FLIGHT MANUAL

USAF SERIES F-106A & F-106B AIRCRAFT

AF SERIAL NO. 56-[illegible], -454, -456 AND ON

AF SERIAL NO. 57-2508 AND ON

F41608-79-D-A007

- THIS CHANGE REPLACES OPERATIONAL SUPPLEMENTS T.O. 1F-106A-1S-211, T.O. 1F-106A-1S-212, T.O. 1F-106A-1S-214, T.O. 1F-106A-1S-215, T.O. 1F-106A-1S-216, T.O. 1F-106A-1S-217, T.O. 1F-106A-1S-219, AND T.O. 1F-106A-1S-220.
- SEE NUMERICAL INDEX T.O. 0-1-1-4, AND SUPPLEMENTS THERETO, FOR CURRENT STATUS OF FLIGHT MANUALS, SAFETY SUPPLEMENTS, OPERATIONAL SUPPLEMENTS, AND FLIGHT CREW CHECKLIST.

THIS PUBLICATION IS INCOMPLETE WITHOUT T.O. 1F-106A-1-1, PERFORMANCE DATA FLIGHT MANUAL; T.O. 1F-106A-1-2, SUPPLEMENT FLIGHT MANUAL (C); T.O. 1F-106A-1CL-1, PILOTS' ABBREVIATED FLIGHT CREW CHECKLIST; AND T.O. 1F-106A-29, AIRCREW SPECIAL WEAPON DELIVERY TECHNICAL MANUAL (S-RD).

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48000A

BASIC AND ALL CHANGES HAVE BEEN MERGED TO MAKE THIS A COMPLETE PUBLICATION.

1 NOVEMBER 1980
CHANGE 2 30 APRIL 1985

AIR FORCE-5-12-88-150 Reprint

LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES: DESTROY SUPERSEDED PAGES.

Dates of issue for original and changed pages are:

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Change	1	1 Nov 82
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CURRENT FLIGHT CREW CHECKLIST

T.O. 1F-106A-1CL-1

1 November 1980
Change 2 — 30 April 1985

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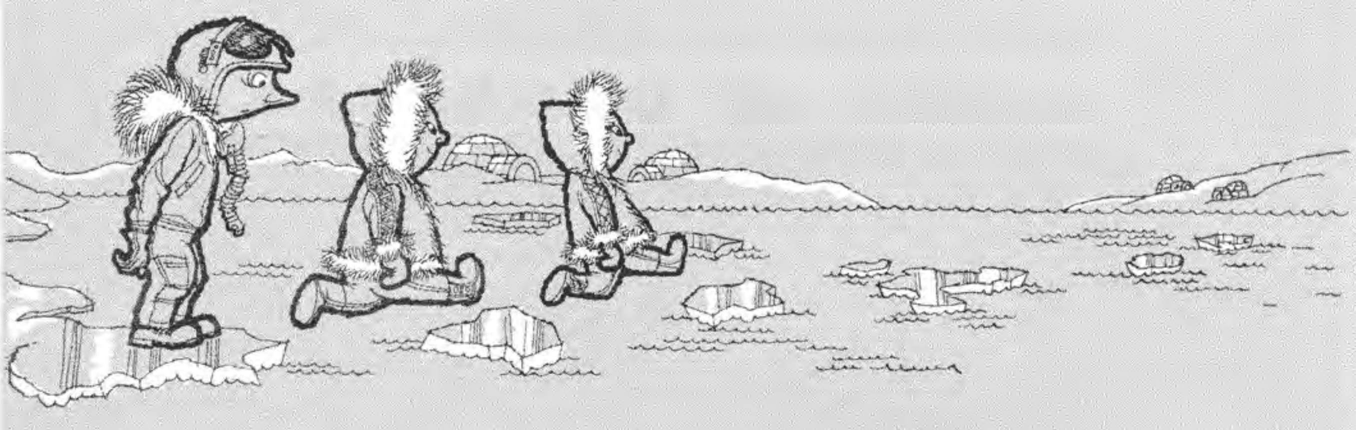

DON'T SLIP...!

...BY THESE PAGES...

SCOPE

This manual contains the necessary information for safe and efficient operation of the F-106A and the F-106B. These instructions provide you with a general knowledge of the airplane, its characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and therefore, basic flight principles are avoided. More detailed technical information on aircraft systems is contained in the T.O. 1F-106A-2-series technical orders.

SOUND JUDGMENT

Instructions in this manual are for a pilot inexperienced in the operation of these airplanes. *This manual 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.

PERMISSIBLE OPERATIONS

The Flight Manual takes a "positive approach" and normally states only what you can do. Unusual operations or configurations (such as asymmetrical loading) are prohibited unless specifically covered herein. Clearance must be obtained from San Antonio ALC (MMUA) before any questionable operation is attempted which is not specifically permitted in this manual.

STANDARDIZATION AND ARRANGEMENT

Standardization assures that the scope and arrangement of all Flight Manuals are identical. The manual is divided into nine fairly independent sections to simplify reading it straight through or using it as a reference manual. The first three sections must be read thoroughly and fully understood before attempting to fly the airplane. The remaining sections provide important information for safe and efficient mission accomplishment.

CHANGES TO THE FLIGHT MANUAL AND CHECKLIST

Changes are periodically made to keep the Flight Manual and Checklist current. New or revised information on a page is indicated by a black vertical line in the margin opposite new or revised text. Changes to illustrations, charts, and tables are indicated by miniature pointing hands. When you receive a Change to the Flight Manual or Checklist, insert the changed pages in the basic publication and destroy the superseded pages.

CHECKLISTS

The Flight Manual contains only amplified checklists. Abbreviated checklists have been issued as separate technical orders. The Checklist consists of three parts, arranged in the following order: Emergency Procedures, Normal Procedures, and Performance Data. The numbered items (line items) in the emergency and normal procedure sections of the Checklist correspond to identically numbered amplified items in Sections III and II of the Flight Manual. The Checklist contains airplane performance data in tabular and chart forms for both the Ⓐ and Ⓑ airplanes. Use of this data is explained in T.O. 1F-106A-1-1. See the A page of this manual and the latest supplement flyleaf for the current applicable Checklist. If an

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interim safety or operational supplement affects a Checklist, write in the applicable change on the affected Checklist. A formal supplement will be issued with the revised Checklist page attached. Insert the new page in the Checklist, but keep the old page in case the supplement is rescinded and the page is needed.

SAFETY SUPPLEMENTS

Information involving safety will be promptly forwarded to you in a safety supplement. Urgent information is published in interim safety supplements and transmitted by teletype. Formal supplements are mailed. The supplement title block and status page (published with formal supplement only) should be checked to determine the supplement's effect on the manual and other outstanding supplements.

OPERATIONAL SUPPLEMENTS

Information involving changes to operating procedures will be forwarded to you by operational supplements. The procedure for handling operational supplements is the same as for safety supplements.

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to "Warnings," "Cautions," and "Notes" used throughout the manual:

WARNING

Operating procedures, techniques, etc., that could result in personal injury or loss of life if not carefully followed.

CAUTION

Operating procedures, techniques, etc., that could result in damage to equipment if not carefully followed.

NOTE

An operating procedure, technique, etc., that is considered essential to emphasize.

SHALL, WILL, SHOULD, AND MAY

The words "shall" or "will" are used in this manual to indicate a mandatory requirement. The word "should" is used to indicate a nonmandatory desire or preferred method of accomplishment. The word "may" indicates an acceptable or suggested means of accomplishment.

YOUR RESPONSIBILITY — TO LET US KNOW

Every effort is made to keep the Flight Manual current. However, we cannot correct an error unless we know about it. It is essential that you do your part. Any comments, questions, or recommendations should be forwarded on AF Form 847 through your Command Headquarters, to: San Antonio ALC/MMUA, Kelly AFB, Texas 78241.

HOW TO BE ASSURED OF HAVING LATEST DATA

Refer to T.O. 0-1-1-4 for a listing of all current flight manuals, safety supplements, operational supplements, and checklists. Also, check the flight manual title page and the status page attached to formal safety and operational supplements.

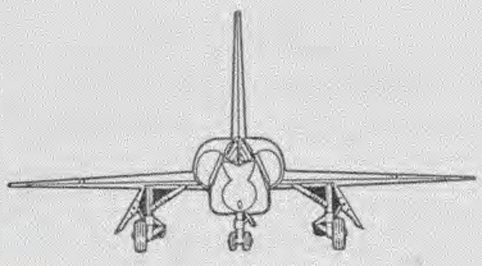
HOW TO GET PERSONAL COPIES

Each flight crew member is entitled to personal copies of the flight manual, supplements, and checklist. Contact your publication distribution officer to fill your technical order request.

