compressor Connected*	*External Electrical Power Connected*
Automatic	Yes	Yes	Yes
Manual	No	Yes	Yes
Battery	Yes or No	Yes	No

The normal recommended starting procedure is defined as an AUTOMATIC start. If a MANUAL or BATTERY start is to be attempted, the procedure is basically the same as the AUTOMATIC start with the exception of the following considerations:

DANGER AREAS

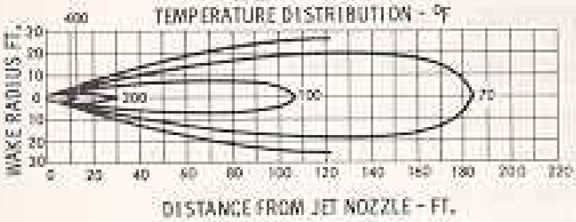
WARNING

- 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 FEET USE EAR PLUGS. WITHIN 50 FEET USE EAR PLUGS AND PROTECTIVE COVERS.
- IF BLAST DEFLECTOR IS NOT AVAILABLE, CLEAR AREA FOR 250 FEET.

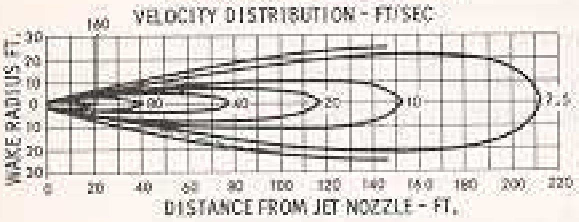


IDLE THRUST

TEMPERATURE DISTRIBUTION - °F

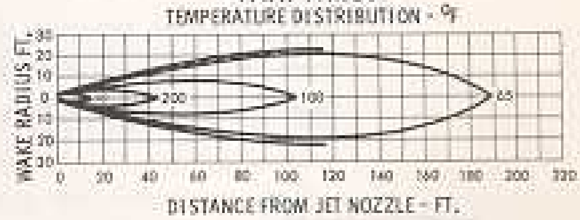


VELOCITY DISTRIBUTION - FT/SEC

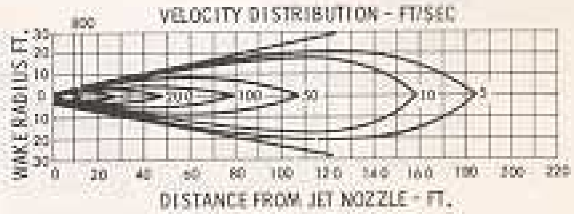


TAXI THRUST

TEMPERATURE DISTRIBUTION - °F

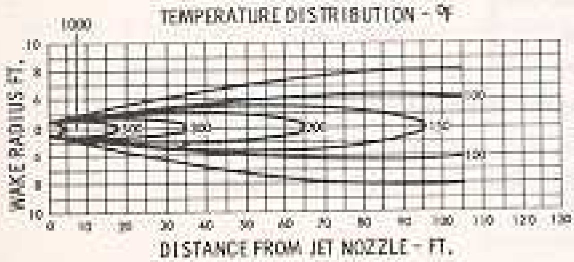


VELOCITY DISTRIBUTION - FT/SEC

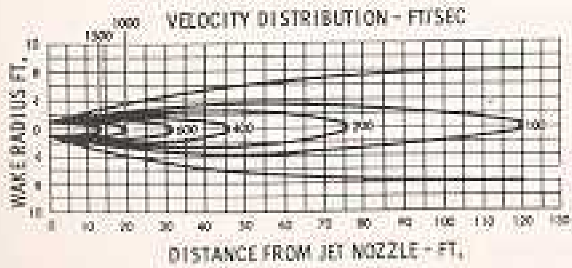


MILITARY THRUST

TEMPERATURE DISTRIBUTION - °F

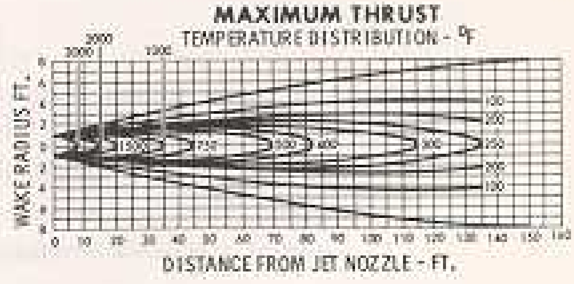


VELOCITY DISTRIBUTION - FT/SEC



MAXIMUM THRUST

TEMPERATURE DISTRIBUTION - °F



VELOCITY DISTRIBUTION - FT/SEC

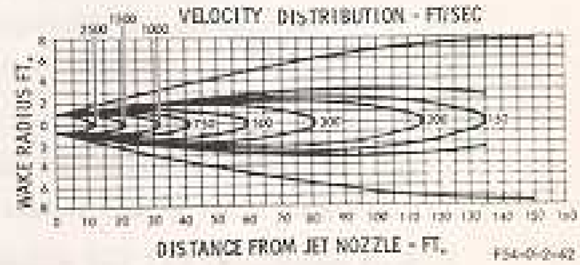


Figure 2-3

STARTING ENGINE CONTINUED

MANUAL START.

Without the auto-start control cable connected, no automatic cockpit control is available to control starting air. The procedures are the same as an automatic start, except that starting air should be supplied prior to actuating the start switch.

CAUTION

When the auto-start control cable is not connected, the pilot has no control over starting air in the event of starter overspeed. The pilot must signal for the ground crew to disconnect starting air when the engine rpm reaches 40%. Repeated exposure to overspeed conditions (above 40% rpm) will cause starter fatigue and subsequent disintegration of the starter. This can result in serious damage to the airplane.

BATTERY START.

A battery start is accomplished with only the air compressor unit connected and with or without the auto-start control cable connected. With the auto-start control cable connected, the starting procedure is the same as an automatic start. Without the auto-start control cable connected, the starting procedure is the same as a manual start.

CAUTION

During a battery start, the only instruments available will be the exhaust gas temperature and the tachometer until the generators reach operating speed. Therefore, exhaust gas temperature must be monitored closely to prevent a possible overtemperature condition.

AUTOMATIC START.

Start engine as follows:

1. Ground turbine compressor and auto-start control cable — Connected and ON.
   MA-2 or MA-1 ground turbine compressor connected and delivering proper air volume.
2. Start switch — START and release.
   If either ignition system is known to be defective the flight shall be aborted.

STARTING ENGINE CONTINUED

Note

- Successive engine starts should be alternated between ignition systems. This procedure will serve as a check on system operation. Make the first engine start on the No. 1 ignition system and the second start on the No. 2 ignition system.
- The maximum starting time should not exceed 60 seconds from the time the start switch is actuated until reaching idle rpm.

3. Throttle — IDLE.

   At first indication of engine rotation, advance throttle beyond IDLE detent and then retard to IDLE detent.

4. Fuel flow, 500-800 pounds per hour — Check.

CAUTION

- If fuel flow exceeds 800 pounds per hour, a hot start may result. If fuel flow is less than 500 pounds per hour for ground starts, it may be too low at alititude to accomplish an air start. Therefore the aircraft should be cleared by maintenance personnel before flight.
- Combustion should occur before reaching 20% rpm or within 20 seconds after fuel flow is established. If no combustion occurs within this rpm or time limit after fuel flow indication, or the engine fails to accelerate to normal idle rpm, or exhaust gas temperature exceeds starting limits, proceed as indicated in False or hanging start procedures in this section.

5. No. 1 and No. 2 start switches — STOP-START at 40% rpm.

   At 40% rpm, simultaneously move the No. 1 and No. 2 start switches to the STOP-START position and signal ground crew to stop air flow.

CAUTION

If the throttle is unintentionally retarded to OFF, a flameout occurs immediately. Do not reopen throttle, as relight is impossible and the resultant flow of unburned fuel into the engine will create a fire hazard.

6. External electrical power and ground turbine compressor — Disconnect at idle.

Note

The INSTRUMENTS ON EMERG. POWER warning light will remain on until the ground power unit is disconnected.

STARTING ENGINE CONTINUED

7. Engine instruments for proper indications — Check.
   a. Nozzle position — Approximately 7.5.
   b. Tachometer — 66% rpm minimum.
   c. Exhaust gas temperature — 320-420° C.
   d. Oil pressure — 12 psi minimum.
   e. Fuel flow — 1000-1300 lbs./hr.

FALSE OR HANGING START PROCEDURES.

1. Throttle — OFF.
2. No. 1 and No. 2 start switches — STOP-START.
   Simultaneously move No. 1 and No. 2 start switches to the STOP-START position and signal crew to stop air flow.
3. Check for absence of fuel in tailpipe.

CAUTION

- Wait until the engine stops rotating before checking for fuel in the tailpipe. If fuel is present, motor engine.
- The starter is limited to 1 minute of continuous operation, after which 2 minutes must be allowed for cooling before using the starter again.

4. Attempt restart.

GROUND OPERATION

With the assistance of ground personnel, proceed as follows:

1. Generator — Check.

   To insure operation of the generator bus transfer circuits:
   a. No. 1 generator — OFF, check warning light and RESET.
   b. No. 2 generator — OFF, check warning light and RESET.
2. Boost pump circuit breakers — Checked and ON, electrical load center door secure.
3. UHF, VHF and IFF — As required.

GROUND OPERATION CONTINUED

4. Hydraulic systems — Check.

   To insure that the hydraulic systems are operating properly, perform the following checks:

   a. Hydraulic systems pressure gage selector switch — No. 2.

   b. Speed brakes and flight controls — Check.

      (1) Operate speed brakes through a complete cycle. Pressure should drop quickly to approximately 2150 psi then rise momentarily to approximately 3300 psi and return to normal.

      (2) Move stabilizer only through complete cycle. Pressure should drop to approximately 2700 psi then rise to 3300 psi maximum and return to normal.

      (3) Move ailerons only through complete cycle. Pressure should drop to approximately 2600 psi then rise to 3300 psi maximum and return to normal.

      (4) Move rudder through maximum travel and check that hydraulic pressure drops, rises and returns to normal.

   c. Hydraulic systems pressure gage selector switch No. 1 or EMER.

   d. Flight controls — Check for full travel.

      (1) Repeat tests b(2) through b(4).

   e. Hydraulic systems pressure gage selector switch — No. 2.

5. Trim system — Check.

CAUTION

It is possible to damage the trim mechanism by operating trim controls with the control stick in a full throw position. To preclude this possibility, make all trim system checks with the control stick in NEUTRAL.

Make the following checks and have ground crew assure you that control surfaces respond correctly:

a. Directional trim rheostat — Operate through full travel and return to neutral.

b. Aileron and horizontal stabilizer trim switch — Test (all four positions).

WARNING

An improperly installed or defective trim switch is subject to sticking in any or all of the actuated positions, resulting in application of extreme trim. If this condition occurs, during preflight check and the switch does not return automatically to the center OFF position, enter this fact in the Form 781 with red cross and do not fly the airplane.

GROUND OPERATION CONTINUED

Note

Aileron and stabilizer take-off trim indicator lights should momentarily illuminate as the trim motors pass through the take-off setting.

6. Trim — Set for take-off and verified by ground personnel.

Note

Leading edge of horizontal stabilizer should be aligned with black "T" index painted on the vertical stabilizer.

7. Stick kicker, stick shaker, and stability augmentation control system — Check.
   With the assistance of ground personnel, proceed as follows:
   a. Wing flap lever — UP.
      (1) Rotate right vane clockwise until stick shaker operates at 4½.
      (2) Continue clockwise rotation until stick kicker operates at 5.
      (3) Set right vane approximately one degree below the position where the stick kicker operates and sharply lift nose of aircraft until stick kicker operates.
   b. Wing flap lever — LAND.
      (1) Have ground crew check BLC for proper operation and for possible warpage of the BLC ducts. During normal BLC operation at idle rpm, an EGT rise of approximately 40° C should occur.
   c. Wing flap lever — TAKE-OFF.
      (1) Have ground crew verify flap position, check for absence of BLC airflow and that ducts have not been crushed.

Note

If any malfunction is detected, the flight should be aborted.

      (2) Rotate right vane clockwise until stick shaker operates.
      (3) Continue clockwise rotation of vane to its stop to check that stick kicker does not operate.
      (4) Rotate left vane counter-clockwise until stick shaker operates.

BEFORE TAXIING

Observe the following instructions:

1. External stores auto drop system safety pins — Removed.

MINIMUM TURNING RADIUS AND GROUND CLEARANCES

GROUND CLEARANCES

VERTICAL STABILIZER TIP	13.5 FEET
HORIZONTAL STABILIZER	12.6 FEET
NOSE BOOM	4.13 FEET
TIP TANKS	2.07 FEET

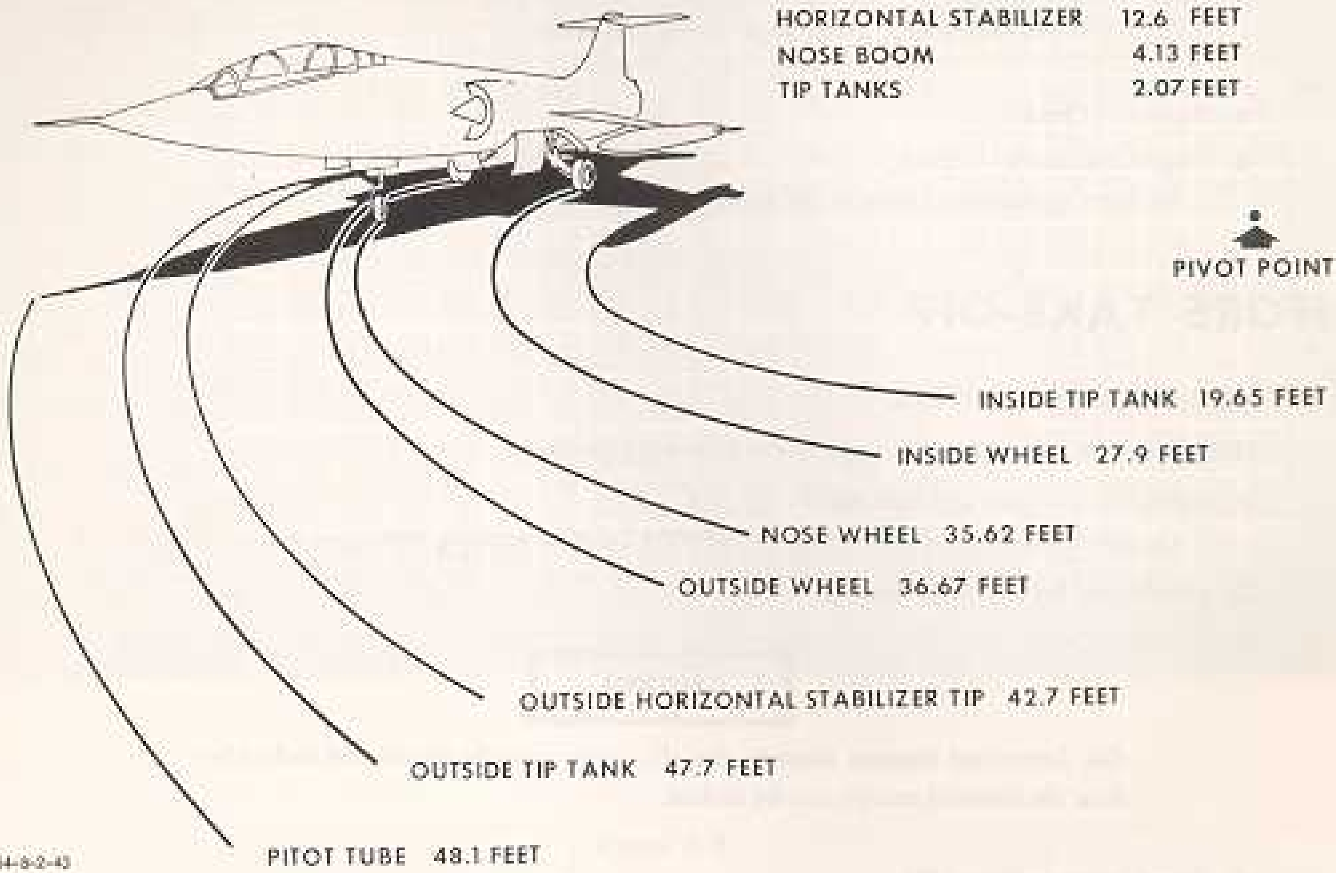


Figure 2-4

BEFORE TAXIING CONTINUED

2. Hydraulic door — Closed.
3. Canopies — As desired.
4. Ground crew interphone — Disconnected.
5. Seat safety pins — Removed.
6. Wheel chocks — Removed.

TAXIING

See figure 2-4 for minimum turning radius and ground clearance.

1. Nose wheel steering — Engage.

   The nose wheel and rudder pedals must be in the same relative position before the steering mechanism can be engaged.

TAXIING CONTINUED

CAUTION

To prevent possible damage to the main landing gear wheel assemblies from excessive side loads, avoid high speed taxi turns.

2. Brakes — Check.
3. Flight indicators — Check.
   Perform operational check of all flight indicators.

BEFORE TAKE-OFF

PRE-FLIGHT AIRPLANE CHECK.

After taxiing to take-off area, complete the following checks:

1. Canopies — Closed and LOCKED.
   On modified aircraft, check that CANOPY UNSAFE warning light goes out.
2. Inertia reel lock lever — Locked.

CAUTION

On downward ejection aircraft, the aft canopy must be closed and locked before the forward canopy can be locked.

3. Speed brake switch — IN.
   To prevent inadvertent extension, switch should be positioned to the IN position when speed brakes are not being used.
4. Trim set for take-off — Check.
5. Wing flap lever — TAKE-OFF (Check indicators).
6. Pitot heat, rain removal and canopy defrost — As required.

Note

Experience has shown that on the ground, moisture can collect in the pitot static tube after exposure to rain or high humidity. Heating the tube will help to eliminate some of the entrapped moisture.

PRE-FLIGHT ENGINE CHECK.

Refer to Figure 1-14 of Confidential Supplement for exhaust nozzle positions at various throttle settings and to Figure 5-1 for engine limitations. While in the take-off area make the following checks:

1. Align aircraft with runway — Nose wheel centered.
   a. Attitude indicator — Set for take-off.
   b. Directional indicator — Set with runway heading.

MILITARY THRUST FUEL FLOW

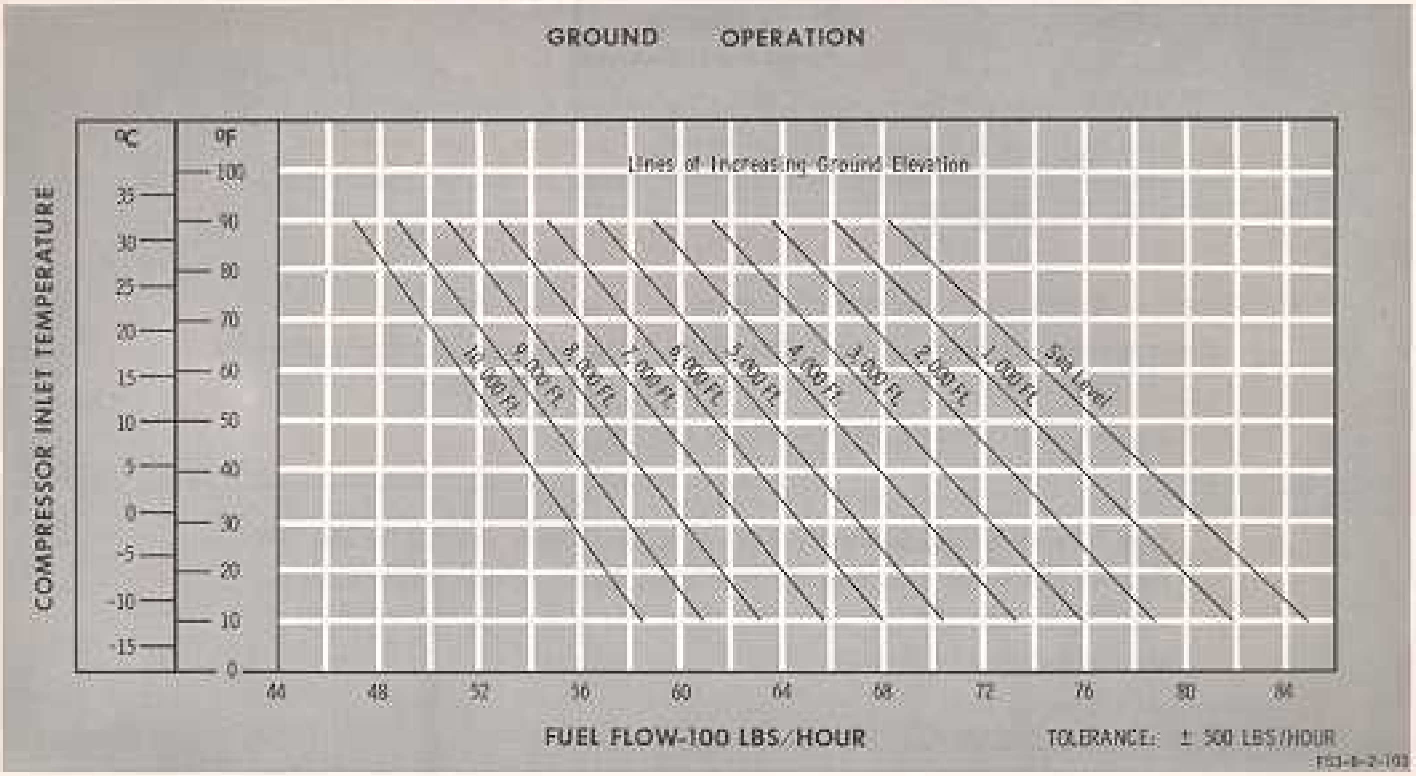


Figure 2-5

BEFORE TAKE-OFF CONTINUED

2. Brakes — Pump and hold.
3. Throttle, Military Thrust — Check instruments.
   a. RPM — 100% (plus or minus 1%).
   b. Exhaust gas temperature (588° C ±11° C).

      Some EGT gages may indicate a momentary fluctuation of ±5° C over normal limits. This indication is allowable provided the fluctuation does not exceed a maximum of ±5° C and does not occur oftener than once every 20 seconds.

   c. Nozzle position — 1 to 3.
   d. Fuel flow — Check.
      Refer to figure 2-5.
   e. Oil pressure — Check.

BEFORE TAKE-OFF CONTINUED

CAUTION

After oil pressure has stabilized, check indications against oil pressure record card at Military Thrust. If the indicated oil pressure varies more than ±5 psi from that listed on the card, the flight should be aborted and an engine inspection performed.

4. Throttle — Reduce slowly to 80% rpm, check for compressor stall.

   If compressor stall is encountered, abort flight. Make appropriate entry in Form 781A.

5. Throttle — Rapidly retard to IDLE — Check fuel flow.

Note

Fuel flow should momentarily drop to approximately 500-700 lbs./hr. This fuel flow indicates that sufficient minimum fuel flow will be available during idle descents and for air starts. If the fuel flow drops below 500 lbs./hr. the flight should be aborted.

6. Throttle — MILITARY.

   a. Advance throttle rapidly to MILITARY and check for normal engine acceleration.

TAKE-OFF

Note

The procedures set forth below will produce the results shown in the take-off charts in the Appendix.

NORMAL TAKE-OFF. (Refer to figure 2-6)

CAUTION

The roll stability augmenter should be turned off with wing tip stores installed. With tip stores installed and the roll stability augmenter operating, wing torsional oscillations sufficient to cause structural damage may be experienced at high indicated airspeeds. Missile launchers are not considered as tip stores; therefore, the roll stability augmenter should be left on when carrying bare launchers.

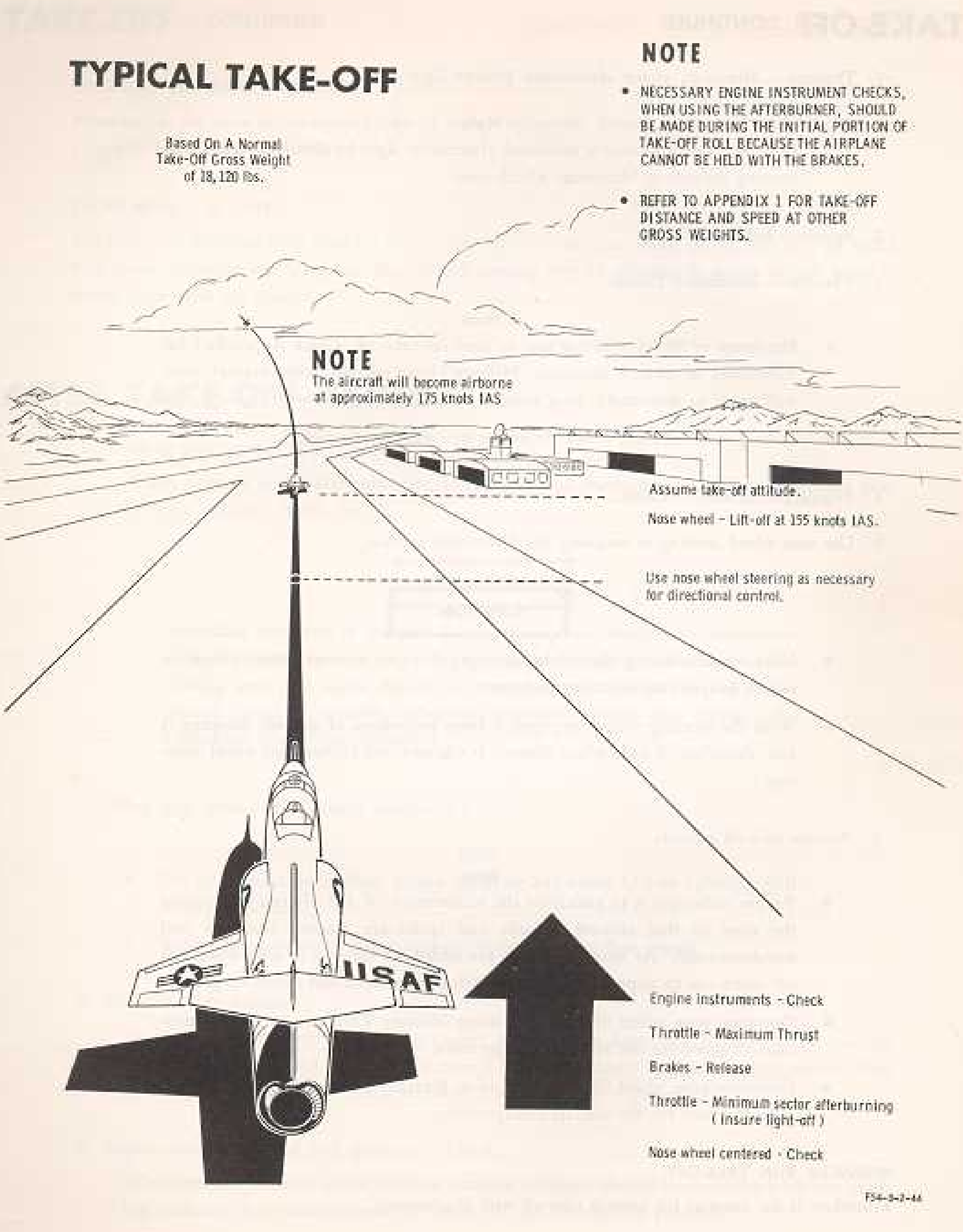

TYPICAL TAKE-OFF
Based On A Normal Take-Off Gross Weight of 18,120 lbs.
NOTE
• NECESSARY ENGINE INSTRUMENT CHECKS, WHEN USING THE AFTERBURNER, SHOULD BE MADE DURING THE INITIAL PORTION OF TAKE-OFF ROLL BECAUSE THE AIRPLANE CANNOT BE HELD WITH THE BRAKES.
• REFER TO APPENDIX 1 FOR TAKE-OFF DISTANCE AND SPEED AT OTHER GROSS WEIGHTS.
NOTE
The aircraft will become airborne at approximately 175 knots IAS
Assume take-off attitude.
Nose wheel - Lift-off at 155 knots IAS.
Use nose wheel steering as necessary for directional control.
USAF
Engine instruments - Check
Throttle - Maximum Thrust
Brakes - Release
Throttle - Minimum sector afterburning (Insure light-off)
Nose wheel centered - Check
F54-0-2-46

Figure 2-6

TAKE-OFF CONTINUED

1. Throttle — Minimum sector afterburner (insure light-off).

Note

It is recommended that a stabilized afterburner light be obtained prior to advancing throttle to Maximum Afterburner.

2. Brakes — Release.

3. Throttle — Maximum Thrust.

Note

- Maximum or Military Thrust may be used for take-off. Check Appendix I for differences in take-off distances. Military Thrust take-offs with external stores will result in abnormally long take-off rolls.
- During A/B take-off, avoid throttling into the sector range.

4. Engine instruments — Check.

5. Use nose wheel steering as necessary for directional control.

CAUTION

- Nose wheel steering should be disengaged prior to nose wheel lift-off to ensure proper steering clutch release.
- With the steering system engaged, a large percentage of shimmy damping is lost; therefore, if nose wheel shimmy is encountered, release nose wheel steering.

6. Assume take-off attitude.

Note

- Proper technique is to anticipate the acceleration of the aircraft and rotate the nose so that take-off attitude and speed are reached smoothly and simultaneuosly. As external stores are added, an increase in nose wheel lift off speed can be expected due to the change in weight and center of gravity.
- Optimum nose wheel lift-off speed using Military Thrust is 10 knots below take-off speed for the aircraft configuration.
- Optimum nose wheel lift-off speed using Maximum Thrust is 20 knots below take-off speed for the aircraft configuration.

MINIMUM RUN TAKE-OFF.

Procedure is the same as for normal take-off with afterburner.

TAKE-OFF CONTINUED

OBSTACLE CLEARANCE TAKE-OFF.

Procedure is the same as for normal take-off with afterburner. Refer to Appendix I for distances to clear a 50 foot obstacle.

CROSS-WIND TAKE-OFF.

In addition to the procedures used for normal take-off, increase nose wheel lift-off and take-off speed 5-10 knots to compensate for gusts. Nose wheel steering may be required in excess of 100 knots if strong crosswinds are present.

AFTER TAKE-OFF—CLIMB

1. Landing gear lever — UP.

   When airplane is definitely airborne, retract gear and check that red and green landing gear position indicator lights are off.

   CAUTION

   Immediate retraction of the gear is important when making an afterburner take-off to prevent exceeding the landing gear transient limit airspeed. The landing gear and doors should be completely up and locked before the placard speed is reached; otherwise excessive airloads may damage the mechanism or stall gear retraction.

2. Wing flap lever — UP (check indicators.)

   Note

   - Do not retract wing flaps before reaching 240 knots IAS as buffeting will be experienced.
   - Expect an easily controllable nose up tendency as the flaps retract.

3. Throttle — As desired.

   As soon as afterburner thrust is no longer needed, shut down the afterburner by moving throttle aft and inboard. Monitor the nozzle position indicator to check that the nozzles close normally as the throttle is being retarded from Maximum Afterburning.

4. Engine instruments and fuel quantity — Check.

   When carrying external tanks, the fuel quantity indicator should be monitored. A low reading indicates that external tanks are empty or are not feeding properly.

AFTER TAKE-OFF—CLIMB CONTINUED

5. Zero-delay lanyard — Unhook.

   After reaching minimum ejection altitude.

6. Airspeed — Best climb.

   Refer to Appendix I for best climb speed. Care should be taken following take-off to anticipate the high forward acceleration. As climb speed is approached assume the proper climb attitude to insure maximum performance.

7. Altimeter — Reset to 29.92" Hg or as required when passing 23,500 feet.

CLIMB

The climbing attitude with Maximum Thrust is extremely steep and until experience is gained, some difficulty in holding the climb schedule will be experienced.

Refer to Climb Charts in Appendix I for recommended speeds to be used during climb, and for rates of climb and fuel consumption.

CRUISE

Refer to Appendix I for Cruise Operating Data.

The windshield and canopy defrosting system should be operated throughout the flight at the highest flow possible (consistent with pilot comfort) so that a sufficiently high temperature is maintained to preheat the canopy and windshield areas. It is necessary to preheat because there is insufficient time during rapid descents to heat these areas to temperatures which prevent the formation of frost or fog.

Note

The auto-pitch and stick shaker may be checked in flight as follows: While applying a slow stick deflection, note APC indicator reading increase in relation to angle of attack and increasing G force indicating satisfactory system operation from sensing of vane angle. Apply a small rapid stick deflection and note APC indicator reading increase rapidly in relation to the increasing pitch rate, indicating a satisfactory signal from the pitch rate gyro. The stick deflection should be great enough to induce a pitch rate sufficient to actuate the stick shaker.

AFTERBURNER OPERATION

Before moving the throttle into the afterburner range, check that the nozzle position indicator is in its normal range for Military Thrust. Move the throttle smoothly outboard and forward into the afterburner range. Check exhaust gas temperature, rpm and nozzle position.

CAUTION

If an afterburner light is not obtained within approximately 3 seconds at sea level or approximately 5 seconds at altitude, after the throttle is moved into the afterburner range, the throttle should be moved inboard to MILITARY and then after 3 to 5 seconds, return to the afterburner range to recycle the system. After the initial light is obtained, move the throttle forward with a positive motion if Maximum Thrust is desired.

Note

The fuel flow indicator does not indicate afterburner fuel flow.

When shutting the afterburner off, retard the throttle aft and inboard to the MILITARY position.

FLIGHT CHARACTERISTICS

Refer to Section VI for information regarding Flight Characteristics.

DESCENT

Refer to Appendix I for recommended descent technique and accomplish the following steps:

1. Engine anti-ice and pitot heat — As required.
2. Armament switches — OFF.
3. Radar master selector switch — STBY.
4. Gunsight mechanical cage switch — CAGE.
5. No. 1 and No. 2 hydraulic system pressures — Check.
6. Inertia reel lock lever — Locked.
7. Altimeter — Reset to 29.92" Hg. or as required when passing 23,500 feet.

BEFORE LANDING

The procedures set forth below will produce the results shown in the landing chart in Appendix I.

WARNING

The airspeeds listed herein are based on landing gross weight of 15,000 lbs. (1000 lbs. fuel remaining). Increase approach and landing speeds 5 knots for each 1000 lbs. of fuel remaining above 1000 lbs.

INITIAL.

1. Zero-delay lanyard — Hook.
2. Wing flap lever — TAKE-OFF at pitch (check indicators).

WARNING

Unmodified aircraft do not have APC kicker protection with the take-off flaps.

Note

It is possible to bind the wing flap lever so that it cannot be moved by holding the rudder pedals against the stop. This is most likely to occur with the wing flap lever in the UP position because rudder travel is limited to 6 degrees. The binding is due to insufficient clearance of the mechanical linkage between the wing flap lever and the rudder pedal limiter stop. In view of this, do not hold the rudder pedals against the stop when operating the wing flap lever.

DOWNWIND.

1. Landing gear lever — DOWN (check indicators).
2. Wing flap lever — LAND below 240 knots IAS and above 210 knots IAS. (Check indicators.) Maintain level flight and keep hand on lever until it is determined that the flaps and BLC are functioning normally.

BEFORE LANDING CONTINUED

Note

A mild roll transient may be experienced on some aircraft as flaps move from the take-off to the land position. This is attributed to asymmetric difference in boundary layer control systems and will vary in intensity and direction with individual aircraft but should not exceed one inch of lateral stick displacement. After the flaps are in the full down position some lateral unbalance may persist. This unbalance can be trimmed out, if desired.

CAUTION

If a boundary layer control system malfunction is experienced as manifested by a strong rolling moment as the wing flaps travel to the land position, proceed as follows:

a. Immediately return the wing flap lever to TAKE-OFF.

b. Throttle — Adjust to minimum safe setting to reduce the effect of asymmetric BLC.

c. Fly final approach at not less than 195 knots IAS.

d. Touchdown at 165 knots IAS.

Note

A slight EGT rise may occur during BLC operation, however this rise will not exceed the limit temperature.

BASE LEG TURN.

1. Landing gear down and locked — Check.
2. Brakes — Pump.
3. Airspeed — 200 knots IAS minimum.

FINAL.

When on final approach, accomplish the following:

1. Roll out on final approach, minimum distance from end of runway — 6000 feet; recommended airspeed — 190 knots IAS.
2. Engine speed 87-90% rpm.
3. Airspeed — 170 knots IAS recommended.

Note

The recommended final approach speed includes sufficient margin to cover most operating conditions such as turbulent air, minor landing weight variation, etc. This margin makes additional allowances for such factor unnecessary.

TYPICAL LANDING PATTERN

Based on landing gross weight of 15,000 lbs. (1,000 lbs. fuel remaining)

NOTE

Increase approach and landing speeds 5 knots for each additional 1,000 lbs. of fuel above 1000 lbs. of fuel remaining. Refer to landing distance charts in APPENDIX I for final approach and touchdown speeds at other gross weights.

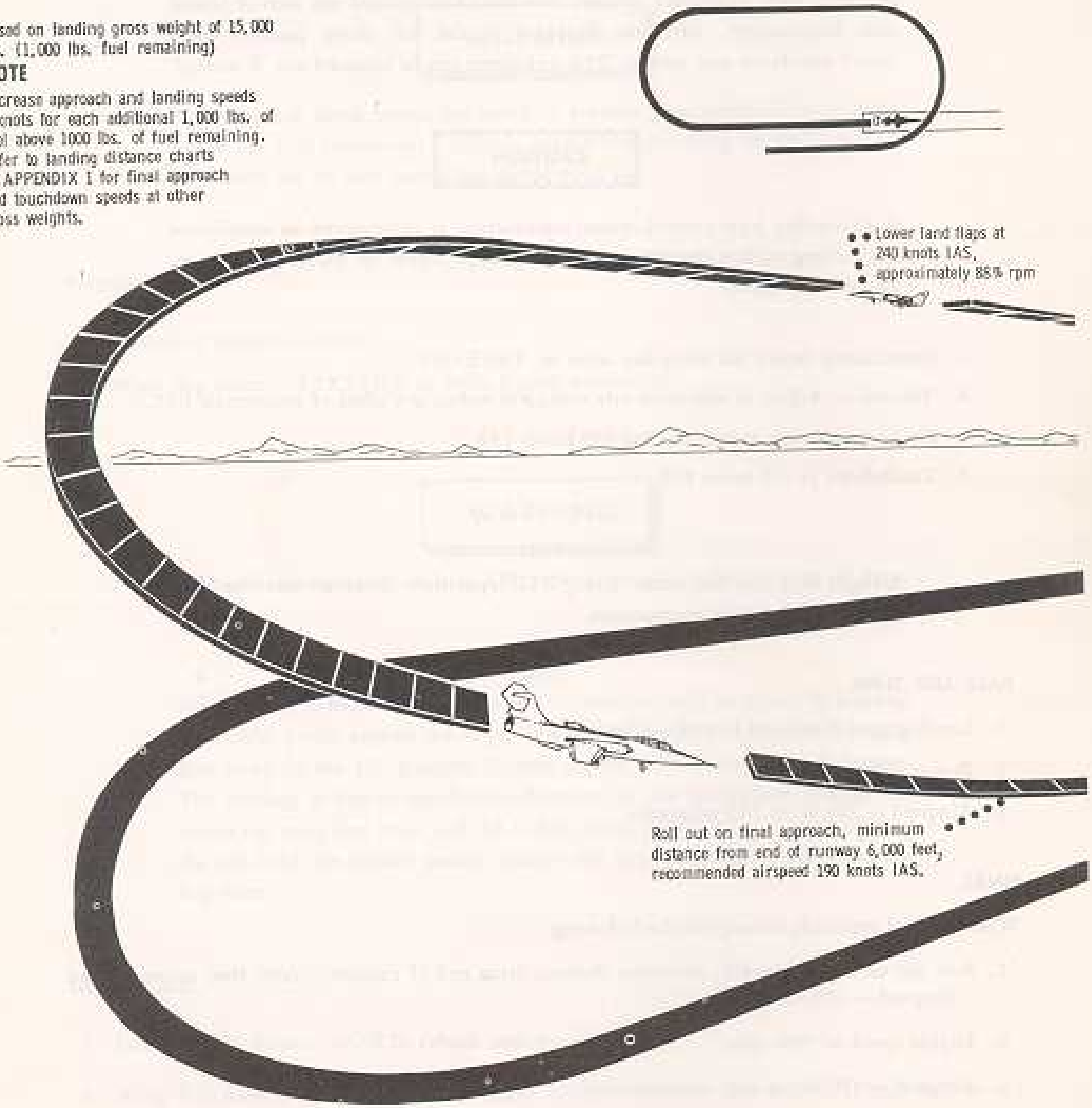


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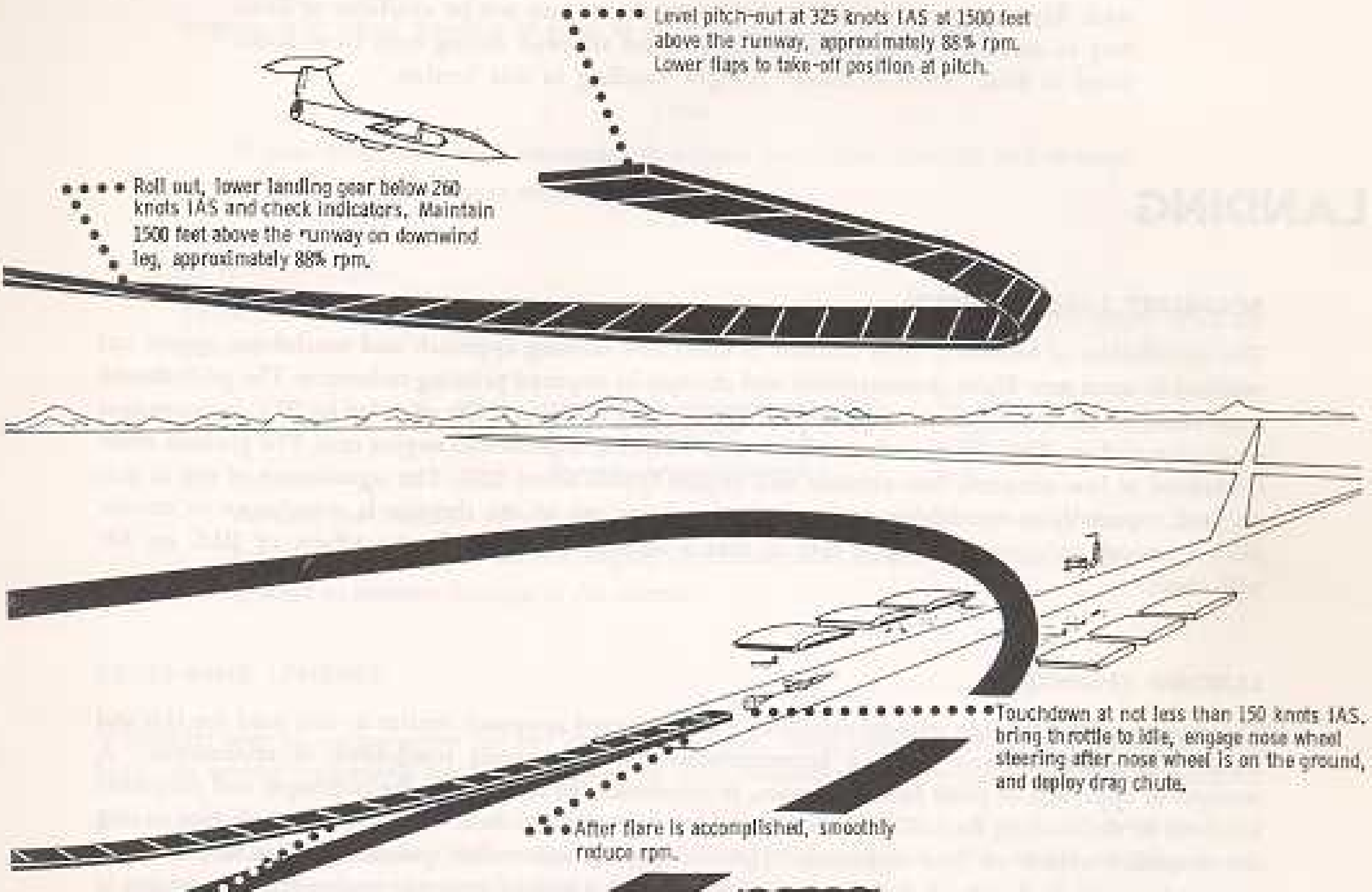
Figure 2-7



CAUTION

Do not "chop" throttle while airborne as abrupt loss of lift will accompany the decrease in boundary layer control airflow.

CAUTION

- Steep final approaches can be hazardous if the airspeed drops below normal, turns are made, or gusty winds prevail. These factors may cause an excessive rate of sink which will not be recognized and corrected before contact with the ground.

- All final approaches should be made with power and on a glide slope similar to that for ILS / GCA (700-800 feet per minute). This slope may be intercepted at any point, but should be intercepted at not less than one mile from touchdown.

F54-1-2-46 (2)

BEFORE LANDING CONTINUED

WARNING

Under various conditions of heavy gross weight or high ambient temperatures, with flaps in the land position, sufficient thrust may not be available at Military to maintain proper rate of descent and airspeed during turn from down wind to final. Refer to Heavy Weight Landing in this Section.

LANDING

BOUNDARY LAYER CONTROL.

The installation of boundary layer control to effect low landing approach and touchdown speeds has resulted in some new flight characteristics and changes in required piloting technique. The pilot should remember, at all times, when using land flaps that the additional lift afforded by BLC is dependent on engine airflow. This lift, therefore, varies with airspeed, altitude and engine rpm. The greatest effect is realized at low airspeed, low altitude and engine speeds above 82%. The significance of this is that on final, especially as touchdown is approached, proper use of the throttle is mandatory to accomplish a smooth reduction in engine rpm so that a smooth reduction in the effects of BLC on lift will result.

LANDING TECHNIQUE.

The recommended landing pattern results in a flat powered approach similar to that used for ILS and Radar Approach patterns carrying approximately 88% rpm until touchdown is approached. A straight-in approach of 6000 feet, minimum, is recommended to simplify the technique and judgment involved in the landing flare. The thrust should be controlled to hold airspeed and sink rate to the recommended values on final approach. (Use of the recommended speeds provides ample speed margin from the back side of the power required curve.) Airspeed response to throttle adjustments is extremely positive and rapid, aiding considerably in establishing a good approach. The high drag of the airplane in the landing configuration makes it unnecessary to use speed brakes in the landing pattern (especially on approach). Speed brakes may be used during roundout to aid in controlling the touchdown point. The approach should be maintained to establish a flare-out just short of the runway. As the touchdown point is approached, flare-out rotation should be started, followed by a smooth reduction of thrust to 82-83%. The gradual rpm reduction induces a right roll-off which is associated with the thrust reduction and not BLC since a similar roll-off is experienced accompanying a thrust reduction with take-off flaps. An abrupt thrust reduction results in abrupt roll-off tendency and a rapid increase in rate of sink. These characteristics make it necessary to approach touchdown carrying power and reduce power to idle as the main gear contacts the runway. The smooth thrust reduction reduces the roll-off tendency, thereby making it easy to maintain wings level flight thoughout the flare as well as provide positive control of rate of sink. It may seem unnatural to touch down with more than idle thrust; however, with the drag of the landing flaps, it is possible to slow down rapidly enough so that idle thrust need not be used. Adhere to recommended approach and touchdown speeds. If the aircraft is held off to lower speeds lateral stability and control will deteriorate and wing drop tendencies will be experienced. In addition, the high pitch angle required for flight at these low airspeeds will be excessive and can result in tail dragging.

LANDING CONTINUED

NORMAL LANDING. (Refer to figure 2-7)

1. Throttle — Retard to IDLE (after touchdown).
2. Nose wheel steering — Engage.

   Engage nose wheel steering as soon as nose wheel is on the ground.

   Note

   If nose wheel shimmy is encountered, release nose wheel steering and attempt to hold weight off nose wheel.

3. Drag chute — Deploy.

   To obtain maximum aerodynamic braking, deploy drag chute as soon as nose wheel is on the ground.

   CAUTION

   Because the location of the drag chute will cause a nose down pitching moment when deployed, do not deploy the chute until all three gear are on the ground to prevent damage to the aircraft.

CROSS-WIND LANDING.

Winddrift may be compensated for by "crabbing" or the "wing down" method, or a combination of both. In strong crosswinds the "wing down" or a combination of the two methods is more suitable.

The most important thing to remember is to lower the nose immediately after touchdown and engage the nose wheel steering before deploying the drag chute. When nose wheel steering is engaged, the drag chute may be deployed as follows:

a. 90° crosswinds of 20 knots, or

b. 45° crosswinds of 30 knots.

The airplane will tend to weather vane, but directional control can be maintained with nose wheel steering.

HEAVY WEIGHT LANDING.

Landing pattern airspeeds on the base leg turn, the final approach and touchdown must be increased for heavy weight landings. The necessary airspeed corrections are 5 knots for every 1,000 pounds over normal gross weight (a clean aircraft with 1,000 pounds of fuel remaining). Fly a larger than normal pattern, or a straight in approach, and exercise caution because of the reduced excess thrust. This is especially important on approaches under hot and/or high altitude landing field conditions. Rate of descent must be monitored closely and not allowed to exceed the 700-800 feet per minute recommended during the final portion of the approach. Be prepared to use afterburning

LANDING CONTINUED

thrust if necessary. Refer to Section VI and Appendix I for charts showing the variation of flight performance to expect. When operating under circumstances approaching these conditions, a straight in approach is recommended. Use either a take-off flap or gear-up approach. When adequate runway is available, use take-off flaps. If landing roll distance is a major consideration use landing flaps and delay gear extension until landing is assured. Gear extension may be delayed until the flare is assured.

WARNING

Under these conditions, afterburner will have to be used if a go-around is attempted after the landing gear has been extended.

MINIMUM RUN LANDING.

For a minimum run landing, use normal pattern speeds and techniques. Fly final approach at 160 knots IAS, touch down at 140 knots IAS as near the end of the runway as possible and extend the speed brakes. As nose wheel touches, deploy drag chute and apply heavy braking, but do not skid the tires. Hold heavy braking action until the aircraft stops. Increase approach and landing speeds 5 knots for each 1000 pounds of fuel in excess of 1000 pounds of fuel remaining.

Note

- Stick shaker can be experienced as the airspeed drops to 140 knots IAS.
- Heavy braking is accomplished by applying high brake pedal force as soon as the drag chute deploys. Hold brake pedal force with no pumping action until the aircraft stops. This procedure causes the brakes to heat and is not recommended as normal practice.

CAUTION

Do not retract the wing flaps to get heavier braking action as this restricts nose-wheel steering.

LANDING ON SLIPPERY RUNWAYS.

Normal landing can be made on wet or icy runways. Use minimum run landing touchdown speed as dictated by the gross weight of aircraft. Extend speed brakes on flare. Engage nose wheel steering as nose wheel touches down and deploy drag chute. (Refer to Cross-wind Landing in this section for drag chute operation in crosswinds.) Leave wing flaps at land during the landing roll and use light to moderate braking as dictated by runway condition.

TOUCH AND GO LANDINGS

No special technique is required during touch and go landings.

After touchdown proceed as follows:

1. Wing flap lever — TAKE-OFF.

TOUCH AND GO LANDINGS CONTINUED

2. Throttle — MILITARY.
3. Speed brake switch — IN.
4. Trim — Set for take-off.
5. Use normal take-off technique.

CAUTION

On unmodified aircraft the wing flap lever can be moved inadvertently through the TAKE-OFF position to the UP position if the lever is moved throughout the range of travel. Be careful to positively position the wing flap lever to the TAKE-OFF position.

GO-AROUND (Refer to figure 2-8)

Make decision to go-around as soon as possible and observe the following procedures:

1. Throttle — MILITARY (Maximum Thrust if necessary).

CAUTION

- The use of excessive nose-up trim during final approach will appreciably reduce the effect of forward stick. Therefore, as power is advanced, the aircraft should be trimmed toward neutral.
- The available excess thrust to perform a go-around varies with airspeed, gross weight, airplane configuration, field elevation and ambient temperature. As extremes of these variables are approached the ability to perform a successful go-around with Military Thrust decreases, thus requiring afterburning thrust. Refer to Section VI and Appendix I for illustrations and charts showing the variation in performance to expect with changes in these operating conditions.

2. Speed brake switch — IN.
3. Landing gear lever — UP.

GO-AROUND CONTINUED

Note

Raise landing gear only after you are sure that the aircraft will not contact the runway.

4. Wing flap lever — TAKE-OFF.

   At not less than 170 knots IAS.

Note

Expect a definite nose up trim change when raising the flaps to take-off.

WARNING

- When making a go-around, leave the wing flap lever in the TAKE-OFF position for 30 to 60 seconds. This action will cool the BLC ramp and keep the retracting flaps from pinching the ramp. Pinched BLC ramps can cause undesirable rolling moments when the BLC system is operating.
- On unmodified aircraft the wing flap lever can be moved inadvertently through the TAKE-OFF position to the UP position, if the lever is depressed throughout the range of movement. In the event of a go-around at low altitude or a touch-and-go landing, the results could be hazardous. Be extremely careful to positively position the wing flap lever to the TAKE-OFF position whenever a go-around is necessary.

5. Wing flap lever — UP.

   At not less than 215 knots IAS.

AFTER LANDING

Maintain directional control with nose wheel steering and brakes and proceed as follows:

1. Speed brake switch — IN.
2. Wing flap lever — TAKE-OFF.
3. Rain remover — OFF. (If rain remover has not been used, turn ON for 30 seconds, then OFF.)

Note

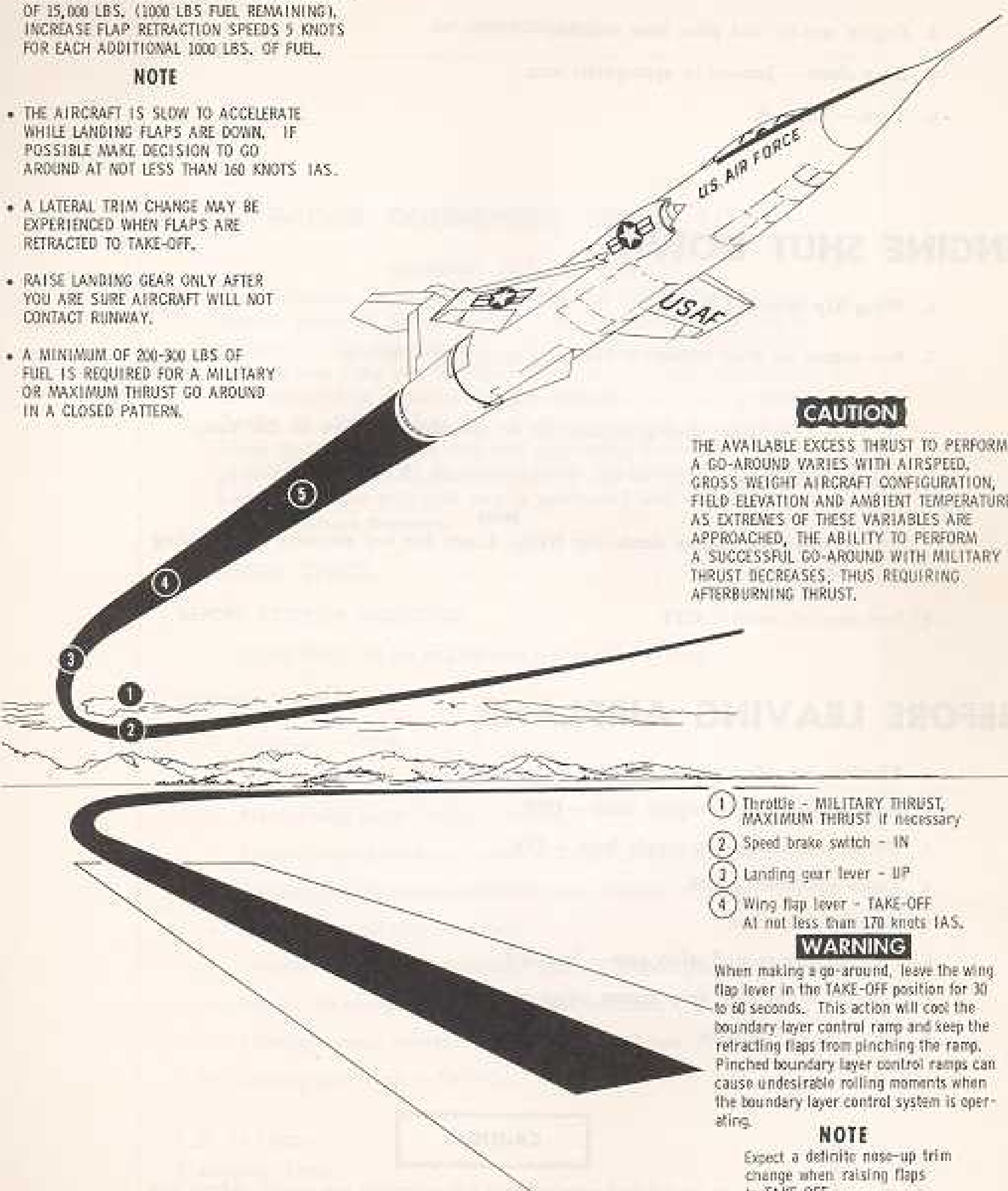
- This procedure is necessary to free the lines of condensation in order to protect the rain removal shut-off valve from corrosion.
- If visible moisture disappears before 30 seconds, turn switch OFF.

TYPICAL GO-AROUND

BASED ON A NORMAL LANDING GROSS WEIGHT OF 15,000 LBS. (1000 LBS FUEL REMAINING). INCREASE FLAP RETRACTION SPEEDS 5 KNOTS FOR EACH ADDITIONAL 1000 LBS. OF FUEL.

NOTE

- THE AIRCRAFT IS SLOW TO ACCELERATE WHILE LANDING FLAPS ARE DOWN. IF POSSIBLE MAKE DECISION TO GO AROUND AT NOT LESS THAN 160 KNOTS IAS.
- A LATERAL TRIM CHANGE MAY BE EXPERIENCED WHEN FLAPS ARE RETRACTED TO TAKE-OFF.
- RAISE LANDING GEAR ONLY AFTER YOU ARE SURE AIRCRAFT WILL NOT CONTACT RUNWAY.
- A MINIMUM OF 200-300 LBS OF FUEL IS REQUIRED FOR A MILITARY OR MAXIMUM THRUST GO AROUND IN A CLOSED PATTERN.



CAUTION

THE AVAILABLE EXCESS THRUST TO PERFORM A GO-AROUND VARIES WITH AIRSPEED, GROSS WEIGHT AIRCRAFT CONFIGURATION, FIELD ELEVATION AND AMBIENT TEMPERATURE. AS EXTREMES OF THESE VARIABLES ARE APPROACHED, THE ABILITY TO PERFORM A SUCCESSFUL GO-AROUND WITH MILITARY THRUST DECREASES; THUS REQUIRING AFTERBURNING THRUST.

1. Throttle - MILITARY THRUST, MAXIMUM THRUST if necessary
2. Speed brake switch - IN
3. Landing gear lever - UP
4. Wing flap lever - TAKE-OFF At not less than 170 knots IAS.

WARNING

When making a go-around, leave the wing flap lever in the TAKE-OFF position for 30 to 60 seconds. This action will cool the boundary layer control ramp and keep the retracting flaps from pinching the ramp. Pinched boundary layer control ramps can cause undesirable rolling moments when the boundary layer control system is operating.

NOTE

Expect a definite nose-up trim change when raising flaps to TAKE-OFF

5. Wing flap lever - UP At not less than 215 knots IAS.

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Figure 2-8

AFTER LANDING CONTINUED

4. Engine anti-ice and pitot heat switches — OFF.
5. Drag chute — Jettison in appropriate area.
6. Trim — Take-off.

ENGINE SHUT DOWN

1. Wing flap lever — UP.
2. Run engine for three minutes at idle for proper engine cooling.

Note

Operation during taxiing can be considered as part of this time.

3. Throttle — OFF.

Note

Check that engine decelerates freely. Listen for any excessive noise during shut down.

4. Fuel shut-off switch — OFF.

BEFORE LEAVING AIRPLANE

1. Ejection seat safety pins — Installed.
2. Pressure suit oxygen supply lever — OFF.
3. Diluter demand oxygen supply lever — ON.
4. Radio equipment — Off.
5. Wheels — Chocked.
6. Landing gear ground safety pins — Installed.
7. External stores auto drop system safety pins — Installed.
8. Form 781 — Complete.

CAUTION

In addition to established requirements for reporting any system defects, unusual and excessive operations, the flight crew will also make entries in Form 781 to indicate when any limits in the Flight Manual have been exceeded.

CUT ON DOTTED LINE

F-104D CONDENSED CHECK LIST

NORMAL PROCEDURES

The following check list is a condensed version of the procedures presented in Section II. This condensed check list is arranged so that you may remove it from your Flight Manual and insert it into a flip pad for convenient use. It is arranged so that each section is in sequence with the expanded procedure given in Section II. Presentation of the condensed check list does not imply that you need not read and thoroughly understand the expanded version. To fly the aircraft safely and efficiently, you must know the reason why each step is performed and why the steps occur in certain sequence.

PREFLIGHT CHECK.

BEFORE EXTERIOR INSPECTION.

1. Check Form 781 for engineering status and servicing.

EXTERIOR INSPECTION.

1. Canopies — Check.
2. Seat free fall linkages — Secure (unmodified aircraft).
3. Manual cable cutter D-ring — Secure.
4. Ejection hatch release mechanism — Secure (unmodified aircraft).
5. Ejection rings in position and safety pins installed — Check.
6. Shoulder harness straps — Check.
7. Ejection seat and seat belt initiator hoses — Inspect general condition.
8. Survival kit emergency oxygen pressure — Check.
9. Flashlight, maps, reference books and personal gear — Check.
10. Landing gear levers — DOWN.

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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.
Wheel chocks in place.

1. RIGHT FORWARD FUSELAGE.

a. Canopies unlocked, external handle in detent.
b. Electronics compartment cover — Secure.
c. Open electrical load center — Check circuit breakers.
d. Ram air turbine — Secure, no leakage.
e. Air conditioning ram air scoop, no debris.
f. Engine intake duct — Unobstructed.
g. Engine intake duct inspection door — Secure.
h. Navigation lights — Undamaged.

2. RIGHT MAIN GEAR.

a. Landing gear door uplocks, cocked.
b. Ground safety pins — Removed.
c. Landing gear dump valve — Safetied.
d. Downlocks in place (knob on drag strut down).
e. Shock struts extended (1½ - 1¾").
f. Landing lights — Secure and undamaged.
g. Check for clearance between wheel and tie rod.
h. Wheel brake lines secure, no leakage, self adjuster exposed not less than ¼".
i. Tires — inflation, condition and slippage.

3. RIGHT WING.

a. Leading edge flap and tip — Condition, no cracks or distortions.

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CUT ON DOTTED LINE

CUT ON DOTTED LINE

b. Attachment of external stores secure, general condition.

c. Aileron and trailing edge flap — Condition, no cracks or distortions.

d. Surface — Condition, no cracks or distortions, panels secure.

e. Visually check right tip and pylon tanks, if installed, for fuel level and amount.

4. **RIGHT AFT FUSELAGE.**

a. Blow out panel — Secure.

b. Speed brake — Condition, connections, no leakage.

c. Navigation lights — Undamaged.

d. Drag chute — Installed.

e. Ventral fin for alignment.

5. **EMPENNAGE.**

a. Vertical and horizontal stabilizers and yaw dampers — Secure, no cracks or distortions.

b. Exhaust nozzle flap linkages and segments — Secure, no cracks or distortions or oil leaks.

c. Afterburner spray bars, flameholder and liners — Condition, no cracks or distortions.

6. **LEFT AFT FUSELAGE.**

a. Navigation lights — Undamaged.

b. Speed brake — Condition, connections, no leakage.

c. Hydraulic system accumulator pressures 1000 $\pm$25 PSI.

d. Hydraulic system manual selector valve — Safetied in number 2 position.

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e. Hydraulic system quantity gages at proper level.

f. Heat exchanger for cracks or discoloration, check.

g. Engine oil dipstick cover —— Secure, flag down.

7. LEFT WING.

(Same as step 3.)

8. LEFT MAIN GEAR.

(Same as step 2) except:

a. Ground-air safety switch, clean, undamaged.

9. LEFT FORWARD FUSELAGE.

a. Fuel filler cap — Secure.

b. Navigation light undamaged.

c. Engine intake duct inspection door — Secure.

d. Engine intake duct — Unobstructed.

e. Single point filler cap—Secure (AF Serials 57-1329 and subsequent).

f. Air refueling probe — Secure (if installed).

g. Refueling precheck switch cover — Secure.

10. NOSE GEAR.

a. Ground safety pin — Removed.

b. Scissors — Properly connected.

c. Downlock — Fully engaged in slot.

d. Taxi light secure and unbroken.

e. Shock strut — Extended 2 inches.

f. Tire — Inflation condition.

g. Seat ejection hatches — Properly secured (unmodified aircraft).

CUT ON DOTTED LINE

CUT ON DOTTED LINE

11. NOSE SECTION.

a. Infra-red sight window — Undamaged.
b. Radome latches — Secure.
c. Pitot head — Secure, cover removed, openings clean.
d. Pitch sensor vanes — Free to move, guards removed.

AFT COCKPIT CHECK (SOLO FLIGHTS).

1. Seat belt, tie down strap, shoulder harness and all personal leads — Secured.
2. Circuit breakers — IN.
3. Stability control switches — ON.
4. External stores release selector switch — OFF.
5. Fuel shut-off switch — ON.
6. Radio control transfer switches — Forward.
7. Auxiliary trim control switch — NEUTRAL.
8. Auxiliary trim selector switch — STICK TRIM.
9. UHF command radio — OFF.
10. Wing flap lever — UP.
11. Throttle — OFF (Check).
12. Speed brake switch — NEUTRAL.
13. Exhaust nozzle control switch — AUTO (guard down).
14. Landing and taxi lights switch — OFF.
15. IGV switch — AUTO (guard down and safetied).
16. Drag chute handle — Stowed.
17. Manual landing gear handle — Stowed.
18. Ram air turbine handle — Stowed.
19. Radar — STANDBY.

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20. Escape hatch jettison handle — Stowed (unmodified aircraft).
21. Canopy jettison handle — Stowed (modified aircraft).
22. Face plate heat rheostat — OFF.
23. Generator switches — NEUTRAL (guards down).
24. Survival kit oxygen supply lever — OFF.
25. Diluter demand oxygen supply lever — OFF.
26. VHF navigation radio — OFF.
27. Ram air scoop lever — CLOSED.
28. Pitch sensor and pitot heat switch — OFF.
29. Thunderstorm lights switch — OFF.
30. Circuit breakers — IN.
31. Aft canopy — LOCKED.

FORWARD COCKPIT CHECK (ALL FLIGHTS).

* 1. Foot retractors — Attach.
* 2. Seat belt, shoulder harness, tie down strap and parachute lanyard anchor — Fasten.
* 3. Zero-delay lanyard — Hook.
* 4. Oxygen hoses to face plate and pressure suit, other personal leads — Connect.
* 5. If pressure suit is not used; head set, oxygen mask, G-suit — Connect.
6. MA-2 or MD-3 external power unit — Connected and ON.
7. Attitude indicator — Check.
* 8. Left console circuit breakers — IN.
* 9. Anti-G suit valve — As desired.
* 10. Radio control transfer switches — As desired.
11. Auto-pitch control system cut-out switch — ON and safetied.
* 12. Stability control switches (roll, pitch, and yaw) — ON.
13. Directional trim rheostat — Centered.
14. Missile firing selector switch — SAFE.

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CUT ON DOTTED LINE

* 15. External stores release selector switch — OFF.
16. External fuel tank selector switch — As required.
* 17. Fuel shut-off switch — ON.
18. External tank fuel and air refueling selector switch (AF Serials 57-1329 and subsequent) — As required.
19. Air refueling indicator light (AF Serials 57-1329 and subsequent) — Push to test.
* 20. Auxiliary trim control switch — NEUTRAL.
* 21. Auxiliary trim selector switch — STICK TRIM.
* 22. UHF command radio — As required.
* 23. Exhaust nozzle control switch — AUTO (guard down).
* 24. Wing flap lever — UP (check indicator).
* 25. Throttle — OFF (Check).
* 26. Speed brake switch — NEUTRAL.
* 27. Red landing gear warning light off — Check.
* 28. Green landing gear indicator lights on — Check.
* 29. Landing and taxi lights switch — OFF.
30. Engine anti-ice switch — OFF.
* 31. IGV switch — AUTO (guard down and safetied).
* 32. Drag chute handle — Stowed.
* 33. Manual landing gear release handle — Stowed.
34. Gun sight target span selector switch — As desired.
35. Gun sight mechanical cage switch — CAGE.
* 36. Accelerometer — Set.
* 37. Clock — Check.
* 38. Airspeed setting index — Set as desired.
* 39. Altimeter — Set at field elevation.
* 40. Radar — STANDBY.
41. Arming switch — OFF.

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* 42. Armament panel security — Check.

43. Weapon selector switch — GUN or as required (AF Serials prior to 57-1321).

44. Gun clearing switch — OFF (AF Serials prior to 57-1321).

45. IR sight switch — OFF.

46. Reticle lights rheostat — Check (both lights).

47. Camera shutter selector switch — As desired.

* 48. Hatch jettison handle — Stowed (unmodified aircraft).

49. Canopy jettison handle — Stowed (modified aircraft).

* 50. Face plate heat rheostat — As required.

* 51. Hydraulic systems pressure gage selector switch — NO. 2.

* 52. Ram air turbine extension handle — Stowed.

* 53. No. 1 and No. 2 generator switches — NEUTRAL (guards down).

54. Canopy defrosting lever — As required.

* 55. Fuel quantity and fuel indicating system — Check.

* 56. Warning lights system test switch — WARNING LIGHTS TEST.

* 57. Oxygen pressure gage — 295-315 psi.

* 58. Liquid oxygen quantity gage — 9-10 liters.

* 59. Oxygen system — Check.

* 60. VHF navigation radio — OFF.

61. S.I.F. panel — As required.

62. IFF master switch — OFF.

* 63. Interphone control panel — As desired.

* 64. Ram air scoop lever — CLOSED (lever in last detent).

65. Air refueling probe light switch — OFF (AF Serials 57-1329 and subsequent).

66. Engine motoring switch — OFF.

* 67. Thunderstorm lights switch — OFF.

68. Ventilated suit blower switch — As desired.

* 69. Interior lights rheostat — As desired.

70. Exterior lights switches — As desired.

71. Cockpit heat rheostat — AUTO (position as desired).

* 72. Pitch sensor and pitot heat switch — OFF.

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CUT ON DOTTED LINE

CUT ON DOTTED LINE

73. Rain removal switch — OFF.
74. Directional indicator function selector switch — MAG.
* 75. Right console circuit breakers — IN.

STARTING ENGINE.

1. Ground turbine compressor and auto-start control cable — Connected and ON.
2. Start switch — START and release.
3. Throttle — IDLE.
4. Fuel flow, 500-800 pounds per hour — Check.
5. No. 1 and No. 2 start switches — STOP-START at 40% rpm.
6. External electrical power and ground turbine compressor — Disconnect at idle.
7. Engine instruments for proper indications — Check.

FALSE OR HANGING START PROCEDURES.

1. Throttle — OFF.
2. No. 1 and No. 2 start switches — STOP-START.
3. Check for absence of fuel in tailpipe.
4. Attempt restart.

GROUND OPERATION.

1. Generator — Check.
2. Boost pump circuit breakers — Checked and ON, electrical load center door secure.
3. UHF, VOR and IFF — As required.
4. Hydraulic systems — Check.
5. Trim system — Check.
6. Trim — Set for take-off and verified by ground personnel.
7. Stick kicker, stick shaker, and stability augmentation control system — Check.

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BEFORE TAXIING.

1. External stores auto drop system safety pins — Removed.
2. Hydraulic door — Closed.
3. Canopies — As desired.
4. Ground crew interphone — Disconnected.
5. Seat safety pins — Removed.
6. Wheel chocks — Removed.

TAXIING.

1. Nose wheel steering — Engage.
2. Brakes — Check.
3. Flight indicators — Check.

BEFORE TAKE-OFF.

PREFLIGHT AIRPLANE CHECK.

1. Canopies — Closed and LOCKED.
2. Inertia reel lock lever — Locked.
3. Speed brake switch — IN.
4. Trim set for take-off — Check.
5. Wing flap lever — TAKE-OFF (check indicators).
6. Pitot heat, rain removal and canopy defrost — As required.

PREFLIGHT ENGINE CHECK.

1. Align aircraft with runway — Nose wheel centered.
2. Brakes — Pump and hold.
3. Throttle, Military thrust — Check instruments.
4. Throttle — Reduce slowly to 80% rpm, check for compressor stall.
5. Throttle — Rapidly retard to IDLE — Check fuel flow.
6. Throttle — MILITARY.

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CUT ON DOTTED LINE

CUT ON DOTTED LINE

TAKE-OFF DATA CARD

CONDITIONS.

Gross Weight	______Lbs.
Runway Length	______Ft.
Runway Temperature	______° F.
Pressure Altitude	______Ft.
Runway Gradient	______% (Up) (Down)
Runway Wind Component	______Kts.

TAKE-OFF.

Afterburner, Yes______, No______

Ground Run Distance (Zero Wind, Zero Slope)	______Ft.
Acceleration Check Marker	______Ft. Remaining
Acceleration Check Speed	______K.I.A.S.
Take-off Speed	______K.I.A.S.

LANDING IMMEDIATELY AFTER TAKE-OFF:	______Flaps
Gross Weight	______Lbs.
Approach Speed	______K.I.A.S.
Touchdown Speed	______K.I.A.S.
Landing Ground Roll	______Ft.

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CUT ON DOTTED LINE

TAKE-OFF.

1. Throttle — Minimum sector afterburner (insure light off).
2. Brakes — Release.
3. Throttle — Maximum Thrust.
4. Engine instruments — Check.
5. Use nose wheel steering as necessary for directional control.
6. Assume take-off attitude.

AFTER TAKE-OFF — CLIMB.

1. Landing gear lever — UP.
2. Wing flap lever — UP (check indicators).
3. Throttle — As desired.
4. Engine instruments and fuel quantity — Check.
5. Zero-delay lanyard — Unhook.
6. Airspeed — Best climb.
7. Altimeter — Reset to 29.92" Hg or as required when passing 23,500 feet.

DESCENT.

1. Engine anti-ice and pitot heat — As required.
2. Armament switches — OFF.
3. Radar master selector switch — STBY.
4. Gunsight mechanical cage switch — CAGE.
5. No. 1 and No. 2 hydraulic system pressures — Check.
6. Inertia reel lock lever — Locked.
7. Altimeter — Reset to 29.92" Hg or as required when passing 23,500 feet.

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BEFORE LANDING.

WARNING

The airspeeds listed herein are based on a landing gross weight of 15,000 lbs. (1,000 lbs. fuel remaining). Increase approach and landing speeds 5 knots for each 1,000 lbs. of fuel remaining above 1,000 lbs.

INITIAL.

1. Zero delay lanyard — Hook.
2. Wing flap lever — TAKE-OFF at pitch (check indicators).

DOWNWIND.

1. Landing gear lever — DOWN (check indicators).
2. Wing flap lever — LAND below 240 knots IAS and above 210 knots IAS (check indicators).

BASE LEG TURN.

1. Landing gear down and locked — Check.
2. Brakes — Pump.
3. Airspeed — 200 knots IAS minimum.

FINAL.

1. Roll out on final approach, minimum distance from end of runway — 6,000 feet; recommended airspeed — 190 knots IAS.
2. Engine speed 87-90% rpm.
3. Airspeed — 170 knots IAS recommended.

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CUT ON DOTTED LINE

CUT ON DOTTED LINE

LANDING DATA CARD

RUNWAY CONDITIONS.

Length .... ______Ft.

Air Temperature .... ______° F.

Pressure Altitude .... ______Ft.

Slope Gradient .... ______% (Up) (Down)

Wind Component .... ______Kts.

LANDING.

Gross Weight .... ______Lbs.

Approach Speed .... ______K.I.A.S.

Touchdown Speed .... ______K.I.A.S.

Ground Roll With Chute .... ______Ft.

Ground Roll Without Chute .... ______Ft.

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CUT ON DOTTED LINE

LANDING.

NORMAL LANDING.

1. Throttle — Retard to IDLE (after touchdown).
2. Nose wheel steering — Engage.
3. Drag chute — Deploy.

TOUCH AND GO LANDINGS.

1. Wing flap lever — TAKE-OFF.
2. Throttle — MILITARY.
3. Speed brake switch — IN.
4. Trim — Set for take-off.
5. Use normal take-off technique.

GO-AROUND.

1. Throttle — MILITARY (Maximum Thrust if necessary).
2. Speed brake switch — IN.
3. Landing gear lever — UP.
4. Wing flap lever — TAKE-OFF.
5. Wing flap lever — UP.

AFTER LANDING.

1. Speed brake switch — IN.
2. Wing flap lever — TAKE-OFF.
3. Rain remover — OFF. (If rain remover has not been used, turn ON for 30 seconds, then OFF).
4. Engine anti-ice and pitot heat switches — OFF.
5. Drag chute — Jettison in appropriate area.
6. Trim — Take-off.

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ENGINE SHUT DOWN.

1. Wing flap lever — UP.
2. Run engine for three minutes at idle for proper engine cooling.
3. Throttle — OFF.
4. Fuel shut-off switch — OFF.

BEFORE LEAVING AIRPLANE.

1. Ejection seat safety pins — Installed.
2. Pressure suit oxygen supply lever — OFF.
3. Diluter demand oxygen supply lever — ON.
4. Radio equipment — OFF.
5. Wheels — Chocked.
6. Landing gear ground safety pins — Installed.
7. External stores auto drop system safety pins — Installed.
8. Form 781 — Complete.

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CUT ON DOTTED LINE

emergency procedures

SECTION III

TABLE OF CONTENTS

Note

CRITICAL ACTION ITEMS ARE DEFINED AS THOSE ACTIONS WHICH MUST BE PERFORMED IMMEDIATELY AND INSTINCTIVELY IF THE EMERGENCY IS NOT TO BE AGGRAVATED AND INJURY OR DAMAGE IS TO BE AVOIDED. CRITICAL ACTION ITEMS ARE IDENTIFIED IN THE FOLLOWING TEXT BY MEANS OF BOLD FACE TYPE.

ENGINE FAILURE.

Engine failure is defined as a complete power failure which, in the pilot's judgment, makes it impossible or inadvisable to attempt a new start. Examples are engine seizure, explosion, etc.

ENGINE FAILURE DURING TAKE-OFF RUN.

If engine failure occurs before airplane leaves ground.

1. ABORT TAKE-OFF.

Refer to Abort Procedure under Take-off and Landing Emergencies in this Section.