AIRPLANE DESIGNATION CODE

Where text or illustrations are not specifically identified for particular models, it may be assumed that such items are common to both the F-106A and F-106B airplanes. This is also true for items common to the forward and aft cockpits of the F-106B and the cockpit of the F-106A. Illustrations which do not show minor variations in the airplane models are labeled "Typical." Text and illustrations applicable to F-106A or F-106B airplanes are identified by the following code symbols:

CODE	AIRPLANE
Ⓐ	F-106A
Ⓑ	F-106B



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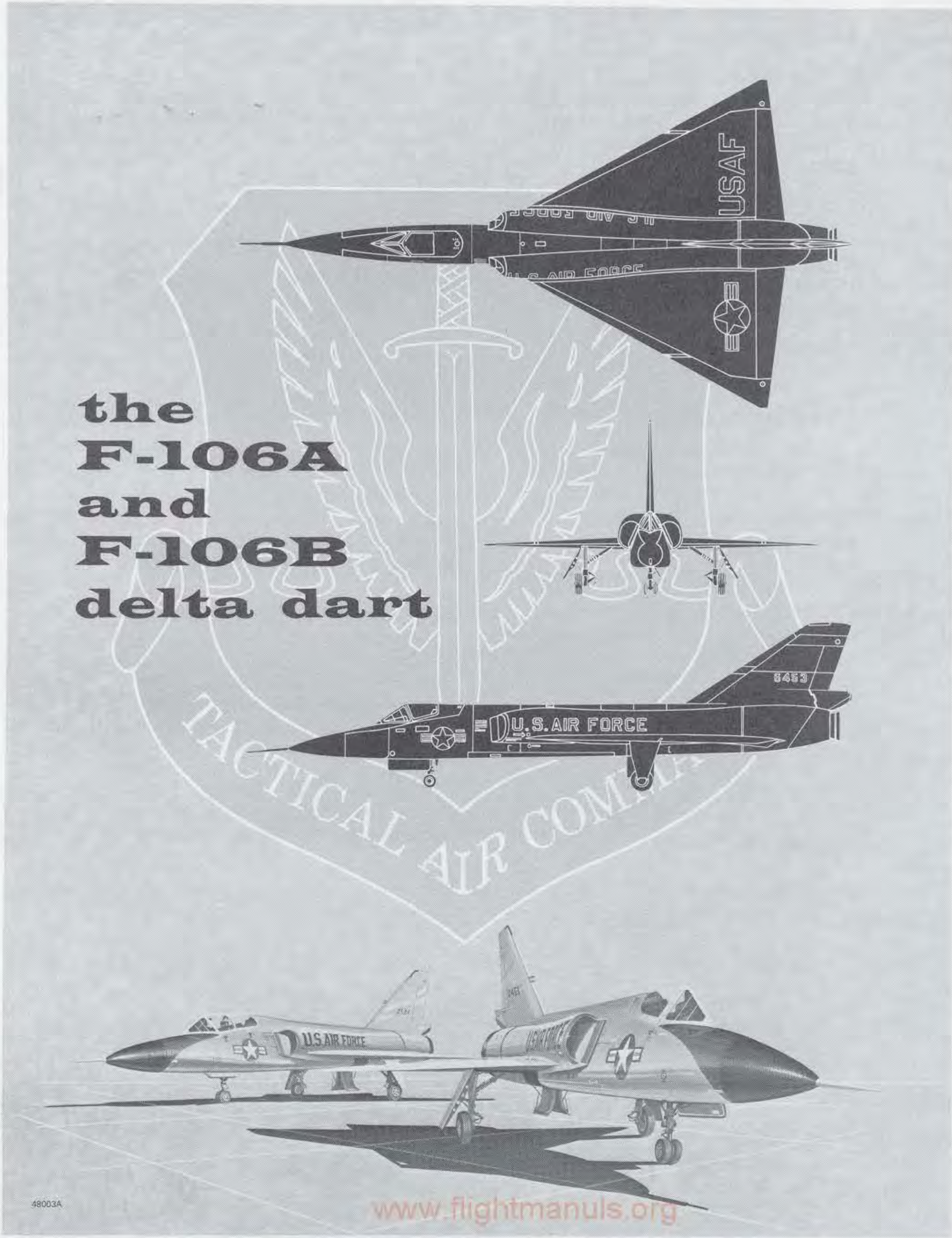
the
F-106A
and
F-106B
delta dart
USAF
U.S. AIR FORCE
6453
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description
Section I

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THE AIRPLANE

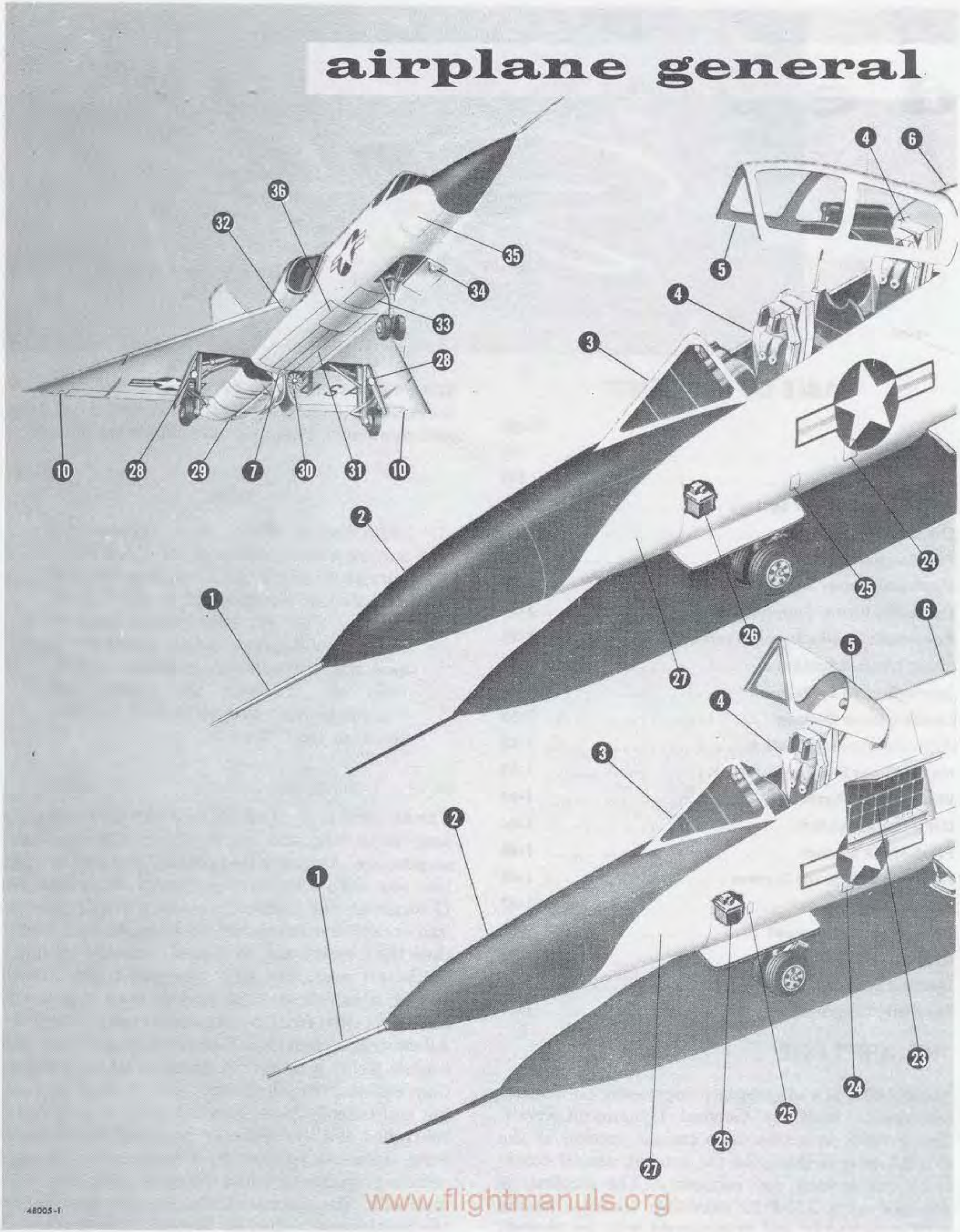
The F-106A is a single-place supersonic all-weather interceptor built by General Dynamics/Convair. The F-106B is a two-place trainer version of the F-106A and is designed for combat use, if conditions make such use necessary. The airplane is powered by a J75-P-17 axial-flow turbojet engine with afterburner and is equipped with an aircraft and weapon control system which includes an automatic flight control system, a fire control system, and communications and navigation equipment.

NOTE

This manual covers two aircraft and weapon control systems, the MA-1 incorporated in the F-106A airplane and the AN/ASQ-25 incorporated in the F-106B airplane. The text distinguishes between the two configurations only where necessary and will refer to all switches, controls, etc., in both the F-106A and F-106B aircraft weapon and control systems, as the "MA-1."

The airplane is typified by an area rule fuselage, a large delta wing, and the absence of a conventional empennage. A pressurized cockpit contains an ejection seat with a one-motion control for escape. On Ⓑ airplanes the ejection seats in a single pressurized cockpit are in tandem with the aft seat higher than the forward seat to improve forward visibility in the aft seat. The fully powered flight control system uses "elevons" to provide both aileron and elevator action from conventional cockpit controls. All control surfaces are hydraulically actuated, and control feel is provided by an artificial feel system. Conventional tricycle landing gear is used for landing and takeoff. Nose wheel steering is electrically controlled and hydraulically powered. The integral wing tanks are serviced by a single-point pressure refueling system and fuel usage is sequenced automatically. The external tanks are also serviced by the single-point refueling system. The airplane is