LOW SPEED ZOOM CAPABILITY WITH DEAD ENGINE

NO EXTERNAL STORES 19000 POUNDS
ESTIMATED DATA

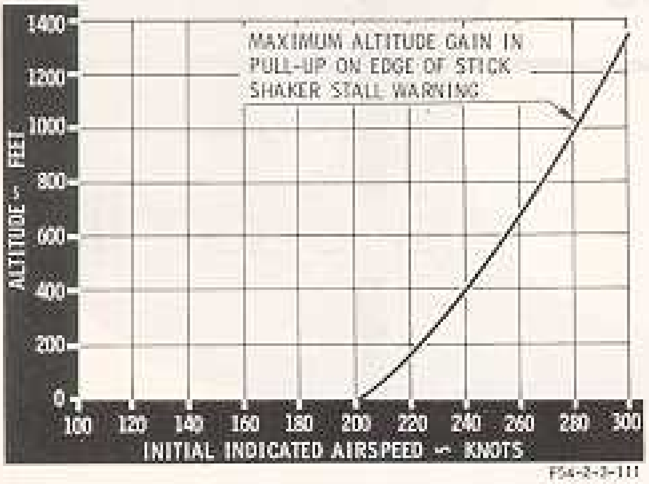


Figure 3-1

ENGINE FAILURE DURING TAKE-OFF (AIRPLANE AIRBORNE).

Abandon the aircraft if altitude permits rather than land on an unprepared surface.

1. EXTERNAL STORES—JETTISON.

Note

Maximum altitude gain can be achieved by jettisoning external stores prior to zoom. The higher up the climbing flight path external stores are jettisoned, the less additional altitude will be gained.

2. Zoom to safe ejection altitude.

Note

- Airplane zoom capability at low airspeeds is shown in Figure 3-1. This information should be used *only as a guide* in deciding whether to zoom or not. The decision to eject is dependent on type of ejection equipment, parachute, etc. Figure 3-1 shows that, in most cases, a mild pull-up on the edge of the stick shaker stall warning will produce the maximum altitude gain. If a rapid pull-up is attempted, the aircraft will stall before sufficient altitude has bein gained even though the initial airspeed appeared adequate.
- If a decision to eject is made, the aircraft should be allowed to climb as high as possible. Ejection should be accomplished while the nose of the airplane is above the horizon but prior to reaching a stall or sink.

Upward Ejection Seat.

1. IF UNABLE TO ZOOM—EJECT.

Downward Ejection Seat.

1. IF UNABLE TO ZOOM, THROTTLE—OFF.
2. MANUAL LANDING GEAR RELEASE HANDLE—PULL DURING FLARE.

WARNING

Less injury and less aircraft damage results when the landings are made with the gear extended because of the absorption of the initial shock by the extended landing gear.

3. CANOPY INTERNAL LOCKING LEVER—UNLOCK.
4. FUEL SHUT-OFF SWITCH—OFF.

Note

Land straight ahead, changing course only enough to miss obstacles.

5. DRAG CHUTE—DEPLOY AT TOUCHDOWN.

ENGINE FAILURE DURING FLIGHT.

If a complete loss of thrust occurs and an airstart is impossible or inadvisable, proceed as follows:

1. THROTTLE—OFF.

2. **RAM-AIR TURBINE EXTENSION HANDLE—PULL.**

3. **WING FLAP LEVER—TAKE-OFF.**

4. **GLIDE SPEED—REDUCE TO 240 KNOTS IAS.**

5. IFF—EMERGENCY.

6. Radio — Advise of emergency.

7. Eject or attempt forced landing.

ENGINE AIR START.

If a flameout has been experienced, an airstart may be made using the following procedure:

1. **BOTH START SWITCHES—START.** Hold momentarily to insure contact of switches.)

    Monitor engine instruments for immediate re-light if engine rpm is still high.

2. **IF IMMEDIATE RE-LIGHT IS NOT OBTAINED, THROTTLE — POSITIVELY OFF AND IMMEDIATELY RETURN TO MILITARY.**

3. **GLIDE SPEED—275 KNOTS IAS.**

    While establishing best glide speed, the aircraft should be headed toward the nearest suitable landing field.

4. **IF NO AIR START OCCURS WITHIN 20 SECONDS, BOTH START SWITCHES—START.**

    Do not move throttle to OFF before this second actuation of the start switches.

5. **RAM-AIR TURBINE EXTENSION HANDLE — PULL, CHECK FOR FUEL FLOW.**

Note

Do not extend the RAT above 35,000 feet as chances of obtaining normal engine operation are remote and the increased drag will reduce glide distance.

6. **WING FLAP LEVER—TAKE-OFF.**

7. **GLIDE SPEED—REDUCE TO 240 KNOTS IAS.**

Note

With the RAT extended, the same glide distance may be realized at 240 Knots IAS and take-off flaps as with 275 Knots IAS and no flaps. However, the slower speed will result in a lower rate of descent.

8. **START SWITCHES—START.**

9. **THROTTLE—ADJUST AS REQUIRED.**

    Allow engine instruments to stabilize and adjust throttle to settings necessary for flight. Engine instruments will give the most reliable indication of a re-light.

ENGINE STALL CLEARING.

Refer to Section VII for additional information.

Below 15,000 Feet.

1. **ENGINE AIR START PROCEDURE.**

2. **IGV SWITCH—MANUAL.**

Note

- Do not use the afterburner with the IGV switch in MANUAL.
- Entries must be made in the Form 829A each time this emergency device is actuated to clear a compressor stall. If five emergency actuations are made on any one engine, this information should be forwarded to SMAMA for disposition.

3. **MAINTAIN 97% RPM UNTIL LANDING IS ASSURED.**

    Rpm may be reduced below 97% if landing conditions require reduced thrust. Care must be exercised not to reduce thrust below that necessary to complete the landing because it may not be possible to regain higher thrust, once it is reduced. Speed brakes should be used to keep airspeed consistent with pattern and landing conditions.

Note

If landing roll distance is critical, deactivate the inlet guide vane switch after touchdown. Idle thrust is slightly higher when the IGV switch is in the MANUAL POSITION.

Above 15,000 Feet.

Note

> Any of the following procedures may clear the engine stall and all procedures need not be accomplished in the event the stall clears.

1. THROTTLE--MILITARY.

2. THROTTLE--IDLE. CHECK EGT FOR NORMAL READING AND RPM FOR POSSIBLE HANG-UP.

3. ENGINE AIR START PROCEDURE. IF STALL IS NOT CLEARED, DESCEND TO BELOW 30,000 FEET AND ATTEMPT ANOTHER AIR START.

4. CHECK FOR IGV STALL BEFORE DESCENDING TO LAND BY RETARDING THROTTLE SLOWLY TO 80% RPM. THIS CHECK MAY NOT INDICATE AN OPEN IGV CONDITION STALL ABOVE 20,000 FEET.

5. IF STALL REOCCURS AT THIS TIME OR DURING DESCENT, USE THE PROCEDURE FOR BELOW 15,000 FEET.

MAXIMUM GLIDE.

Windmilling or Frozen Engine (Figure 3-2).

Maximum distance is obtained by gliding with flaps and gear retracted at 275 knots IAS. Almost the same distance can be obtained with take-off flaps extended at 240 knots IAS. The difference is approximately 3 percent. With the RAT extended, exactly the same distance is obtainable in either configuration; however, the rate of descent with take-off flaps is approximately 1,000 feet per minute less due to the lower speed for the same glide ratio. With the RAT extended, it is advantageous to glide with take-off flaps at 240 knots. This is also the configuration recommended for the flame-out landing pattern. The glide distances for take-off flaps, 240 knots and RAT extended are shown in figure 3-2. Gliding without the RAT extended will increase these distances approximately 2 nautical miles per 10,000 feet of altitude.

Note

> Unless the engine is damaged, the windmilling engine speed will produce sufficient hydraulic pressure to operate the flight control system.

EJECTION VS. FORCED LANDING.

Because of the many variables encountered, the final decision to attempt a flame-out landing or eject must remain with the pilot. These variables make a quick and accurate decision difficult. Furthermore, it is impossible to establish a pre-determined set of rules and instructions which would provide a ready made decision applicable to all emergencies of this nature because unique circumstances will be associated with each such emergency. However, certain basic conditions, as listed below, must exist before attempting a flame-out landing. Otherwise ejection is the best course of action.

a. Flame-out landings should only be attempted by pilots who have satisfactorily completed simulated flame-out approaches in this aircraft.

b. Flame-out landings should only be attempted on prepared or designated suitable surfaces that provide at least twice the landing distance normally required.

c. Approaches to the landing field must be unrestricted (clear area of approximately three to five thousand feet in length).

Note

> No attempt should be made to land a flamed-out aircraft at any field whose approaches are over heavily populated areas if a suitable area is available to abandon the aircraft.

d. Weather and terrain conditions must be favorable. Cloud cover, ceiling, visibility, turbulence, surface wind, etc., must not impede in any manner the establishment of a proper flame-out landing pattern.

e. Flame-out landings should only be attempted when either a satisfactory "High Key" or "Low Key" position can be achieved.

Note

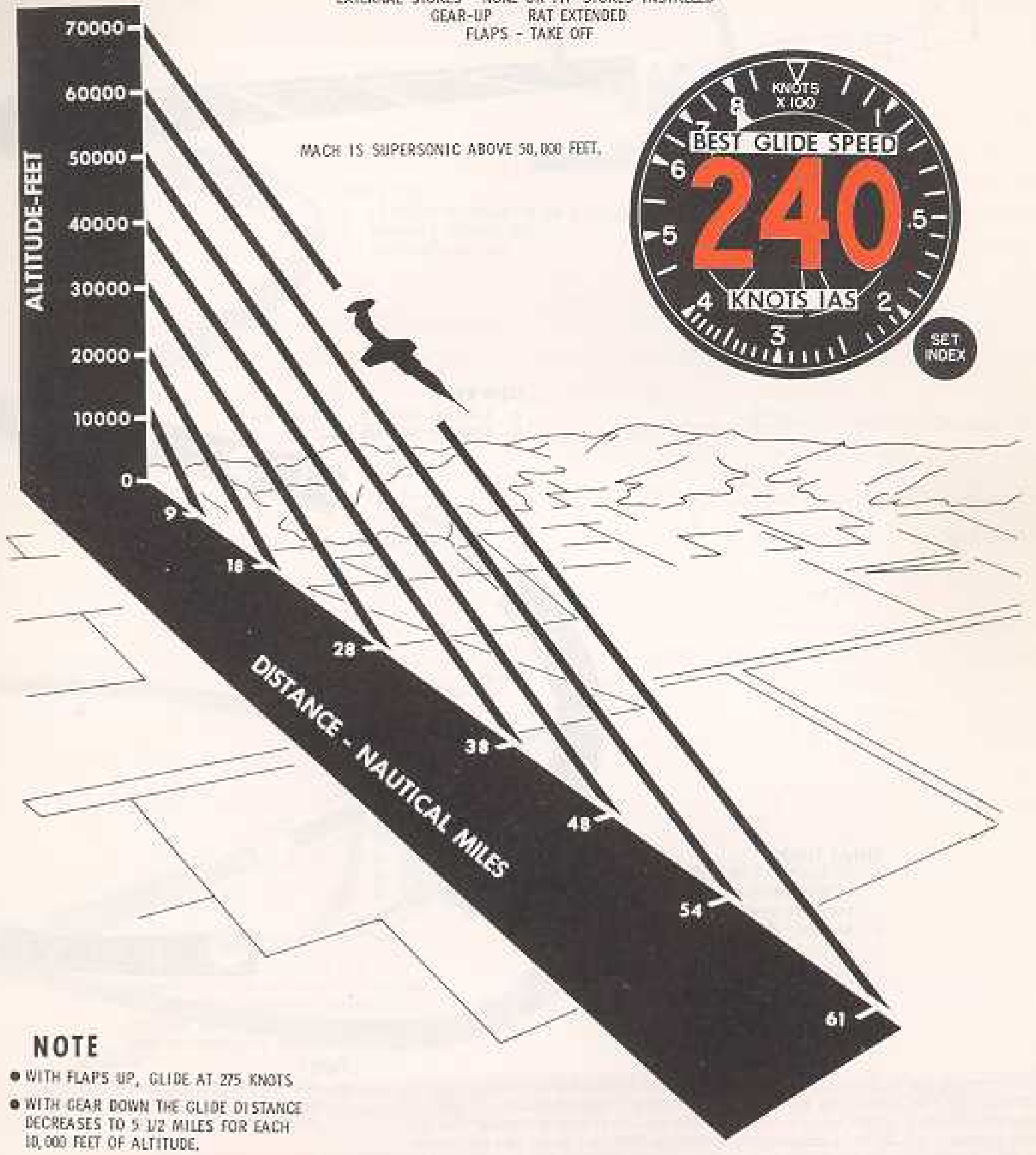
> Night flame-out landings or flame-out landings under poor lighting conditions such as at dusk or dawn should not be contemplated regardless of weather or field lighting.

f. If at any time during the flame-out approach, conditions do not appear ideal for successful completion of the landing, ejection should be accomplished. Eject no later than the Low Key altitude.

All of the above basic conditions combined with the pilot's analysis of the condition of the aircraft, type of emergency, and his proficiency are of prime importance in determining whether to attempt a flame-out landing or to eject.

MAXIMUM GLIDE DISTANCES

ZERO WIND STRAIGHT LINE GLIDE
ENGINE WINDMILLING OR FROZEN
EXTERNAL STORES - NONE OR TIP STORES INSTALLED
GEAR-UP RAT EXTENDED
FLAPS - TAKE OFF



NOTE

- WITH FLAPS UP, GLIDE AT 275 KNOTS
- WITH GEAR DOWN THE GLIDE DISTANCE DECREASES TO 5 1/2 MILES FOR EACH 10,000 FEET OF ALTITUDE.

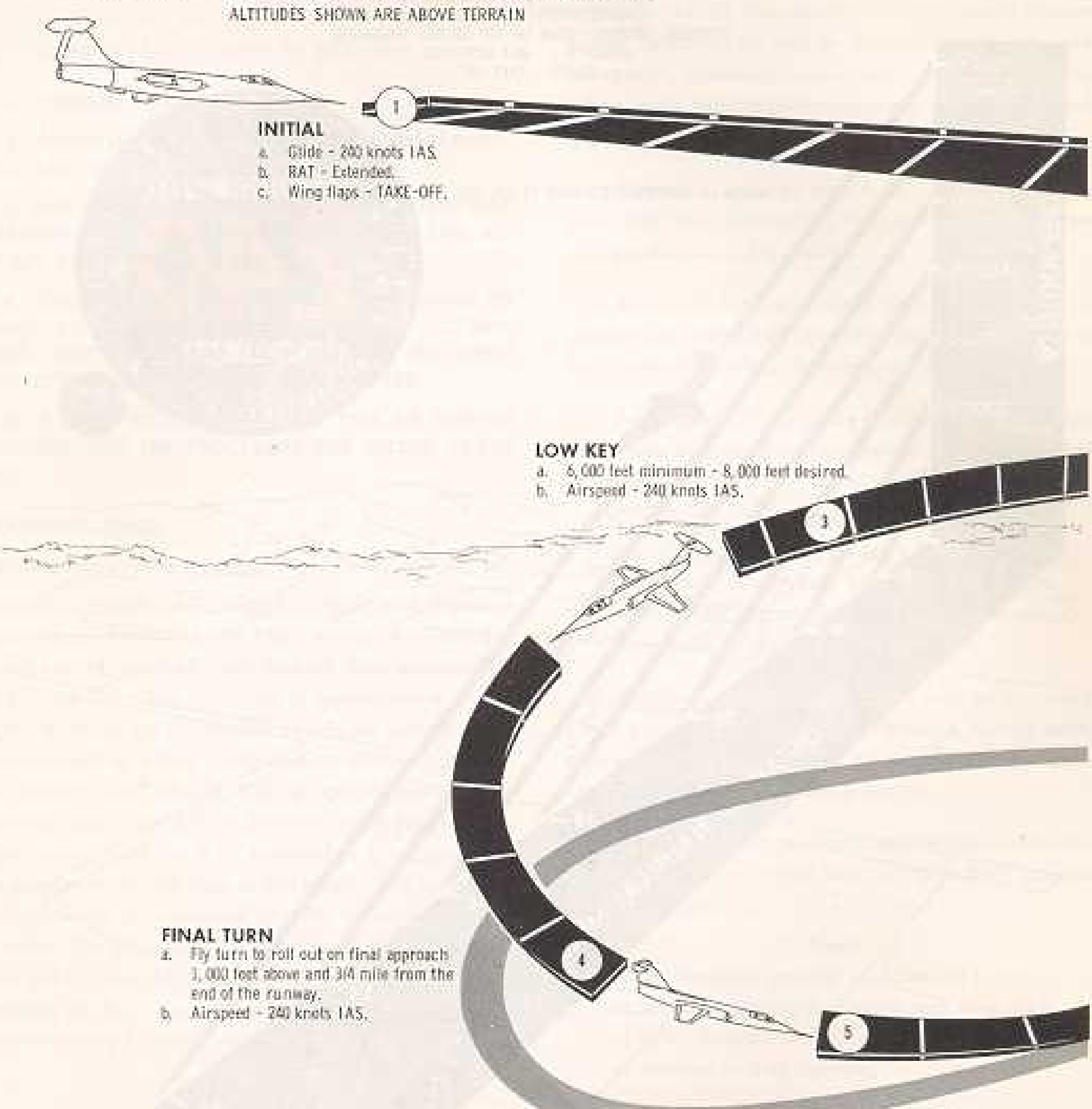
F51-C-3-50

Figure 3-2

TYPICAL FORCED LANDING PATTERN

WINDMILLING OR FROZEN ENGINE GLIDE CHARACTERISTICS ARE THE SAME

ALTITUDES SHOWN ARE ABOVE TERRAIN



WARNING

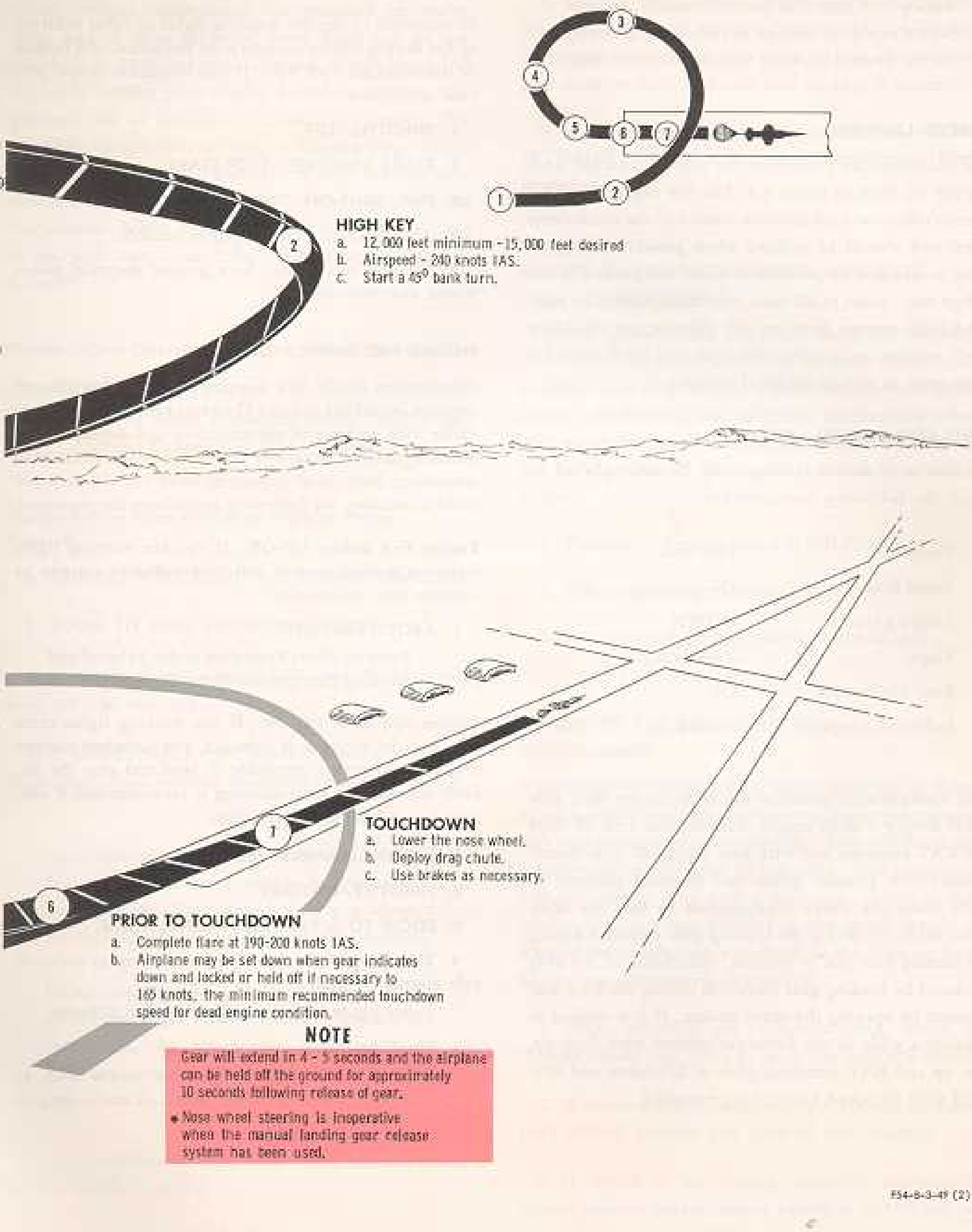
It is imperative that the landing gear remain retracted until after the flare has been started otherwise the rate of descent will be increased from approximately 7,000 feet to approximately 11,000 feet per minute and the altitude and speed loss required for flare will be increased to the point that a safe dead-stick landing will be extremely difficult to perform.

It has been found that after leaving the low key point the airspeed should be monitored closely and held as close as possible to the recommended 240 knots. In any case the airspeed should not be allowed to drop below 220 knots. Attempts to regain speed will cause the rate of descent to increase to the point where the flare cannot be accomplished.

FLARE
a. Start flare 300-500 feet above ground.
b. When flare is assured, pull the manual landing gear release handle.

F54-3-3-49 (1)

Figure 3-3


HIGH KEY
a. 12,000 feet minimum - 15,000 feet desired
b. Airspeed - 240 knots IAS.
c. Start a 45° bank turn.
TOUCHDOWN
a. Lower the nose wheel.
b. Deploy drag chute.
c. Use brakes as necessary.
PRIOR TO TOUCHDOWN
a. Complete flare at 190-200 knots IAS.
b. Airplane may be set down when gear indicates down and locked or held off if necessary to 165 knots, the minimum recommended touchdown speed for dead engine condition.
NOTE
Gear will extend in 4 - 5 seconds and the airplane can be held off the ground for approximately 10 seconds following release of gear.
• Nose wheel steering is inoperative when the manual landing gear release system has been used.

F54-8-3-49 (2)

Note

If a decision to eject is made, the pilot should attempt to turn the aircraft toward an area where injury or damage to persons or property on the ground or water is least likely to occur.

FORCED LANDING.

The recommended procedures for making a forced landing are set forth in figure 3-3. The 360 degree overhead pattern offers the most accurate control of the touch down point and should be utilized when possible. However, since it may not be possible to enter the pattern at the "High Key" point in all cases, conditions should be practiced with pattern entry at any point up to the "Low Key" position to develop technique and proficiency for these cases as well as the ideal situation.

SIMULATED FORCED LANDING.

Simulation of forced landings may be accomplished by using the following configuration.

Throttle	83% rpm
Speed Brakes	IN
Landing Gear	DOWN
Flaps	TAKE-OFF
Ram Air Turbine	IN
Indicated Airspeed	240 Kts.

This configuration produces the approximate drag provided during a dead engine descent with take-off flaps and RAT extended and with gear retracted. It is recommended that practice glides and flameout patterns be made using the above configuration so that the additional safety of having the landing gear extended during the landing flare can be realized. Simulation of the drag produced by landing gear extension during the flare may be made by opening the speed brakes. If it is desired to simulate a glide to the flame-out pattern with flaps up, gear up and RAT retracted, glide at 275 knots and 87% RPM with the speed brakes fully extended.

FIRE.

ENGINE FIRE DURING STARTING.

Illumination of the fire warning lights or other evidence of fire during engine starting is an indication of a broken or disconnected fuel line. If this condition occurs proceed as follows:

1. **THROTTLE—OFF.**
2. **START SWITCHES—STOP-START.**
3. **FUEL SHUT-OFF SWITCH—OFF.**
4. Abandon aircraft as quickly as possible.
5. If conditions permit, have ground electrical power source disconnected.

ENGINE FIRE DURING TAKE-OFF.

Illumination of the fire warning lights during take-off requires immediate action. The exact procedure to follow varies with each set of circumstances and depends upon altitude, airspeed, length of runway and overrun clearing remaining, location of populated areas, etc. To help you make a decision, the following procedures are presented.

Engine Fire Before Lift-Off. If the fire warning lights come on during ground roll, and sufficient runway or overrun area is available

1. **ABORT TAKE-OFF.**

   Refer to Abort Procedure under Take-off and Landing Emergencies in this Section.

Engine Fire After Lift-Off. If fire warning lights come on after the airplane is airborne, and sufficient runway and overrun are not available to land and stop the aircraft successfully, the following is recommended if altitude is too low for safe ejection.

1. **EXTERNAL TANKS—JETTISON.**
2. **THROTTLE—MILITARY.**
3. **ZOOM TO A SAFE EJECTION ALTITUDE.**
4. Throttle — Adjust to minimum setting to maintain safe ejection altitude.

   See figure 3-5 for minimum ejection altitudes.
5. Check for fire.

   Confirm fire by any possible means such as report from ground, other aircraft, engine instruments, smoke in cockpit or visible smoke trail behind aircraft.

6. If fire exists — Eject.

7. If fire cannot be confirmed, make decision to land or eject.

ENGINE FIRE DURING FLIGHT.

If Fire Warning Lights Come ON During Flight, Proceed As Follows:

1. THROTTLE—IDLE OR MINIMUM PRACTICAL THRUST.

2. HEAD TOWARD NEAREST EMERGENCY FIELD — 275 KNOTS IAS.

3. CHECK FOR FIRE.

   Confirm fire by any possible means such as report from other aircraft, engine instruments, smoke in cockpit or visible smoke trail behind aircraft.

If Fire Is Confirmed And Lights Remain ON:

1. THROTTLE — OFF.

2. IF LIGHTS REMAIN ON — EJECT.

3. IF LIGHTS GO OUT — EXTEND RAT.

WARNING

The fire warning lights are powered from the battery bus. However, the warning light test switch is powered from the d.c. emergency bus. Therefore, the warning lights cannot be energized by the test switch below Idle rpm unless the RAT is extended. On modified aircraft, extension of the RAT is not required since the warning light test circuit is powered from the battery bus.

4. WARNING LIGHTS — TEST.

5. IF LIGHTS DO NOT ILLUMINATE — EJECT.

6. IF LIGHTS ILLUMINATE — MAKE DECISION TO EJECT OF ATTEMPT A FLAME-OUT LANDING.

If Fire Cannot Be Confirmed And Lights Go Out After Retarding Throttle:

1. WARNING LIGHTS — TEST.

2. IF LIGHTS ILLUMINATE AND THERE ARE NO OTHER INDICATIONS OF FIRE, LAND AS SOON AS POSSIBLE AT REDUCED POWER.

3. IF LIGHTS DO NOT ILLUMINATE — EJECT.

If There Are No Indications Of Fire And Lights Remain On After Retarding Throttle:

1. Land as soon as possible, continually checking for fire.

ENGINE FIRE AFTER SHUT-DOWN.

1. Ground turbine compressor — Connected and on.

2. Throttle OFF—Check.

3. Fuel shut-off switch — OFF.

4. Start switches — START and hold until engine rpm reaches 15%.

   Simultaneously place both start switches to START and signal ground crew to deliver air until engine speed reaches 15% rpm.

ELECTRICAL FIRE.

Circuit breakers and fuses protect most of the circuits and tend to prevent electrical fires. However, if electrical fire occurs, proceed as follows:

1. OXYGEN EMERGENCY LEVER — EMERGENCY.

2. GENERATOR SWITCHES — OFF.

Note

Cockpit pressure will be dumped when the generator switches are turned off.

3. All electrical accessory switches — OFF.

4. Operate only those units necessary for safe flight and landing, by placing that unit on and resetting the generators.

5. Return generator switches to OFF position when operation is complete.

6. Land as soon as possible.

ELIMINATION OF SMOKE OR FUMES.

Should smoke or fumes enter the cockpit, proceed as follows:

1. OXYGEN EMERGENCY LEVER — EMERGENCY.

2. Descend to 25,000 feet, or lower, if circumstances permit.

EJECTION PROCEDURE

BEFORE EJECTION
(IF TIME AND CONDITIONS PERMIT)

1. REDUCE SPEED AS MUCH AS POSSIBLE.
2. HEAD AIRCRAFT TOWARD UNPOPULATED AREA.
3. GIVE LOCATION AND INTENTIONS TO NEAREST RADIO FACILITY AND TURN IFF TO EMERGENCY.
4. LOWER VISOR.
5. ACTUATE BAILOUT BOTTLE IF USING A-13A MASK.

EJECTION

1. ASSUME EJECTION POSITION
2. PULL EJECTION RING WITH BOTH HANDS

EMERGENCY MINIMUM EJECTION ALTITUDE-LEVEL FLIGHT

MANUALLY ACTUATED PARACHUTE	1300 FEET
AUTOMATIC PARACHUTE ACTUATED BY SEAT BELT	SEE FIGURE 3-5

AFTER EJECTION

1. RELEASE EJECTION RING.
2. PHYSICALLY PUSH FREE OF SEAT.

NOTE

- IF THE SEAT BELT FAILS TO OPEN AUTOMATICALLY AFTER 1 SECOND, PULL MANUAL CABLE CUTTER AND MANUALLY OPEN SEAT BELT.
- IN NORMAL OPERATION, THE SEAT BELT WILL OPEN 1 SECOND AFTER EJECTION ALLOWING SEPARATION FROM THE SEAT. WITH THE PARACHUTE LANYARD ANCHOR ATTACHED TO THE BELT, THE PARACHUTE WILL OPEN AUTOMATICALLY AT A PRESET ALTITUDE, OR IF BELOW THAT ALTITUDE, THE PARACHUTE WILL OPEN 1 OR 2 SECONDS AFTER SEPARATION FROM SEAT (DEPENDING ON PARACHUTE TIME DELAY).

3. PULL "D" RING BELOW 14,000 FEET.

NOTE

- IF WEARING AUTOMATIC OPENING PRACHUTE WITHOUT LANYARD ANCHOR ATTACHED TO SEAT BELT BUCKLE, PULL PARACHUTE LANYARD ANCHOR

4. RELEASE SURVIVAL KIT BEFORE GROUND CONTACT.

WARNING

RELEASING SURVIVAL KIT DISCONNECTS EMERGENCY OXYGEN. THEREFORE DO NOT RELEASE KIT ABOVE 14,000 FEET.

F54-II-3-50

Figure 3-4

3. Ram air scoop lever — OPEN.

4. Generator switches — OFF.

5. If smoke persists, unlock canopy below 260 knots IAS (downward ejection only) and land as soon as possible.

6. If it can be determined that the smoke is caused by an electrical fire, use Electrical Fire procedures, otherwise, reset generators.

EJECTION.

The basic ejection procedure is shown in figure 3-4.

EJECTION ALTITUDES.

On ejection, the seat and the pilot will have a component of thrust provided by the aircraft. Therefore, if seat ejection is initiated when the aircraft is in a climb, the ejected pilot will reach a higher altitude than if he were ejected from an aircraft in level flight — the opposite will be true if ejection is accomplished when the aircraft is in descent. Accordingly, in marginal altitude ejections, the aircraft should be "zoomed" and ejection initiated while the aircraft is at the peak of the zoom with zero rate of descent. Refer to figure 3-1.

WARNING

In most cases, no advantage will be gained by rolling the aircraft to an inverted attitude for ejection. If airspeed is low, the altitude lost during the roll may exceed any altitude advantage intended to be gained due to the direction of ejection.

EJECTION ATTITUDES.

For low altitude ejections all excess airspeed should be used to reduce rate of descent or to increase altitude before ejection. Figure 3-5 indicates the minimum altitude for successful ejection with different combinations of automatic ejection equipment. These figures are applicable for LEVEL FLIGHT. The data are conservative for climbing flight paths and optimistic for descending flight paths.

The "one-and-zero" system has been successfully flight tested at speeds between 120 knots IAS and the maximum safe parachute opening speeds. Therefore, data for this system are applicable between 120 knots IAS and the maximum safe ejection speeds for the "one-and-zero" system as shown in figure 3-6.

Note

- Style of automatic parachute and type of canopy, pack and automatic release is defined in T. O. 14D1-1-1.
- The type of automatic seat belt used does not affect the determination of the emergency minimum altitude.

Once the equipment is known, the minimum altitude for safe ejection can be found on figure 3-5. For example, on figure 3-5 if the B-5 pack/C-11 canopy with the 2 second F-1A timer is used, the sequence is a 1 and 2 system and the emergency minimum ejection altitude under level flight conditions is 700 feet. With the zero-delay attached, the emergency minimum altitude is 450 feet. The altitudes given in figure 3-5 should be used only as a guide. Once an emergency minimum altitude has been determined for a particular configuration of equipment, the decision as to when to eject or not to eject in an emergency should not be rigidly determined by the fact that the aircraft is above or below the emergency minimum altitude as determined from these figures. Every emergency will have its particular set of circumstances involving such factors as aircraft speed, altitude and control, as well as altitude. Based on the figures and the escape configuration available, a decision should be made before take-off concerning action to be taken in the event of a low-altitude emergency.

EJECTION SPEEDS.

Analysis of escape techniques pertaining to possible injury from air blast and deceleration has revealed that ejection accomplished at airspeeds ranging from stall speed to 525 knots IAS result in relatively minor forces being exerted on the body, thus reducing the injury hazard. The pilot will undergo appreciable forces on the body when ejection is performed at airspeeds between

MINIMUM SAFE EJECTION ALTITUDES (LEVEL FLIGHT)

DOWNWARD EJECTION SEAT

	2 SECOND PARACHUTE	2 SECOND PARACHUTE	1 SECOND PARACHUTE	1 SECOND PARACHUTE	0 SECOND PARACHUTE	0 SECOND PARACHUTE
	(F-1A TIMER)	(F-1A TIMER)	(F-1B TIMER)	(F-1B TIMER)	(LANYARD TO "D" RING)	(LANYARD TO "D" RING)
	B-4 OR B-5 PACK / C-9 CANOPY	B-5 PACK / C-11 CANOPY	B-4 OR B-5 PACK / C-9 CANOPY	B-5 PACK / C-11 CANOPY	B-4 OR B-5 PACK / C-9 CANOPY	B-5 PACK / C-11 CANOPY
1 SECOND AUTOMATIC SEAT BELT M-12 INITIATOR	650	700	500	550	400	450

UPWARD EJECTION SEAT

	2 SECOND PARACHUTE	2 SECOND PARACHUTE	1 SECOND PARACHUTE	1 SECOND PARACHUTE	0 SECOND PARACHUTE	0 SECOND PARACHUTE
	(F-1A TIMER)	(F-1A TIMER)	(F-1B TIMER)	(F-1B TIMER)	(LANYARD TO "D" RING)	(LANYARD TO "D" RING)
	B-4 OR B-5 PACK / C-9 CANOPY	B-5 PACK / C-11 CANOPY	B-4 OR B-5 PACK / C-9 CANOPY	B-5 PACK / C-11 CANOPY	B-4 OR B-5 PACK / C-9 CANOPY	B-5 PACK / C-11 CANOPY
1 SECOND AUTOMATIC SEAT BELT T-35 INITIATOR	300	350	125	200	0	100

WARNING

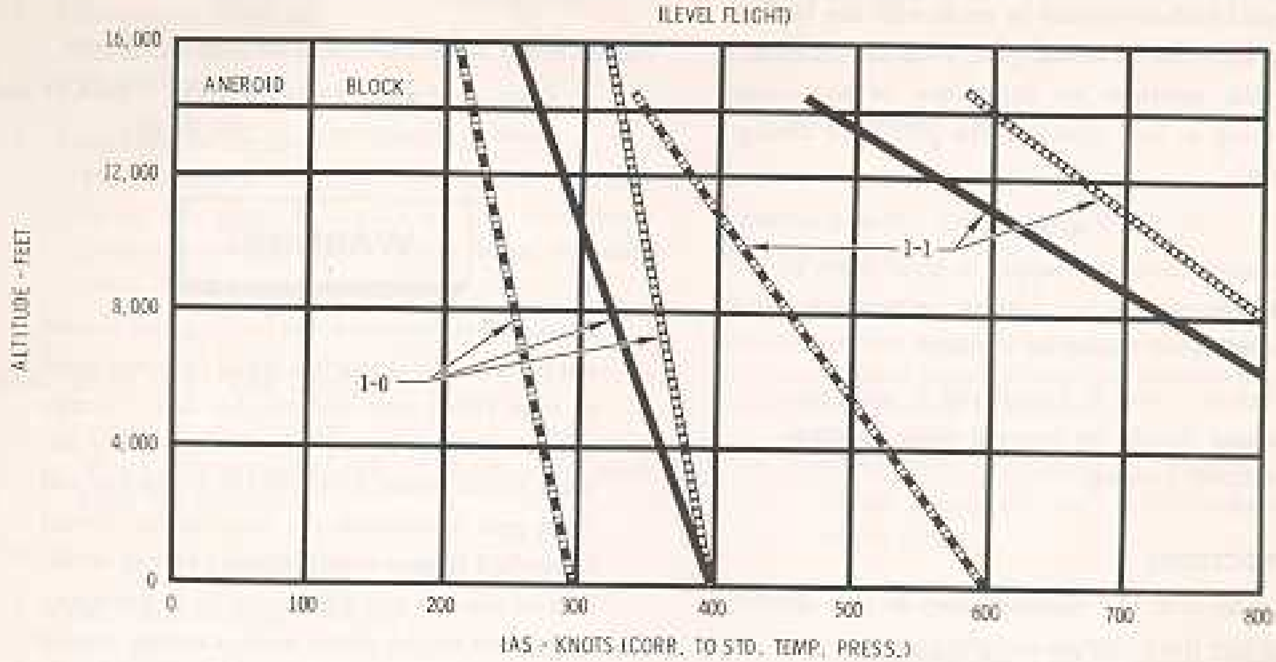
- THESE ARE EMERGENCY MINIMUMS. EJECTION SHOULD BE STARTED ABOVE 2000 FEET, IF POSSIBLE.
- MINIMUM EJECTION ALTITUDES QUOTED HEREIN WERE DETERMINED THROUGH AN EXTENSIVE SERIES OF FLIGHT TESTS AND ARE BASED ON DISTANCE ABOVE TERRAIN ON INITIATION OF SEAT EJECTION (INITIATION OF SEAT EJECTION IS DEFINED AS THE TIME THE SEAT IS FIRED). HOWEVER, HUMAN ERROR AND EQUIPMENT MALFUNCTIONS WERE NOT CONSIDERED IN THE DETERMINATION OF THESE ALTITUDES, THEREFORE, WHENEVER POSSIBLE, EJECTION SHOULD BE INITIATED AT ALTITUDES HIGHER THAN THE MINIMUMS SHOWN IN THE CHART.

F54-9-3-52

Figure 3-5

SAFE EJECTION SPEEDS—ALTITUDE VS. SEQUENCE

(LEVEL FLIGHT)



LEGEND

- TYPE C-9, 28 FT. FLAT CANOPY, TYPE B-4 PACK
- TYPE C-9, 28 FT. FLAT CANOPY, TYPE B-5 PACK WITH 1/4 BAG
- TYPE C-11, 30 FT. GUIDE CANOPY, TYPE B-5 PACK

NOTE

THIS GRAPH DEPICTS SAFE EJECTION SPEEDS FOR PARACHUTE STRUCTURAL CAPABILITY UNDER IDEAL LEVEL FLIGHT AND AVERAGE PARACHUTE PERFORMANCE CONDITIONS ONLY; OTHER EJECTION ATTITUDES, TUMBLING, SEPARATION DELAYS, VARIATIONS IN PARACHUTE OPENING TIME, ETC., ARE NOT INCLUDED. F54-3-3-53

Figure 3-6

525-600 knots IAS, and escape is more hazardous than at lower airspeeds. Above 600 knots IAS, ejection is extremely hazardous because of the excessive forces to which the body is subjected.

Figure 3-6 is a plot of three parameters, namely: altitude, speed, and sequence time of the parachute-automatic seat belt combination. The graph shows safe ejection speeds with regard to parachute capability and body injury because of parachute opening shock. The sequence lines (slanting lines) indicate the limits above which the parachute will probably be damaged on opening or the crew member will probably suffer body injury resulting from parachute opening shock.

FAILURE OF SEAT TO EJECT (DOWNWARD EJECTION).

If the seat does not eject when the ejection ring is pulled, continue holding ejection ring with one hand and proceed as follows:

1. Feet back into stirrups — Check.
2. Escape hatch jettison handle — Pull.

Note

This action releases and ejects the escape hatch and removes the free fall disconnect safety pin.

3. Ejection ring — Re-pull through maximum travel.

Note

- This by-passes the thruster initiator, locks the foot retractor cables in the retracted position, fires the catapult and ejects the seat, or the seat will gravity fall.
- With the thruster by-passed, the automatic features of the knee guards, tie-down strap tightening, inertia reel lock and control stick stowage, will not operate. The foot retractor cables will be cut by the action of seat movement.

TAKE-OFF AND LANDING EMERGENCY.

All landing emergencies involving landing on prepared or unprepared surfaces should be made with the landing gear extended. The extended gear, even on reasonably rough terrain, provides an absorption of the initial shock resulting in less injury to the pilot and damage to the aircraft.

Note

- These instructions also apply in those cases in which the runway is overshot or undershot and touchdown cannot be avoided.
- The helmet visor is considered a protective device and should be lowered prior to ditching or crash landing.

ABORT PROCEDURE.

Accomplish those of the steps necessary to stop aircraft.

1. Throttle—IDLE, or OFF (as necessary).
   For Fire—OFF
   For barrier engagement—IDLE

   Note

   Nose wheel steering becomes inoperative due to loss of hydraulic pressure when the throttle is retarded at OFF. Refer to Runway Overrun Barrier procedure in this Section.

2. Drag chute—Deploy.
3. Brakes—Apply.
   Use wheel brakes hard but do not skid.
4. External Stores—Jettison.
5. Canopy internal locking lever — Unlock (downward ejection aircraft only).
6. Fuel shut-off switch—OFF, for engine fire.

MAIN GEAR TIRE FAILURE ON TAKE-OFF.

The following procedure is recommended when a main gear tire fails during take-off run. This recommended technique applies to all gross weights and airplane configurations. Directional control of the airplane is naturally more difficult at the higher gross weights.

1. If nose wheel lift-off speed has been attained, external stores should be retained and take-off continued.
2. If speed is greater than 150 KIAS, but below nose wheel lift-off speed, jettison external stores and continue take-off.
3. If speed is less than 150 KIAS, abort take-off.
   Refer to Abort Procedure under Take-Off and Landing Emergencies in this Section.

WARNING

If take-off is continued, the landing gear should not be retracted if tire has failed or is suspected to have failed until the tire has been visually checked for fire by a report from another airplane or the tower. After the tire is checked and if the gear is retracted, the wheel brakes should be applied to stop wheel rotating before retraction to prevent tire fragments from damaging equipment in the wheel well. Landing should be made in accordance with the instructions in Main Gear Flat Tire Landing in this Section.

BELLY LANDING.

Successful belly landings have been made on prepared surfaces. Abandon the aircraft rather than attempt a belly landing on an unprepared surface. If a gear up landing is unavoidable proceed as follows:

1. External stores — Jettison.
   Jettison external stores in appropriate area; retain tip and pylon tanks if they are empty.
2. Survival kit release handle — Pull.
3. Make normal pattern.
   Make normal pattern with landing gear lever UP and landing flaps extended.
4. Canopy internal locking lever — UNLOCKED. (downward ejection aircraft only)
5. Make flat approach.
6. Throttle — OFF at touchdown.
7. Drag chute — Deploy.
8. Fuel shut-off switch — OFF.

NOSE GEAR FLAT TIRE LANDING.

If landing with a flat nose gear tire, proceed as follows:

1. Nose gear — Hold off.
   Hold the nose wheel off as long as practical and then lower gently to runway.
2. Drag chute — Deploy.
   Do not deploy the drag chute until nose wheel is on the ground because of the nose down pitching moment which occurs when the drag chute inflates.

MAIN GEAR FLAT TIRE LANDING.

1. Touch down on good tire.
   Touch down on the side of the runway away from the flat tire.
2. Nose wheel — Lower.
3. Nose wheel steering — Engage.
4. Drag chute — Deploy.

ASYMMETRIC TIP TANK FUEL LOAD LANDING.

Adequate control is available for landing with one tip tank full and one tank empty under smooth air conditions; however, consideration should be given to the added aileron requirements under strong or gusty cross-wind conditions before attempting a landing with an asymmetric fuel load. A crosswind from the side with the light tank increases the aileron requirements in the same direction as used to balance the heavy tank. It is recommended that low speed control be evaluated prior to entering the landing pattern. If the lateral control appears marginal for the existing landing condition, the tanks should be jettisoned.

FULL OR PARTIALLY FULL PYLON TANK LANDING.

With fuel in the pylon tanks, the pylon strength may be exceeded during a landing; therefore, if a landing must be made with more than 1000 lbs. total fuel in the pylon tanks, adhere to the recommended landing speeds and exercise close control over sink rate at touchdown.

PARTIAL GEAR LANDING.

Landing With Nose Gear Retracted.

1. Make normal landing.
2. Trim — Full nose up during ground roll.
3. Gently lower nose wheel to runway.
4. Drag chute — Deploy after nose drops.
5. Apply brakes.

LANDING WITH ONE MAIN GEAR UP OR UNLOCKED.

Refer to Landing Gear Emergency Extension in this Section. In the event one main gear remains up or in an intermediate position, after all procedures to extend have failed, proceed as follows:

1. External stores — Jettison (if required).
   Retain empty tip and pylon tanks to absorb initial shock.

Note

- If time and conditions permit, burn excess fuel to lighten airplane and to minimize fire hazard.
- If a choice is possible, select a wide concrete runway without a crosswind.

2. Inertia reel lock lever — LOCKED.
   Assure seat belt and shoulder harness are tight.
3. Canopies — UNLOCKED (downward ejection aircraft) or jettison (upward ejection aircraft).

Note

- On upward ejection aircraft, the canopies should be jettisoned prior to landing if it has been determined by ground or air check that a gear is up or in an intermediate position.
- Before unlocking or jetisoning the canopies, place helmet visor in the down position.

4. Make normal approach and landing.
   Touch down on the side of the runway away from the faulty gear.
5. Immediately After Touchdown.
   a. Throttle — OFF.
   b. Drag chute — Deploy.

c. Fuel shut-off switch — OFF.

CAUTION

Nose wheel steering is not available after the manual landing gear release handle has been pulled.

6. Hold faulty gear off as long as posible.

7. Brakes — As required.

NO FLAP LANDING.

Because of the high approach and touchdown speeds required to accomplish a no-flap landing, it is recommended that the following instructions be observed.

Note

- All of the following speeds are based on a ing gross weight of 15,000 lbs. which includes 1,000 lbs. fuel remaining. Increase approach and touchdown speeds 5 knots for each additional 1000 lbs. of airplane weight.

TRAILING EDGE FLAP FAILURE.

If the trailing edge flap fails to extend (regardless of the position of the leading edge flap) the following procedure is recommended.

1. Wing flap lever — TAKE-OFF.
   With the wing flap lever at TAKE-OFF the aileron and rudder travel limiters are removed.

2. Recommended runway length — 10,000 feet.

Note

A runway length of 10,000 feet is recommended as an added safety precaution in event of brake or drag chute failure.

3. Base leg speed — 40 knots IAS above normal.

4. Final approach speed — 230 knots IAS minimum.

5. Make flat approach.
   A flat approach will decrease required rotation for flare.

Note

Airframe buffeting will be experienced as speed is reduced and/or G-load is increased.

6. Touchdown speed — 195 knots IAS minimum.

7. Lower nose and deploy drag chute immediately.

LEADING EDGE FLAP FAILURE ONLY.

1. If only the leading edge flaps fail and the trailing edge flaps can be lowered to the land position, thereby making boundary layer control available, normal pattern and touchdown speeds can be used.

2. If trailing edge flaps can be extended only to the take-off position, fly final approach at not less than 195 knots IAS and touchdown at not less than 165 knots IAS.

RUNWAY OVERRUN BARRIER

The minimum speed for successful engagement of MA-1A runway overrun barrier is 40 knots ground speed. Barrier engagements have been made in excess of 100 knots; however, speeds above 100 knots accentuate the inherent limitations of the MA-1A overrun barrier increasing the possibility of unsuccessful or one gear engagements. Wing tip stores and wing flap position have no effect on barrier engagement. It was determined that successful engagements cannot be made with pylon tanks installed. Pylon racks alone have no effect on barrier engagements. With the landing gear lowered by means of the manual landing gear release system (forward main doors fully open), successful barrier engagements can be made up to 100 knots ground speed. However, the reliability of the engagements is considerably reduced above this speed. After landing (or aborted take-off), if the aircraft cannot be slowed to a safe turn-off speed before reaching the end of the runway, the steps listed below should be accomplished if a runway overrun barrier is available:

1. THROTTLE – IDLE.

2. PYLON TANKS (IF INSTALLED) – JETTISON.

The pilot should jettison pylon tanks immediately after deciding to effect a barrier engagement.

WARNING

- For speeds up to 100 knots, pylon tanks should be jettisoned a minimum of 400 feet prior to barrier engagement (dry runway) to prevent the tanks from over-running the aircraft and causing possible interference with barrier engagement, gear collapse or aircraft fire. This distance should be increased when operating on wet or icy runway, or at higher ground speeds.
- Pylon tanks fuel may ignite by heat generated from the tank skidding on the runway, therefore, in case of known emergency, jettison pylon tanks before landing.

Note

- If time permits, drop only the pylon tanks by placing the external stores jettison selector switch to the PYLON position and pushing the stick external stores jettison button. If sufficient time is not available, drop all external stores by pushing the external stores jettison button.
- If the pylon tanks are jettisoned on the runway, the tanks will strike the adjacent main landing gear but will not alter the course of the aircraft.

3. Ground speed — Reduce.

   Decrease ground speed below 100 knots if possible by deploying the drag chute and utilizing maximum wheel braking.

CAUTION

Avoid excessive braking just prior to and during barrier engagement to prevent blowing tires which may cause loss of control.

4. Canopy internal locking lever — Unlock.
5. Aim for center portion of barrier.

   Contact barrier as close to a 90° angle as possible.

Note

Nose wheel steering is inoperative when the manual landing gear release system has been used. Therefore, differential braking and rudder must be used for directional control.

6. Throttle — OFF.

   After barrier engagement and it has been determined that nose wheel steering is not required.

WARNING

- If a one gear engagement is made and aircraft becomes uncontrollable, stopcock throttle and turn fuel shut-off switch off.
- Do not unfasten the seat belt or shoulder harness until the aircraft has come to rest.

EMERGENCY ENTRANCE.

The procedure to be used by rescue personnel in assisting the pilot from the airplane following a crash landing is shown in figure 3-7 or 3-8.

DITCHING.

Ditch only as a last resort as the nose section of the fuselage may break off. Also, the airplane will probably sink quite rapidly. All emergency survival equipment is carried by the pilot; consequently, there is no advantage in riding the airplane down.

EXTERNAL STORES EMERGENCY JETTISON.

To jettison external stores during an emergency, proceed as follows:

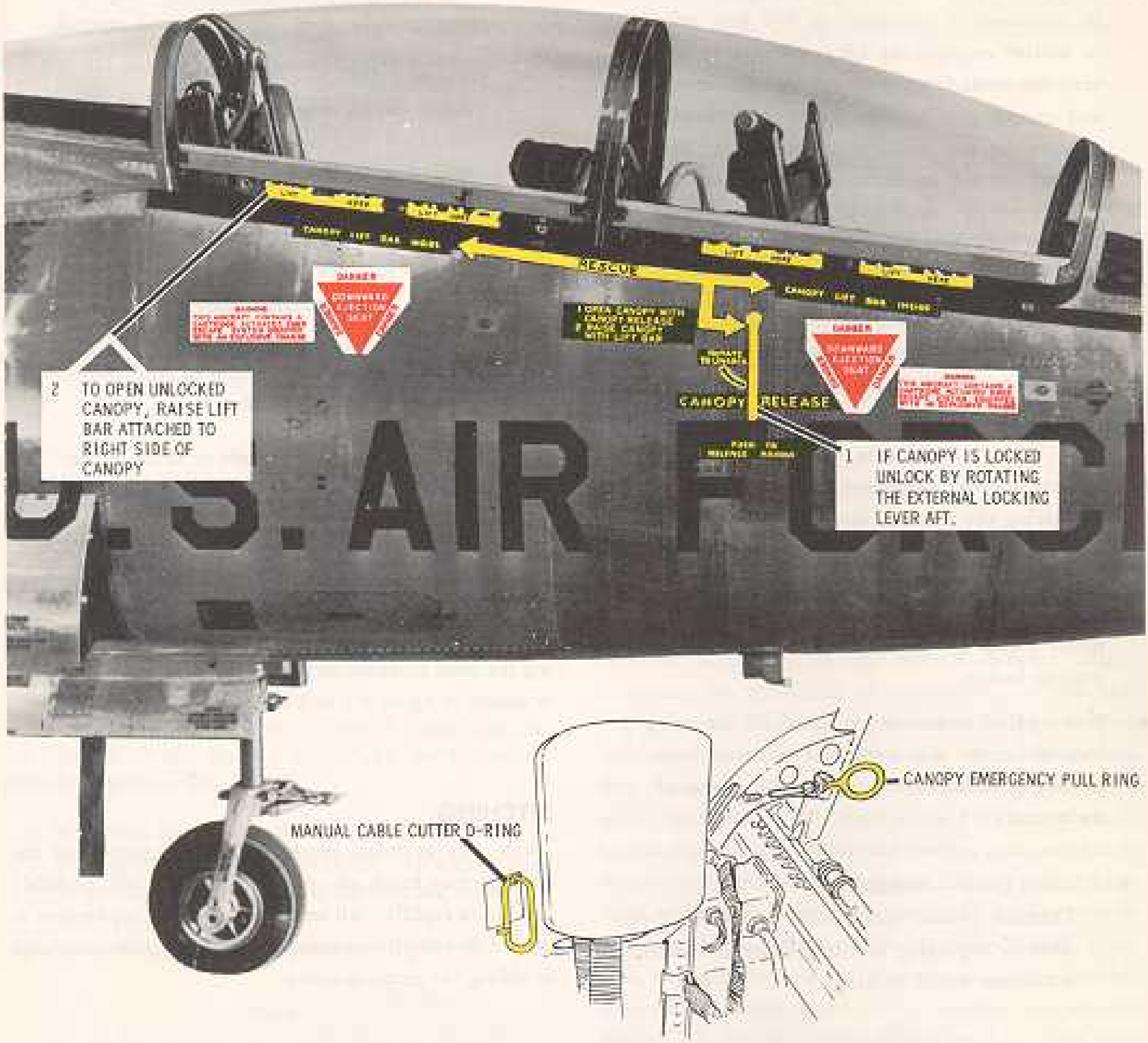
1. External stores jettison button — Press.

   Pressing the external stores jettison button jettisons pylon and tip stores.

2. If stores fail to release, external stores release selector switch — As required.

EMERGENCY ENTRANCE

(UNMODIFIED AIRCRAFT)



3 TO DROP THE CANOPY FROM THE NORMAL OPEN POSITION TO THE EMERGENCY OPEN POSITION USE THE EMERGENCY PULL RING
4 SHUT OFF OXYGEN SUPPLY AT OXYGEN CONTROL PANEL
5 OPEN HELMET FACE PLATE BEFORE DISCONNECTING OXYGEN LINE TO AVOID POSSIBLE RUPTURING OF PILOT'S LUNGS IN EVENT THE PRESSURE SUIT IS PRESSURIZED
6 INSURE THAT SEAT WILL NOT FIRE ACCIDENTLY - SAFETY THE EJECTION RING
7 RELEASE SEAT BELT AND HARNESSES
8 DISCONNECT PILOT'S PERSONAL LEADS
9 PULL MANUAL CABLE CUTTER D-RING TO FREE PILOT'S FEET
10 REMOVE PILOT AS GENTLY AS POSSIBLE TO AVOID AGGRAVATING POSSIBLE INTERNAL INJURIES

NOTE

- THE PILOT MUST BE FREED FROM THE 20 FOOT LANYARD ATTACHING HIM TO THE SURVIVAL KIT. THIS MAY BE DONE BY UNFASTENING THE SURVIVAL KIT PARACHUTE ATTACHMENTS.
- IF CANOPY CANNOT BE OPENED, BREAK CANOPY.

F54-8-3-54

Figure 3-7

EMERGENCY ENTRANCE

(MODIFIED AIRCRAFT)

1. IF CANOPY IS LOCKED, UNLOCK BY ROTATING THE EXTERNAL LOCKING LEVER (A) AFT.
2. IF AIRCRAFT IS ON FIRE, JETTISON CANOPY BY PULLING CANOPY JETTISON "T" HANDLE (B).
3. SHUT OFF OXYGEN SUPPLY AT OXYGEN CONTROL PANEL.
4. OPEN HELMET FACE PLATE BEFORE DISCONNECTING OXYGEN LINE TO AVOID POSSIBLE RUPTURING OF PILOT'S LUNGS IN EVENT THE PRESSURE SUIT IS PRESSURIZED.
5. INSURE THAT SEAT WILL NOT FIRE ACCIDENTALLY - SAFETY THE "D" RING.
6. RELEASE SEAT BELT AND SHOULDER HARNESS.
7. DISCONNECT PILOT'S PERSONAL LEADS.
8. PULL SURVIVAL KIT RELEASE HANDLE.
9. PULL MANUAL CABLE CUTTER RING.
10. REMOVE PILOT GENTLY TO AVOID AGGRAVATING POSSIBLE INTERNAL INJURIES.

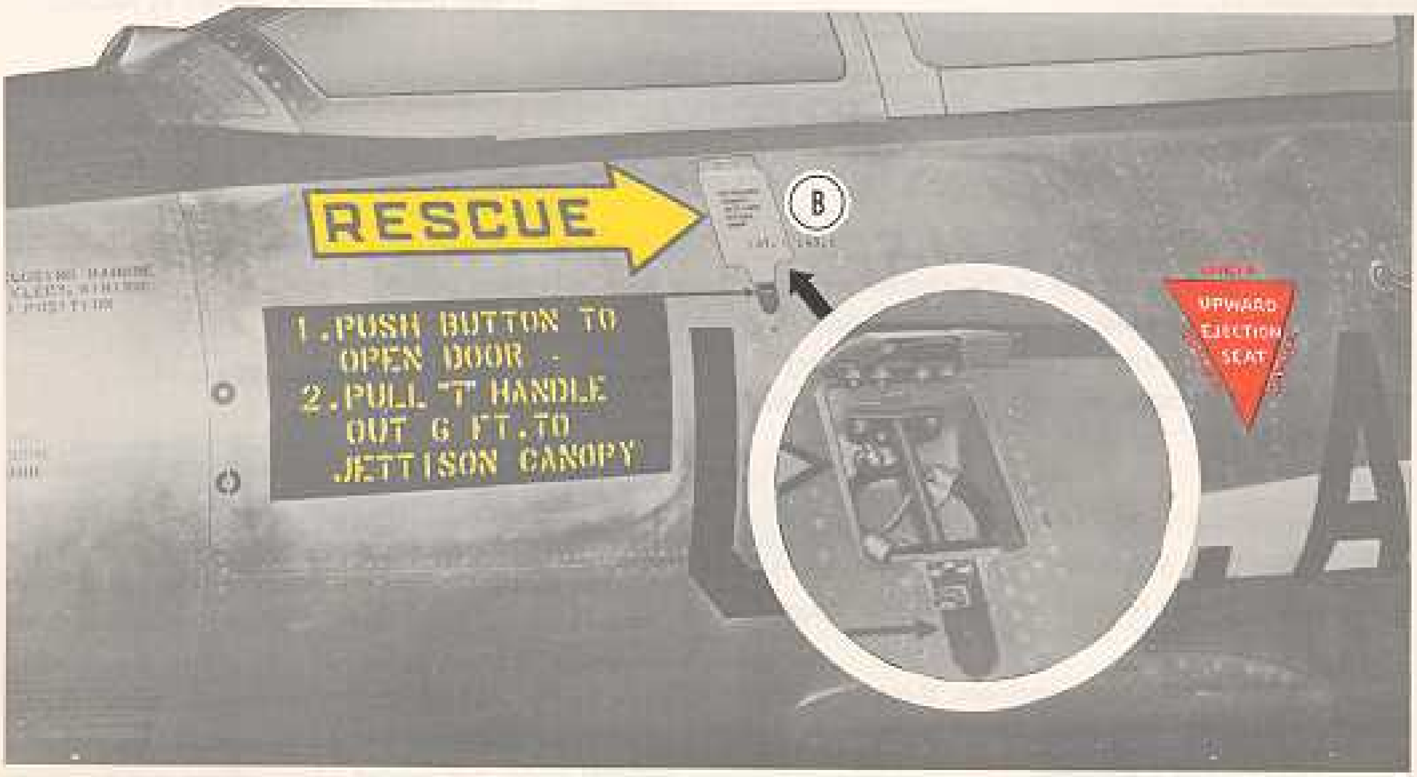


Figure 3-8

3. Stick external stores jettison button — Press.

Note

Refer to External Stores Jettisoning Speed in Section V for jettisoning airspeed limitations.

AFTERBURNER FAILURE.

LOSS OF AFTERBURNER DURING TAKE-OFF.

If the afterburner fails during take-off:

1. ABORT IF SPEED AND RUNWAY PERMIT.

   Refer to Abort Procedure under Take-off and Landing Emergencies in this Section.

If committed to take-off, proceed as follows:

1. Throttle — MILITARY.
2. Continue take-off at Military Thrust.

   Do not attempt an afterburner relight until attaining safe airspeed and altitude.

AFTERBURNER SURGE.

Afterburner surge can easily be detected by instability feel, exhaust gas temperature gage and nozzle position indicator oscillation. If afterburner surging occurs, proceed as follows:

1. Throttle — MILITARY.

   Move the throttle out of the afterburner range as soon as possible, preferably before more than 2 cycles of surge. This action is necessary to prevent compressor stall and possible engine flame-out.

2. Throttle — Afterburner range.

   After 3 to 5 seconds, move throttle smoothly outboard and forward into afterburner range.

3. If afterburner surging continues, throttle — MILITARY.

   Avoid using afterburner.

EXHAUST NOZZLE SYSTEM FAILURE.

The following procedures are recommended in the event of a malfunction of the exhaust nozzle area control system. Such malfunctions or failures might allow the exhaust nozzle to open fully, or to close to the mechanically scheduled area, or to fluctuate during afterburning or non-afterburning operation. Each type of possible malfunction is covered. Failure to the wide open position while non-afterburning is the most critical condition.

Note

Execute landings under any of the following exhaust nozzle control emergency conditions with the flaps in the take-off position.

FAILURE TO THE MECHANICALLY SCHEDULED AREA — NON-AFTERBURNING.

The effect of this failure is apparent only at Military Thrust since the mechanical schedule is the normal position of the nozzle at lower thrust settings. Under Military Thrust conditions, this shift to the mechanically scheduled area produces only a slight change. The nozzle area decreases slightly and the exhaust gas temperature increases with a slight increase in thrust. An attempt to light the afterburner will result in an over-temperature condition. If this failure occurs proceed as follows:

1. Reduce throttle to maintain 600° C maximum.
2. Exhaust nozzle control switch — MANUAL.

   This will insure nozzle position remaining on the mechanical schedule in case of subsequent electrical failure.

FAILURE TO THE WIDE OPEN AREA — NON-AFTERBURNING.

The apparent effects of this failure are a significant decrease in thrust plus a reduction in exhaust gas temperature as well as an increase in nozzle area to the full open indicator position. Insufficient thrust is available to maintain level flight with any configuration or airspeed at take-off gross weights. At normal landing gross weight, level flight cannot be maintained at any speed if the gear and/or landing flaps are extended or external stores are carried. Level flight can be maintained up to 3500 feet in the clean configuration at 300 knots IAS with normal landing gross weights, providing ambient temperatures are standard or cooler. With take-off flaps extended, level flight can be sustained up to 5500 feet at an airspeed of 190 knots IAS at normal landing gross weight, providing ambient temperatures are at standard conditions or cooler. The capability to sustain level flight at landing gross weight in either the clean configuration or with take-off flaps extended is highly improbable on days with ambient temperatures hotter than standard. If the nozzle fails to the wide open area (non-afterburning) proceed as follows:

Nozzle Failure Open During Military Thrust Take-off.

1. **ABORT TAKE-OFF.**

   Refer to Abort Procedures under Take-off and Landing Emergencies in this section.

Nozzle Failure Open Following Military Thrust Take-off.

1. **EXHAUST NOZZLE CONTROL SWITCH — MANUAL.**
2. **ZOOM TO SAFE EJECTION ALTITUDE.**
3. If nozzle closes, monitor EGT 600° C maximum, burn out fuel and land.
4. If nozzle remains open, advance throttle rapidly to Maximum Thrust without hesitating in sector burning.

Note

An afterburner light with a wide open nozzle at low indicated airspeed cannot be guaranteed, but is possible. The best technique is to advance the throttle rapidly to full afterburner position. A 3 to 5 second delay may be experienced before afterburner light is obtained. If an afterburner light is not obtained, leaving the throttle in the afterburner range will not adversely affect engine operation and will reduce the fuel load.

5. If an afterburner light is obtained, exhaust nozzle control switch — AUTO.
6. Obtain desired altitude and airspeed.
7. Fuel load — Reduce and land.
8. Landing gear lever — Down on final approach. Since level flight in Military Thrust with a wide open nozzle can be sustained only with gear up, do not lower gear until on final approach and landing is assured.
9. If afterburner fails to light, external stores — JETTISON and follow Engine Failure During Flight procedures.

FAILURE TO THE MECHANICALLY SCHEDULED AREA — AFTERBURNING.

A nozzle system failure under this condition will result in an over temperature condition. In sector afterburning, excessive rpm drop and/or engine stall may also result. In full afterburning the minimum mechanically scheduled nozzle area is such that these latter conditions will not be experienced. If this failure occurs, proceed as follows:

1. Throttle — Rapidly retard to MILITARY.
2. Exhaust gas temperature — Monitor.
3. Exhaust nozzle control switch — MANUAL.

FAILURE TO THE WIDE OPEN AREA — AFTERBURNING.

This failure is indicated by a slight reduction in thrust, accompanied by a slight decrease in exhaust gas temperature and an increase in nozzle area. This condition will probably not be detected by the pilot. The afterburner will continue to burn with a wide open nozzle as long as the throttle is not retarded to the sector range. As long as the afterburner is maintained above sector burning no corrective action is required.

1. When retarding out of afterburning, retard the throttle slowly and check to see if the nozzle is closing.
2. If nozzle is not closing, maintain afterburner thrust until desired altitude and airspeed are obtained.
3. If nozzle is not closing normally, momentarily actuate exhaust nozzle control switch to MANUAL position and return to AUTO.

4. Check for sharp rise in EGT to insure proper functioning of switch prior to coming out of afterburner. Then proceed as follows:

CAUTION

If nozzle switch is left in the MANUAL position while in afterburner, a severe overtemperature condition will result.

Nozzle Failure Open During Flight.

1. Throttle — MILITARY.
2. Exhaust nozzle control switch — MANUAL.
3. Check nozzle position and monitor exhaust gas temperature to maintain 600° C maximum.

   Military Thrust will be available.

WARNING

If the nozzle switch fails to close nozzle: maintain 300 knots IAS, jettison external stores, reduce fuel load and land when practical. Do not lower the gear until on the final approach and landing is assured.

Nozzle Failure Open in Landing Pattern.

1. Throttle — MILITARY.
2. Speed brakes — IN.
3. Exhaust nozzle control switch — MANUAL.
4. Landing gear lever — UP.
5. Wing flap lever — TAKE-OFF.
6. External stores — Jettison.
7. Nozzle position and exhaust gas temperature — Monitor.
8. When landing is assured, extend landing gear.

SEVERE NOZZLE FLUCTUATIONS IN MILITARY OR AFTERBURNING THRUST.

1. Speed and altitude permitting, throttle — Reduce to just below MILITARY.

   This should place the exhaust nozzle within the mechanically scheduled area.

2. If nozzle does not stabilize, exhaust nozzle control switch — MANUAL.
3. Exhaust gas temperature — Monitor.

OIL SYSTEM FAILURE.

In general, if an oil system malfunction (as evidenced by high or low oil pressure) has caused prolonged oil starvation of engine bearings, the result will be a progressive bearing failure and subsequent engine seizure. The time interval from the moment of oil starvation to complete failure depends on such factors as: condition of the bearings prior to oil starvation, operating temperatures of bearings, and bearing loads. Bearing failure due to oil starvation is generally characterized by a rapidly increasing vibration; when the vibration becomes moderate to heavy, complete failure is only seconds away and in most instances the pilot will increase his chances for a successful ejection or power-off landing by shutting down the engine. For oil system failure during take-off, follow abort Procedure under take-off and Landing Emergencies in this section.

Note

A decrease in oil pressure may indicate an oil loss to the engine, leading eventually to a complete loss of oil to the bearings.

The engine will operate with a complete interruption of oil to the engine system for a period of one minute at Military Thrust without detrimental effects to the bearings. Limited experience has indicated the engine should operate for a period of approximately four to five minutes at 80% to 90% rpm before a complete failure occurs.

In view of the above, the following operating procedures shall be observed for oil system pressure changes:

1. Reduce thrust.

   Reduce thrust to that necessary to maintain safe altitude and level flight (86% to 89% rpm for a clean airplane).

WARNING

Loss of engine oil (as indicated by the ENGINE OIL LEVEL LOW warning light) will also result in loss of exhaust nozzle control. The resulting loss of thrust with the nozzle in the open position may be as much as 70% at 100% rpm. Refer to Exhaust Nozzle Control System Failure in this section.

2. External stores — Jettison (if necessary).

   Jettison external stores if necessary to maintain safe altitude and level flight. Retain external tanks if safe level flight can be maintained and external fuel is needed.

3. Avoid abrupt maneuvers causing high G forces.

4. Avoid rapid and large throttle movements. Hold throttle changes to a minimum.

High thrust settings should be avoided if at all possible in order to keep temperature and bearing loads at a minimum. Upon detection of an oil system malfunction (as evidenced by the oil pressure gage) a minimum thrust setting should be established depending on aircraft configuration, gross weight and altitude. This setting should be sufficient to maintain level flight and allow for safe approach maneuvers (subsequent throttle movement should be avoided if possible). However, if the malfunction has gone unnoticed and has progressed to the point where bearing failure has started, as evidenced by vibration, the throttle should not be retarded. If the throttle is retarded, the resistance to rotation offered by one or more failing bearings may cause further deceleration and complete engine seizure in a very short time.

5. Land as soon as possible using a pattern to insure a safe landing in the event of engine failure.

WARNING

Increasing vibration is an indication of a bearing failure. Extreme vibration, usually accompanied by a rise in EGT, indicates engine seizure will occur within a few seconds. The throttle should be cut off to prevent excessive damage to the engine, resulting in possible damage to the aircraft structure.

6. Throttle — OFF at touchdown.

ENGINE OIL LEVEL LOW WARNING LIGHT.

Illumination of the ENGINE OIL LEVEL LOW warning light indicates that the oil quantity is down to a reserve of approximately 0.8 gallons and that the exhaust nozzle can be expected to fail to the open position. If the loss is due to a leak in the engine hydraulic system, sufficient reserve oil will be available to lubricate the engine for approximately 2 hours. However, if the loss of oil is due to a leak in the lubricating system, as indicated by a drop in oil pressure, engine bearing failure will occur. Refer to Oil System Failure in this section. In view of the above, proceed as follows:

1. If light illuminates prior to take-off — Abort the flight.

2. If light illuminates during take-off and sufficient runway remains — Abort.

   Refer to Abort Procedure under the Take-off and Landing Emergencies in this section.

3. If the light illuminates in flight, land as soon as possible, using a pattern to insure a safe landing. Depending upon the oil pressure indications, use one of the following procedures:

   a. If light illuminates *without* an oil pressure drop — Follow procedure for Exhaust Nozzle Control System Failure.

   b. If light illuminates *with* an oil pressure drop — follow procedure for Oil System Failure.

ELECTRICAL POWER SYSTEM FAILURES.

COMPLETE ELECTRICAL SYSTEM FAILURE.

If a complete electrical failure occurs, (which includes failure of both engine driven generators and ram air turbine driven generator) only those items powered from the battery bus will be operable. (Refer to figure 1-22). Flight under these conditions is limited, and the following precautions should be observed:

1. **EMERGENCY OXYGEN LEVER — EMERGENCY.**

Note

Without electrical power, cockpit pressure is dumped.

2. Land as soon as possible.

3. Use manual landing gear release handle to lower landing gear.

4. Use No Flap Landing procedure.

   It will be impossible to lower the wing flaps. Refer to No Flap Landing in this section.

Note

Under the above conditions of complete electrical failure, all of the instruments except the tachometer, exhaust gas temperature gage, the airspeed and Mach number indicator, accelerometer, clock, altimeter, cabin altimeter, and vertical velocity indicator, will be inoperative.

Refer to figure 1-22 for instruments inoperative with ram air turbine extended.

GENERATOR FAILURE.

No. 1 or No. 2 Generator Out.

If the No. 1 or No. 2 generator out warning light illuminates:

1. Move generator switch corresponding to the generator out light to OFF, then to ON RESET and release.

   This will restore generator to service if failure was caused by momentary over-voltage.

No. 1 and No. 2 Generator Out.

If both generators fail, as evidenced by failure of all electrical equipment except that powered from the batteries, proceed as follows:

1. No. 1 generator switch — OFF, then ON RESET position.

2. No. 2 generator switch — OFF, then ON RESET position.

3. If generator operation is not restored and electrical power is required — Extend RAT.

   (Refer to Flight with RAT Extended, this section.)

4. Land as soon as possible.

D.C. MONITORED BUS FAILURE.

If the d.c. monitored bus warning light illuminates, the "INST ON EMER POWER" light will also illuminate, and the flight should be aborted. Refer to figure 1-22 for systems rendered inoperative with the d.c. monitored bus out.

AUTOMATIC BUS TRANSFER FAILURE.

Should the automatic bus transfer fail to operate, as indicated by electrical equipment failure proceed as follows:

1. No. 2 Generator switch — OFF.

2. If failure is not remedied, No. 2 Generator switch—ON-RESET.

3. No. 1 Generator switch — OFF.

Note

Leaving one of the two generator switches in the OFF position should activate the bus transfer system and allow the other generator to assume the entire load.

4. If bus transfer fails to operate, both Generator switches — ON-RESET.

Note

Illumination of the "D.C. MONITORED BUS OUT" and the "INST. ON EMER. POWER" warning lights may also indicate automatic bus transfer failure. In this case the No. 1 generator switch should be placed in the OFF position to activate the bus transfer system and allow the No. 2 generator to assume the entire load.

HYDRAULIC SYSTEM FAILURE.

NO. 1 SYSTEM OUT.

If the No. 1 hydraulic system fails as indicated by the "HYD. SYSTEM OUT" and "AUTO-PITCH OUT" warning light, the stick trim and yaw damper will be inoperative but the stick shaker and auxiliary trim will be operative. If this failure occurs, proceed as follows:

1. Trim selector switch — AUX. TRIM.
2. Hydraulic systems pressure gage selector switch — No. 2. Monitor for remainder of flight.
3. Land as soon as possible.

NO. 2 SYSTEM OUT.

WARNING

Close speed brakes if a hydraulic failure is imminent. Without No. 2 hydraulic system pressure, the speed brakes cannot be closed.

Failure of the No. 2 system will render the pitch and roll dampers inoperative in addition to those items operated by the utility hydraulic system. If a No. 2 system failure is experienced as indicated by the illumination of the "HYD. SYSTEM OUT" warning light, proceed as follows:

1. Hydraulic systems pressure gage selector switch — No. 1. Monitor pressure for remainder of flight.
2. Land as soon as possible. Lower gear with the manual landing gear release handle.

Note

Nose wheel steering is inoperative with No. 2 system out or when gear is extended by the manual landing gear release handle.

BOTH NO. 1 AND NO. 2 SYSTEMS OUT.

WARNING

Close speed brakes if a hydraulic failure is imminent. Without No. 2 hydraulic system pressure, the speed brakes cannot be closed.

1. Ram-air turbine extension handle — Pull (above minimum recommended airspeed).

   See Flight with RAT Extended, this Section.

2. Hydraulic systems pressure gage selector switch — No. 1.
3. If pressure builds up, land as soon as possible. Continue to monitor pressure and extend landing gear with manual landing gear release handle.

Note

Maximum hydraulic flow available under these conditions is reduced; however, it is sufficiently high for safe flight and moderate maneuvers necessary for landing.

4. If pressure fails to increase sufficiently for adequate flight control response — Eject.

Note

Aircraft may be steered towards selected ejection area using power and rudder.

FLIGHT WITH RAT EXTENDED.

The ram-air turbine is available for emergency electrical and hydraulic power when the engine-driven power sources are lost. Extension of the RAT with the engine running can, under certain conditions, adversely affect engine operation. Because several inadvertent RAT extensions have been experienced, the contractor has investigated the operating envelope with the engine running and the RAT extended. These investigations have shown:

a. The RAT can be extended in level flight without affecting engine operation at any speed up to 550 knots IAS, except as follows:

At 40,000 feet and above—350 knots IAS minimum.

At 35,000 feet — 325 knots IAS minimum.

At 30,000 feet and below — No minimum limit.

b. Normal airstarts with the RAT extended can be made at all altitudes up to 35,000 feet.

c. Maneuverability is satisfactory with the No. 1 and No. 2 hydraulic pumps inoperative with the RAT supplying hydraulic pump power up to 500 knots IAS.

d. Spiral climbs and descents can be made without affecting normal engine operation or airplane maneuverability.

e. Best range with the RAT extended and 3,000 lbs. of fuel remaining is realized by cruising at 0.82 Mach number at 27,000 feet. Range will be approximately 170 nautical miles per 1,000 lbs. of fuel used.

f. Factors such as G's, yaw, abrupt maneuvers, or rapid throttle movements may induce engine instability, stalls, or flameouts with the RAT extended, especially above 30,000 feet. Below 30,000 feet, 45 degree banks do not affect engine operation.