airplane general



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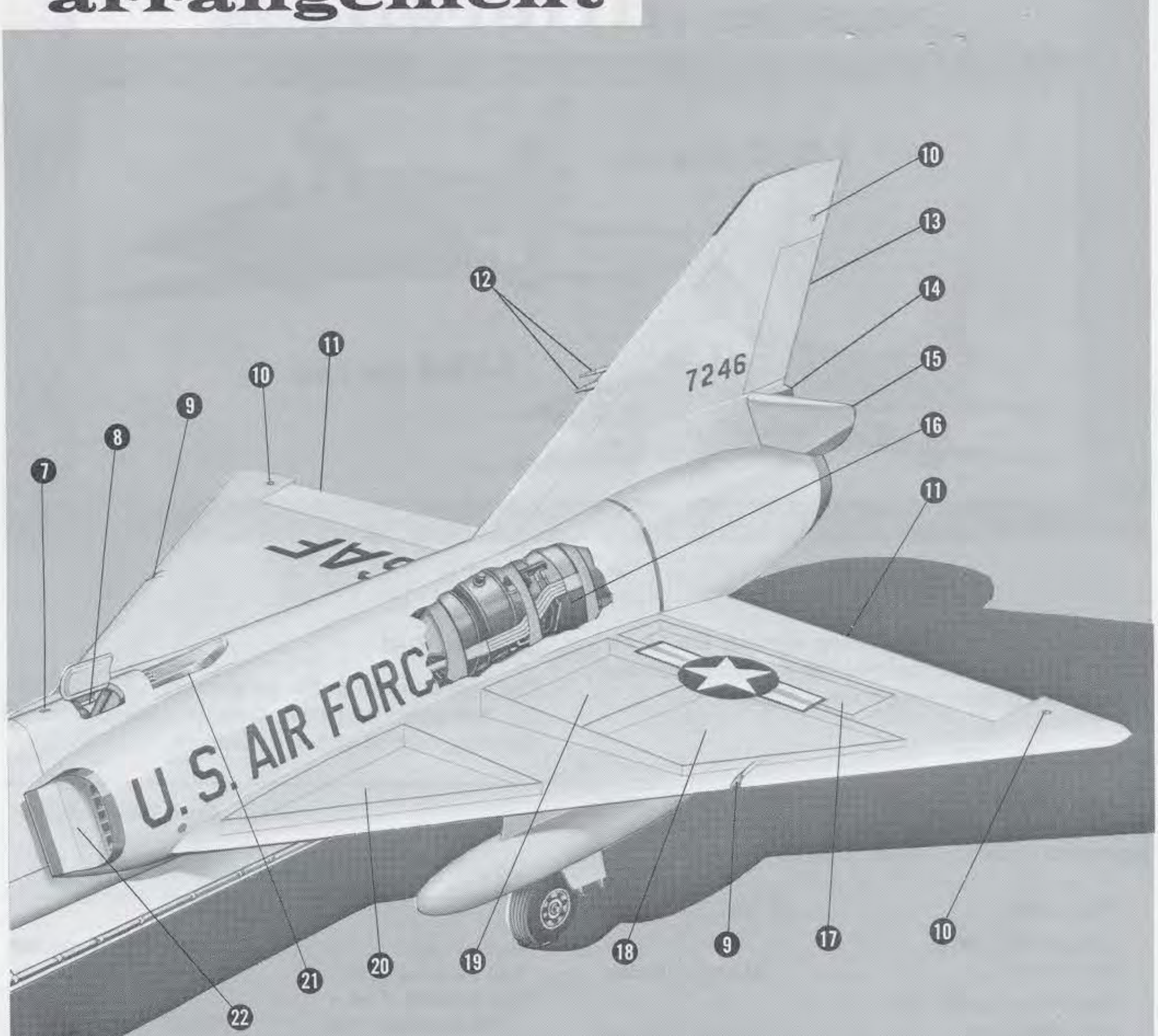
arrangement



1. Nose Boom
2. Radome
3. Windshield
4. Ejection Seats
5. Canopy
6. Fuselage Fuel Tank
7. Anticollision Lights (2)
8. Air Conditioning Compartment
9. Wing Slots (2)
10. Navigation Lights (3)
11. Elevons (2)
12. Ram Air (Q) Intake
13. Rudder
14. Drag Chute
15. Speed Brakes
16. J-75 Engine With Afterburner
17. Wing Transfer Fuel Tank
18. Fuel Tank No. 2
19. Fuel Tank No. 3
20. Fuel Tank No. 1
21. Air Refueling Slipway Door
22. Engine Intake Duct
23. Upper Aft Electronics (A)
24. External Power Receptacle
25. Liquid Oxygen Filler Valve
26. Battery (Nose Wheel Well)
27. LH Forward Electronics Compartment
28. Landing Lights (2)
29. Tail Hook
30. Ram Air Turbine (Hydraulic Compartment)
31. Missile Bay and M61A1 Gun (A)
32. Single Point Refueling Receptacle (Under RH Intake Duct)
33. Lower Aft Electronics Compartment (A)
    Lower Mid-Electronics Compartment (B)
34. Taxi Light
35. RH Forward Electronics Compartment
36. Lower Aft Electronics Compartment (B)

48005-2A

Figure 1-1 (Sheet 2 of 2)

Figure 1-2

equipped with an air refueling system. On Ⓐ airplanes an automatic fuel transfer system is included to control cg during supersonic flight.

DIMENSIONS

The approximate overall dimensions of the airplane under normal conditions of gross weight, tire and gear strut inflation are as follows:

Wing span	38 feet, 3.5 inches
Length (including pitot boom)	70 feet, 8 inches
Height (to tip of vertical stabilizer)	20 feet, 3 inches
Landing gear tread	15 feet, 5 inches

NOTE

Refer to Section II for Minimum Turning Radius and Ground Clearances.

GROSS WEIGHT

The approximate gross weights for airplanes having 360-gallon external tank provisions and air refueling capability are as follows:

Condition	Gross Weight, Pounds Ⓐ	Ⓑ
Basic Weight	25,546	25,986
Full Internal Fuel	35,387	35,411
Full Internal Fuel + Full External Fuel	40,555	40,579
AIM-4 Missiles (4)	+594	+594
M61A1 Gun		
Full Ammunition	+1237	—
No Ammunition	+1048	—
AIS Pod	+229	+229

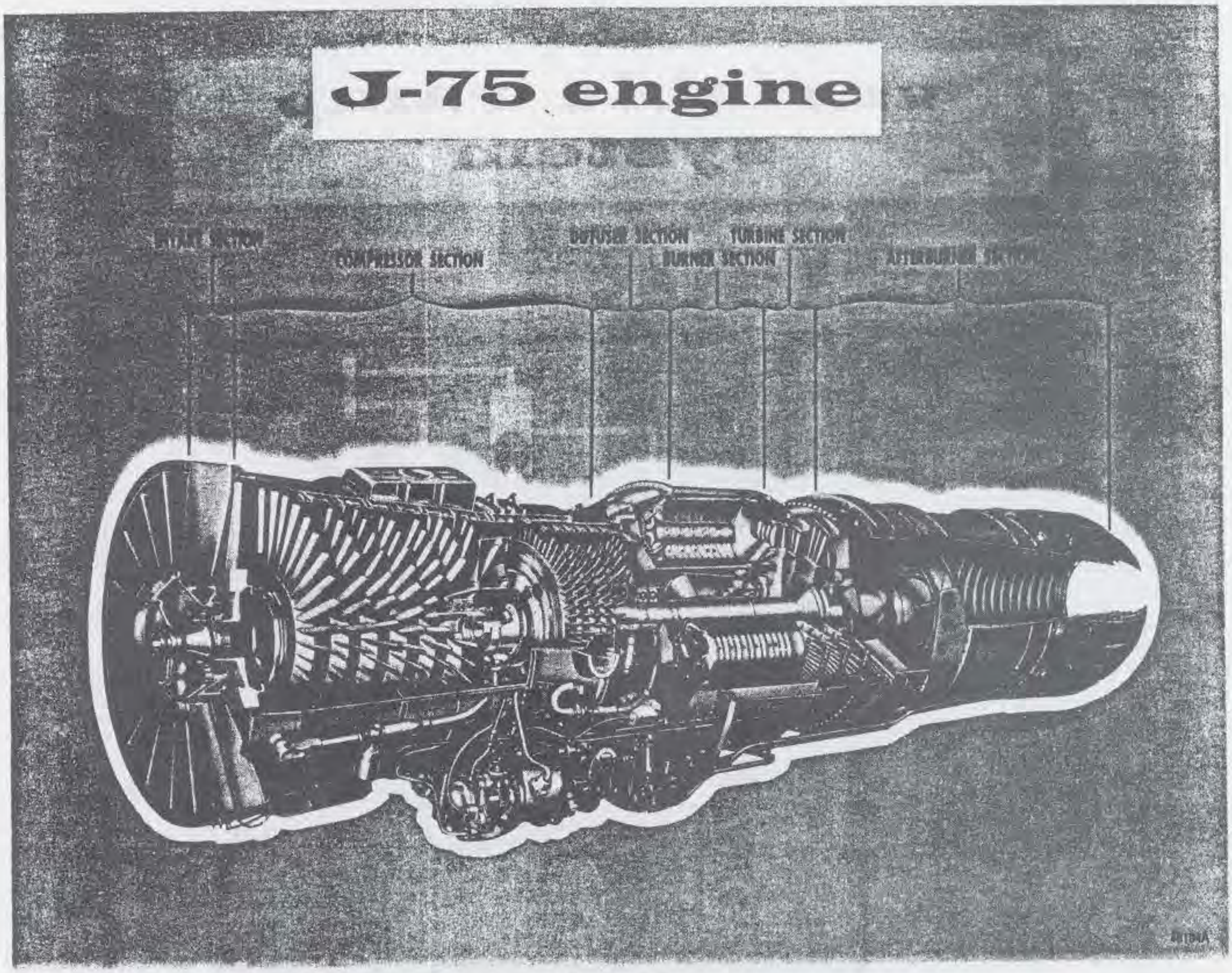


Figure 1-3

NOTE

- Basic weight includes the airplane, external tank pylons, unusable internal fuel, unusable oil, and also includes M61A1 gun provisions Ⓐ.
- Other gross weights include 235 pounds for pilot Ⓐ or 470 pounds for pilots Ⓑ, 34 pounds for usable oil, 514 pounds for external tanks where an external tank configuration is specified, and 181 pounds for retained ammunition and cases Ⓐ.