Deploy the ram-air turbine only for:

a. Double hydraulic failure.

b. Double electrical failure.

c. Flameout landing.

d. Seized engine.

e. Dead engine descent in weather.

Note

If a flameout or engine stall occurs when the RAT is extended, accomplish normal airstart or stall clearing procedures.

When flying with the RAT extended, avoid abrupt or uncoordinated maneuvers and move throttle slowly and only when necessary. Do not attempt afterburner lights unless absolutely necessary. Land as soon as practical and use thrust as required.

Note

The leading and trailing edge flaps are sequenced to extend separately to the Take-off position only, when using ram air turbine driven generator for electrical power. Therefore, the LAND or UP position should never be selected under this condition as it may stall the generator. Keep airspeed above 200 knots IAS until flaps have reached take-off position. (The wing flap position indicator will be inoperative.)

TRIM FAILURE.

If trim failure occurs, proceed as follows:

1. Trim selector switch — AUX. TRIM position.

2. Use auxiliary trim control switch as necessary.

3. If trim still malfunctions, trim circuit breaker — Pull.

CAUTION

An improperly installed or defective trim switch may be subject to occasional sticking in an actuated position, resulting in extreme trim. When this condition occurs, the auxiliary trim switch should be used and the failure entered in Form 781 with a red cross.

STABILITY AUGMENTATION CONTROL SYSTEM FAILURE.

Failure in any one of the stability augmentation control system channels (roll, pitch or yaw) may cause control system oscillation. If this occurs, proceed as follows:

1. Switch for the affected channel — OFF.

AUTO-PITCH CONTROL SYSTEM FAILURE.

If the APC system fails (as indicated by illumination of the AUTO-PITCH OUT warning light, or malfunctions in any way such as repeated or unreleased kicks under low angle of attack flight conditions proceed as follows:

1. APC switch — OFF.

2. Observe the stick shaker boundary as "kicker" will be inoperative.

WING FLAP SYSTEM FAILURE.

Refer to No Flap Landing in this Section.

SPEED BRAKE SYSTEM FAILURE.

Operation of the speed brakes is by means of the No. 2 hydraulic system through the priority valve. The priority valve will close and prevent speed brakes operation if the No. 2 hydraulic system pressure drops below 2000 psi. If hydraulic pressure is lost the speed brakes will not retract due to airload distribution. Because of the decreased range capabilities of the aircraft in this configuration a decision should be made to land as soon as possible. On unmodified aircraft the speed brakes cannot be operated unless the d.c. emergency bus is energized by either the normal electrical system or the ram-air turbine. If an engine flame-out is experienced with the speed brakes extended, electrical power for speed brake retraction is lost. At best glide speed with the brakes full out, the rate of descent increases to approximately 11,000 feet per minute. If an airstart cannot be obtained after several attempts the ram-air turbine should be lowered and airstarts re-attempted. The ram-air turbine will furnish electrical power for speed brake control and the windmilling engine at best glide speed will supply sufficient hydraulic pressure to the No. 2 system to retract the speed brakes.

WARNING

If the flame-out is due to a frozen engine, the speed brakes cannot be retracted and the resulting high rate of descent will preclude a safe forced landing.

Modified aircraft incorporate provisions for automatically closing the speed brakes in the event of electrical power loss. Electrical power from the d.c. emergency bus is only required to open the speed brakes or to hold them open. When the solenoid operated control valve in the speed brake system is de-energized, it moves to the closed position allowing the speed brakes to close provided that normal hydraulic pressure or windmilling engine hydraulic pressure is available.

LANDING GEAR EMERGENCY OPERATION.

LANDING GEAR LEVER DOWNLOCK MALFUNCTION.

1. Reduce airspeed.

   Keep airspeed below transient landing gear structural limit.

2. Landing gear lever down-lock override button — Press.

3. Landing gear lever — UP.

LANDING GEAR RETRACTION FAILURE.

If the landing gear warning light in the landing gear lever remains on after the lever has been placed in the UP position, proceed as follows:

1. Reduce airspeed.

   Keep the airspeed below the transient landing gear structural limits; use speed brakes if necessary.

2. Recycle gear at lowest practical airspeed.

3. If warning light remains on, lower gear and land.

LANDING GEAR EMERGENCY EXTENSION.

If the landing gear indicators do not show gear down and locked after lever is placed in the DOWN position, keep speed below the transient landing gear structural limit and proceed as follows:

1. Recycle gear.

2. If gear does not lock down, leave gear lever down and pull manual landing gear release handle.

CAUTION

- Airspeed must be below 225 knots IAS before the nose gear will lock down.
- The landing gear cannot be retracted in flight after being lowered by means of the manual landing gear release handle.
- Also, nose wheel steering will be inoperative if the gear is lowered by this method.

Note

Pulling G's and yawing the aircraft will help to lock the gear in the down position.

LOSS OF EMERGENCY BLOW-OUT PANEL.

1. Reduce airspeed.
2. Reduce fuel load.
3. Land.

Note

Aircraft vibration will be proportional to airspeed.

LOSS OF ESCAPE HATCH.

Loss of an escape hatch will be accompanied by cold and buffet. If the rear cockpit hatch is lost, the UHF antenna will be lost, preventing UHF transmission. Seat security is not affected by loss of an escape hatch.

CUT ON DOTTED LINE

F-104D CONDENSED CHECK LIST

EMERGENCY PROCEDURES

Note

- The following check list is a condensed version of the procedures presented in Section III. This condensed check list is arranged so that you may remove it from your Flight Manual and insert it into a flip pad for convenient use. It is arranged so that each action is in sequence with the expanded procedure given in Section III. Presentation of the condensed check list does not imply that you need not read and thoroughly understand the expanded version. To fly the airplane safely and efficiently, you must know the reason why each step is performed and why the steps occur in certain sequence.
- Critical action items are defined as those actions which must be performed immediately and instinctively if the emergency is not to be aggravated and injury or damage is to be avoided. Critical action items are identified in the following text by means of bold face type.

ENGINE FAILURE.

ENGINE FAILURE DURING TAKE-OFF RUN.

1. **ABORT TAKE-OFF.**

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ENGINE FAILURE DURING TAKE-OFF (AIRPLANE AIRBORNE).

1. EXTERNAL STORES — JETTISON.
2. Zoom to safe ejection altitude.

Upward Ejection Seat.

1. IF UNABLE TO ZOOM — EJECT.

Downward Ejection Seat.

1. IF UNABLE TO ZOOM, THROTTLE — OFF.
2. MANUAL LANDING GEAR RELEASE HANDLE — PULL DURING FLARE.
3. CANOPY INTERNAL LOCKING LEVER — UNLOCK.
4. FUEL SHUT-OFF SWITCH — OFF.
5. DRAG CHUTE — DEPLOY AT TOUCHDOWN.

ENGINE FAILURE DURING FLIGHT.

1. THROTTLE — OFF.
2. RAM-AIR TURBINE EXTENSION HANDLE — PULL.
3. WING FLAP LEVER — TAKE-OFF.
4. GLIDE SPEED — REDUCE TO 240 KIAS.
5. IFF — EMERGENCY.
6. Radio — Advise of emergency.
7. Eject or attempt forced landing.

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ENGINE AIR START.

1. BOTH START SWITCHES — START (HOLD MOMENTARILY TO INSURE CONTACT OF SWITCHES.
2. IF IMMEDIATE RE-LIGHT IS NOT OBTAINED, THROTTLE — POSITIVELY OFF AND IMMEDIATELY RETURN TO MILITARY.
3. GLIDE SPEED — 275 KIAS.
4. IF NO AIR START OCCURS WITHIN 20 SECONDS, BOTH START SWITCHES — START.
5. RAM-AIR TURBINE EXTENSION HANDLE — PULL, CHECK FOR FUEL FLOW.
6. WING FLAP LEVER — TAKE-OFF.
7. GLIDE SPEED — REDUCE TO 240 KIAS.
8. START SWITCHES — START.
9. THROTTLE — ADJUST AS REQUIRED.

ENGINE STALL CLEARING.

Below 15,000 Feet.

1. ENGINE AIR START PROCEDURE.
2. IGV SWITCH — MANUAL.
3. MAINTAIN 97% RPM UNTIL LANDING IS ASSURED.

Above 15,000 Feet.

1. THROTTLE — MILITARY.
2. THROTTLE — IDLE. CHECK EGT FOR NORMAL READING AND RPM FOR POSSIBLE HANG-UP.
3. ENGINE AIR START PROCEDURE. IF STALL IS NOT CLEARED DESCEND TO BELOW 30,000 FEET AND ATTEMPT ANOTHER AIR START.
4. CHECK FOR IGV STALL, BEFORE DESCENDING TO LAND, BY RETARDING THROTTLE SLOWLY TO 80% RPM. THIS CHECK MAY NOT INDICATE AN OPEN IGV CONDITION STALL ABOVE 20,000 FEET.
5. IF STALL REOCCURS AT THIS TIME OR DURING DESCENT, USE THE PROCEDURE FOR BELOW 15,000 FEET.

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FORCED LANDINGS.

1. **Initial.**
   a. Glide — 240 KIAS.
   b. RAT — Extended.
   c. Wing flaps — TAKE-OFF.

2. **High Key.**
   a. 12,000 feet minimum, 15,000 feet desired.
   b. Airspeed — 240 KIAS.
   c. Start a 45° bank turn.

3. **Low Key.**
   a. 6,000 feet minimum, 8,000 feet desired.
   b. Airspeed — 240 KIAS.

4. **Final Turn.**
   a. Fly turn to roll out on final approach not less than 1,000 feet above and ¾ mile from end of the runway.
   b. Airspeed — 240 KIAS.

5. **Flare.**
   a. Start flare 300-500 feet above ground.
   b. When flare is assured, pull the manual landing gear release handle.

6. **Prior to Touchdown.**
   a. Complete flare at 190-200 KIAS.
   b. Airplane may be set down when gear indicates down and locked or held off if necessary to 165 knots, the minimum recommended touchdown speed for dead engine condition.

7. **Touchdown.**
   a. Lower nose wheel.
   b. Drag chute — Deploy.
   c. Brakes — As necessary.

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FIRE.

ENGINE FIRE DURING START.

1. **THROTTLE — OFF.**
2. **START SWITCHES — STOP-START.**
3. **FUEL SHUT-OFF SWITCH — OFF.**
4. Abandon aircraft as quickly as possible.
5. If conditions permit, have ground electrical power source disconnected.

ENGINE FIRE DURING TAKE-OFF.

Engine Fire Before Lift Off.

1. **ABORT TAKE-OFF.**

Engine Fire After Lift-Off.

1. **EXTERNAL STORES — JETTISON.**
2. **THROTTLE — MILITARY.**
3. **ZOOM TO A SAFE EJECTION ALTITUDE.**
4. Throttle — Adjust to minimum setting to maintain safe ejection altitude.
5. Check for fire.
6. If fire exists — Eject.
7. If fire cannot be confirmed, make decision to land or eject.

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ENGINE FIRE DURING FLIGHT.

If Fire Warning Lights Come On During Flight:

1. THROTTLE — IDLE OR MINIMUM PRACTICAL THRUST.
2. HEAD TOWARD NEAREST EMERGENCY FIELD — 275 KIAS.
3. CHECK FOR FIRE.

If Fire Is Confirmed And Lights Remain On:

1. THROTTLE — OFF.
2. IF LIGHTS REMAIN ON — EJECT.
3. IF LIGHTS GO OUT — EXTEND RAT.
4. WARNING LIGHTS — TEST.
5. IF LIGHTS DO NOT ILLUMINATE — EJECT.
6. IF LIGHTS ILLUMINATE — MAKE DECISION TO EJECT OR ATTEMPT A FLAMEOUT LANDING.

If Fire Cannot Be Confirmed And Lights Go Out After Retarding Throttle:

1. WARNING LIGHTS — TEST.
2. IF LIGHTS ILLUMINATE AND THERE ARE NO OTHER INDICATIONS OF FIRE, LAND AS SOON AS POSSIBLE AT REDUCED POWER.
3. IF LIGHTS DO NOT ILLUMINATE — EJECT.

If There Are No Indications Of Fire And Lights Remain On After Retarding Throttle:

1. Land as soon as possible, continually checking for fire.

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E E E E E E E E E E E E

ENGINE FIRE AFTER SHUT-DOWN.

1. Ground turbine compressor connected and on.
2. Throttle OFF — Check.
3. Fuel shut-off switch — OFF.
4. Start switches — START and hold until engine rpm reaches 15%.

ELECTRICAL FIRE.

1. **OXYGEN EMERGENCY LEVER – EMERGENCY.**
2. **GENERATOR SWITCHES – OFF.**
3. All electrical accessory switches — OFF.
4. Operate only those units necessary for safe flight and landing, by placing that unit on and re-setting the generators.
5. Return generator switches to OFF position when operation is complete.
6. Land as soon as possible.

ELIMINATION OF SMOKE OR FUMES.

1. **OXYGEN EMERGENCY LEVER – EMERGENCY.**
2. Descend to 25,000 feet, or lower, if circumstances permit.
3. Ram air scoop lever — OPEN.
4. Generator switches — OFF.
5. If smoke persists, unlock canopy below 260 KIAS (downward ejection aircraft only) and land as soon as possible.
6. If it can be determined that the smoke is caused by an electrical fire, use Electrical Fire procedures, otherwise, reset generators.

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EJECTION.

BEFORE EJECTION, IF TIME AND CONDITIONS PERMIT.

1. Reduce speed as much as possible.
2. Head aircraft toward unpopulated area.
3. Give location and intentions to nearest radio facility and turn IFF to EMERGENCY.
4. Lower visor.
5. Actuate bailout-bottle if using A-13A mask.

On Aircraft With Upward Ejection Seat.

6. Sit back in seat. Check seat belt and shoulder harness tight.
7. Canopy jettison handle — Pull.

EJECTION PROCEDURE.

1. **ASSUME EJECTION POSITION.**
2. **PULL EJECTION RING WITH BOTH HANDS.**

AFTER EJECTION.

1. Release ejection ring.
2. Physically push free of seat.
3. Pull D ring below 14,000 feet.
4. Release survival kit before ground contact.

FAILURE OF SEAT TO EJECT (DOWNWARD EJECTION).

1. Feet back in stirrups — Check.
2. Escape hatch jettison handle — Pull.
3. Ejection ring — Re-pull through maximum travel.

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CUT ON DOTTED LINE

E E E E E E E E E E E E

TAKE-OFF AND LANDING EMERGENCIES.

ABORT PROCEDURE.

Accomplish those of the steps necessary to stop aircraft.

1. Throttle — IDLE, or OFF (as necessary).
2. Drag chute — Deploy.
3. Brakes — Apply.
4. External Stores — Jettison.
5. Canopy internal locking lever — Unlock (downward ejection aircraft only).
6. Fuel shut-off switch — OFF, for engine fire.

MAIN GEAR TIRE FAILURE ON TAKE-OFF.

1. If nose wheel lift-off speed has been attained, external stores should be retained and take-off continued.
2. If speed is greater than 150 KIAS, but below nose wheel lift-off speed, jettison external stores and continue take-off.
3. If speed is less than 150 KIAS, abort take-off.

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BELLY LANDING.

1. External stores — Jettison.
2. Survival kit release handle — Pull.
3. Make normal pattern.
4. Canopy internal locking lever — UNLOCKED (downward ejection aircraft only).
5. Make flat approach.
6. Throttle — OFF at touchdown.
7. Drag chute — Deploy.
8. Fuel shut-off switch — OFF.

NOSE GEAR FLAT TIRE LANDING.

1. Nose gear — Hold off.
2. Drag chute — Deploy.

MAIN GEAR FLAT TIRE LANDING.

1. Touch down on good tire.
2. Nose wheel — Lower.
3. Nose wheel steering — Engage.
4. Drag chute — Deploy.

PARTIAL GEAR LANDING.

Landing With Nose Gear Retracted.

1. Make normal landing.
2. Trim — Full nose up during ground roll.
3. Gently lower nose wheel to runway.
4. Drag chute — Deploy after nose drops.
5. Apply brakes.

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LANDING WITH ONE MAIN GEAR UP OR UNLOCKED.

1. External stores — Jettison (if required).
2. Inertia reel lock lever — LOCKED.
3. Canopies — UNLOCKED (downward ejection aircraft) or jettison (upward ejection aircraft).
4. Make normal approach and landing.
5. Immediately After Touchdown.
   a. Throttle — OFF.
   b. Drag chute — Deploy.
   c. Fuel shut-off switch — OFF.
6. Hold faulty gear off as long as possible.
7. Brakes — As required.

TRAILING EDGE FLAP FAILURE.

1. Wing flap lever — TAKE-OFF.
2. Recommended runway length — 10,000 feet.
3. Base leg speed — 40 KIAS above normal.
4. Final approach speed — 230 KIAS minimum.
5. Make flat approach.
6. Touchdown speed — 195 KIAS minimum.
7. Lower nose and deploy drag chute immediately.

LEADING EDGE FLAP FAILURE ONLY.

1. If only the leading edge flaps fail and the trailing edge flaps can be lowered to the land position, thereby making boundary layer control available, normal pattern and touchdown speeds can be used.
2. If trailing edge flaps can be extended only to the take-off position, fly final approach at not less than 195 KIAS and touchdown at not less than 165 KIAS.

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RUNWAY OVERRUN BARRIER.

1. **THROTTLE — IDLE.**
2. **PYLON TANKS (IF INSTALLED) — JETTISON.**
3. Ground speed — Reduce.
4. Canopy internal locking lever — Unlock (downward ejection aircraft only).
5. Aim aircraft for center portion of barrier.
6. Throttle — OFF.

EXTERNAL STORES EMERGENCY JETTISON.

1. External stores jettison button — Press.
2. If stores fail to release, external stores selector switch — As required.
3. Stick external stores release button — Press.

AFTERBURNER FAILURE.

LOSS OF AFTERBURNER DURING TAKE-OFF.

If The Afterburner Fails During Take-Off:

1. **ABORT IF SPEED AND RUNWAY PERMIT.**

If Committed To Take-Off, Proceed As Follows:

1. Throttle — MILITARY.
2. Continue take-off at Military Thrust.

AFTERBURNER SURGE.

1. Throttle — MILITARY.
2. Throttle — Afterburner range.
3. If afterburner surging continues, throttle — MILITARY.

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CUT ON DOTTED LINE

CUT ON DOTTED LINE

E E E E E E E E E E E E

EXHAUST NOZZLE CONTROL SYSTEM FAILURE.

FAILURE TO THE MECHANICALLY SCHEDULED AREA, NON-AFTERBURNING.

1. Reduce throttle to maintain 600° C maximum.
2. Exhaust nozzle control switch — MANUAL.

FAILURE TO THE WIDE OPEN AREA — NON-AFTERBURNING.

Nozzle Failure Open During Military Thrust Take-Off.

1. ABORT TAKE-OFF.

Nozzle Failure Open Following Military Thrust Take-Off.

1. EXHAUST NOZZLE CONTROL SWITCH — MANUAL.
2. ZOOM TO SAFE EJECTION ALTITUDE.
3. If nozzle closes, monitor EGT 600° C maximum, burn out fuel and land.
4. If nozzle remains open, advance throttle rapidly to Maximum Thrust without hesitating in sector burning.
5. If an afterburner light is obtained, exhaust nozzle control switch — AUTO.
6. Obtain desired altitude and airspeed.
7. Fuel load — Reduce and land.
8. Landing gear lever — DOWN on final approach.
9. If afterburner fails to light, external stores — Jettison and follow Engine Failure During Flight procedures.

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E E E E E E E E E E E E

FAILURE TO THE MECHANICALLY SCHEDULED AREA — AFTERBURNING.

1. Throttle — Rapidly retard to MILITARY.
2. Exhaust gas temperature — Monitor.
3. Exhaust nozzle control switch — MANUAL.

FAILURE TO THE WIDE OPEN AREA — AFTERBURNING.

1. When retarding out of afterburning, retard the throttle slowly and check to see if the nozzle is closing.
2. If nozzle is not closing, maintain afterburner thrust until desired altitude and airspeed are obtained.
3. If nozzle is not closing normally, momentarily actuate exhaust nozzle control switch to MANUAL position and return to AUTO.
4. Check for sharp rise in EGT to insure proper functioning of switch prior to coming out of afterburner. Then proceed as follows:

Nozzle Failure Open During Flight.

1. Throttle — MILITARY.
2. Exhaust nozzle control switch — MANUAL.
3. Check nozzle position and monitor exhaust gas temperature to maintain 600° C maximum.

CUT ON DOTTED LINE

CUT ON DOTTED LINE

Nozzle Failure Open In Landing Pattern.

1. Throttle — MILITARY.
2. Speed brakes — IN.
3. Exhaust nozzle control switch — MANUAL.
4. Landing gear lever — UP.
5. Wing flap lever — TAKE-OFF.
6. External stores — Jettison.
7. Nozzle position and exhaust gas temperature — Monitor.
8. When landing is assured, extend landing gear.

SEVERE NOZZLE FLUCTUATION IN MILITARY OR AFTERBURNING THRUST.

1. Speed and altitude permitting, throttle — Reduce to just below MILITARY.
2. If nozzle does not stabilize, exhaust nozzle control switch — MANUAL.
3. Exhaust gas temperature — Monitor.

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OIL SYSTEM FAILURE.

1. Reduce thrust.
2. External stores — Jettison (if necessary).
3. Avoid abrupt maneuvers causing high G forces.
4. Avoid rapid and large throttle movements. Hold throttle changes to a minimum.
5. Land as soon as possible using a pattern to insure a safe landing in the event of engine failure.
6. Throttle — OFF at touchdown.

ENGINE OIL LEVEL LOW WARNING LIGHT.

1. If light illuminates prior to take-off — Abort the flight.
2. **IF LIGHT ILLUMINATES DURING TAKE-OFF AND SUFFICIENT RUNWAY REMAINS — ABORT.**
3. If the light illuminates in flight, land as soon as possible using a pattern to insure a safe landing. Depending upon the oil pressure indications, use one of the folowing procedures:
   a. If light illuminates *without* an oil pressure drop — Follow procedure for Exhaust Nozzle Control System Failure.
   b. If light illuminates *with* an oil pressure drop — Follow procedure for Oil System Failure.

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CUT ON DOTTED LINE

CUT ON DOTTED LINE

ELECTRICAL POWER SYSTEM FAILURE.

COMPLETE ELECTRICAL SYSTEM FAILURE.

1. **EMERGENCY OXYGEN LEVER — EMERGENCY.**
2. Land as soon as possible.
3. Use manual landing gear release handle to lower landing gear.
4. Use No Flap Landing procedure.

GENERATOR FAILURE.

No. 1 or No. 2 Generator Out.

1. Move corresponding generator switch to OFF then to ON RESET and release.

No. 1 and No. 2 Generator Out.

1. No. 1 generator switch — OFF, then ON-RESET position.
2. No. 2 generator switch — OFF, then ON-RESET position.
3. If generator operation is not restored and electrical power is required — Extend RAT.
4. Land as soon as possible.

AUTOMATIC BUS TRANSFER FAILURE.

1. No. 2 generator switch — OFF.
2. If failure is not remedied, No. 2 generator switch—ON-RESET.
3. No. 1 generator switch — OFF.
4. If bus transfer fails to operate, both generator switches — ON-RESET.

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HYDRAULIC SYSTEM FAILURE.

NO. 1 SYSTEM OUT.

1. Trim selector switch — AUX. TRIM.
2. Hydraulic systems pressure gage selector switch — No. 2. Monitor for remainder of flight.
3. Land as soon as possible.

NO. 2 SYSTEM OUT.

1. Hydraulic systems pressure gage selector switch — No. 1. Monitor pressure for remainder of flight.
2. Land as soon as possible. Lower gear with the manual landing gear release handle.

BOTH NO. 1 AND NO. 2 SYSTEMS OUT.

1. Ram-air turbine extension handle — Pull (above minimum recommended airspeed).
2. Hydraulic systems pressure gage selector switch — No. 1.
3. If pressure builds up, land as soon as possible. Continue to monitor pressure and extend landing gear with manual landing release handle.
4. If pressure fails to increase sufficiently for adequate flight control response — Eject.

TRIM FAILURE.

1. Trim selector switch — AUX. Trim position.
2. Use auxiliary trim control switch as necessary.
3. If trim still malfunctions, trim circuit breaker — Pull.

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CUT ON DOTTED LINE

CUT ON DOTTED LINE

E E E E E E E E E E E E

STABILITY AUGMENTATION CONTROL SYSTEM FAILURE.

1. Switch for the affected channel — OFF.

AUTO-PITCH CONTROL SYSTEM FAILURE.

1. APC switch — OFF.
2. Observe the stick shaker boundary as "kicker" will be inoperative.

LANDING GEAR EMERGENCY OPERATION.

LANDING GEAR EMERGENCY DOWNLOCK MALFUNCTION.

1. Reduce airspeed.
2. Landing gear lever downlock override button — Press.
3. Landing gear lever — UP.

LANDING GEAR RETRACTION FAILURE.

1. Reduce airspeed.
2. Recycle gear at lowest practical airspeed.
3. If warning light remains on, lower gear and land.

LANDING GEAR EMERGENCY EXTENSION.

1. Recycle gear.
2. If gear does not lock down, leave gear lever down and pull manual landing gear release handle.

LOSS OF EMERGENCY BLOW-OUT PANEL.

1. Reduce airspeed.
2. Reduce fuel load.
3. Land.

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auxiliary equipment

SECTION IV

TABLE OF CONTENTS

AIR CONDITIONING AND PRESSURIZATION SYSTEM.

COCKPIT AIR CONDITIONING.

Heated, compressed air for cockpit air conditioning and pressurization is obtained by bleeding air from the 17th stage of the engine compressor (figure 4-1). After passing through a primary heat exchanger, a small part of the air is directed to the fuel tank pressurization system. 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, anti-G suit and radar pressurization systems. The remainder then passes either through or around a refrigeration unit (figure 4-1), depending upon the positions of the by-pass valves. The compressor air which goes through the by-pass 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 cockpits depends upon the position of the by-pass valves. For maximum heating, the by-pass valves are fully opened and most of the air entering the cockpit by-passes the refrigeration unit. For maximum cooling, the by-pass valves are completely closed and all the air entering the cockpit passes 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

AIR CONDITIONING AND PRESSURIZATION SYSTEM

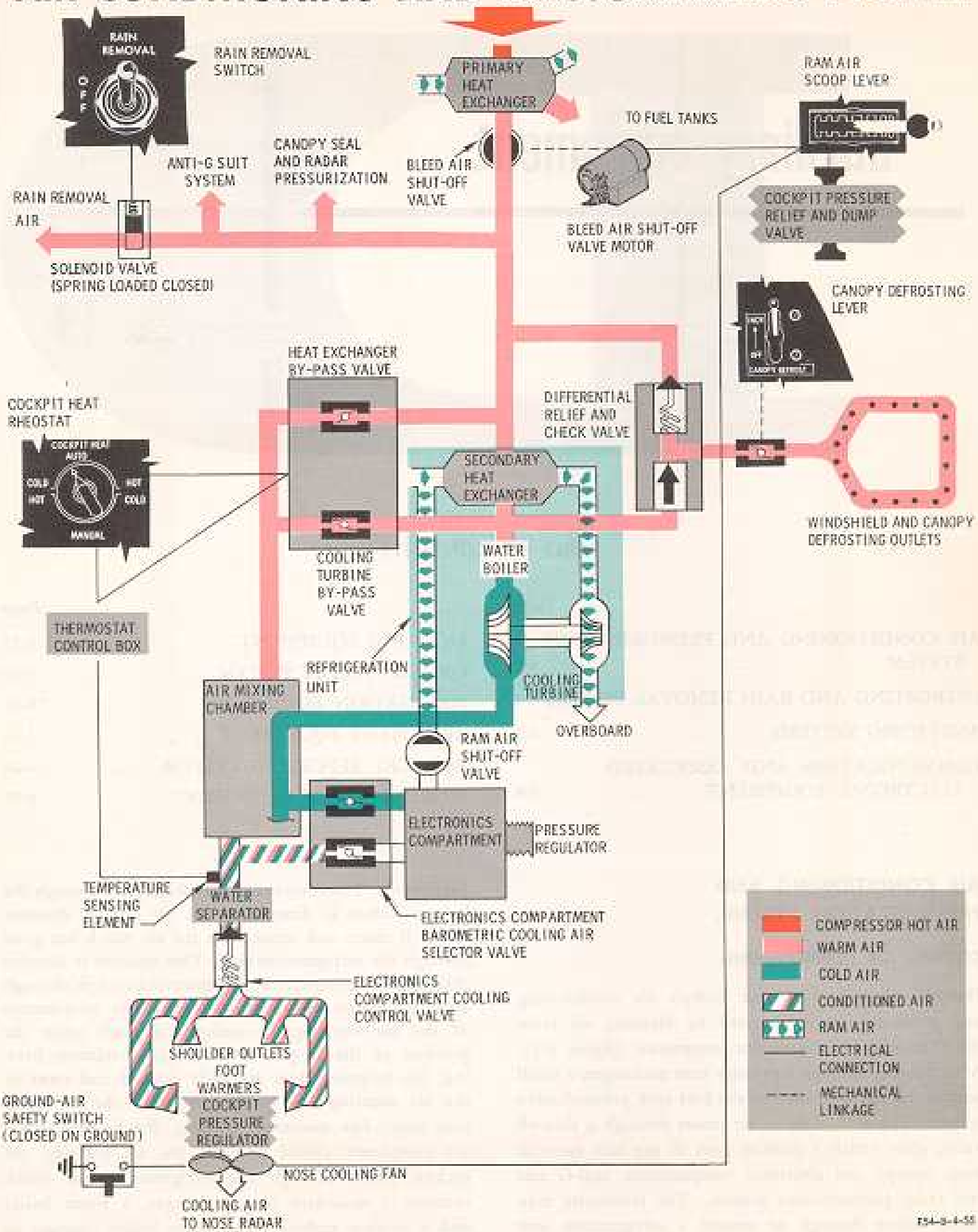

Figure 4-1

water boiling temperature, the water will boil and the air will be cooled through this evaporation process. The temperature of the air entering the cockpits can be varied by the cockpit heat rheostat which controls the position of the by-pass valves. In normal operation, air temperature is maintained between 40°F and 100°F automatically by means of a thermostat control. This senses cockpit temperatures, compares this temperature with the cockpit heat rheostat selection, and sends electrical signals to the by-pass valves to change their positions as necessary to make cockpit air temperature correspond with rheostat selection. Temperature can be controlled manually by means of the cockpit heat rheostat. When this is done, the thermostat control is by-passed and the by-pass 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 cockpits below 5,000 feet. Between 5,000 and 18,500 feet, cockpit altitude is constant (figure 4-2), while the differential pressure varies from 0 to 5.0 psi. Above 18,500 feet, 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 compartment forward of the cockpit for cooling purposes. The cockpit pressure regulator unit incorporates a cooling fan which forces cockpit air into the radar compartment whenever the aircraft is on the ground. This fan is also actuated whenever the ram air scoop 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 this condition by use of the ram air scoop. This allows outside ram air to enter the cockpit; it also shuts off the flow of compressor air into the cockpit and releases cabin air overboard through the cockpit pressure relief and dump valve. Pressurization may be checked on the ground with the canopy locked by pulling the landing gear (IND) circuit breaker and noting slight pressure rise.

COCKPIT HEAT RHEOSTAT.

The cockpit heat rheostat (figure 4-3) is located in the forward cockpit on the right console. Under normal conditions the rheostat is used in the AUTO mode of operation and may be set at any point between COLD and HOT. Cockpit temperature is then maintained automatically by the thermostat control unit which controls the pneumatically-operated by-pass valves. With the rheostat in the MANUAL mode of operation, the thermostat does not function and the by-pass valves are positioned directly in response to movement of the rheostat between the COLD and HOT positions. The cockpit heat rheostat is powered from the emergency a.c. bus.

COCKPIT PRESSURIZATION SCHEDULE

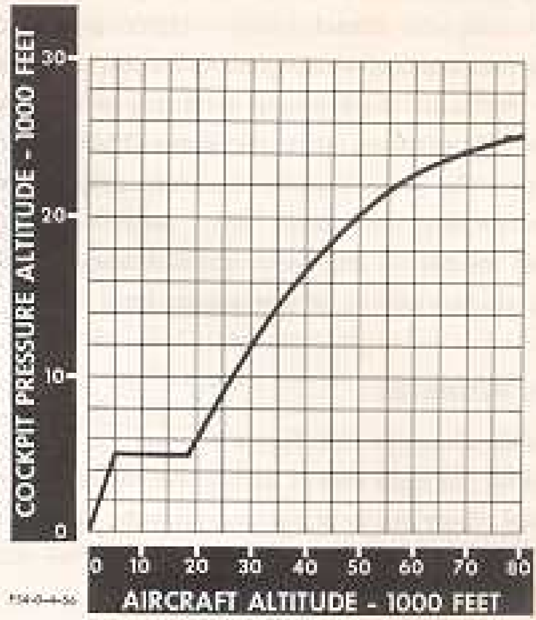

Figure 4-2

RAM AIR SCOOP LEVER.

The ram air scoop lever (5, figure 1-9 and 5, figure 1-11), located outboard of both right consoles, controls the position of the ram air scoops which are directly connected to the levers. Forward movement of either lever opens the scoop and allows outside ram air to enter the cockpits. In addition to this, initial motion of either lever actuates a switch which causes d.c. emergency bus power to close the hot air shut-off valve, open the cockpit relief and dump valve, and energize the nose cooling fan.

CAUTION

- In order to move the lever into the last detent position (fully closed), the button on the levers must be depressed. If this is not done, cockpit pressurization and cooling air for the electronic compartment will not be available.
- With the engine operating and the ram air scoop opened on the ground, the supply of cooling air to the electronics compartment is shut off. This can cause the electronic equipment to reach over-temperature limits.

ELECTRONICS COMPARTMENT COOLING.

Electronics compartment cooling is provided through a cooling air selector valve on the air conditioning package. At airplane altitudes below 25,000 feet, the electronics compartment cooling air selector valve provides air at the same temperature as that provided to the cockpit. At airplane altitudes above 25,000 feet, the valve provides cold air to the electronics equipment. A ground cooling air control valve, located in the ram air duct insures cooling air to the electronic equipment during aircraft taxiing or low engine rpm.

CABIN ALTIMETER.

The cabin altimeter (20, figure 1-6 and 19, figure 1-7), located on the right side of each lower instrument panel, is vented to the inside of the cockpit only. These instruments give an accurate indication of cockpit altitude regardless of actual aircraft altitude.

NORMAL OPERATION OF COCKPIT AIR CONDITIONING AND PRESSURIZATION SYSTEM.

1. Ram air scoop levers—CLOSED.

2. Cockpit heat rheostat—AUTO, and positioned as desired.

EMERGENCY OPERATION OF COCKPIT AIR CONDITIONING AND PRESSURIZATION SYSTEM.

Pressure surging may be encountered when operating on MANUAL. This surging is caused by the thermal switch, which is installed in the system as a high temperature safeguard, shutting off the hot air to the mixing chamber when the air in the duct reaches 210°F. Shutting off this air increases the air flow to the turbine which causes a pressure drop in the air to the cockpits. When the cold air from the turbine hits the thermal switch, it opens and allows hot air to flow again. This cycle may occur from eight to forty times per minute depending upon the temperature of the bleed air and the setting of the control. At low airspeeds, where bleed air temperature is below 200°F, no surging will occur even when the control is on full HOT. At higher airplane speeds, where bleed air temperature may exceed 400°F, surging will occur at one quarter (¼) MANUAL HOT setting, and if the setting is increased the surge cycle will increase to a faster rate.

If cockpit temperature is not maintained at the desired level automatically:

1. Cockpit heat rheostat—MANUAL and position as desired.

Note

- If airflow surging occurs, move cockpit heat rheostat toward COLD.
- If cockpit temperature is excessive and cannot be decreased automatically or manually, open the ram air scoop.

CAUTION

Manual control is provided as a back-up feature only, and should not be used except in case of automatic control failure. There is danger of fogging up the cabin on take-off if manual control is used. This will not happen on automatic.

If air in the cockpit becomes contaminated or if depressurization becomes necessary:

1. If using A-13A oxygen mask, diluter lever—100%.

2. Emergency lever—EMERGENCY.

3. Descend to 25,000 feet or lower, if circumstances permit.

4. Ram air scoop lever—OPEN.

DEFROSTING AND RAIN REMOVAL SYSTEM.

DEFROSTING SYSTEM.

The defrosting system consists of a number of small air jets directed parallel to the canopies and windshield surfaces. These jets act to entrain cabin air causing it to flow over the inside surface, thereby raising the surface temperature. As long as the surface temperature is above the cockpit dew point, no fog or frost will be formed.

Air for the defrosting system is normally routed from the secondary heat exchanger through a check valve and the defrost flow control and shut-off valve (figure 4-1) to the defrosting outlets. This air flow, in itself, is not sufficient to meet all requirements of the system. To supplement this flow, a bleed line is provided which directs air from a point just downstream of the hot air shut-off valve to a differential relief and check valve. When pressure in the normal flow line drops because of large demands on the system (defrost flow control and shut off valve open), the differential relief valve will open and furnish the additional air necessary for effective defrosting under all conditions.

CANOPY DEFROSTING LEVER.

The amount of air directed to the windshield and canopy defrost outlets is determined by the position of the canopy defrosting lever (figure 1-13) located on the right forward panel in the forward cockpit. Upward movement of the lever increases the amount of defrost air to the outlets by actuating the pneumatically operated shut-off valve. With the lever in the INCR. (up) position, the valve will be fully opened, while in the OFF (down) position, the valve will be closed and no defrosting air will be available.

Note

The windshield and canopy defrosting system should be operated throughout the flight at the highest flow possible (consistent with pilot comfort) so that sufficiently high temperature is maintained to preheat the canopy and windshield areas. It is necessary to preheat because there is insufficient time during rapid descents to heat these areas to temperatures which prevent the formation of frost or fog.

ELECTRICALLY HEATED WINDSHIELD.

The left windshield panel is electrically heated on all modified aircraft. Glass temperature is controlled by a thermal switch (no manual switch is installed). This switch will provide electrical power to the heating element whenever the glass temperature falls below 95° ±5° F. When the glass is heated to 105° ±5° F, the electrical power will be automatically disconnected. The windshield obtains power from the emergency a.c. bus. A circuit breaker located on the right console in the forward cockpit labeled WINDSHIELD DEFOG, may be pulled to deactivate the system in the event of a malfunction.

FACE PLATE HEAT SYSTEM.

Heating elements are incorporated in the pilot's face plate to prevent or remove any accumulation of moisture on the face plate which would otherwise hinder vision. This system becomes especially important at high altitudes in the event of any malfunction which causes rapid decrease in cockpit temperature and pressure. To insure that forward cockpit face plate heating will be available under all operating conditions except complete electrical failure, electrical power for the forward cockpit heating elements is taken from the No. 2 battery bus. Power for the aft cockpit heating elements is taken from the No. 2 a.c. bus through the 115- to 28-volt auto-transformer.

FACE PLATE HEAT RHEOSTAT.

Electrical power to the face plate heating elements is controlled by means of the face plate rheostats (25, figure 1-6 and 24, figure 1-7) on the lower instrument panels. Heat may be applied to the face plates in varying degrees by moving either rheostat clockwise from OFF to any desired position. Heating intensity is maximum with the rheostat in the ON (extreme clockwise) position.

Note

- Prior to take-off, check face plate heat for proper operation.
- Use the minimum required heat to prevent or remove any accumulation of moisture on the face plate.
- The face plate heat rheostat should be at maximum heat just long enough to remove moisture, then returned to the minimum heat required to prevent moisture accumulation.

RAIN REMOVAL SYSTEM.

The rain removal system receives compressor air from the same line (figure 4-1) which furnishes pressure for the canopy seal, radar system and anti-G suit valve. Rain removal air passes through a pilot controlled shut-off

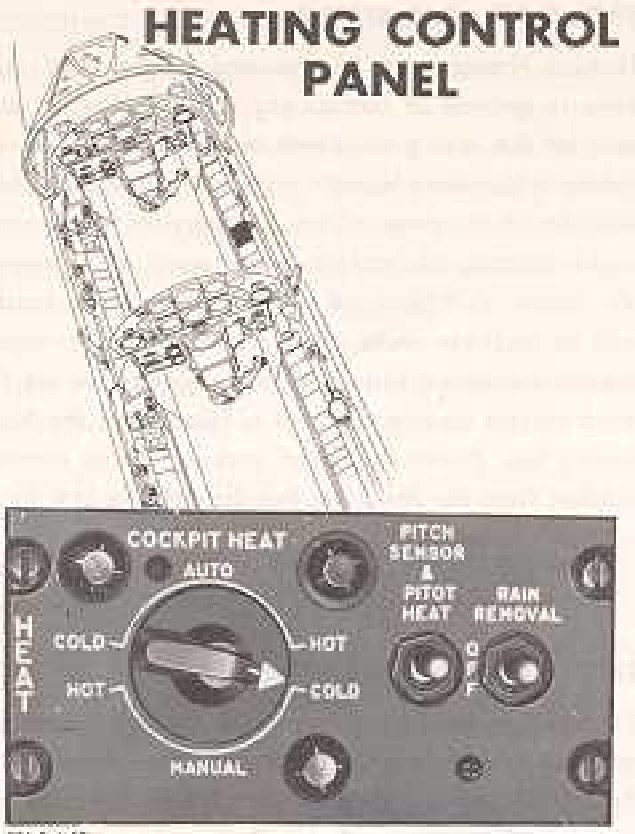

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Figure 4-3

valve and is then routed to nozzles at the outside base of the left windshield panel. This high velocity hot air flows over the panel to remove rain and prevent windshield icing.

CAUTION

Rain removal air is ducted through the left side of the cockpit. If a leak develops in this duct line, air under very high temperature will enter the cockpit, in which case the ram air scoop should be opened. This will shut off all compressor air to the duct line and direct cold ram air into the cockpit.

RAIN REMOVAL SWITCH.

The rain removal switch (figure 4-3) located in the forward cockpit on the right console controls the flow of compressor air to the rain removal outlets. Moving the switch forward from OFF to the RAIN REMOVAL position closes a 28-volt d.c. monitored bus circuit to the rain removal shut-off valve which opens the valve and allows hot, pressurized air to pass through the valve to the outlets.

CAUTION

Do not turn the rain removal system on above its limit air speed, because the rain removal nozzles may be damaged.

NORMAL OPERATION OF DEFROSTING AND RAIN REMOVAL SYSTEMS.

If any portion of the windshield or canopy becomes obscured by moisture, proceed as follows:

1. Canopy defrosting lever—INCR.
2. Cockpit heat rheostat—AUTO—HOT.
3. Rain removal switch—RAIN REMOVAL, if precipitation is obscuring forward visibility.

Note

Canopy defrosting air should be operated at the highest temperature consistent with pilot comfort at all times during high altitude flight. This will minimize the possibility of the windshield and canopies becoming fogged by the extreme temperature differentials which accompany an engine failure or a rapid descent from altitude.

EMERGENCY OPERATION OF DEFROSTING AND RAIN REMOVAL SYSTEMS.

If the windshield cannot be cleared by normal procedures and it is necessary to land without delay, proceed as follows:

1. Canopy defrosting lever—Check (INCR. position)
2. Cockpit heat rheostat—MANUAL—HOT.
3. Rain removal switch—RAIN REMOVAL.
4. Engine rpm—Maximum, if fuel and time permit.

The above procedure directs compressor air to the windshield outlets at its maximum available temperature and pressure.

WARNING

If excessive fog, vapor, or visible moisture of any kind enters the cockpit, restricting visibility on take-off, open the ram air scoop.

ANTI-ICING SYSTEMS.

ENGINE ANTI-ICING SYSTEM.

The anti-icing system is designed to prevent formation of ice in the compressor inlet. Icing of the inlet guide vanes reduces airflow through the engine and causes a loss of power accompanied by a possible increase in nozzle area and an increase in fuel flow. Hot seventeenth stage compressor air flows through a port in the compressor rear frame to the inlet of the solenoid-operated anti-ice valve. The anti-icing valve regulates pressure and air flow to the horizontal struts of the engine front frame. Air is ported through the struts into a manifold in the hub of the frame. Air in the manifold enters the top vertical strut and inlet guide vanes. Holes in the outer end of the vanes and top strut allows air to discharge into the inlet air stream. The bottom strut is anti-iced continuously by scavenge oil which flows through it.

Engine Anti-Ice Switch.

The engine anti-ice switch (figure 1-13) located on the left forward panel controls the flow of compressor air to the engine inlet guide vanes. In the OFF position, the circuit to the solenoid operated engine anti-ice shut-off valve will be opened and no air will flow through the valve. Placing the switch up to the ON position allows a.c. power from the No. 2 bus to energize the circuit, which opens the valve, and permits compressor air to be directed to the inlet guide vanes.

Engine "Anti-Icing On" Warning Light.

A light on the warning light panel (figure 1-13) is provided as a visual indication that the anti-icing system is operating. The light is operated by a temperature sensing device mounted in the air duct between the anti-icing valve and the compressor front frame. This temperature sensing device will cause the warning light to illuminate whenever anti-icing air temperature reaches approximately 163° C. The light will remain on for approximately ½ minute after the anti-icing valve has closed, because of hot air remaining in the duct.

OPERATION OF THE ENGINE ANTI-ICING SYSTEM.

Icing will occur on the inlet ducts and engine compressor front frame at subsonic speeds only. Ram air temperature rise at supersonic speeds will be sufficient to preclude icing. If the engine is operated above 82%, the anti-icing air temperature is sufficient to prevent rapid ice build-up on the engine front frame and inlet guide vanes. The engine can safely ingest aircraft inlet duct ice at engine rpm less than 88%, however; at higher rpm the inlet guide vanes may sustain some damage. Engine operation is still possible with limited inlet guide vane damage. The requirement for engine anti-icing is a direct function of indicated compressor inlet temperature (CIT). Operation of the anti-icing system above a CIT of 10 degrees Centigrade compromises the service life expectancy of the magnesium front frame. Therefore, if weather conditions indicate a need for anti-icing, the system should be necessary only at a CIT indication of 10 degrees Centigrade, or below. Furthermore, the "ENGINE ANTI-ICING ON" warning light will stay on for approximately ½ minute after the anti-icing switch has been deactivated. This condition exists because the temperature sensing device is in the de-icing air duct and there is no means of dumping the hot air immediately after the anti-icing valve is closed. Light illumination for more than 1½ minutes indicates the valve is either stuck full or partially open. In view of the above information, the following instructions shall be observed:

Ground Check (prior to flight in suspected icing conditions).

1. After the engine comes to idle rpm, actuate the anti-icing switch.
2. Advance throttle until light illuminates, not to exceed 85% rpm.

Note

The light should illuminate between idle and 85% rpm, depending on ambient air temperature.

3. Deactivate the switch after light illuminates and monitor light; maintain rpm.

WARNING

Abort the flight if light stays on more than 2 minutes after switch is deactivated and make appropriate entry in Form 781.

In Flight Procedure.

1. If flight is anticipated through known or suspected icing conditions, activate the anti-icing system when at subsonic speed and when the indicated CIT is 10 degrees Centigrade or below. With the anti-icing valve open, a maximum speed of 350 knots or Mach 1.0, whichever is lower, should not be exceeded.
2. After flying in moderate to heavy icing for two minutes or more, reduce power (where practical) to 88% to minimize inlet duct ice ingestion damage to the engine.

TABLE OF COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT

TYPE	DESIGNATION	FUNCTION	PRIMARY OPERATOR	RANGE	LOCATION OF CONTROLS
INTERPHONE	AN/AIC-10	INTER COMMUNICATIONS BETWEEN COCKPITS AND TO GROUND CREW	EITHER CREW MEMBER	BETWEEN COCKPITS	RIGHT CONSOLE EACH COCKPIT
UHF COMMAND	AN/ARC-66	TWO WAY COMMUNICATIONS	EITHER CREW MEMBER	LINE OF SIGHT	LEFT CONSOLE EACH COCKPIT
VHF NAVIGATION	AN/ARN-56	VOR NAVIGATION VOICE AND LOCALIZER RECEPTION	EITHER CREW MEMBER	LINE OF SIGHT	RIGHT CONSOLE EACH COCKPIT
	AN/ARN-57	GLIDE SLOPE RECEPTION	EITHER CREW MEMBER	LINE OF SIGHT	RIGHT CONSOLE EACH COCKPIT
		MARKER BEACON RECEPTION	AUTOMATIC	ANY DISTANCE OVER MARKER BEACON	NONE
IFF	AN/APX-35	AIRCRAFT IDENTIFICATION	FORWARD COCKPIT ONLY	LINE OF SIGHT	RIGHT CONSOLE FORWARD COCKPIT

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Figure 4-4

3. Should it be necessary to fly in known icing conditions at low altitude and low power settings (80 to 86% rpm), the engine power should be increased to 100% rpm every five minutes to assure that adequate anti-icing air circulation is available at the engine compressor front frame. This power increase should be maintained for approximately thirty seconds.

PITCH SENSORS AND PITOT HEAT SWITCHES.

The auto-pitch control and stick shaker pitch sensor vanes and pitot-static head are heated electrically by power from the No. 2 a.c. bus. Heating elements within the sensor vanes and the pitot-head receive this power whenever the heating circuit is closed. The circuit is closed by placing either pitch sensor and pitot-heat switch (17, figure 1-9 and 6, figure 1-11) on the right consoles from OFF to PITCH SENSOR and PITOT HEAT position. Heat should be applied whenever instrument flying conditions are encountered in order to prevent the formation of ice on these units.

CAUTION

Since the rain removal switch is adjacent to the pitot heat switch, the rain removal system could possibly be turned on inadvertently, causing damage to the windshield.

COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT.

The communications and associated electronic equipment installed in the aircraft is listed in figure 4-4.

MICROPHONE AND HEADSET CONNECTIONS.

The microphone and headset connections are a complement of the oxygen supply hose which plug into the pilot's personal head gear equipment.

MICROPHONE SWITCH.

The microphone switch consists of a button (3, figure 1-5) located on the throttle grip in each cockpit. It is used for transmitting with the AN/ARC-66 UHF command radio and for manual interphone communications.

AN/AIC-10 INTERCOMMUNICATION SET.

This equipment is powered by the d.c. emergency bus and is protected by a circuit breaker located on the aft cockpit left side panel. The set provides high intelligibility of speech and communications at all altitudes. It gives the crew simplified control over the radio receivers and transmitters and permits maximum flexibility of communications facilities: intercommunication within the aircraft, communication beyond the aircraft, monitoring of received radio signals including simultaneous monitoring of three radio receivers, and a call facility for use in establishing interphone communication between the pilots. The set incorporates two AN/AIC-10 control panels and a relay assembly for "hot-mike" operation. "Hot-mike" provides continuous operation on interphone without the necessity of manual operation of the microphone button.

AN/AIC-10 INTERPHONE CONTROL PANEL

An interphone control panel (figure 4-5) is located on the right console in each cockpit. It acts as a master control box for the associated electronic equipment, radio and inter-communication equipment. The panel does not contain an ON-OFF switch. The equipment is "on" whenever the d.c. emergency bus is energized. The following controls are provided:

Note

The interphone power source will automatically switch from the d.c. emergency bus to the battery bus when engine rpm falls below 63% and the ram air turbine is not operating.

Volume Control.

The volume control is provided for the adjustment of aural signal intensity.

Monitoring Switches.

The five monitoring switches provide individual or simultaneous reception of audio signals with the rotary selector knob in either the INTER or COMM. INTER position, as follows:

INTER. For interphone reception only.

COMM. For AN/ARC-66 reception.

MARKER. For AN/ARN-57 visual reception only.

VHF NAV. For AN/ARN-56 reception.

Figure 4-5

Rotary Selector Knob.

This control provides for individual transmission and/or reception in accordance with the 4 functions placarded on the rotary base, as follows:

CALL. For intercommunication, permits the user in an emergency, to interrupt or override any signals being received by the other pilot if the other pilot is operating his interphone with the rotary selector knob set on any position other than INTER. or COMM INTER.

COMM INTER. For transmission or reception with the AN/ARC-66 radio, two way "hot-mike" intercommunication and the reception of other signals as selected by the monitoring switches.

INTER. For manual transmission and reception of intercommunication signals using the MIC button, on the throttle and the reception of other signals as selected by the monitoring switches.

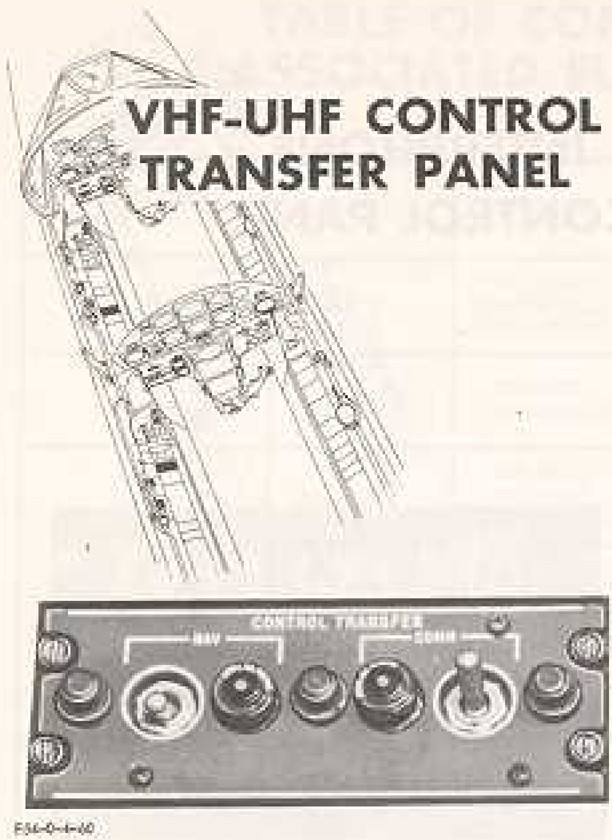


Figure 4-6

Figure 4-7

COMM. For transmission or reception with the AN/ARC-66 radio only.

Normal, Aux. Listen Switch.

This switch has two positions, NORMAL and AUX. LISTEN. The NORMAL position allows all audio signals to pass through the AN/AIC-10 amplifier thus allowing the volume control knob on the AN/AIC-10 panel to adjust audio signal intensity. The AUX. LISTEN position by-passes the amplifier in case it fails and audio signal intensity must be adjusted with the individual receiver's volume control.

VHF AND UHF CONTROL TRANSFER PANEL.

The VHF and UHF control transfer panel (figure 4-6) is located on the left console of both cockpits. The panel contains two switches and two green indicator lights. The inboard switch is the command radio control transfer switch and is placarded COMM and transfers control of channel selection between cockpits for the AN/ARC-66 command radio. The outboard switch is the navigation receiver control transfer switch and is placarded NAV; it transfers control of channel selection between cockpits for the AN/ARN-56 VHF-NAV receiver. The green indicator light associated with each switch illuminates only in the cockpit having control. The operator in the cockpit that does not have control can transmit and receive but has no control over frequency selection.

AN/ARC-66 UHF COMMAND RADIO.

The AN/ARC-66 UHF command radio provides voice transmission and reception in the UHF frequency range. This range is divided into 1750 frequencies which can be selected in increments of one-tenth of a megacycle. Any 20 of the 1750 frequencies may be set on a channel selector to facilitate immediate use. In addition, any one of the remaining frequencies on the channel selector may be changed on the ground or in flight. Receiver and transmitter tuning is accomplished automatically after a channel or frequency change. In addition to the main receiver a separate, fixed-tuned guard receiver with a frequency range of from 238.0 to 248.0 megacycles is installed to provide a constantly alerted emergency channel. This emergency guard channel frequency must be pre-tuned prior to installation. Provisions only are made for the adaption of automatic direction finding equipment utilizing the main receiver.

AN/ARC-66 CONTROL PANEL.

An AN/ARC-66 control panel (figure 4-7) is located on the left console in each cockpit. Control of channel selection is transferred between cockpits through the command radio control transfer switch previously described. Panel lighting is accomplished by two red shaded bulbs which illuminate the transparent plastic material of which the panel is made. Each panel has the following controls:

Manual Frequency Selector Knobs.

Four manual frequency selector knobs are installed across the top of the panel. These knobs are used to set up any desired operating frequency which is not set on the channel selector. From left to right, the first knob selects hundreds of megacycles, the second knob selects tens of megacycles, the third knob selects units of megacycles and the fourth knob selects tenths of megacycles. These numbers appear in a window above their respective knobs, so that any frequency in the UHF band can be selected manually.

Tone Button.

The tone button, when pressed, energizes the transmitter and excites a tone oscillator which feeds the tone into the modulator providing continuous tone transmission.

Volume Control.

The volume control consists of a rheostat type switch that is used to control the audio level of the received signal.

Mode Switch.

This switch selects the method of frequency selection. The MANUAL position permits operation on the frequency selected by the manual frequency selector knobs. The preset channel number is covered in this position and the PRESET and GUARD positions are seen through a green window. The PRESET position permits the use of the channel selector for operation on any one of the 20 preset frequencies. The GUARD position selects a pre-tuned fixed frequency on the main receiver and transmitter for emergency or distress calls.

Channel Selector.

The rotary channel selector knob is used to select any one of the 20 preset channels. The number of the selected channel appears in a window above the knob. The window is covered when the mode switch is in the MANUAL or GUARD position.

Function Switch.

This switch sets up the functions of the equipment which are selected by the four following positions:

OFF—For de-energizing the equipment.

MAIN—Operates the transmitter and the main receiver on the same frequency. The equipment is switched from the receiver to the transmitter by depressing the MIC button. Releasing the button returns the equipment to a receiving condition.

BOTH—The main receiver, transmitter and the guard receiver are operative in the BOTH position. The main receiver and transmitter operate on that frequency determined by the frequency control components. The guard receiver operates on a pre-tuned frequency determined prior to installation. This position permits simultaneous monitoring of the main and guard receivers.

ADF—This position permits the main receiver to be used in conjunction with automatic direction finding equipment (not operative on this aircraft).

Channel Preset Buttons.

The lower portion of the control panel contains a hinged cover held in place by two captive thumb screws. Releas-

Figure 4-8

ing the thumb screws allows the cover to swing down and expose a small channel window and four channel preset buttons. These buttons are used to preset frequencies on the channel selector. Above the button on the left are the numbers 2 and 3 for selecting hundreds of megacycles, above each of the next three buttons are numbers from 0 through 9 for selecting tens of megacycles, units of megacycles and tenths of megacycles respectively. A presetting tool for positioning the buttons is located on clips on the inside of the cover. The front of the cover contains a white plastic card for recording the frequencies set on the channel selector.

AN/ARC-66 OPERATION.

1. Check the channel preset frequencies as indicated on the plastic write-in card. Change preset frequencies as required for the mission.

2. Set AN/AIC-10 Interphone panel as desired.

3. Obtain control with the command radio control transfer switch and check indicator light.

4. Rotate function switch to MAIN and allow at least one minute for the set to warm up.

5. Rotate the function switch to BOTH if simultaneous monitoring of a preset channel and the guard channel is desired.

6. Set the mode switch so that PRESET is visible through the clear window.

7. Select a preset channel using the channel selector so that the channel number appears in the clear window.

8. Before transmitting a message, check operation and warm up of the transmitter by using either the microphone button or the tone button while listening for side tone.

9. If it is desired to transmit and receive on a frequency not previously preset on the channel selector, set-up the new frequency on the manual frequency selector knobs and place the mode switch in the MANUAL position.

10. Turn the function switch to OFF to de-energize the set.

AN/ARN-56 NAVIGATION RECEIVER.

The AN/ARN-56 receiver (figure 4-8) operates in the VHF frequency range of 108.0 to 135.9 megacycles. Both visual and aural reception information are provided to assist the pilot in determining the position of the aircraft relative to ground and omni range stations. Visual reception may be observed on the azimuth scale opposite both pointers of the ID-250 radio magnetic indicator (RMI) located on the instrument panel in both cockpits. The receiver may be monitored aurally through the AIC-10 interphone panel by placing the VHF-NAV monitoring switch in the VHF-NAV position. Instrument approach station (localizer) frequencies are also selected on this set for the ARN-57 glide slope indications. The VHF band of frequencies (108.0 to 135.9 megacycles) is divided into 5 groups for the different services. The following table lists the various services available.

Frequency Band In Megacycles	*Type of Service*
108.1 to 111.9 (odd tenth megacycle channels).	Tone localizer (runway location) and VHF Visual-aural range (airway location).
108.0 to 111.0 (even tenth megacycles) and 112.0 to 117.9 (inclusive).	Omni-Directional range (radial location).
*118.0 to 121.9 megacycles	Tower Communications
*122.0 to 135.9 megacycles	General Communications

*Because of the small amount of cross polarization existing in the omni range antenna (designed for reception of tone localizer, VHF visual range and omni directional range signals) reception of VHF tower and general communications may be experienced only at very close range.

AN/ARN-56 CONTROL PANEL.

The AN/ARN-56 control panels (figure 4-8) are located in each cockpit on the right console and contain the following controls:

Power Switch.

The set may be energized or de-energized by placing this toggle switch in either the ON or OFF position.

Volume Control.

Audio level may be adjusted by moving this rotary switch to the left or right as desired.

Frequency Selector.

Frequency selection is accomplished by setting the desired frequency into the window with the concentric frequency selector knobs provided. Vertically downward, the numbers represent hundreds, tens, units, and tenths of megacycles. Two lamps illuminate the window as well as other markings on the panel.

Figure 4-9

AN/ARN-57 GLIDE SLOPE AND MARKER BEACON RECEIVER.

The AN/ARN-57 glide slope receiver is installed in the airplane for instrument landings. Selection of proper frequencies for an indication on the horizontal cross-pointer of the course indicator (figure 4-9) is automatic and needs no action on the part of the pilot other than the selection on the AN/ARN-56 frequency selector knob of a frequency authorized for the place of landing. The horizontal cross-pointer will indicate to the pilot whether the airplane is above, below or on glide slope during an ILS approach to landing. The vertical cross-pointer will indicate whether the airplane is to the left, right or on course during an ILS approach to landing. The AN/ARN-56 is used for localizer information. The marker beacon receiver is automatically turned on when power is supplied to the electrical system of the airplane. A marker beacon indicator light is located on the upper right corner of the course indicator (figure 4-9). The marker beacon receiver is powered through the d.c. emergency bus.

Figure 4-10

Figure 4-11

ID-351 ILS COURSE INDICATOR.

An ID-351 course indicator is mounted on the instrument panel in both cockpits (10, figure 1-6, and 9, figure 1-7). Signals are directed into this indicator from the AN/ARN-56 receiver to operate the vertical needle for course guidance. A course SET knob in the lower left corner of the instrument is used to select the desired course for inbound or outbound tracking, the magnetic value of which appears in a window at the top of the instrument. The horizontal needle is operated by the AN/ARN-57 glide slope receiver for glide path guidance during ILS operations. TO and FROM indications are shown in a window in the upper left corner of the instrument. This instrument is provided with the two flag alarms (one for course and one for glide slope), which operate whenever a signal is unreliable, weak or nonexistent. The amber light on the upper right corner of the ID-351 course indicator provides visual signals supplied by the marker beacon receiver.

ID-250 RADIO MAGNETIC INDICATOR (RMI).

Radio magnetic indicators are installed on the front and rear instrument panels. The indicators are dual pointer instruments with a rotating azimuth card. Information from the AN/ARN-56 and the flux gate compass is directed into these indicators. The rotating azimuth card provides magnetic heading information. The No. 2 pointer on each instrument is connected to the AN/ARN-56 receiver. The No. 1 pointers are not connected and are inoperative.

WARNING

If the slaved gyro becomes inoperative or the RMI compass card is stuck and the VOR is still operative, the No. 2 needle will continue to point to the magnetic bearing to the station, *not the relative bearing*. In this case, attempt to align the DG with the magnetic compass, but in no case assume that the bearing under the No. 2 needle is a relative bearing to the station.

AN/APX-35 IFF AND SIF RADAR.

An AN/APX-35 IFF radar set automatically identifies the airplane as friendly when properly challenged by suitably equipped friendl air or surface forces. SIF (Surface Identification Fea..re) permits an aircraft, when interrogated, to not only reveal itself as friendly, but also identify itself with regard to serial number, flight number, mission or any other method previously arranged. The control panels are located on the right console in the forward cockpit (figure 4-11). The IFF is powered from the emergency a.c. bus and the d.c. emergency bus.

OPERATION OF AN/APX-35.

1. On IFF control panel, rotate master switch to STDBY and allow 3 to 4 minutes for equipment to warm up.

2. Select NORM position on master space switch.

3. Set mode 2 and 3 switches as required.

4. Set I/P-MIC switch as required.

5. On SIF panel set mode 1 and 3 knobs as required.

6. Rotate master switch on IFF panel to OFF to de-energize set.

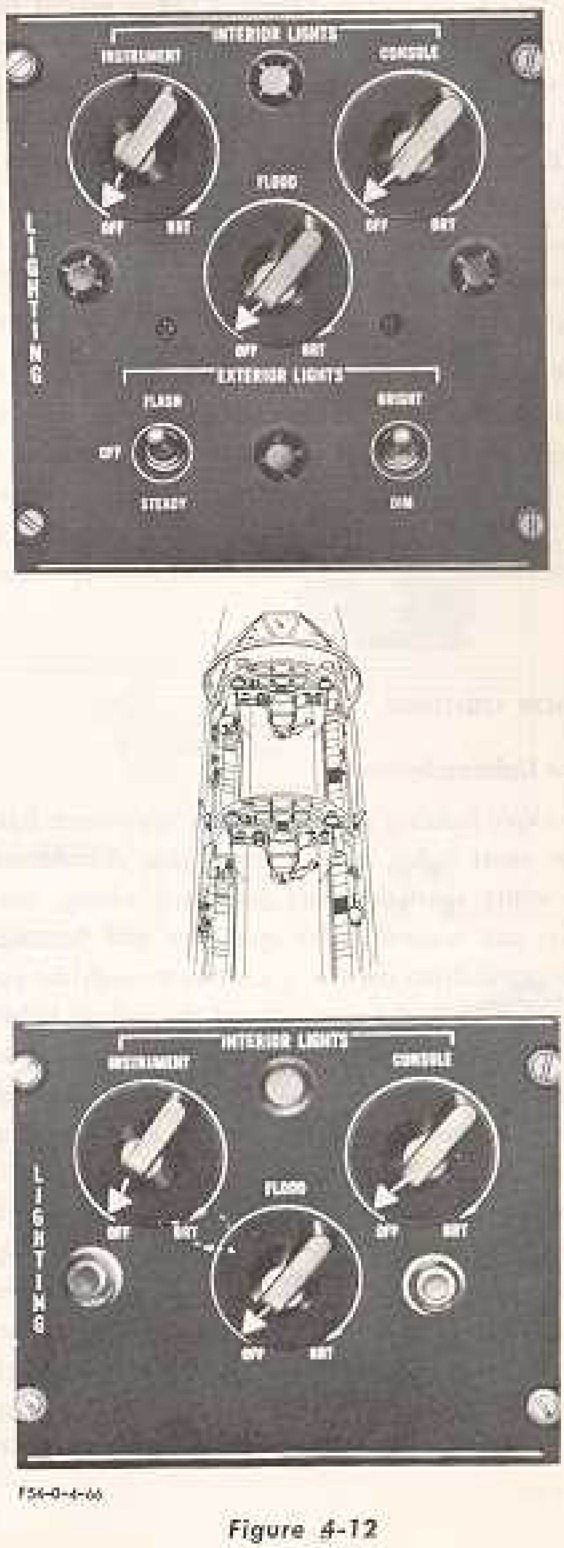
LIGHTING EQUIPMENT.

EXTERIOR LIGHTING.

Landing ·nd Taxi Lights.

A landi g light is installed, one on each main gear aft doo . The lights will be in position for use any time the lar ing gear is extended. The right light is used also as a t i light. These lights receive their power from the No . .c. bus and are controlled by switches (figure 1-13) on the left forward panels. The switches have three positions, LANDING LT, OFF, and TAXI LT. When eith.. switch is placed up to the LANDING LT. position, both lights will be energized. Moving either switch down to the TAXI LT position will cause only the right light to be energized. On modified aircraft the lights automatically shut off when the gear is retracted, and either position energizes both taxi and landing lights.

FORWARD AND AFT LIGHTING CONTROL PANEL



F56-D-4-66

Figure 4-12

Navigation Lights and Switches.

The navigation lights include two yellow upper tail lights, two white lower tail lights, a green and a red fuselage light, and white top and bottom fuselage lights. The lights are controlled by a selector switch and a dimming switch located in the forward cockpit, on the right console (figure 4-12). The lights are energized by 28-volt a.c. power from the No. 2 a.c. bus auto-transformer when the selector switch (figure 4-12) is moved from OFF to STEADY or FLASH. Intensity of the navigation lights will depend upon the position (BRIGHT or DIM) of the dimming switch. With the selector switch in the STEADY position, all of the navigation lights will be continuously energized. In the FLASH position, the top and bottom fuselage lights still burn steadily while the remaining navigation lights are energized intermittently through a flasher unit at a rate of 40 flashes per minute.

On AF Serials 57-1321 and subsequent and modified aircraft, formation lights are installed on the missile launchers and tip tanks. All modified aircraft have wing tip lights installed. These lights automatically illuminate if the tip stores are fired or jettisoned, provided the selector switch is in the STEADY or FLASH position.

INTERIOR LIGHTING.

Cockpit Lighting System.

The cockpit lighting system includes instrument lights, console panel lights, console floodlights, thunderstorm lights utility spotlights, and associated wiring, circuit breakers and controls. The spotlights and floodlights receive power from the No. 2 a.c. bus through the autotransformer while the remainder of the cockpit lighting system is powered directly from the emergency a.c. bus. The instruments are individually illuminated by lights placed in shields above each instrument on the panels. The consoles are lighted by recessed lamps so that all of the controls and decals on each panel are readily discernible. The console floodlights are provided to light the left and right consoles directly. The thunderstorm lights are located on the left and right consoles and direct light forward onto the instrument panels to overcome the effects of blindness caused by lightning. One C-4A type utility spotlight is mounted on both sides of each cockpit above the right and left consoles. These spotlights are detachable and may be moved about the cockpits to take care of special lighting situations. A rheostat on the aft end of the light is used to vary the intensity of the spotlight. Red or white light may be selected by rotating the lens. A push-button switch on the light enables the pilot to by-pass the rheostat and obtain maximum spotlight brilliance instantaneously. The instrument lights, console panel lights and floodlights are controlled by three dimming rheostats (figure 4-12) located in each cockpit on the right consoles. These rheostats, labeled INSTRUMENT, CONSOLE, and FLOOD, may be rotated clockwise from OFF to BRT, as desired to vary the intensity of the associated lights. When starting the engine at night, the cockpit lights will be at maximum brilliance and the rheostat must be re-positioned to dim lights. Thunderstorm lights are controlled by switches (13, figure 1-9 and 11, figure 1-11) labeled ON and OFF, located on the right console of each cockpit.

OXYGEN SUPPLY SYSTEM.

A liquid oxygen system (figure 4-13) is used to provide the normal oxygen supply requirements. The liquid oxygen is converted to a gaseous state in a converter container tank which has a 10 liter (2.6 gallon) capacity. The oxygen is made suitable for breathing after passing through a heat exchanger which keeps the oxygen within a few degrees of cockpit ambient temperature. Oxygen is delivered to a reducer valve at the control panel where pressure is reduced from approximately 300 psi to 70 psi. (This pressure will remain constant as long as there is liquid in the system.)

SURVIVAL KIT CONNECTION.

Flow of oxygen is directed to pressure reducers and control panels on the right consoles. From here, oxygen flows through disconnects on the bottom of the pilots' seats to manifold assemblies in the rear section of the survival kits located in the seat buckets (figure 4-13). This section of each survival kit also contains two emergency oxygen bottles connected to the manifold assembly, and a regulator unit. The manifold assembly includes a pressure gage, relief valve, check valve and filler valve. Either normal aircraft oxygen or emergency oxygen can

OXYGEN SUPPLY SYSTEM

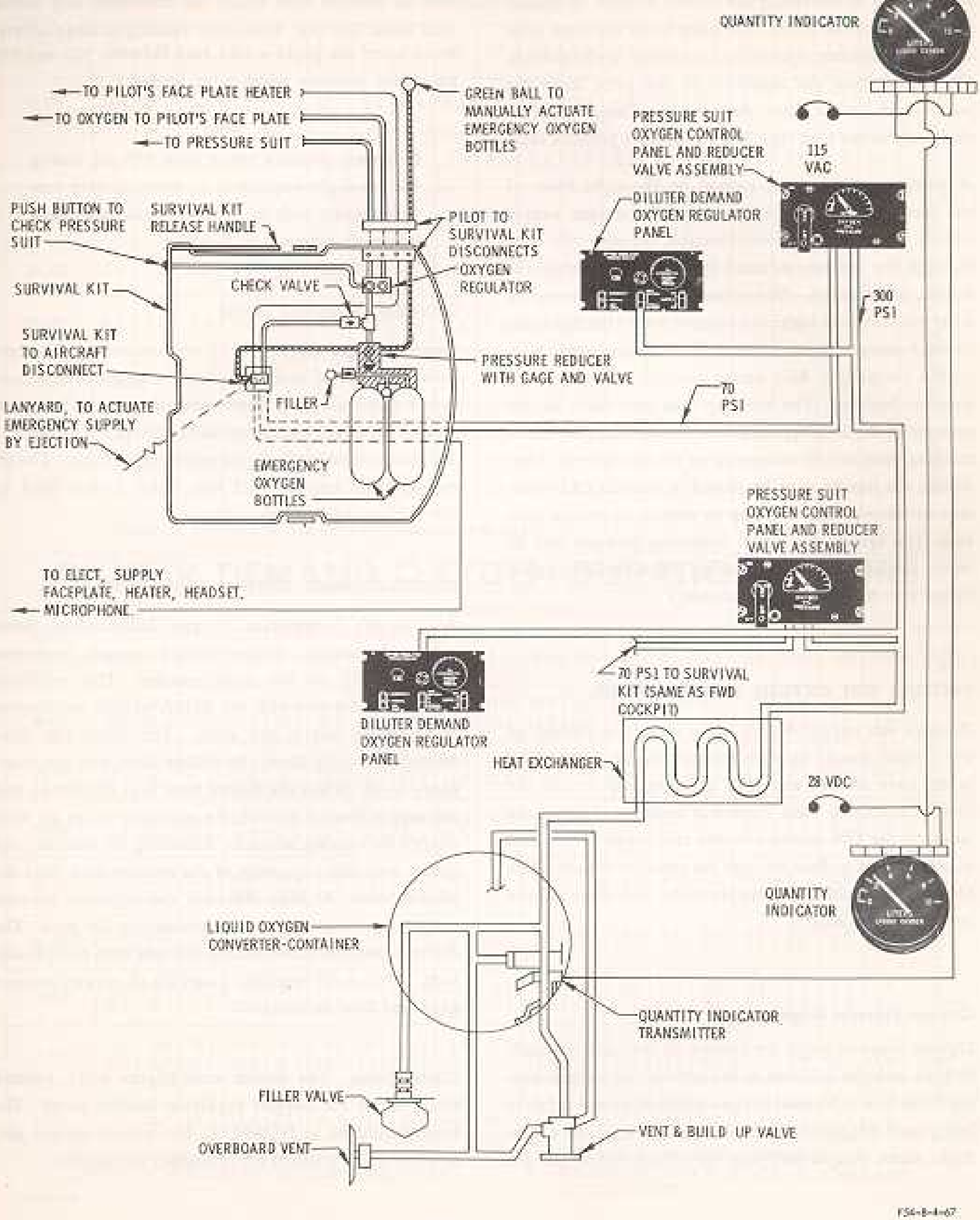


Figure 4-13

be directed from the manifold assembly to the regulator unit which sends oxygen pressure to the pilots' pressure suits as well as delivering the correct amount of breathing oxygen to the pilots' face plate hoses from sea level up to the maximum operational capability of the aircraft. The hoses from the regulator to the pilot leave the survival kit at the right rear corner. These hoses are designed for use with type MC-3 and MC-4 pressure suits.

A press-to-test button is located on the right front of the survival kit to test operation of the oxygen supply system. If there is no malfunction, oxygen will flow through the pressure suit and face plate hoses when the button is depressed. The system is serviced through a filler point located within an access door on the right side of the fuselage (figure 1-39). A build-up and vent valve, within the oxygen filler access door, is used to control pressure build-up. The build-up and vent valve handle must be in the OPEN position before the filler valve and transfer hose can be connected to fill the system. After filling, the handle must be placed in the CLOSED position to allow system build-up to normal operating pressure. The system will reach operating pressure and be ready for use within 10 minutes after servicing. (See figrue 1-39 for oxygen specification.)

PRESSURE SUIT OXYGEN CONTROL PANEL.

Pressure suit oxygen supply valve levers are located on the control panels in each cockpit (figure 4-15). The levers have an ON and OFF position and control the oxygen supply to their respective cockpits. Placing the lever to the ON position opens the supply valve and allows oxygen to flow through the pressure reducer. The OFF position closes the supply valve and shuts off the normal oxygen supply.

Oxygen Pressure Gage.

Oxygen pressure gages are located on the control panels in both cockpits adjacent to the survival kit oxygen supply valve levers. Normal oxygen pressure when oxygen is being used (flight conditions) is 295-315 psi. In a preflight status the pressure may vary from 300 to 370 psi depending on the time span between filling of the converter and reading the gage. For example, if the gages are read 10 minutes after filling the converter, they would read about 300 psi. If another reading is taken several hours later, the gages would read between 320 and 370 psi. (Low pressure relief valve setting.)

Note

If system pressure reads over 370 psi during the pre-flight inspection, an unsatisfactory condition exists and the system should be checked before the aircraft is flown.

OXYGEN QUANTITY GAGE.

Quantity gages (figure 4-15) are located on the right forward panel of each cockpit. The gages should indicate a minimum of 9 liters, with the system fully serviced. The gages are calibrated from 0 to 10 and receive a.c. electrical power from the emergency a.c. bus. The aft cockpit gage requires d.c. also which is furnished by the d.c. emergency bus.

DILUTER-DEMAND OXYGEN REGULATOR PANEL.

All aircraft incorporate a type MD-1 combination pressure-breathing, diluter-demand oxygen regulator (figure 4-15) on the right consoles. This regulator is provided for use with the A-13A oxygen mask when the pressure suit is not worn. The panel has three levers: the supply lever, the diluter lever, and the emergency lever. When the diluter lever is at NORMAL and the supply lever is at ON, the regulator mixes air with oxygen in varying amounts, according to altitude, and makes available a quantity of the mixture each time the pilot inhales. At high altitudes, the regulator supplies oxygen at continuous positive pressure to the pilot. The delivery pressure automatically changes with cockpit altitude. Also on the regulator panel are an oxygen pressure gage and flow indicator.