AIRPLANE CONFIGURATION

Block numbers are not used in this manual to identify airplane configuration. When changes are readily visible to the pilot, they are usually identified by "some airplanes" and "other airplanes." If the change is not readily visible, footnotes are used to identify airplanes by serial number. For instance, the illustration of the compass control panel uses "some airplanes" and "other airplanes" because the difference is easily recognized.

ENGINE

Thrust is supplied by a Pratt and Whitney J75-P-17 engine equipped with an afterburner (figure 1-3). This engine has a sea-level standard day static thrust rating of approximately 16,100 pounds at military thrust and 24,500 pounds at maximum thrust (afterburning). A main engine accessory section, driven by a high-pressure rotor, provides reduction gearing and mounting pads for all the engine-driven accessories.

VARIABLE RAMP SYSTEM

Variable ramps (figure 1-4) are provided to obtain optimum airplane performance and to maintain

variable ramp system

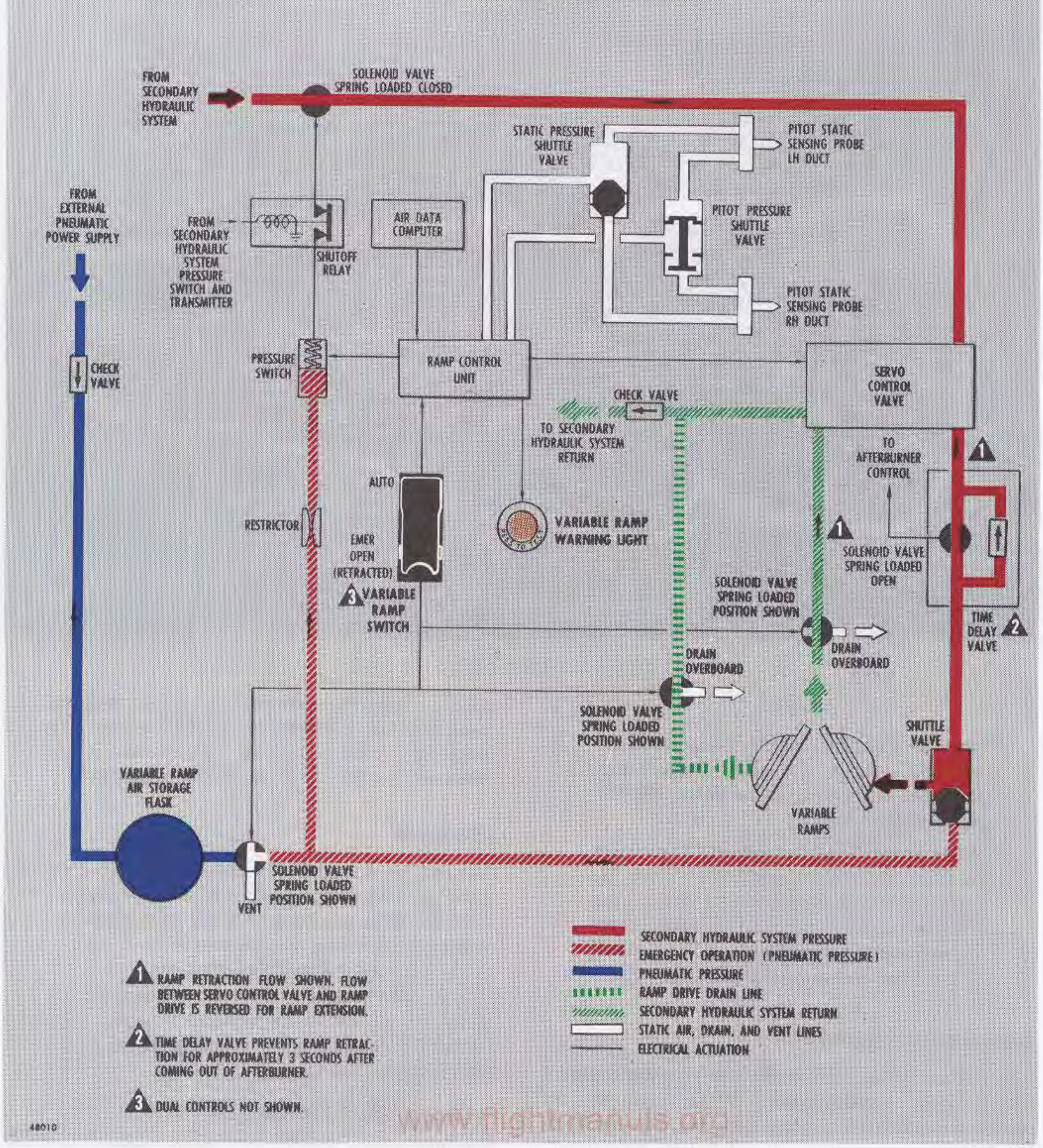


Figure 1-4

inlet stability over a wide range of speed and altitude. The variable ramps maintain an inlet throat static-to-total pressure ratio that varies with airplane Mach number. Static and total pressures are sensed by a pitot-static probe. Whenever the sensed pressure ratio differs from the desired pressure ratio, the inlet control system drives the variable ramp to change the duct area, causing the duct throat pressures to vary and bring the pressure ratio within desired limits. The variable ramps in both left and right intake ducts are extended and retracted automatically by a hydraulic motor. During normal operation the variable ramp system will start to maintain an inlet duct Mach schedule by partially extending the ramps at approximately Mach 1.4.

NOTE

When the airplane accelerates to Mach 1.25 the variable ramp system is energized by the air data computer and remains energized until the airplane is decelerated to speeds less than Mach 1.20.

In the event of hydraulic pressure failure or loss of ac and dc nonessential power, an emergency source of high-pressure air (stored in a 100 cu. in. flask) can be selected to drive the variable ramps to the fully retracted position (engine inlets open) to facilitate flight at subsonic airspeeds. If the ramps are retracted by use of the emergency system, they should not be used during the remainder of the flight. After landing, the operation should be entered on Form 781 to direct ground servicing of the system.

Variable Ramp Switch

The guarded variable ramp switch (figures FO-1 and FO-2), placarded "Vari-Ramp," is located on the left-hand console. The switch has AUTO and EMER OPEN (retracted) positions. With the switch in AUTO position the system will operate automatically to maintain the optimum engine inlet airflow through the intake ducts. In the event of failure of normal operation of the variable ramps, placing the switch to EMER OPEN position will supply pneumatic pressure to the ramp drive motor to drive the ramps to the full retracted position. The emergency retraction system will only retract the ramps; therefore, flight at airspeeds above variable ramp inoperative limit speed should not be attempted during the remainder of the fight. After landing, use of the emergency system should be entered on Form 781 to direct ground servicing of the system. The switch receives power from the dc essential bus.

Variable Ramp Warning Light

An amber variable ramp warning light (figures FO-1 and FO-2), placarded "Variable Ramp Not Retracted," or "Vari-Ramp Not Retracted," is located on the instrument panel on A airplanes and the forward instrument panel on B airplanes. The light will illuminate to indicate failure of the ramps to fully retract at airspeeds below Mach 1.2. The light will extinguish when the ramps are fully retracted. The warning light receives power from the dc essential bus.

ENGINE FUEL CONTROL SYSTEM

Desired engine rpm is established by throttle movement, and fuel flow to the engine is delivered and regulated by the engine fuel control system (figure 1-5). The system includes the engine-driven fuel pump unit, the fuel control unit, the fuel pressurizing and dump valve unit, and the afterburner fuel system. For details of the afterburner system refer to ENGINE AFTERBURNER SYSTEM, this Section.

Engine-Driven Fuel Pump Unit

The engine-driven fuel pump unit (figure 1-5) supplies the fuel pressure required by the engine and the afterburner systems. If the engine pump fails, an emergency transfer valve in the engine-driven fuel pump unit automatically opens to allow fuel from the output side of one of the afterburner fuel pumps to flow to the fuel control unit.

NOTE

The only visual indication that the engine stage fuel pump has failed is failure of the engine pressure ratio to recover from the normal 0.3 to 0.5 drop following afterburner light. If the throttle is in AFTERBURNER range, a significant loss of thrust will occur. No thrust loss will occur in the military thrust range.

Fuel Control Unit

The fuel control unit (figure 1-5) regulates fuel to the combustion chambers and incorporates normal and emergency fuel control systems. During rapid engine accelerations the normal fuel control system

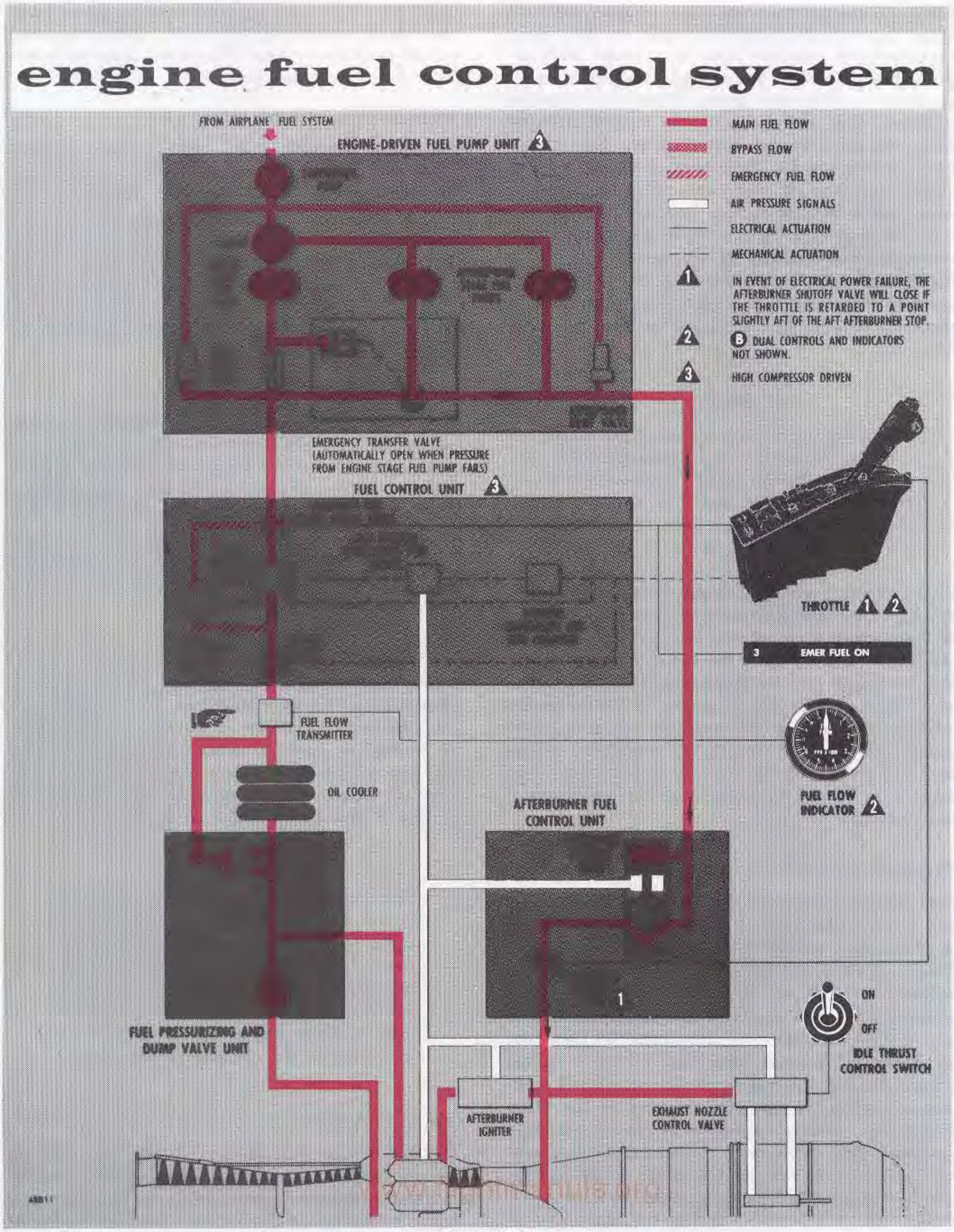

engine fuel control system
FROM AIRPLANE FUEL SYSTEM
ENGINE-DRIVEN FUEL PUMP UNIT 3
MAIN FUEL FLOW
BYPASS FLOW
EMERGENCY FUEL FLOW
AIR PRESSURE SIGNALS
ELECTRICAL ACTUATION
MECHANICAL ACTUATION
1 IN EVENT OF ELECTRICAL POWER FAILURE, THE AFTERBURNER SHUTOFF VALVE WILL CLOSE IF THE THROTTLE IS RETARDED TO A POINT SLIGHTLY AFT OF THE AFT AFTERBURNER STOP.
2 B DUAL CONTROLS AND INDICATORS NOT SHOWN.
3 HIGH COMPRESSOR DRIVEN
EMERGENCY TRANSFER VALVE (AUTOMATICALLY OPEN WHEN PRESSURE FROM ENGINE STAGE FUEL PUMP FAILS)
FUEL CONTROL UNIT 3
THROTTLE 1 2
3 EMER FUEL ON
FUEL FLOW TRANSMITTER
OIL COOLER
AFTERBURNER FUEL CONTROL UNIT
FUEL FLOW INDICATOR 2
1
FUEL PRESSURIZING AND DUMP VALVE UNIT
ON
OFF
IDLE THRUST CONTROL SWITCH
AFTERBURNER IGNITER
EXHAUST NOZZLE CONTROL VALVE

Figure 1-5

regulates fuel flow to prevent overspeed, overtemperature, compressor stalls, and flameouts. The normal fuel control system also maintains a minimum fuel flow at high altitudes and during rapid decelerations to prevent engine flameout. The emergency fuel control system provides an alternate system of regulating fuel flow to the combustion chambers in event of failure of components within the normal system. To transfer to the emergency system, in the event of failure of the normal system, the fuel control switch must be placed to EMER. When the emergency fuel control system is energized, the normal system is rendered inoperative and fuel flow is controlled by the emergency throttle valve. This valve is connected directly to the throttle; therefore, emergency fuel flow is manually controlled. The emergency fuel system is capable of supplying sufficient fuel to obtain at least 95% military thrust on a 100°F day at low altitudes and at least 80% military thrust at altitudes up to 30,000 feet.

NOTE

When operating in the emergency fuel system, full obtainable thrust will result in lower rpm and exhaust gas temperature than when operating in the normal fuel system.

The engine may be started on the emergency system, either in flight or on the ground. The afterburner may be operated on the emergency fuel system.

WARNING

Inflight use of the emergency fuel control system is permitted only during an actual emergency condition requiring its use.

CAUTION

- To prevent possible heat damage to the turbine section, ground starts on the emergency system should be limited to emergency situations only.
- When operating on the emergency fuel control system, rapid throttle movements must be avoided to prevent overspeed, overtemperature, compressor stalls, and flameouts.

When the throttle is retarded to OFF a mechanically controlled cutoff valve in the fuel control unit cuts off all fuel to the combustion chambers.

Fuel Pressurizing and Dump Valve

The fuel pressurizing and dump valve (figure 1-5) is located in the fuel control system between the fuel cutoff valve and the combustion chambers. The unit controls fuel flow to the primary and secondary injector nozzles in the engine combustion chambers. When the engine is to be shut down, the cutoff valve in the fuel control unit is closed by throttle movement, and the dump valve automatically opens to permit residual fuel in the manifolds of the main combustion system to drain overboard.

Fuel Control Switch

The side-guarded fuel control switch (figure 1-6) is located on the throttle quadrant, aft of the throttle. This switch is used to select either the normal or emergency fuel control system. The switch is placarded "Fuel Cont" and has two positions, NORM and EMER. When in EMER position the emergency throttle valve in the fuel control unit is positioned to permit emergency fuel control operation. If dc essential power is lost, the engine will continue to operate on the fuel control system selected. A warning light illuminates when the emergency fuel control is in operation. Power is supplied by the dc essential bus.

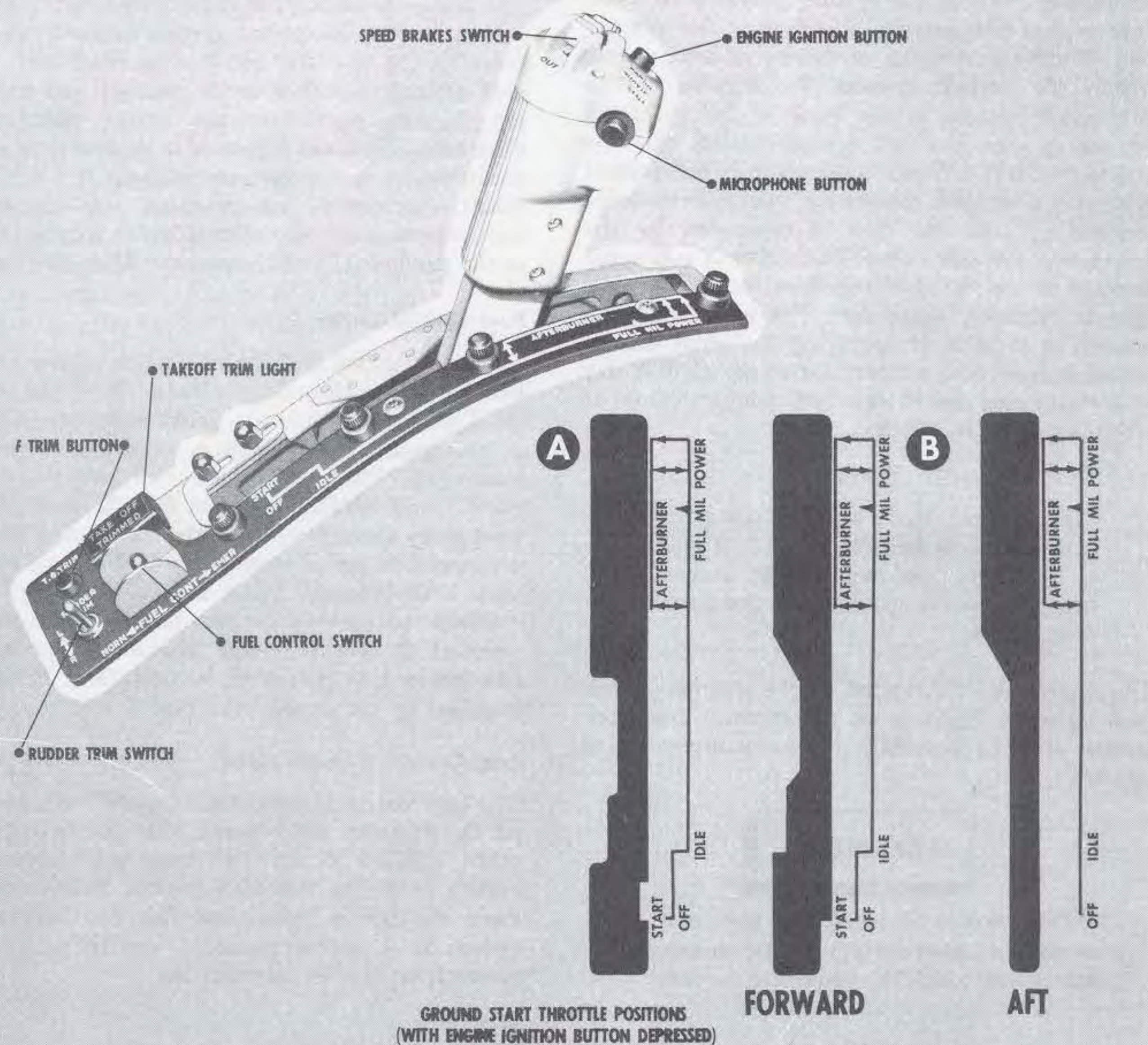
Fuel Control Warning Light

The fuel control warning light (figure 1-36), located on the warning light panel, illuminates and displays "EMER FUEL ON" when the fuel control switch is in the EMER position. Before engine start, the light is illuminated when the fuel control switch is in either position. The light receives power from the dc essential bus.