Diluter Lever. The diluter lever (figure 4-15), painted black, is on the oxygen regulator control panel. The lever should be at NORMAL, for normal oxygen use, or at the 100% position for emergency oxygen use.

PRESSURE SUIT OXYGEN DURATION-HOURS

CABIN ALTITUDE (FEET)	QUANTITY - LITERS																		
	10.0	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	BELOW 1.0
35,000 & UP	16.3	15.5	14.6	13.8	13.0	12.2	11.4	10.6	9.8	9.0	8.1	7.3	6.5	5.7	4.9	4.1	3.3	2.4	1.6	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
30,000	12.8	12.1	11.5	10.8	10.2	9.6	8.9	8.3	7.7	7.0	6.4	5.7	5.1	4.5	3.8	3.2	2.6	1.9	1.3	
25,000	9.7	9.3	8.8	8.3	7.8	7.3	6.8	6.3	5.8	5.4	4.9	4.4	3.9	3.4	2.9	2.4	1.9	1.5	1.0	
20,000	7.6	7.2	6.8	6.4	6.1	5.7	5.3	4.9	4.5	4.2	3.8	3.4	3.0	2.6	2.3	1.9	1.5	1.1	.8	
15,000	6.0	5.7	5.4	5.1	4.8	4.5	4.2	3.9	3.6	3.3	3.0	2.7	2.4	2.1	1.8	1.5	1.2	.9	.6	
10,000	4.8	4.6	4.3	4.1	3.8	3.6	3.4	3.1	2.9	2.6	2.4	2.2	1.9	1.7	1.4	1.2	1.0	.7	.5	
5,000	3.9	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.3	2.1	2.0	1.8	1.6	1.4	1.2	1.0	.8	.6	.4	
SEA LEVEL	3.1	2.9	2.7	2.6	2.4	2.3	2.1	2.0	1.8	1.7	1.5	1.4	1.2	1.1	.9	.8	.6	.5	.3	

BREATHING RATES FOR MC-3 OR MC-4 PRESSURE SUIT AND HELMET

TWO CREW MEMBERS.

DILUTER DEMAND OXYGEN DURATION-HOURS

CABIN ALTITUDE (FEET)	QUANTITY - LITERS																		
	10.0	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	BELOW 1.0
35,000 & UP	31.4 31.4	29.9 29.9	28.3 28.3	26.7 26.7	25.1 25.1	23.6 23.6	22.0 22.0	20.4 20.4	18.9 18.9	17.3 17.3	15.7 15.7	14.1 14.1	12.6 12.6	11.0 11.0	9.4 9.4	7.9 7.9	6.3 6.3	4.7 4.7	3.1 3.1	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
30,000	22.6 23.3	21.5 22.1	20.4 21.0	19.3 19.8	18.1 18.6	17.0 17.5	15.9 16.3	14.7 15.1	13.6 14.0	12.5 12.8	11.3 11.6	10.2 10.5	9.1 9.3	7.9 8.2	6.8 7.0	5.7 5.8	4.5 4.7	3.4 3.5	2.3 2.3	
25,000	17.5 22.0	16.6 20.9	15.7 19.8	14.9 18.7	14.0 17.6	13.1 16.5	12.2 15.4	11.4 14.3	10.5 13.2	9.6 12.1	8.7 11.0	7.9 9.9	7.0 8.8	6.1 7.7	5.2 6.6	4.4 5.5	3.5 4.4	2.6 3.3	1.8 2.2	
20,000	13.3 24.9	12.6 23.7	12.0 22.4	11.3 21.2	10.6 19.9	10.0 18.7	9.3 17.4	8.7 16.2	8.0 14.9	7.3 13.7	6.7 12.4	6.0 11.2	5.3 10.0	4.7 8.7	4.0 7.5	3.3 6.2	2.7 5.0	2.0 3.7	1.3 2.5	
15,000	10.7 30.2	10.1 28.7	9.6 27.2	9.1 25.6	8.5 24.1	8.0 22.6	7.5 21.1	6.9 19.6	6.4 18.1	5.9 16.6	5.3 15.1	4.8 13.6	4.3 12.1	3.7 10.6	3.2 9.1	2.7 7.5	2.1 6.0	1.6 4.5	1.1 3.0	
10,000	8.6 30.2	8.1 28.7	7.7 27.2	7.3 25.6	6.9 24.1	6.4 22.6	6.0 21.1	5.6 19.6	5.1 18.1	4.7 16.6	4.3 15.1	3.9 13.6	3.4 12.1	3.0 10.6	2.6 9.1	2.1 7.5	1.7 6.0	1.3 4.5	.9 3.0	
5,000	7.0 30.2	6.6 28.7	6.3 27.2	5.9 25.6	5.2 22.6	4.9 21.1	4.5 19.6	4.2 18.1	3.8 16.6	3.5 15.1	3.1 13.6	2.8 12.1	2.4 10.6	5.6 24.1	2.1 9.1	1.7 7.5	1.4 6.0	1.1 4.5	.7 3.0	
SEA LEVEL	5.7 30.2	5.4 28.7	5.1 27.2	4.9 25.6	4.6 24.1	4.3 22.6	4.0 21.1	3.7 19.6	3.4 18.1	3.1 16.6	2.9 15.1	2.6 13.6	2.3 12.1	2.0 10.6	1.7 9.1	1.4 7.5	1.1 6.0	.9 4.5	.6 3.0	

UPPER FIGURE IN EACH BLOCK INDICATES "100"% OXYGEN.
LOWER FIGURE IN EACH BLOCK INDICATES NORMAL OXYGEN.

ONE TEN LITER LIQUID OXYGEN CONVERTER
BREATHING RATES FOR A-13A PRESSURE DEMAND MASK
TWO CREW MEMBERS

F-04-0-4-48

Figure 4-14

Emergency Lever. The emergency lever (figure 4-15), on the oxygen regulator panel, is red and should be in the center NORMAL position at all times, unless an unscheduled oxygen pressure increase is required. Moving the lever to EMERGENCY provides continuous positive pressure to the mask for emergency use. When the lever is held at TEST, oxygen at positive pressure is provided to test the mask for leaks.

CAUTION

When positive pressures are required, it is mandatory that the oxygen mask be well fitted to the face. Unless special precautions are taken to insure no leakage, continued use of positive pressure will result in rapid depletion of the oxygen supply. This rapid depletion could result in extremely cold oxygen flowing to the mask.

Supply Lever. The supply lever (figure 4-15), painted green, is on the oxygen regulator panel. The lever has two positions, ON and OFF and is used to control the supply of oxygen at the panel.

Pressure Gage and Flow Indicator. The pressure gage and flow indicator (figure 4-15) are on the oxygen regulator control panel. The pressure gage shows oxygen system pressure. The flow indicator (blinker) consists of an oblong opening in the face of the regulator panel which shows black and white alternately during the breathing cycle.

Figure 4-15

EMERGENCY OXYGEN SUPPLY.

An emergency supply of oxygen, for use in the event of failure of the normal supply system, or for high altitude ejection, is stored in two bottles (cylinders) in the survival kit. The emergency oxygen supply from these bottles goes through the manifold assembly which incorporates a pressure reducer for the emergency system. The emergency supply system is actuated automatically, during ejection, or manually, whenever desired. Upon ejection, the movement of the seat creates a force which triggers the disconnect mechanism, separating the seat, survival kit, and associated oxygen equipment from the normal oxygen supply line. Simultaneously, the emergency oxygen pressure-reducer valve in the manifold assembly is opened, allowing the emergency oxygen supply to flow through this reducer-valve (where pressure is reduced from 1800 psi to 70 psi), and into the regulator. If the emergency bottles are fully serviced (1800 psi), they will provide the pilot with a regulated supply of oxygen for pressure suit, as well as breathing, for a minimum of twelve minutes. The emergency oxygen supply is actuated manually by pulling a green ball handle connected to the right aft corner of the survival kit. The emergency pressure-reducer valve is then opened by a cable attached to the ball handle. Oxygen pressure in the emergency bottles can be determined by means of a pressure gage attached to the manifold assembly in the survival kit. This gage is visible through a window on top of the rear section of the kit.

Note

When using the diluter demand system and A-13A oxygen mask, the only emergency oxygen supply available is from a bail-out bottle attached to the parachute.

Oxygen Hose Attachment.

Proper attachment of the oxygen mask connector tie-down strap is extremely important to assure that:

a. The oxygen hose does not become accidentally disconnected during flight resulting in loss of oxygen supply to the pilot.

b. The oxygen hose does not prevent quick separation from the seat during ejection.

c. The oxygen hose does not flail during ejection causing pilot injury.

d. The tie-down strap does not accidentally open the parachute chest strap snap during ejection.

The following procedures shall be observed:

1. Attach oxygen mask hose (male connector) to parachute chest strap by wrapping the mask connector tie-down strap underneath and up behind the chest strap twice, as close to the chest strap snap as posisble, and then snapping it.

WARNING

- Failure to double loop the connector tie-down strap around the parachute chest strap may permit the tie-down strap to slip into and open the chest strap snap during ejection.
- Do not wrap the tie-down strap around the chest strap snap.

2. Connect the mask-to-regulator tubing female disconnect to the mask male connector. Listen for the click and visually check that sealing gasket is only half exposed.

3. Attach the alligator clip to the tie-down strap as close to the chest strap snap as possible.

WARNING

Do not attach alligator clip to the parachute harness as this may prevent quick separation from the seat during ejection. The force required to pull the clip loose from the parachute harness is considerably greater than from the tie-down strap.

OXYGEN SYSTEM PRE-FLIGHT CHECK.

Pressure Suit.

1. Diluter demand supply lever—OFF (both cockpits).

WARNING

- Be sure the diluter demand supply lever is OFF in both cockpits when the regulator is not to be used. If the supply lever is left ON in either cockpit when not being used, the regulator can automatically go to positive pressure should cockpit altitude exceed 25,000 feet. This will result in rapid depletion of the oxygen supply.
- Before solo flights, both the diluter demand supply lever and the survival kit oxygen supply lever in the aft cockpit should be OFF.

2. Oxygen pressure gage—300 (+15, —5 psi).

3. Liquid oxygen quantity gage—9-10 liters.

4. Quick disconnect—Secure, lanyard attached to airplane structure.

5. Manual disconnect knob on forward part of seat back—Locked (pin holes forward). (Downward ejection aircraft only.)

6. Automatic emergency oxygen actuator cable—Attached to right knee guahrd. (Downward ejection aircraft only.)

7. Survival kit emergency oxygen pressure—1800 psi—Check through window in aft section of kit.

8. Check that survival kit cover and straps are connected to lower part of kit.

9. Check security and connection of fittings and hoses at right aft corner of kit.

10. Check between sides of seat and kit for obstructions.

11. Connect and lock kit straps to parachute harness.

12. Attach and lock oxygen and radio connections.

13. Pressure suit oxygen supply valve lever—ON.

14. Press-to-test button—Depress and note positive pressure to suit and face plate.

Note

All connections and checks should be made with the assistance of a personal equipment man.

Diluter Demand.

1. Pressure suit oxygen supply valve levers—OFF (both cockpits).

2. Oxygen pressure—300 (+15, —5).

3. Liquid oxygen quantity gage—9-10 liters minimum.

4. Check oxygen regulator with diluter lever first at NORMAL and then at 100% as follows: Blow gently into end of oxygen regulator hose as during normal exhalation. There should be resistance to blowing. Little or no resistance to blowing indicates a leak or faulty operation.

5. With diluter demand supply lever ON, oxygen mask connected to regulator, and diluter lever at 100%, breathe normally into mask and conduct following checks:

a. Observe flow indicator for proper operation.

b. Deflect emergency lever to EMERGENCY.

A positive pressure should be supplied to the mask. Hold breath to determine whether there is leakage around mask. Return emergency lever to NORMAL position. Positive pressure should cease.

6. Return diluter lever to NORMAL.

Note

All connections and checks should be made with the assistance of qualified personnel.

NORMAL OPERATION OF THE OXYGEN SYSTEM.

Pressure Suit.

1. Oxygen quantity indicators—9-10 liters.

2. Oxygen pressure gages—300 (+15, —5 psi).

3. Pressure suit oxygen supply valve levers—ON.

4. Diluter demand supply levers—OFF (both cockpits).

WARNING

If flight is to be solo, make sure that the survival kit and diluter demand supply levers in the aft cockpit are OFF.

Diluter Demand.

1. Oxygen pressure gage—300 (+15, —5 psi).

2. Liquid oxygen quantity gage—9-10 liters.

3. Pressure suit oxygen supply valve levers—OFF (both cockpits).

4. Diluter demand supply levers—ON. (Occupied cockpit only).

5. Diluter lever—NORMAL.

6. Emergency lever—NORMAL.

EMERGENCY OPERATION OF THE OXYGEN SYSTEM.

Pressure Suit.

Whenever symptoms of hypoxia are noted, or if it is known that the normal oxygen system has failed, proceed as follows:

1. Manual emergency oxygen supply actuator (green ball)—Pull.

2. Descend to an altitude where oxygen is not required.

J-4 DIRECTIONAL INDICATORS AND CONTROL PANEL

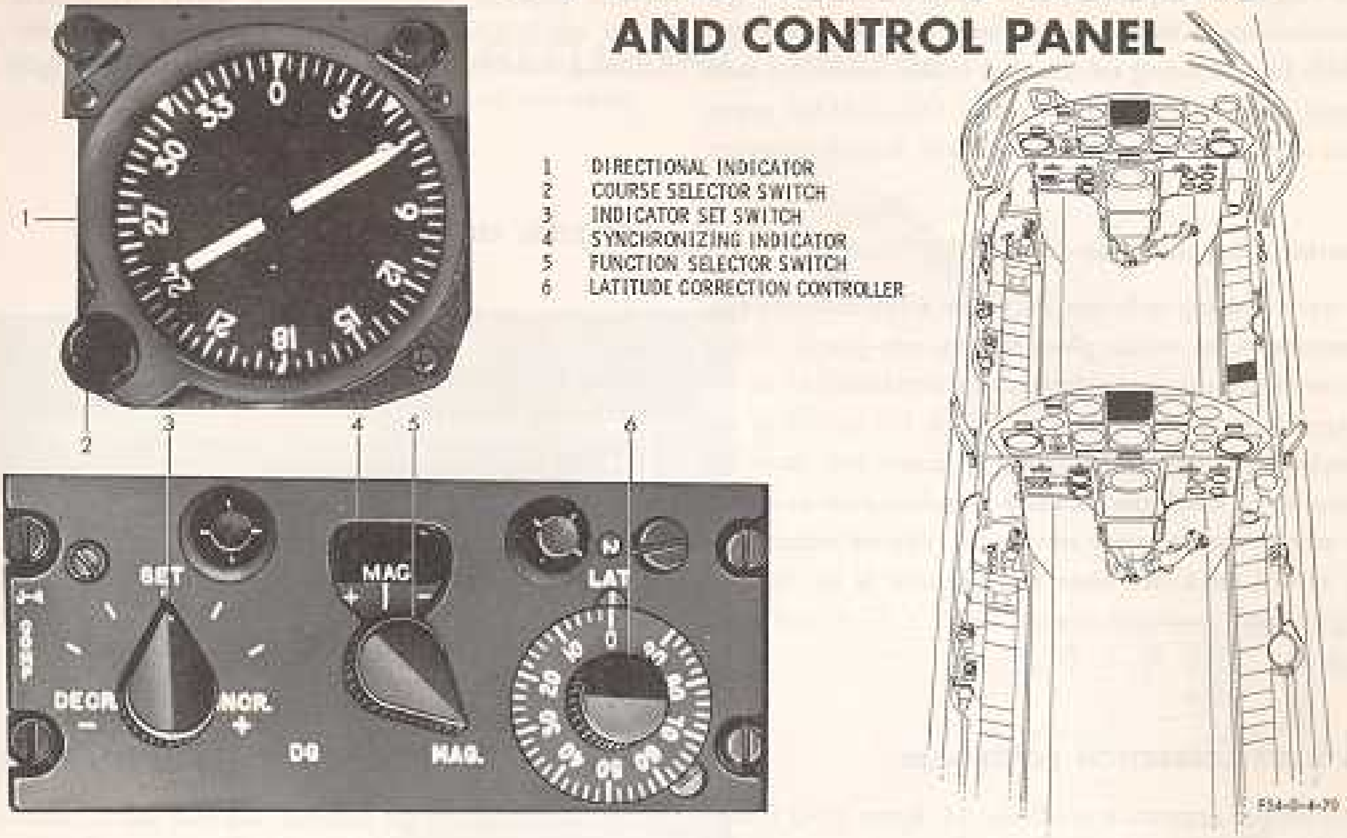


Figure 4-16

Diluter Demand.

1. Move diluter lever to 100%.
2. Push emergency lever to EMERGENCY.
3. If oxygen regulator becomes inoperative, pull the green ball handle on bail-out bottle to actuate the emergency oxygen supply.
4. Descend to an altitude where oxygen is not required.

NAVIGATION EQUIPMENT.

J-4 DIRECTIONAL INDICATOR SYSTEM.

The J-4 directional indicator system is designed to provide the pilot with a directional reference by operating either as a directional gyro or a slaved gyro magnetic compass. The control panel in the forward cockpit only (figure 4-16), contains all of the controls necessary for proper operation of the system under all conditions. The system requires 28-volt d.c. from the emergency bus, as well as instrument a.c. bus power, for normal operation.

FUNCTION SELECTOR SWITCH.

A function selector switch (5, figure 4-16) is provided to select the mode of operation of the directional indicator system. When this switch is in the MAG. position, the system will operate as a normal slaved gyro magnetic compass, and the directional indicators will respond accordingly. Placing the function selector switch to the DG position causes the compass to operate as a directional gyro. This mode of operation is designed for use in the polar regions where the earth's magnetic field causes the slaved gyro magnetic compass to be very unreliable. If it is deemed necessary, the system can be sent into a fast slaving cycle by moving the function selector switch from MAG to DG and back to MAG. The gyro will then be erected, and any large errors in the system eliminated very rapidly.

INDICATOR SET SWITCH.

The indicator set switch (3, figure 4-16) is used during the magnetic compass mode of operation to effect synchronization of the compass system and the transmitter which feeds heading information to the directional indicator. This control is used during DG or MAG operation to position the transmitter to any desired reference.

Synchronizing Indicator.

A synchronizing indicator (4, figure 4-16) indicates synchronization to within plus or minus one-quarter degree between the compass system and the transmitter in the magnetic mode of operation. When the system is not synchronized the synchronizing indicator will show the direction in which the indicator set switch must be turned to achieve the necessary correction. The set switch must be turned clockwise when the indicator is in the (+) region and counterclockwise when a (—) indication appears.

LATITUDE CORRECTION CONTROLLER.

The latitude correction controller (6, figure 4-16) is used in the DG mode of compass operation to correct for the apparent drift of the directional gyro due to the earth's rotation. Latitude corrections are made in a clockwise direction in the Northern Hemisphere and counterclockwise in the Southern Hemisphere.

DIRECTIONAL INDICATOR AND COURSE SELECTOR KNOB.

The directional indicators (1, figure 4-16) on the instrument panel in each cockpit receive heading information from the compass system and give the pilot visual indication of compass heading by means of an indicator pointer and a compass card. Any desired course may be placed under the index at the top of the indicator by turning the course selector knob at the lower left corner of the indicator (2, figure 4-16).

ARMAMENT EQUIPMENT.

Refer to Confidential Supplement, T. O. 1F-104D-1A.

PRESSURE REFUELING SYSTEM.

(AF Serials 57-1329 and subsequent.)

The pressure refueling system makes it possible to fill all internal fuel cells and external fuel tanks on the ground by single-point refueling and in flight by probe-and-drogue refueling.

GROUND REFUELING.

Single-point Refueling.

The internal fuel cells and external fuel tanks are normally filled by using the single-point refueling system. The internal fuel cells can be filled in about 3 minutes, the internal fuel cells and external fuel tanks in about 5 minutes. The single-point refueling receptacle is located on the left side of the fuselage, forward of the intake ducts. When the air refueling probe is installed, a special fitting must be used to adapt the ground refueling hose to the probe nozzle. Cell mounted, dual fuel level control valves automatically shut off fuel to the internal fuel cells as they become full. Precheck test switches are provided to assure proper operation of these valves. An electrical external power source should be connected, and the external tank fuel and air refueling selector switch placed in the A/R position. A refueling valve is provided for each set of external fuel tanks. Float switches, located in each tank, close the respective refueling valve as soon as either tip tank or pylon tank becomes full.

Fuel Level Control Valve Selector Switches and External Tanks Refuel Selector Switch. A refueling precheck switch panel (figure 1-39) located forward and below the single-point refueling receptacle, contains four switches used for selecting the external tanks to be refueled and to check the internal cells dual fuel level control valves for proper operation. These switches are powered from the d.c. monitored bus. The external tanks refuel selector switch is labeled TIP, PYLON and BOTH and is guarded to the BOTH position. The auxiliary cell and forward main cell precheck switches are for maintenance personnel use only. The master precheck switch is labeled PRIMARY and SECONDARY and is used to test the primary and secondary operation of the dual fuel level control valves. This switch is spring loaded to the center OFF position. During the first few seconds of refueling the master precheck switch should

AIR REFUELING PROBE

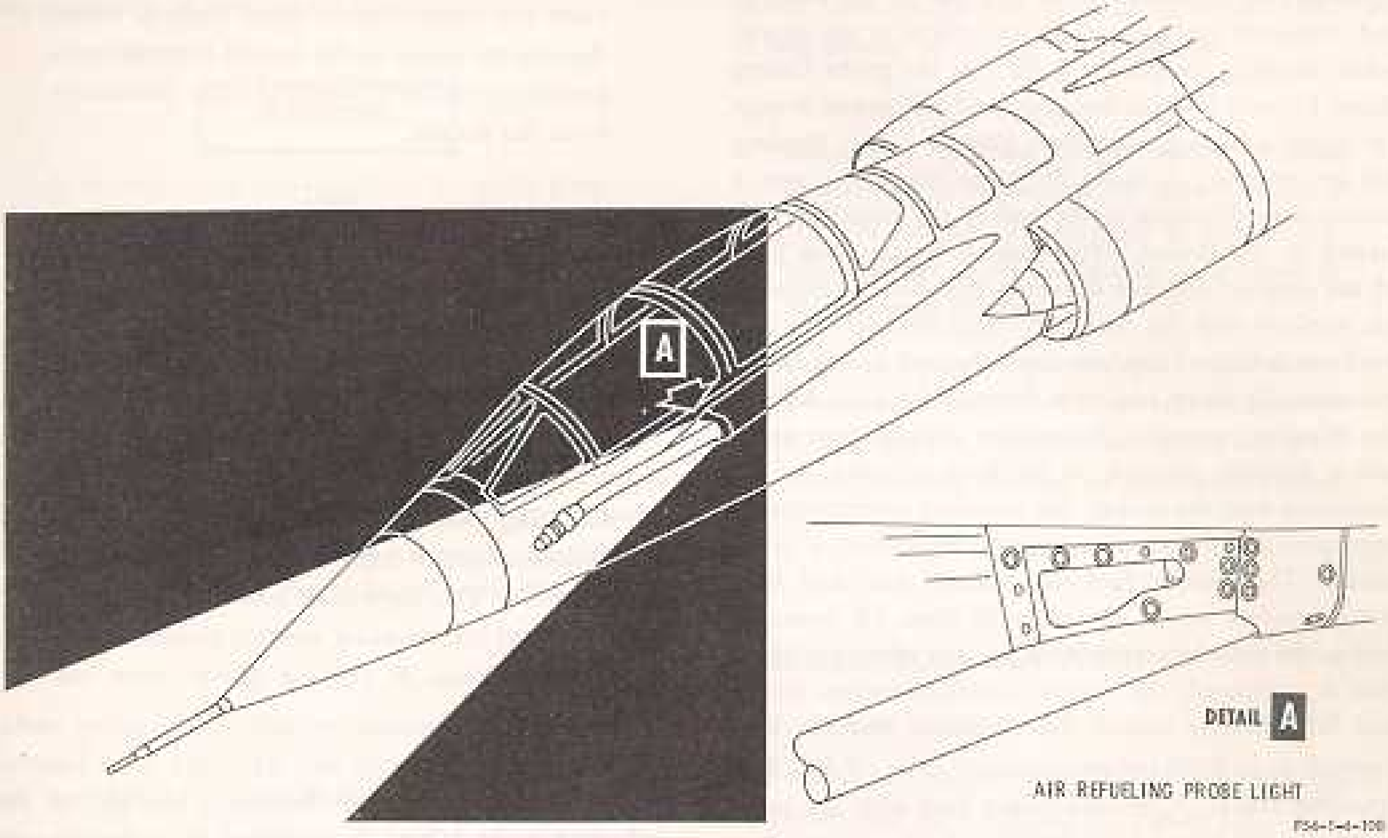


Figure 4-29

be placed first to the PRIMARY, and then to the SECONDARY position to check that the dual fuel level control valves close. Satisfactory valve operation is indicated by the shut-off of fuel flow causing gradual stiffening of the refueling hose after the switch is moved to each position. A more positive indication of fuel shut-off, however, can be obtained by checking the counter on the ground refueling equipment. There is approximately a 10 second delay between the time the switch is activated and the shut-off of fuel. If fuel flow continues, pressure refueling must be stopped immediately to prevent possible fuel cell rupture or airframe damage, and this fact entered in Form 781. If necessary, the aircraft can then be refueled by the Alternate Refueling Method. The cover plate for the switches, when in place, assures that the external tanks refuel selector switch guard is in position.

WARNING

If the pressure refueling system is not operating properly, air refueling should not be attempted.

Alternate Refueling Method.

When single-point refueling cannot be used, the aircraft can be refueled in the conventional manner. Two filler wells (figure 1-39), are provided for refueling the internal fuel cells and individual filler wells are provided for refueling the pylon tanks. Two filler wells are provided for each tip tank. Both must be used to fully refuel both compartments of each tip tank.

AIR REFUELING.

Air refueling permits all internal fuel cells and external fuel tanks to be filled from a tanker aircraft by means of probe-and-drogue type refueling equipment. The probe, which consists of a boom and nozzle, is a detachable unit mounted on the left side of the fuselage and connected through an adapter elbow to the single-point refueling receptacle. A light at the probe fairing shines forward to light the probe and the tanker drogue for night refueling operations (figure 4-17). Hookup for air refueling is made by flying the probe into a conical-shaped drogue at the end of the refueling hose trailed by the tanker. After making contact, the pilot of the receiver airplane decreases the distance between his airplane and the tanker by approximately 10 feet until rewinding of the hose onto the reel in the tanker automatically starts fuel flow through the hose. During the refueling operation, the receiver airplane must maintain a position forward of the hookup point and fly formation with the tanker. Air refueling is completed in approximately 5 minutes when maximum fuel is taken aboard. The internal fuel cells contain dual fuel level control valves which automatically shut off incoming fuel as the cells become full. When the refueling operation is completed, the receiver airplane reduces power and falls directly behind the tanker so that the hose unwinds to its limit and automatically shuts off fuel flow from the tanker. When the tanker hose reels out to its limiting stop, the probe pulls from the drogue. Contact may be broken by the receiver airplane at any time during the refueling operation by reducing power and dropping aft.

Air Refueling Controls and Indicators.

External Tank Fuel and Air Refueling Selector Switch.

The OFF and A/R positions of this switch (figure 1-20) control the fail-open solenoid-operated tip and pylon tank refueling valves and pressurization of the external fuel tanks. The OFF position closes the refueling valves allowing the external tanks to pressurize and feed as selected. The A/R position opens the refueling valves, shuts off and dumps external tank air pressure allowing the tanks to be refueled. If external tanks are to be air refueled, the air refueling switch must be moved to A/R just prior to hookup. The switch need not be used to air refuel internal fuel cells only.

CAUTION

Since positioning the external tank fuel and air refueling selector switch to the A/R position dumps external tank air pressure and prevents the external tanks from feeding, return the selector switch to the desired external tanks position as soon as possible after breakaway from the drogue.

Note

In the event of d.c. monitored bus failure, the fail-open tip and pylon tank refueling valves will allow the external tanks to be air refueled. However, external tank air pressure will not be shut off or dumped, and refueling time will be increased considerably.

Air Refueling Indicator Light. A push to test air refueling indicator light is located on the fuel control panel (figure 1-20). This light illuminates when the external tank fuel and air refueling selector switch is placed in the A/R position. It receives power from the d.c. monitored bus.

Air Refueling Probe Light Switch. The light on the refueling probe fairing is controlled by a rheostat-type switch on the right console (8, figure 1-9). The switch is powered by the No. 2 a.c. bus and increases the intensity of the air refueling probe light as it is rotated clockwise.

Air Refueling Procedure.

Success of the air refueling operation depends upon pilot proficiency, atmospheric conditions (visibility, turbulence, etc.), stability of the tanker and drogue, and loading of the receiver airplane. With a clean airplane, satisfactory air refueling from a KB-50J, should be made with take-off flaps, at a recommended altitude of 20,000 feet and at the maximum speed of the tanker, which is 230 knots IAS. If external tanks are to be air refueled, place the external tank fuel and air refueling selector switch to the A/R position prior to hookup. When the hose is fully extended from the tanker, a yellow light will illuminate in the tanker hose-reel pod. This indicates to the receiver that the hookup should be started. Tests show that the optimum technique for hookup is for the receiver aircraft to accelerate into contact from a point about 10 to 12 feet directly aft of the drogue. (Closing very slowly on the drogue and chasing it through its oscillation reduces the possibility of a successful hookup.)

CAUTION

It is imperative that hookups be made from a position directly aft of the drogue to prevent drogue whipping and possible damage to the radome or pitot boom.

The speed and altitude of the receiver airplane should be stabilized so that position is maintained without large longitudinal or directional control movements. When the airplane is stabilized, a straight, forward acceleration gives the best probability of successful hookup.

After hookup, the receiver airplane must be flown forward until about 10 feet of hose has rewound on the reel in the tanker. When this occurs, the yellow signal light on the tanker hose reel pod goes out and a green light illuminates to indicate that fuel transfer will start if the probe is fully engaged in the drogue. Control of the airplane after hookup is not difficult. The receiver airplane takes on the extra drag of the drogue, and right aileron must be held to maintain position. This stick pressure can be trimmed out. Relatively large movements are needed to obtain good airplane response at the necessarily low airspeed during the refueling operation.

Note

If hookups are performed at lower than recommended speeds, some stick shaker action may be encountered. This shaker action is usually a function of rate input and occurs just at contact with the drogue.

When refueling is completed, breakaway is made by slowly dropping aft of the tanker until the hose has reeled out its full length. As the hose reel hits the stops, fuel flow is automatically cut off, and as the receiver airplane continues to drop back, the probe is pulled from the drogue. In breaking contact, back out of engagement as straight aft as possible.

Note

- Breakaway from the drogue should be made directly aft or slightly to the right and below the trail position of the drogue to prevent possible damage to the radome or pitot boom by the whipping drogue.
- Contacts on the wing tip drogues of the tanker present less trouble than contacts at the fuselage drogue position, because there is less of the receiver airplane exposed to turbulence created by the tanker.

MISCELLANEOUS EQUIPMENT.

ANTI-G SUIT EQUIPMENT.

The anti-G suit equipment consists of a pressure regulating valve and valve control (2, figure 1-8 and 3, figure 1-10) on the left console of each cockpit and a pressure hose leading from the valve outlets, through the quick disconnects on the left rear of the seats, to the pilots' anti-G suit tube. When this tube is connected to the pressure hose, air from the engine compressor will flow into the pilots' anti-G suit under pressure which will vary in accordance with valve control setting and aircraft G forces. When the valve control is in the LOW position, the valve will open at 1.7 G, and the suit pressurization will increase at a rate of 1.0 psi for each additional G force. With the valve control in the HI position, suit pressurization begins at 1.5 G and increases at a rate of 1.5 psi per G. A button on top of the valve control can be manually depressed to inflate the anti-G suit when desired. This feature may be used to produce a massaging effect which will help to reduce fatigue during prolonged flight.

VENTILATED SUIT BLOWER.

A blower supplies cooling air to the pilots' ventilated suits. Flexible ducting carries the cool air from the blower to the suit through a quick disconnect on the left side of each seat. The blower derives electrical power from the No. 2 a.c. bus.

Ventilated Suit Blower Switch.

A two position switch (12, figure 1-9) located on the right console in the forward cockpit and powered from the No. 2 a.c. bus may be used to energize the ventilated suit blower. The switch positions are labeled ON and OFF.

REAR VIEW MIRROR.

Four adjustable rear view mirrors are installed, one on each side of the forward canopy and one on each side of the aft canopy frame.

COMPUTERS.

A manually operated computer (7, figure 1-9 and 8, figure 1-11) located above the right console in each cockpit is provided to aid the pilot in solving navigational problems. The computer is mounted on a swivel arm so that it may be used whenever necessary and stowed underneath the canopy sill when not in use. Both sides of the computer face may be used to solve problems, and the computer itself is constructed in such a manner as to be completely operable with one hand.

NOTE

For Sections V and VI refer to Confidential Supplement, T. O. 1F-104D-1A

systems operation

SECTION VII

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COMPRESSOR AND VARIABLE STATOR OPERATION.

To understand the J79 engine it is important that the operator understand the need for the variable IGV and stator system. In order to optimize subsonic cruise performance in supersonic engines a high pressure ratio compressor is desirable. High pressure ratio compressor can be designed to operate efficiently in only one speed range without incorporating some type of compensating device. This can be accomplished by several methods, most predominant of which are the dual compressor system or the variable stator system as used in the J79 engine. The J79 was designed for maximum operating efficiency at the higher RPM settings. With a fixed guide vane position, the higher the rpm of the engine the lower the effective angle of attack of the compressor blades and conversely as the rpm is reduced the effective angle of attack is increased to the point that blade stall will occur the same as an airplane wing will stall when its critical angle of attack is exceeded. The variable IGV and stator system was designed into the J79 engine to allow stall free operation throughout the entire speed range. As rpm is reduced from Military the IGV's and variable stators (hereafter referred to only as IGV's) will start to close and track closed as a function of rpm at any given air inlet temperature. At sea level standard day conditions the IGV's will be fully open above 93% rpm and below 93% they will track as a function of rpm to the closed position, reaching the closed position at 73% rpm. The IGV's track through a total of 35 degrees of travel from open to closed. The closing of the IGV's avoids the stall area by directing airflow against the compressor blades at an angle below critical as rpm is varied. In addition, total air flow through the compressor is reduced as rpm decreases and the IGV's shift toward closed, relieving the load on the rear stages of the compressor, thereby avoiding compressor stalls. The IGV control senses compressor inlet temperature (CIT) as well as physical rpm of the engine. The IGV schedule follows a constant slope as a function of engine rpm, however the slope is shifted as a result of CIT. At higher CIT values the IGV's will start to close at a higher indicated rpm and conversely will start to close at a lower rpm when the CIT is below standard.

CORRECTED RPM.

When dealing with the J79 engine the term "corrected rpm" is often encountered. This term needs clarification to further understand the operation of the J79. The pumping characteristics of the compressor are affected by the temperature of the air entering the compressor since temperature affects the density. An increase in CIT is effectively the same as a reduction in rpm as far as the compressor is concerned and conversely a decrease in CIT is effectively the same as an increase in rpm. To maintain a constant mass flow of air through the engine the physical rpm must be varied inversely as a function of compressor inlet temperature. As an example, 100% indicated rpm with a 15° C inlet temperature is 100% "corrected rpm." 100% indicated rpm with an inlet temperature at 95° C corrects to an effective or "corrected rpm" of 88.5% while 100% indicated rpm at —28° C is a corrected rpm of 108.6%.

ENGINE SPEED CONTROL FEATURES.

In addition to its normal governing functions, the engine fuel control unit senses CIT which is integrated with the rpm signal and a "corrected rpm" is computed mechanically within the unit. This intelligence is used to vary the IGV angle and limits corrected engine rpm to a preset maximum.

HIGH CORRECT RPM AND RPM CUTBACK.

With a set rpm of 100% physical speed, the "corrected rpm" increases as CIT decreases. At approximately —12° C, 100% indicated rpm is equal to 105% corrected speed which is the limit of the engine. At this point the engine fuel control unit will limit fuel flow to the engine, thereby reducing physical speed to maintain a "corrected rpm" of approximately 105%. The reduction in rpm as the aircraft climbs into colder ambient air conditions is not an rpm "droop" as was prevalent with earlier jet engines, but rather is a scheduled reduction in physical rpm to maintain "corrected rpm" within limits. Refer to 7-1.

LOW CORRECTED RPM AND T_2 RESET.

As CIT is increased, the "corrected rpm" decreases and would decrease to the point where a low corrected speed stall would be encountered if no compensating action were taken. The IGV schedule is designed to follow corrected engine speed and will close to provide stall margin. Increasing physical engine rpm also increases corrected speed for an increased stall margin and at the same time increases the maximum available thrust. This increase in rpm to a maximum of 103.5 ± .5% indicated is referred to as T_2 reset. T_2 reset is initiated at approximately 92° C CIT. Indicated rpm will increase from 100% at 92° C to 104% at CIT's of 105° C or above. The flight idle fuel flow schedule is also raised as a function of CIT, flight idle rpm is the same as maximum rpm at 92° C and above. A throttle "chop" below MILITARY will not produce a reduction in rpm. This feature was incorporated to prevent sudden reduction in rpm at high Mach numbers which would decrease engine air flow, thereby causing duct buzz. Refer to figure 7-1.

CDP LIMITER.

At low altitude when the maximum airspeed region of the airplane is approached, compressor inlet pressure is drastically increased. Compressor discharge pressure (CDP) approaches the maximum value permitted by the physical strength of the engine components. A CDP limiter is incorporated in the engine fuel control unit which senses CDP and reduces fuel flow to the engine allowing rpm to decrease when the maximum CDP limit is attained.

CIT SENSOR.

Compressor inlet temperature (CIT) is sensed by a capillary tube located in the lower left hand side of the compressor inlet. This capillary unit transmits a signal to the engine fuel control unit. This intelligence reacts on internal portions of the fuel controller and modifies IGV and fuel flow schedules as a function of CIT.

IGV RESET SWITCH.