THROTTLE

Engine thrust is controlled by the throttle (figure 1-6) which is located on the left-hand console. The throttle is mechanically linked to the fuel control unit and controls the normal fuel system, emergency fuel system and afterburner operation. The throttle grip contains the speed brakes switch, engine ignition button, and the microphone button. An anticreep assemby is installed in the throttle quadrant to prevent throttle creep in the fore and aft directions. A stop below the IDLE position prevents inadvertent movement of the throttle into the OFF position. Depressing the engine ignition

throttle quadrant (typical)



POSITION	ACTION
START	• GROUND STARTER UNIT OR AIRPLANE PNEUMATIC SYSTEM AIR-MOTORS STARTER INITIATING ENGINE ROTATION. • PNEUMATIC START – AIR APPLIED TO STARTER TO INITIATE ENGINE ROTATION. • CARTRIDGE START – DC ELECTRICAL CIRCUIT COMPLETED TO THE STARTER TO IGNITE CARTRIDGE.
OFF	• ENGINE IGNITION ENERGIZED.
IDLE	• FUEL INJECTED TO ENGINE & IGNITES IN COMBUSTION CHAMBERS.

Figure 1-6

button and moving the throttle outboard to START supplies air or dc electrical power to the starter. While continuing to hold the ignition button depressed, moving the throttle inboard supplies ignition to the engine. Advancing the throttle to IDLE supplies fuel to the combustion chambers. After the engine has started the throttle may be advanced to any desired position in the normal thrust range. At any point along the normal thrust range forward of the rear afterburner stop, the throttle may be moved outboard to the AFTERBURNER range. A detent mechanism in the quadrant prevents inadvertent movement of the throttle into the afterburner range. It also holds the throttle outboard when afterburner operation has been selected. A mechanical pin prevents movement of the throttle inboard at the full forward throttle position. The throttle must be retarded slightly aft before movement inboard out of AFTERBURNER can take place.

NOTE

Stall-buzz can be caused by improper throttle movement. Refer to THROTTLE MANAGEMENT TO AVOID STALL-BUZZ, Section VII.

THROTTLE

Engine thrust is controlled by the throttles (figure 1-6) which are located on the left consoles, one on the forward console and one on the aft console. The throttles are mechanically interconnected to provide simultaneous fore and aft motion but not simultaneous side motion (inboard and outboard). An anticreep assembly is installed on the aft throttle quadrant to prevent throttle creep fore or aft. A stop below the IDLE position, on the forward throttle quadrant only, prevents inadvertent movement of the throttle into the OFF position, and because side motion of the throttles is not interconnected, prevents engine shutdown from the rear seat. Fore and aft movement of either throttle operates the fuel control unit (through a mechanical leakage) to control the normal fuel system and the emergency fuel system. Depressing the engine ignition button and moving the throttle outboard to START supplies air or dc electrical power to the starter. While continuing to hold the ignition button depressed, moving the throttle inboard supplies ignition to the engine. Advancing the throttle to IDLE supplies fuel to the combustion chambers. After the engine has started, the throttles may be advanced to any desired position in the normal thrust range. At any point along the normal thrust range forward of the rear afterburner stop, afterburner operation may be initiated by moving either throttle outboard to the AFTERBURNER range. Afterburner operation is terminated when both throttles are moved inboard. The afterburner stop is canted to allow the opposite cockpit to terminate the afterburner by pulling the throttle below the aft stop. Each quadrant has a "fence" which prevents inadvertent movement of the throttle into the afterburner range and also holds the throttle outboard when afterburner operation has been selected. A mechanical pin prevents movement of the throttle inboard out of AFTERBURNER unless the throttle is retarded slightly aft. The throttle grip contains the speed brakes switch, the ignition button, and the microphone button.

NOTE

Stall-buzz can be caused by improper throttle movement. Refer to THROTTLE MANAGEMENT TO AVOID STALL-BUZZ, Section VII.

ENGINE PRESSURE RATIO (EPR) GAGE

The engine pressure ratio gage (figures FO-1 and FO-2) is located on the instrument panel and indicates engine thrust for use during before takeoff check and for establishing inflight cruise thrust settings. During the before takeoff engine checks the gage is used to determine whether the engine thrust on the ground at full throttle is acceptable for takeoff. Engine pressure ratio (the ratio of turbine discharge pressure to pitot pressure from the pitot-static system) is indicated in increments from 1.2 to 3.4. Maximum and minimum takeoff thrust settings are obtained from the Takeoff Check Table, Section II. These limits vary with ambient temperature. Two windows are in the dial face: the lower window shows takeoff pressure ratio; the upper window shows cruise pressure ratio. The ratios that appear in the windows are set by use of a knob at the lower left corner of the instrument dial. To set the proper takeoff pressure ratio in the window, the knob is pushed in and turned until the desired numbers appear in the lower window. This adjustment also moves the takeoff thrust index marker, at the edge of the dial, to the correct dial reading. During before takeoff engine check the indicating pointer should fall within the arc of the takeoff thrust index marker. To set the proper cruise pressure ratio in the window, the knob is pulled out and turned until the desired numbers appear in the upper window. This adjustment also moves the triangular cruise index marker, at the edge of the dial, to the correct dial reading. Cruise pressure ratio settings are obtained from the cruise charts in T.O. 1F-106A-1-1. Power to the EPR gage is supplied from the ac essential bus.

TACHOMETER

The tachometer (figures FO-1 and FO-2) indicates percentages of engine rpm. The main pointer is calibrate up to 100% rpm and the subpointer makes one complete revolution for each 10% change in engine rpm. By using the subpointer, up to 110% rpm can be read. The tachometer is self-energized and operates independently of the airplane electrical system.

ENGINE HOT-SECTION ANALYZER

The engine hot-section analyzer system provides exhaust gas temperature readings, exhaust thermocouple temperature spread check readings (forward cockpit only O), and an amber warning light indication of engine exhaust temperatures over 630°C. The analyzer system equipment consists of an exhaust gas temperature gage, a temperature spread check button, a hot section factor computer, a temperature spread check computer, a data recorder, an emergency inverter, and six thermocouples. The analyzer system records accumulatively, on the data recorder digital counter in the left main wheel well, engine hot section factor units (temperature versus time) when the engine exhaust temperature is above 575°C. Other features of the recorder consist of two digital counters that record seconds of engine operation at temperatures above 635°C and above 700°C. The recorder also registers "OVER" for engine temperatures over 725°C; "OVER" for temperatures over 800°C; and "OVER" when the exhaust thermocouple temperature differential exceeds specified limits (temperature spread check). The temperature spread check system measures the temperature differential between the coldest and hottest of the exhaust thermocouples. On demand, the spread check system provides a cockpit reading of the number of degrees of temperature differential and a warning light indication if the differential exceeds 140°C (forward cockpit only O). The temperature spread warning light feature is a secondary function of the exhaust overtemperature warning light. The analyzer system is in operation at any time there is electrical power on the airplane either from an external power source or from the airplane systems. Analyzer power for normal operation is supplied by the ac nonessential bus. In the event of ac power failure, power from the dc essential bus automatically operates the analyzer system emergency inverter. The analyzer circuitry is protected by two fuses or circuit breakers on right console.

Exhaust Gas Temperature (EGT) Gage

The exhaust gas temperature gage (figures FO-1 and FO-2) on the instrument panel provides engine exhaust temperature by digital readings in 2°C increments and by conventional sweep hand readings in 50°C increments. An electrical power failure flag displays "OFF" when the gage is not operating. When electrical power is removed, the gage will retain the last reading provided by the analyzer system. An amber overtemperature warning light is incorporated in the lower right side of the gage face. This light is illuminated when EGT exceeds 630°C. The light is also used in conjunction with the engine thermocouple temperature spread check (forward cockpit only O). The light illuminates when the temperature spread check is performed and the temperature differential between the coldest and hottest thermocouple exceeds 140°C.

EGT Spread Button

The EGT spread button, placarded "EGT SPREAD," is installed on the right console (figures FO-1 and FO-2) (forward cockpit only O). When the button is depressed, the exhaust gas temperature gage reading will indicate the engine thermocouple temperature differential reading. Illumination of the exhaust gas temperature gage warning light at this time is an indication that the temperature differential between the coldest and hottest of the engine thermocouples has exceeded 140°C. Release of the EGT spread button will remove the spread reading, extinguish the warning light (if illuminated), and permit resumption of the exhaust gas temperature readings.