Since failures of the CIT sensing system could occur due to breakage of the capillary tube and resultant loss of fluid, an IGV reset switch has been incorporated as an emergency device. Loss of the capillary fluid would result in the CIT sensor giving a —65° F signal to the fuel control. This would schedule the IGV's further open than required in the intermediate speed range and would produce engine stalls when the throttle is retarded. Should the CIT sensor fail, and schedule the IGV's to the —65° F point, the IGV reset switch may be activated to introduce a false signal (by electrical means) to the engine fuel control unit corresponding to an inlet temperature of +150° F. When CIT is below this value the IGV's will be operating further closed than required which will result in increased stall

T_2 RESET AND CUTBACK VS ENGINE SPEED

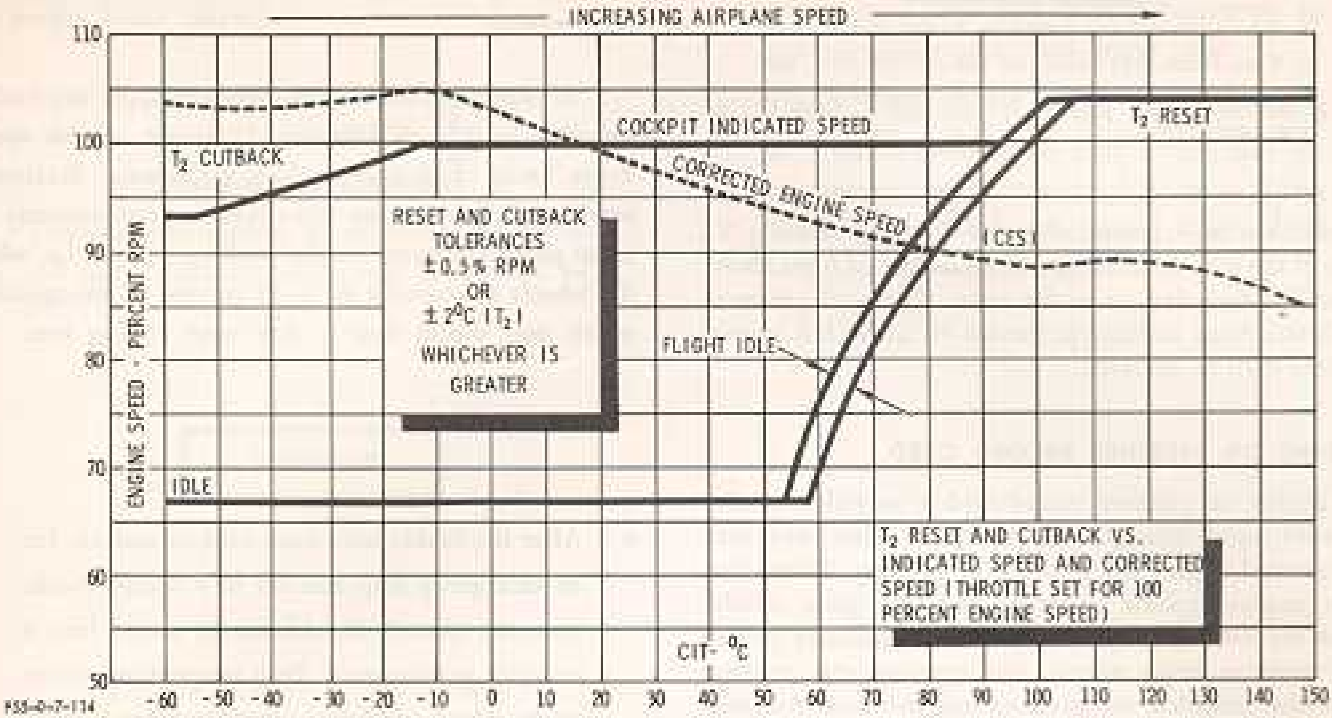

Figure 7-1

margin. It must be stressed that the IGV's do not go to a fixed position when this switch is activated, but rather, follow the same schedule rpm as they would with normal operation with an inlet temperature of +150° F.

ENGINE COMPRESSOR STALLS.

Engine compressor stalls can be caused by various factors such as: engine fuel control malfunction, IGV mis-rigging, CIT sensor cold shift or afterburner surging. Primarily, there are two types of engine compressor stalls, both of which are relatively easy to recognize. One type is most commonly associated with high Mach number flight and is characterized by loud banging and chugging sounds which are definitely noticeable in the cockpit. This type of stall can be eliminated by retarding the throttle below MILITARY. The second type of stall normally associated with subsonic flight is not violent and the only pilot sensation is a mild "rumble" which can be felt through the "seat of the pants" plus a noticeable loss of thrust. Engine instruments will indicate a drop in rpm to 70% - 80% (this rpm range is characteristic of the J79 engine in stall). EGT will slowly rise to a value which may remain within limits but will be higher than normal for the indicated rpm. Throttle manipulation will not produce any thrust variation. A throttle advance may produce an increase in intensity of the "rumble" which the pilot can feel, or an increase in EGT. Refer to Section III for Stall Clearing procedures.

ENGINE OIL PRESSURE.

When a new engine is first run-up or when a pilot is exposed to an engine for the first time the characteristic readings of the various engine operating instruments should be noted. This will assist in quickly recognizing a malfunction so that quick remedial action can be taken. Engine oil pressure can be a good indicator of incipient engine malfunction. The important thing is to notice a difference in the oil pressure reading, for a given rpm, from the value that was considered normal up to this time. The normal engine oil pressure for each engine-airplane combination is stated on the engine oil pressure record card installed in each cockpit. If during pre-flight engine check at Military Thrust, the indicated oil pressure varies within limits (± 5 psi) from the normal pressure stated on the record card, use the indicated pressure observed during the Military Thrust check as the normal oil pressure in lieu of the pressure stated on the record card.

CAUTION

If the indicated oil pressure varies more than ± 5 psi from that listed on the record card, the flight should be aborted and an engine inspection performed.

An oil pressure increase of approximately 6 psi above normal can be expected with full T_5 reset. During T_5 reset if the maximum oil pressure increase of 6 psi above normal is exceeded, or in the event of low oil pressure, the instructions outlined in Section III under Oil System Failure shall be observed.

ENGINE OIL PRESSURE RECORD CARD.

An engine oil pressure record card is provided on the forward right side of both cockpits. This card lists the normal engine oil pressure at Military Thrust for each engine-airplane combination. The pilot should check his stabilized engine oil pressure at Military Thrust just prior to brake release and compare this reading with the recorded oil pressure on the card for this power setting. If the indicated oil pressure varies more than ±5 psi from that listed on the card, the flight should be aborted.

USE OF LANDING WHEEL BRAKES.

Although the following general rules apply to all airplanes, they become increasingly important with high landing speeds:

1. Avoid unnecessary use of brakes.

2. Utilize aerodynamic braking as much as possible commensurate with safety. Leave all high drag items out until just prior to wheel braking.

3. Allow time for brakes to cool between applications, 15 minutes between landings when landing gear remains extended in slipstream, or 30 minutes if it is retracted.

4. Braking efficiency is proportional to the weight on the wheels.

CAUTION

- If one wheel is locked the tire will skid and the aircraft will veer noticeably in the opposite direction. Increased pressure on that brake will have no effect. Release both brakes, then reapply more smoothly.
- Do not retract the wing flaps to get heavier braking action as this restricts nose-wheel steering.

5. If maximum braking is necessary apply the brakes smoothly and with increasing pressure as the speed drops, being careful not to lock the wheels. Maximum braking efficiency occurs when there is approximately 15 to 20 percent slippage on the braking surface, i.e. when the wheels are turning 80 to 85 percent of the speed at which they would turn if they were rolling free.

CAUTION

- After the brakes have been used excessively for an emergency stop and are in a heated condition, the aircraft should not be taxied into a crowded parking area. Peak temperatures occur in the wheel and brake assembly from 5 to 15 minutes after a maximum braking operation. To prevent brake fire and possible wheel assembly explosion, the specified procedures for cooling brakes should be followed.
- A wheel once locked before the full weight of the aircraft is on the gear immediately after touchdown, will not become unlocked as the load is increased as long as brake pressure is maintained. Optimum braking action cannot be expected until the tires are carrying heavy loads.

AUTO-PITCH CONTROL SYSTEM.

There is a possibility of flying through stick shaker action and inadvertently overpowering the auto-pitch control system. Although activation of the auto-pitch control system is easily detected during slow to moderate control stick input rates, it is possible that the system may be activated and inadvertently overpowered during high control stick input rates. This condition may be aggravated during flight in rough air or buffeting or during "follow-through" training maneuvers where both pilots are holding the control sticks. Modifications to the system will be made to increase the force of the auto-pitch control system so that it will be comparable to earlier F-104 aircraft.

WARNING

- Pending modifications to increase the force of the auto-pitch control system, pilots must be extra observant when operating in those areas approaching activation of the auto-pitch control system, especially during maneuvers requiring high control stick input rates.
- Under conditions of rough air or buffeting or when applying high stick forces, stall approaches must be terminated at stick shaker action or the minimum control speeds listed in figure 6-2, whichever occurs first.

Section VIII
CREW DUTIES

Not Applicable To This Airplane

all-weather operation

SECTION IX

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INSTRUMENT FLIGHT PROCEDURES

These procedures and techniques pertain primarily to instrument flight conditions and are in addition to normal procedures. This data is based on normal gross weight. Because navigation facilities and terrain features vary at each base, this information is intended to serve as a guide to commanders in establishing instrument flight procedures. This airplane is capable of supersonic speeds during instrument flight conditions. Because of the distance covered in a short period of time and the wide variety of weather conditions which may be encountered on a single mission, conscientious preflight planning is of paramount importance. Fuel requirements for completion of instrument letdown, approach procedures and possible diversions to alternate bases are much greater than for VFR flights and must have special emphasis in preflight planning. The airplane has immediate and positive control response during any phase of instrument flight. Only essential navigation equipment is installed since ground controlled guidance replaces some of the more conventional navigation aids. The UHF radio is adequate for air-to-air and air-to-ground communications. With existing equipment, three types of instrument approaches may be accomplished: RADAR, VOR and ILS.

INSTRUMENT TAKE-OFF.

An instrument take-off is essentially the same as a normal VFR take-off, and may be made at either Military or Maximum Thrust. Maximum Thrust take-offs have the advantage of a shorter take-off roll.

1. Before taking the runway:

   (1) Engine anti-ice as required.

   (2) Set desired track on course indicator.

   (3) IFF (SIF) to desired position.

   (4) Pitot heat on.

2. After aligning the aircraft with the runway:

   (1) Set directional indicator on runway heading.

   (2) Set attitude indicator 5 degrees nose down.

   (3) Make required engine checks.

   (4) Let engine stabilize at MILITARY.

   (5) Nose wheel steering — Engage.

   (6) Release brakes; light afterburner if desired.

   (7) Use nose wheel steering as necessary for directional control.

   (8) At nose wheel lift off speed, rotate aircraft to a 0 degree pitch attitude.

   (9) As fly off speed is approached, rotate aircraft to 8 degrees nose high pitch attitude.

   (10) Move landing gear lever to UP when definitely airborne.

Note

If the landing gear lever is not moved to the UP position until a climb is indicated on the altimeter and vertical velocity indicator, maximum transient gear speed will be exceeded before the gear is fully retracted.

   (11) Flaps up at 240 knots IAS.

INSTRUMENT CLIMB.

1. Hold 8 degrees nose high pitch attitude until climb schedule airspeed is attained.

Note

If an afterburner take-off was made and a Military Thrust climb is desired, the afterburner may be shut off any time between reaching a safe altitude and intercepting the climb schedule airspeed.

2. Adjust pitch to maintain desired climb speed. For afterburner climbs, pitch will vary between 35 degrees and 50 degrees nose up on attitude indicator.

WARNING

When turns are made during afterburner climb the nose of the aircraft will tend to inscribe an arc which will not be parallel to the horizon, but will be one of increasing pitch attitude. Therefore care should be exercised to use less than normal back pressure in order to maintain the desired pitch attitude. Do not exceed 30 degrees of bank in this climb.

INSTRUMENT CRUISING FLIGHT.

Handling characteristics are such that supersonic instrument cruise flight is possible. Refer to Section VI for level flight characteristics at high speeds. For ease and precision of flight, limit all turns to 30° bank angles.

Note

Expect a momentary indication of a turn opposite to the direction of the bank when originating a turn.

HOLDING.

The following configuration provides minimum fuel consumption as well as optimum stability for formation flights:

1. Flaps — TAKE-OFF.

2. AIRSPEED — 260 knots IAS.

Altitude	*Approx. Fuel Flow*	*Approx. Rpm*
30,000	2300 lb/hr	86%
20,000	2500 lb/hr	85%

Note

Bank angle should not exceed 30 degrees and power should be added when making turns to maintain desired airspeed.

JET PENETRATION.

Several engine and airframe considerations must be made when performing descents. Icing of the inlet guide vanes is most probable at 82% rpm or below, due to inadequate airflow for anti-icing. Therefore, maintain a minimum of 85% rpm when descending in possible icing conditions.

Jet Penetration Procedures.

The following procedures are recommended for jet penetrations.

When approaching the radio fix at initial penetration altitude:

1. Throttle — Adjust to 85% rpm.
2. Pitot heat switch — ON.
3. Engine anti-ice switch — ON.
4. Canopy defrost lever — INCR.

When over the radio fix:

1. Speed brakes switch — OUT.
2. Wing flap lever — TAKE-OFF.
3. Pitch attitude — adjust to maintain 275 knots IAS. (10° to 14° nose down.)

When 1000 feet above desired level-off altitude:

1. Speed brakes — IN.

Note

The average rate of descent will be 4200 ft/min. With take-off flaps and 85% rpm, the aircraft will stabilize at approximately 260 knots IAS in level flight inbound to station. Engine airflow should be adequate to provide anti-icing in light to moderate icing conditions. This procedure will require 7 to 8 minutes from 20,000 feet to return to the radio fix. Distance out from station is about 19 miles and fuel required is approximately 250 pounds. See figure 9-1.

GCI RECOVERY.

GCI recovery procedure to be used following return to base under IFR conditions should be practiced in VFR to develop and improve the team work of the pilot and radar controller. When a radar or ILS approach is required, the descent from the inbound cruising altitude should be initiated at a sufficient distance to permit a straight-in descent at the jet penetration airspeed, allowing 5 to 7 miles for decelerating and changing to approach configuration before reaching the turn on point (GATE) to final approach. Aircraft configuration will be the same as that used during a jet penetration.

INSTRUMENT APPROACHES. (Refer to Figure 9-3.)

The airplane has good handling characteristics during instrument approaches. At low rpm and low indicated airspeeds, response to throttle movement and acceleration is rapid. Therefore, use small thrust changes in the approach configuration and maintain the recommended approach airspeed. In rain or snow, use the windshield rain removal system to increase forward visibility out of the curved left windshield panel.

Radar Approach.

The radar approach requires a minimum of thrust changes and is adaptable to formation as well as single aircraft. This pattern is basic for all types of instrument approaches in this aircraft, therefore, pilots should be very familiar with it. Approach the radar pick up point in a clean configuration, adjust thrust to 85% rpm and place flaps to TAKE-OFF position. Airspeed will stabilize at approximately 260 knots IAS. Limit all bank angles to 30°. Lower the landing gear on the base leg or 10 miles out if making straight-in approach and at 85% rpm. The airspeed will bleed off to approximately 225 knots IAS.

Note

For descents in the pattern use either partial speed brakes or reduce thrust to 83%.

Turning on to final approach, airspeed will bleed off to 190 knots IAS. Place flaps to LAND position at the ten seconds warning prior to entering the glide slope and increase power to 89% rpm. Let airspeed decrease to 170 knots IAS and maintain the airspeed on glide slope. Rate of descent will be approximately 750 feet per minute. Glide path position can be maintained by using either partial speed brakes or throttle.

Note

For take-off flap landing, reduce power to 83% as glide slope is intercepted. Airspeed will be 190 knots IAS and rate of descent approximately 850 feet per minute.

See figure 9-2 for a typical GCI Recovery with Radar Approach.

ILS APPROACH.

During an ILS approach, maintain aircraft attitude with the basic flight instruments and monitor the ILS indicator for reference to the localizer and glide slope. If localizer interception is from a radio fix or GCI control, and is at an angle of 90° or less, allow sufficient distance out to perform final cockpit check, slow to approach speed, and establish correct localizer beam heading. On a typical ILS pattern, fly outbound on a reciprocal heading only long enough to complete the above function after the procedure turn inbound. ILS approach procedures are outlined in figure 9-4.

Missed Approaches.

In case of a missed approach, follow the procedure given in Section II for Go-Around. Adjust thrust to 85% rpm if you are to remain in the pattern; this will yield approximately 260 knots IAS.

ICE AND RAIN

Although this airplane does not have anti-icing systems for the wing, empennage and inlet ducts, flight under icing conditions can be made. Defrosting, rain removal, inlet guide vane anti-icing, pitch sensor and pitot heat should be turned on prior to entering an area where icing conditions prevail or are suspected. Flight tests have shown that, although engine flameout did not occur, the inlet guide vanes and stator blades were damaged and compressor stalls did occur when heavy ice was ingested at 98% rpm. The compressor stalls resulted in a reduction of thrust to idle rpm and prevented obtaining higher than idle rpm. Heavy ice was ingested at an engine rpm of 88% rpm and below, without encountering engine damage or compressor stall. With pitot heat on, ice formed over the static port of the pitot head during heavy icing, resulting in a loss of proper indications on the airspeed indicator and altimeter. The pitot heat was sufficient to clear this ice off the pitot head within one to two minutes after leaving the icing area. After several flights in heavy rain, sufficient moisture collected in the generator compartment to cause one of the generators to fail. Continued use of the rain removal system resulted in discoloration and finally failure of the windshield adjacent to the rain removal nozzle. Successive flights through rain at high speeds may cause erosion to the radome.

1. Whenever possible, avoid flight in conditions conducive to rapid build-up of ice.

2. Have generator compartment dried by hot air after any flight in rain.

3. Inspect windshield for discoloration after any flight in which the rain remover is used, and have windshield replaced if discoloration is noted.

4. After flying in moderate to heavy icing for two minutes or more do not use more than 88% rpm and land as soon as practical.

When instrument take-offs or approaches are to be made and rain is anticipated, the windshield rain removal system should be in operation to increase forward visibility through the left windshield panel.

Note

When flying through light to moderate rain, good visibility will be obtained through the cleared area. The cleared area will be slightly smaller in heavy rain than in moderate rain. If very heavy rain is reported, some visibility will be retained but it will be substantially impaired.

Refer to Sections IV and V for procedures and operating limitations of the anti-icing and rain removal equipment.

TYPICAL PENETRATION

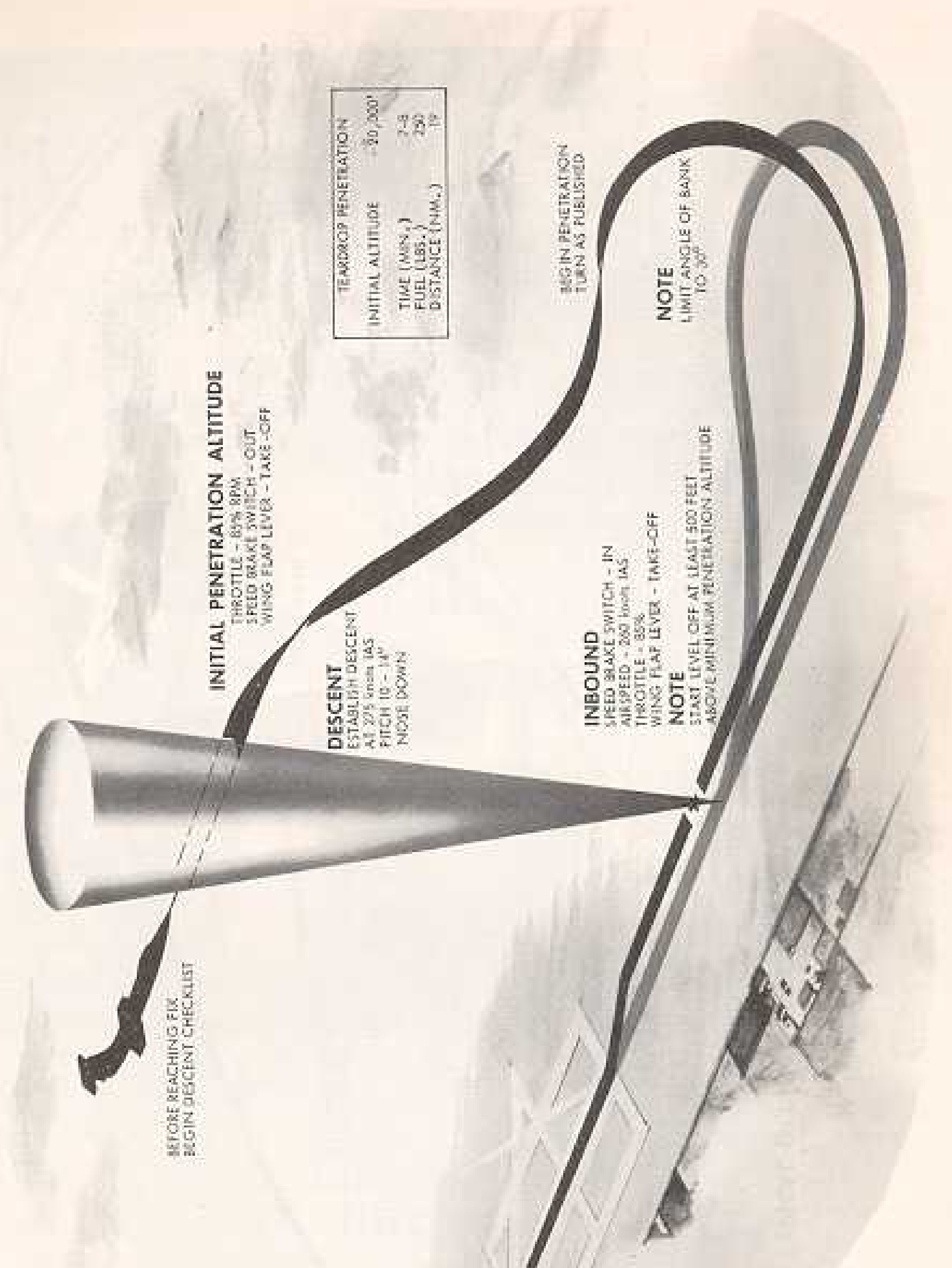

Figure 9-1

TYPICAL GCI RECOVERY WITH RADAR APPROACH

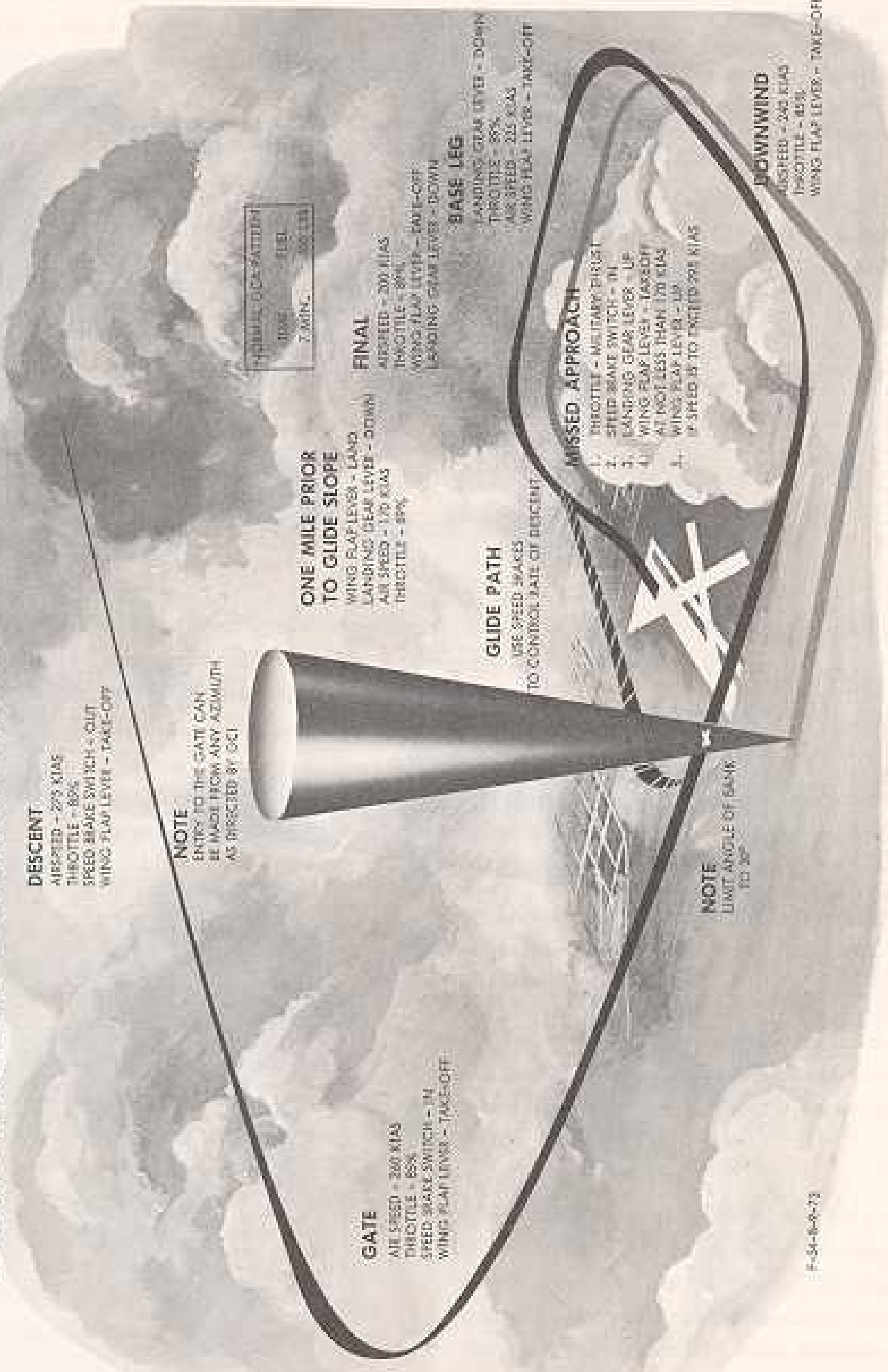

Figure 9-2

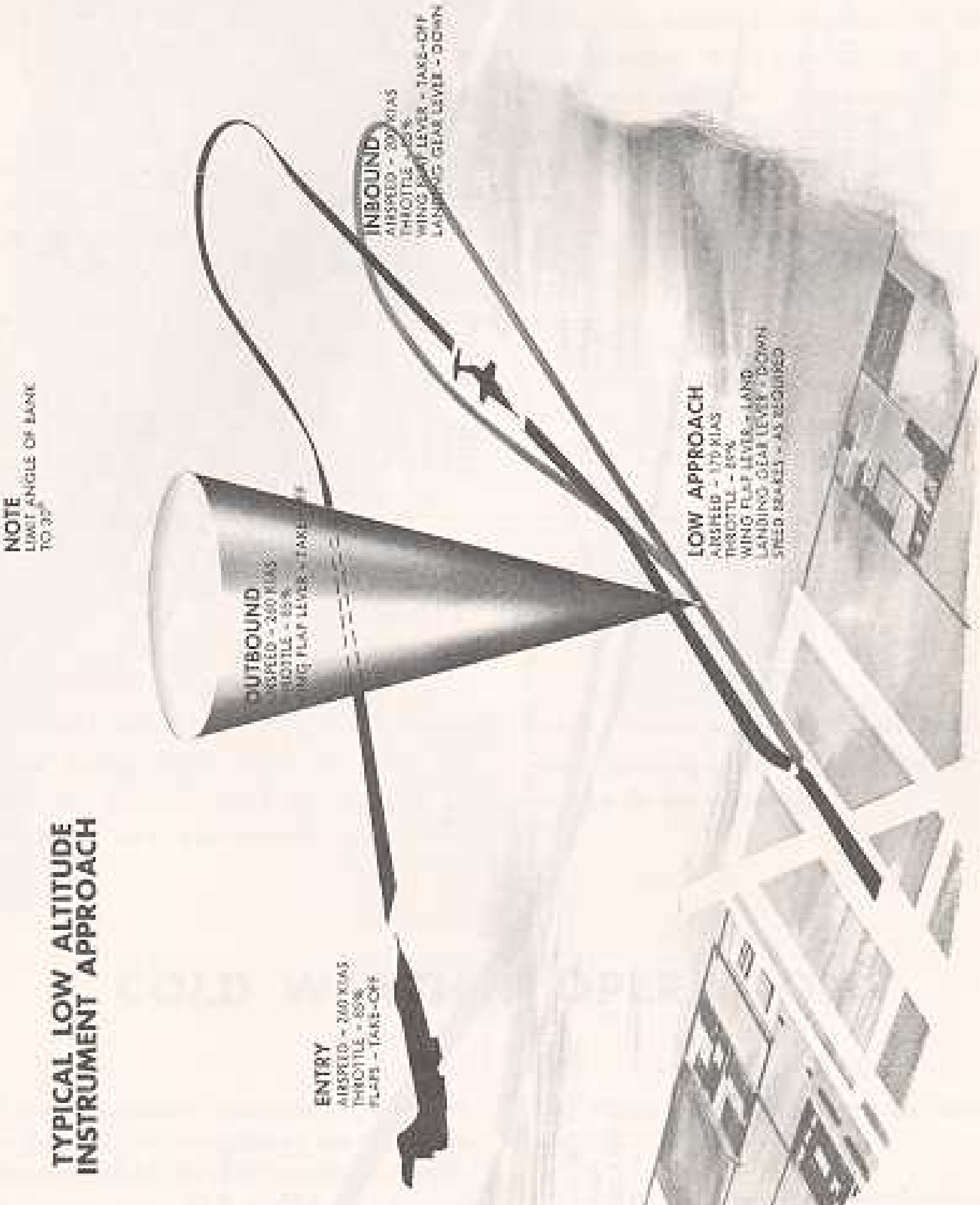
TYPICAL LOW ALTITUDE
INSTRUMENT APPROACH
NOTE
LIMIT ANGLE OF BANK TO 30°
ENTRY
AIRSPEED - 260 KIAS
THROTTLE - 85%
FLAPS - TAKE-OFF
OUTBOUND
AIRSPEED - 260 KIAS
THROTTLE - 85%
WING FLAP LEVER - TAKE-OFF
INBOUND
AIRSPEED - 200 KIAS
THROTTLE - 85%
WING FLAP LEVER - TAKE-OFF
LANDING GEAR LEVER - DOWN
LOW APPROACH
AIRSPEED - 170 KIAS
THROTTLE - 89%
WING FLAP LEVER - LAND
LANDING GEAR LEVER - DOWN
SPEED BRAKES - AS REQUIRED

Figure 9-3

TYPICAL ILS APPROACH

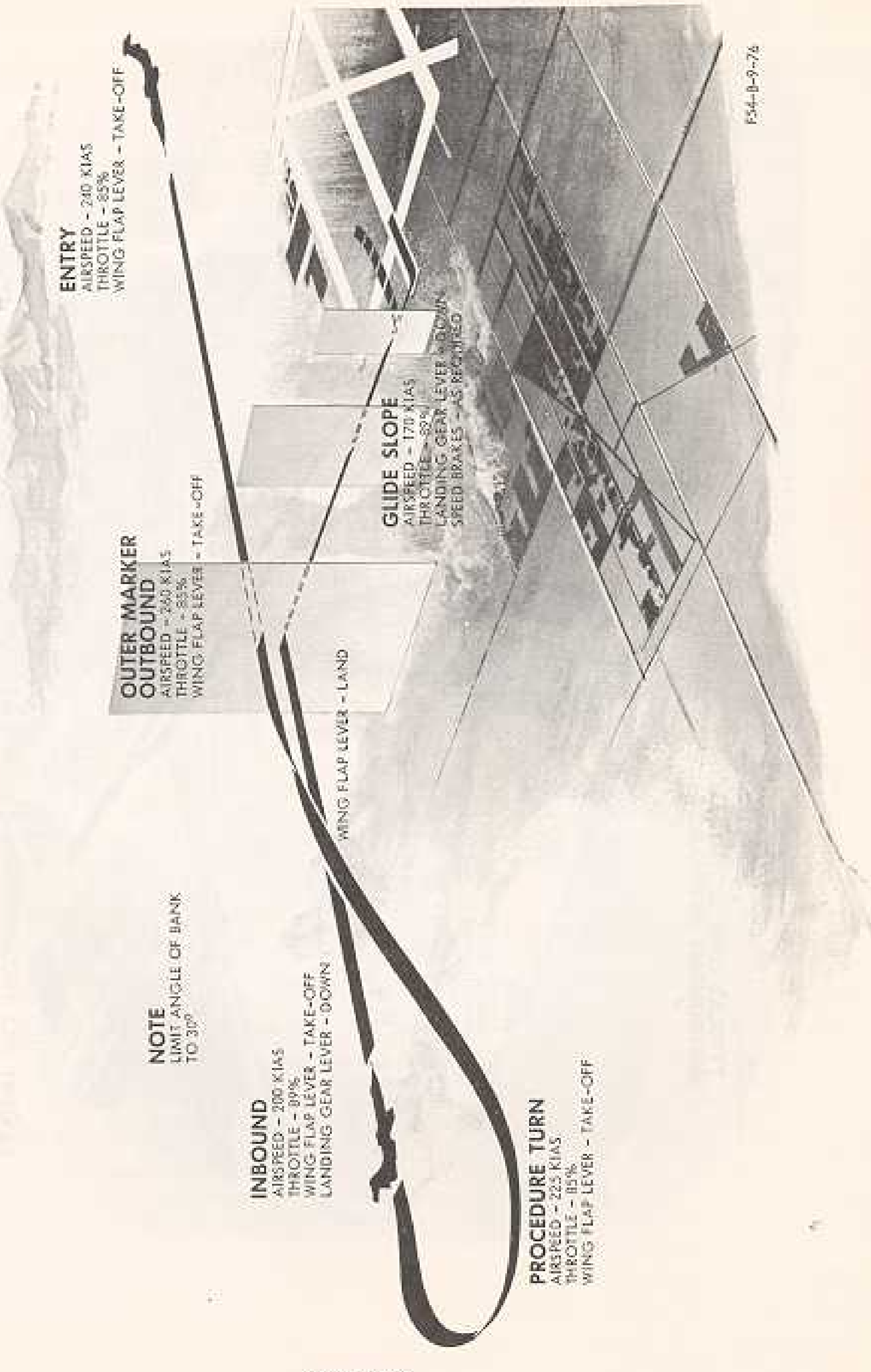

Figure 9-4

TURBULENCE AND THUNDERSTORMS

CAUTION

Flight through a thunderstorm should be avoided if at all possible. Hail encountered could cause rapid deterioration of the radome and unpredictable airplane damage. Hail may shatter the infrared sight cover causing cockpit depressurization.

If mission requirements or emergencies necessitate thunderstorm penetration use these procedures. Prior to entering the storm establish airspeed of 350 knots IAS for a clean aircraft or 275 knots IAS when take-off flaps are extended. Turn pitot heat on and adjust thunderstorm and instrument light to minimize blinding effects of lightning. Engine anti-icing ON. Safety belt and shoulder harness should be locked.

CAUTION

The warning panel lights are automatically dimmed when the instrument lights are turned on. Special care should be exercised to detect any warning light illumination.

NIGHT FLYING

Night flights do not present any special problems or techniques except during landing. During final approach at night, the runway lights are reflected in the windshield panel and disorientation can easily occur. Utilize all possible clues to attitude and flight path, ignoring as much as possible the runway light reflection in the windshield.

COLD WEATHER OPERATIONS

The success of low temperature operation depends primarily upon the preparations made during the post-flight inspection, in anticipation of the requirements for operation on the following day. The procedures outlined should be followed during outdoor operation to expedite the preflight inspection and to insure satisfactory operation of the aircraft and its systems during the next flight.

BEFORE ENTERING THE AIRCRAFT.

1. Have all protective covers and duct plugs removed.
2. Perform exterior inspection as outlined in Section II.
3. Check the entire aircraft for freedom from snow and ice.

WARNING

Dangerous loss of lift and treacherous stalls may result if the aircraft is not adequately cleaned of all snow, frost and ice. Do not attempt to take off if there is any snow, frost, or ice on the aircraft.

4. Place heater duct in cockpit for 5 minutes when the temperature is below —30°F.

5. The pressure of both hydraulic accumulators will drop with temperature. A pressure as low as 700 psi can be expected at —60° F.

6. Inspect plastic airspeed and altitude pitot lines for cracking at temperatures of —30° F and below.

BEFORE STARTING ENGINE.

1. Make normal checks as outlined in Section II.

2. Preheating of the fuel control will be required to warm the fuel and provide proper atomization spray necessary for initial burning. The following minimum preheat times are recommended:

Fuel temperature 0° F — preheat 10-15 minutes

Fuel temperature —30° F — preheat 30 minutes

Fuel temperature —65° F — preheat 1 hour

STARTING ENGINE.

Make normal start as outlined in Section II except as follows:

1. Use No. 1 start switch.

2. If start is not successful, use No. 2 switch.

3. If start is successful, shut down engine and try No. 1 start switch again. If engine fails to start, abort flight.

Note

- Consistent successful starts cannot presently be expected at fuel temperatures of 10° F and below.
- During low ambient temperature engine starts, excessive engine oil pressure for short periods of time is a normal condition and will not cause engine damage.

CAUTION

On ice the aircraft will slide forward at approximately 84-88% rpm with the brakes locked. Make certain the aircraft is clear before advancing the throttle.

WARM-UP AND GROUND CHECK.

Use normal procedures.

Note

It will require 2-4 minutes to obtain warm air from the defroster. If immediate defrosting or de-icing is required, turn rain removal ON until the left windscreen and canopy have cleared and then turn rain removal OFF.

1. Check hydraulic presure, oil pressure, and engine instruments. Allow oil pressure to decrease within limits before taxiing.

2. Check flight instruments.

WARNING

Make sure all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

TAXIING INSTRUCTIONS.

1. Taxi at slow speed when taxiing over rough snow packed surfaces.

2. Allow more room than on a cleared surface to bring the aircraft to a stop.

3. Successful taxiing can be accomplished in snow up to 6 inches deep.

Note

Only nose wheel steering should be used in deep snow. Braking will cause the snow to melt and moisture to form on the wheels which may later freeze.

BEFORE TAKE-OFF.

Make normal before take-off check as outlined in Section II.

Note

Canopy defrosting air should be operated at highest temperature consistent with pilot comfort at all times. This will minimize the possibility of windshield and canopy fogging caused by extreme temperature differentials accompanying an engine failure or rapid descent from altitude.

TAKE-OFF.

Be prepared for increased take-off distances if runway is covered with snow.

CAUTION

Acceleration is very rapid in cold weather. The pilot must make certain that the aircraft is rolling straight down the runway before applying afterburner.

AFTER TAKE-OFF — CLIMB.

Follow procedure as outlined in Section II. Climb performance will be improved during cold weather operation at lower altitudes. Follow recommended climb speeds as given in Climb Charts.

ENGINE OPERATION IN FLIGHT.

Engine operation during flight in cold weather should be governed by normal procedures.

LANDING.

Use normal procedures. Refer to Landing On Slippery Runways in Section II.

STOPPING THE ENGINE.

The engine is shutdown in the normal manner.

BEFORE LEAVING THE ENGINE.

Use normal procedures.

HOT WEATHER AND DESERT OPERATIONS

Hot weather and desert procedures differ from normal procedures mainly in that additional precautions must be taken to protect the airplane from damage due to high temperature and dust. Particular care should be taken to prevent the entrance of sand into the various airplane components and systems (engine, fuel system, pitot-static system, etc.). All filters should be checked more frequently than under normal conditions. Units incorporating plastic and rubber parts should be protected as much as possible from wind blown sand and excessive temperatures. The canopy and electronic compartment should be protected from excessive temperatures, due to the sun's radiation, by use of a canopy-electronic-compartment sun shade. Tires should be checked frequently for signs of blistering, etc.

TAKE-OFF.

Check take-off distance required for existing conditions of air temperature, etc. by referring to the take-off charts in the Confidential Supplement, T. O. 1F-104D-1A. Conditions where take-off airspeed equals the design tire speed are shown on these charts. *Take-off distances are increased under high air temperatures.*

Note

During afterburner take-off under high ambient temperature conditions, EGT limits may be exceeded. Adjust the throttle to maintain EGT within limits.

APPROACH AND LANDING.

Monitor rate of descent closely on approach. Do not allow it to exceed the 700-800 feet per minute recommended during the final portion of the approach. Be prepared to use the afterburner if necessary. Refer to discussion in Section VI and charts in the Appendix (Confidential Supplement, T. O. 1F-104D-1A) pertaining to variations in performance for changes in temperature, weight and altitude.

NOTE

For Appendix I, refer to

Confidential Supplement, T. O. 1F-104D-1A

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