FUEL FLOW INDICATOR

The fuel flow indicator (figures FO-1 and FO-2) registers the rate in pounds per hour of fuel flow into the engine. It is possible to obtain readings through a range of 0 to 24,000 pounds per hour flow. The fuel flow indicator does not indicate fuel flow to the afterburner system. Power is supplied from the ac essential bus. Occasionally fuel flow fluctuations of approximately 400 pph, caused by opening and closing of the pressurizing and dump valve, will be experienced. The rpm fuel flow point at which these fluctuations occur will vary; however, the range of greatest probability is between 3000 to 3500 pph fuel flow.

ENGINE STARTER

The engine is equipped with a breech loading cartridge/pneumatic starter. High pressure air is supplied from a ground source or the airplane's pneumatic power supply system.

Pneumatic Mode Starting

The pneumatic mode is the primary starting mode for all normal and routine flying operations. High pressure air from the ground source is supplied through the pneumatic filler valve in the left main wheel well. The start cycle is initiated by depressing the engine ignition button and moving the throttle outboard to the START position.

Cartridge Mode Starting

The cartridge mode is considered an alternate method of starting. This mode permits engine starting without the use of ground support equipment. Depressing the engine ignition button and moving the throttle outboard to the START position provides dc power for cartridge ignition. Expanding gases from the solid propellant cartridge causes the starter turbine to rotate and crank the engine. Once initiated, termination of the cartridge start will occur only upon cartridge burn out (approximately 20 seconds). Power for electrical controls comes from the dc essential bus. Cartridge and breech cap stowage is provided behind access panel 779 Ⓐ and 651 Ⓑ.

WARNING

- Except in an emergency, engine operation is prohibited when a live (unfired) cartridge is installed in the starter.
- Flights with a live cartridge in the starter breech are prohibited.

NOTE

The starter is inoperative during an air start. Engine rotation is dependent upon windmilling effect only.

IGNITION SYSTEM

The ignition system is energized only during engine starting, as combustion is continuous once the engine starts. The afterburner is ignited by "hot-streak" ignition and requires no electrical ignition for operation.

Automatic Ignition System

The automatic ignition system provides immediate relight following flameouts which are caused by momentary interruptions of air or fuel flow. The ignition deactivates automatically upon engine recovery.

Engine Ignition Button

The engine ignition button (figure 1-6) is located on the throttle. For ground starting, the ignition and starter circuits are electrically interconnected and it is necessary to depress the engine ignition button and move the forward throttle outboard to START to activate the ignition circuit. Ignition is then supplied to the engine by moving the throttle inboard to OFF while continuing to depress the engine ignition button. On Ⓐ airplanes a ground start cannot be accomplished from the aft seat. When airborne, a start can be accomplished at any throttle position by depressing the engine ignition button. The engine starter is bypassed, and windmilling effect provides engine rotation. On **O** airplanes airstarts can be made from the aft seat. During ground or flight operation, depressing the engine ignition button (when the surface and engine anti-icing switch is in AUTO) heats the ice detector probe to remove any accumulated ice. The engine ignition button receives power from the dc essential bus.

Engine Ignition Disconnect Switch

A two-position engine ignition disconnect switch, placarded "Engine Ignition," is located in the right main wheel well. The switch has positions ARM and DISARM. With the switch in DISARM, the engine can be air-motored but will not start. The switch receives power from the dc essential bus.

STARTER MODE SWITCH

A starter mode switch is located in the left main wheel well. The switch has three positions, CARTRIDGE, PNEUMATIC, and TEST. A test lamp adjacent to the switch is incorporated in to the start control circuit to illuminate whenever start power is present. When in the PNEUMATIC position, electrical power is directed to the pneumatic regulator valve. The CARTRIDGE position directs power to the breech cap and cartridge ignitor. In the TEST position, power to the pneumatic valve and the starter cartridge is interrupted, and dc power is available to check the test lamp.

ENGINE COOLING

Engine cooling is completely automatic. Ventilating air is routed through the two engine compartments.

ENGINE COMPARTMENT OVERPRESSURE WARNING LIGHT

The engine compartment overpressure warning light (figure 1-36) is located on the warning light panel and displays "ENG COMPT O PRESS." Illumination of the light indicates that pressure must be reduced in the engine accessory compartment to prevent damage to the fuselage from high pressure. The light is also an indication that the high-pressure pneumatic system has been used to operate the constant-speed drive air-oil cooler air valve actuator and if pressure is not reduced, the actuator will partially deplete the high-pressure pneumatic system. Once illuminated, the light will remain on for the duration of the flight even if the overpressure condition no longer exists. The light receives power from the dc essential bus.

ENGINE AFTERBURNER SYSTEM

Operation of the afterburner is controlled by the throttle. When the throttle is placed outboard to the AFTERBURNER range, the afterburner shutoff valve is opened by power from the dc essential bus. At the same time afterburner fuel pressure to the exhaust nozzle control pneumatically opens the exhaust nozzles during afterburner operation. When engine thrust is varied, afterburner thrust will also vary.

NOTE

The afterburner can be used while the engine is operating on the emergency fuel control system if the main system fails.

CAUTION

When operating on the emergency fuel control system, rapid throttle movements must be avoided to prevent overspeed, overtemperature, compressor stalls, and flameouts.

AFTERBURNER EXHAUST NOZZLE

The two-position exhaust nozzle is closed or opened to provide the proper exhaust opening for either normal or afterburner engine operation. The nozzle moves to the full open position during afterburner operation and returns to the closed position when afterburner is terminated. Emergency override control of the exhaust nozzle is not possible.

Idle Thrust Control Switch

The idle thrust control switch (figures FO-1 and FO-2) is located on the left subconsole. On **O** airplanes the switch is located in the forward cockpit only. The switch is placarded "Idle Thrust Control" and has position ON and OFF. When the switch is ON, the nozzle opens, significantly reducing effective thrust. When the switch of OFF, the exhaust nozzle is closed. Power is supplied by the dc essential bus.

NOTE

- The switch is used to reduce thrust during taxiing or landing roll.
- The switch is operative only when the weight of the airplane is on the left main landing gear.
- Thrust in the afterburner range is not affected by the idle thrust control switch.

AFTERBURNER EXHAUST NOZZLE CONTROL UNIT

The afterburner exhaust nozzle control unit provides automatic control of the exhaust nozzle. A feature is incorporated into this system which aids afterburner ignition at high altitude by delaying the nozzle opening until the afterburner has ignited (hard light). At low altitude the afterburner nozzle opens as the throttle is moved outboard or slightly before afterburner ignition occurs (soft light).

AFTERBURNER EMERGENCY SHUTOFF

Should a failure of the afterburner electrically operated shutoff valve be encountered during afterburner operation, an afterburner shutdown may be accomplished by retarding the throttle to a point slightly aft of the afterburner stop.

OIL SUPPLY SYSTEM

The engine oil system supplies the engine with oil for lubrication and cooling. See figure 2-11, Servicing Diagram, for oil specifications.

OIL PRESSURE GAGE

An oil pressure gage (figures FO-1 and FO-2) is located on the right-hand console. This gage indicates output pressure of the engine oil pump in pounds per square inch. The oil pressure gage is powered by the ac essential bus.

NOTE

The oil pressure gage needle may normally fluctuate as much as ±2.5 psi.

OIL PRESSURE-LOW WARNING LIGHT

The oil pressure-low warning light (figure 1-36) is located on the master warning light panel, and when illuminated displays "OIL PRESS." When oil pressure is increasing, the light should go out before pressure reaches 40 psi. When oil pressure is decreasing, the light will not illuminate until pressure drops to 37 ±2 psi. The oil pressure-low warning light receives power from the dc essential bus.

NUCLEONIC OIL QUANTITY GAGE

The oil quantity gage (figures FO-1 and FO-2) is installed above the master warning light panel. In O aircraft, it is installed in the front cockpit only. The gage is marked in 1/16 graduations from empty (E) to full (F). The E through F range indicates the amount of usable oil in the oil tank. A characteristic of the nucleonic system gage is "wandering" of the needle. It is normal for the needle to fluctuate up to plus or minus two graduations even with wings level, unaccelerated flight. Movements of the needle in excess of this "wandering" are indications of actual oil quantity variations in the oil tank.

During turns, accelerations, and decelerations, the oil quantity in the tank varies slightly and this is reflected on the gage. This variation should not normally exceed plus or minus two graduations either side of normal needle movement. During maneuvers, positive g loads may cause the indicator to show a slight increase in oil quantity while negative g loads may show a decrease in oil quantity.

With power off or with gage or system failure, the gage should read overfull with the needle pointing steady at approximately one graduation beyond the F. Prior to takeoff during the engine check, the needle movement should be in the green range. During flight maneuvers, the needle may momentarily move into the amber range. However, this is considered normal. Continuous needle movement in the amber range or illumination of the oil quantity low warning light is an indication of low oil quantity and the recommended emergency procedure should be followed. The oil quantity gage is powered by the ac essential bus.

Oil Quantity Low Warning Light

The oil quantity low warning light is actuated when the oil quantity in the tank drops to the one-fourth full indication plus or minus one-half of a graduation. On Ⓐ aircraft, the warning light is located on the master warning light panel and illuminates "OIL QUAN LOW." On Ⓑ aircraft, the amber "OIL LOW" indicator light is located on the mounting bracket that supports the oil quantity gage. Illumination of the oil quantity low warning light illuminates the master warning light. The oil quantity low warning light receives power from the dc essential bus.

FUEL SUPPLY SYSTEM Ⓐ

Fuel is supplied to the engine fuel control system by the airplane fuel system (figure FO-3) which consists of four tanks in each wing and an F (fuselage) tank located aft of the cockpit. The fuel system control panels are shown in figure 1-7. To improve airplane performance at supersonic speeds, an automatic fuel transfer system is installed to shift the cg forward and aft under specified flight conditions. To facilitate this cg change as desired, fuel is transferred between the F tank and two T (transfer) tanks which are located along the aft wing sections. Provisions are also included for the installation of two 360-gallon external wing tanks. The airplane may be refueled to full internal fuel or full internal and external fuel configuration. The three main tanks in each wing function as an individual tank and the fuel systems in each wing operate independently of each other. (The pilot cannot transfer fuel from one wing to the other.) All internal fuel tanks are the integral type composed of airplane structure and are not self-sealing. For fuel tank capacities, refer to the Fuel Quantity Data Table, figure 1-8. Fuel specifications are shown in figure 2-11.

NOTE

Fuel quantities quoted in the manual are exact. However, they may vary because of temperature, probe tolerances, and gage tolerances.

FUEL SUPPLY SYSTEM Ⓑ

Fuel is supplied to the engine fuel control system by the airplane fuel supply system (figure FO-3) which consists of two wing tank systems (three main tanks and one T tank in each wing) and an F tank. The three main tanks, and the T tank in each wing, operate as an individual tank system and the fuel systems in each wing operate independently of each other. The fuel system control panels are shown in figure 1-7. (The pilot cannot transfer fuel from one wing to the other.) The airplane may be refueled to the full internal fuel or the full internal and external fuel configuration. Provisions are included for two 360-gallon external wing tanks. All internal fuel tanks are the integral type composed of airplane structure and are not self-sealing. For fuel tank capacities, refer to the Fuel Quantity Data Table, figure 1-8. Fuel specifications are shown in figure 2-11.

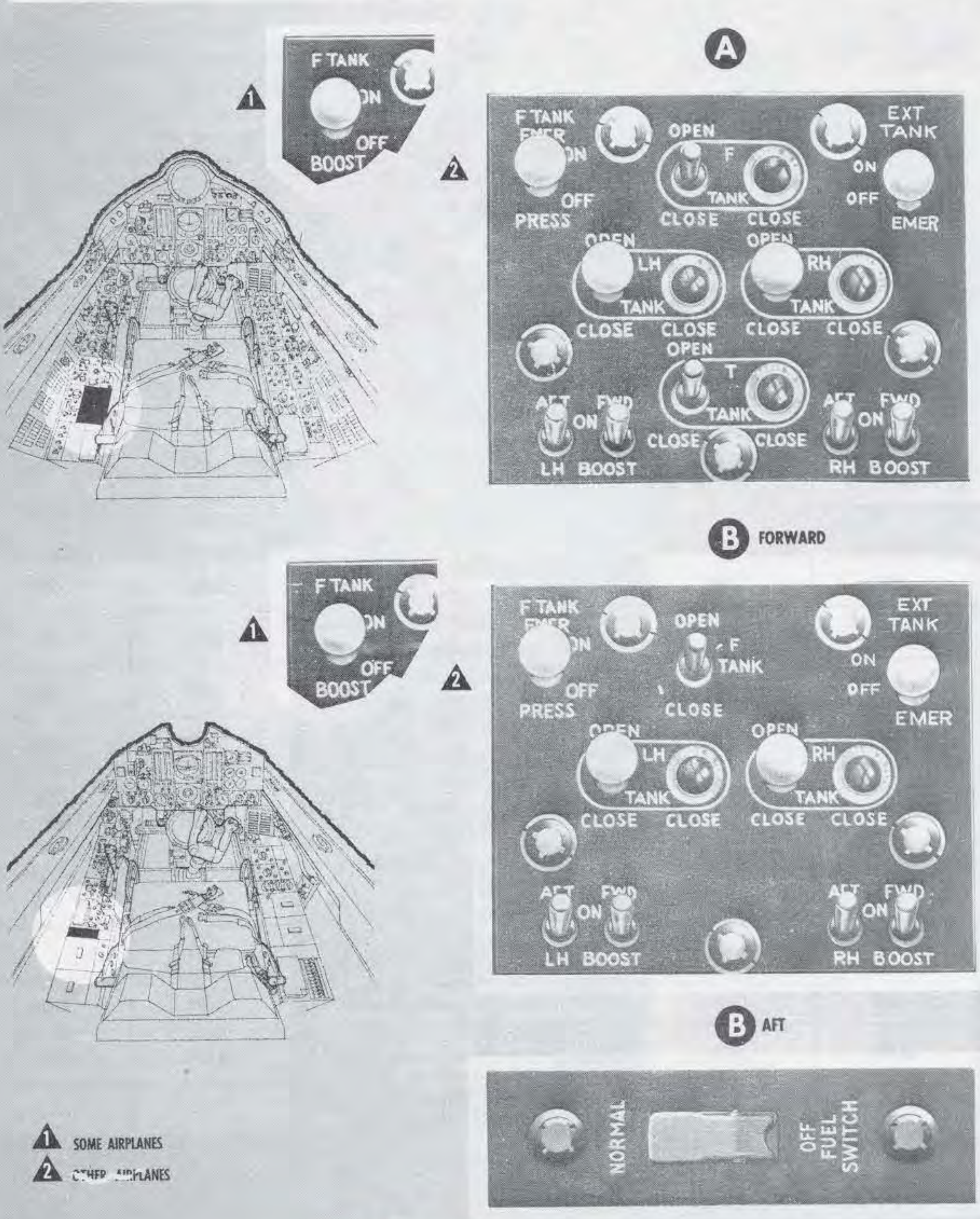
NOTE

Fuel quantities in this manual are exact. However, they may vary because of temperature, probe tolerances and gage tolerances.

FUEL TRANSFER SYSTEM Ⓐ

The main fuel tanks in each wing are numbered in the order in which they are emptied. Tanks No. 1, 2, and 3 are located respectively in the forward, aft-outboard, and aft-inboard sections of the wings. A T tank is located aft of No. 2 and 3 tanks in each wing. Fuel is supplied under pressure from each No. 3 tank by the two electrically driven boost pumps through fuel shutoff valves to the engine fuel control system. These pumps are located in the forward-outboard and aft-inboard sections of each No. 3 tank. Boost pump inlets are located in the top and bottom of the fuel tanks to ensure fuel supply during all airplane attitudes. A fuel flow equalizer is provided to insure symmetrical fuel usage from the left- and right-hand fuel systems. If the boost pumps are inoperative, the engine-driven fuel pumps will draw fuel through a dual check valve inlet located on the outside of the boost pumps. Fuel tank pressurization is provided to facilitate fuel transfer, to provide adequate fuel pressure to the engine fuel control system, and to prevent excessive high-altitude fuel vaporization. The fuel tank pressurization air is engine compressor bleed air which is pressure regulated and has passed through the air-conditioning primary heat exchanger. For tank pressurization and to provide fuel flow through each wing tank system, air pressure enters No. 1 tank in each wing fuel system. As fuel is drawn from No. 3 tank by the boost pumps, the pressure differential between tanks forces fuel from No. 1 tank into No. 2 tank, which in turn, forces fuel into No. 3 tank.

fuel control panels
(typical)



48013

Figure 1-7

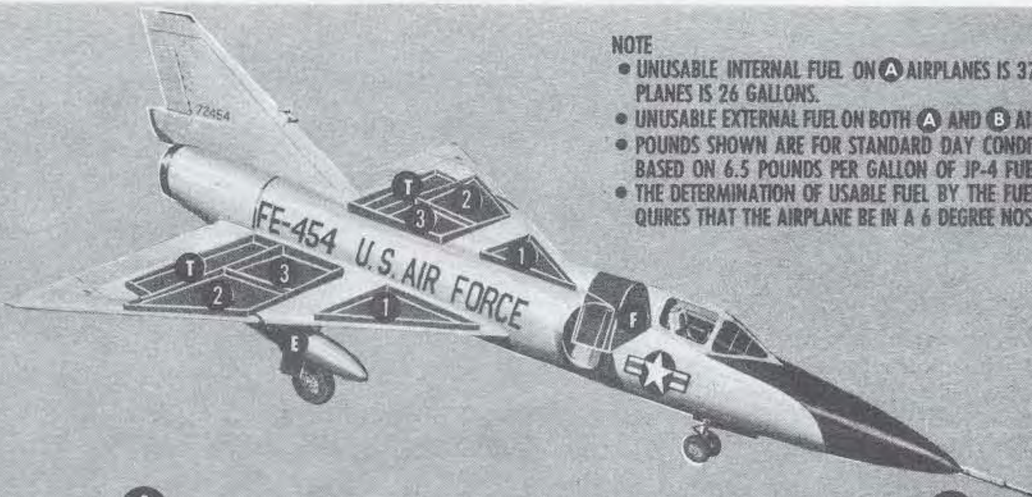
fuel quantity data table

DATE: 21 FEBRUARY 1967
DATA BASIS: ACTUAL

U.S. GALLONS AND POUNDS

NOTE

- UNUSABLE INTERNAL FUEL ON Ⓐ AIRPLANES IS 37 GALLONS ON Ⓑ AIRPLANES IS 26 GALLONS.
- UNUSABLE EXTERNAL FUEL ON BOTH Ⓐ AND Ⓑ AIRPLANES IS 4 GALLONS.
- POUNDS SHOWN ARE FOR STANDARD DAY CONDITIONS ONLY AND ARE BASED ON 6.5 POUNDS PER GALLON OF JP-4 FUEL.
- THE DETERMINATION OF USABLE FUEL BY THE FUEL QUANTITY GAGE REQUIRES THAT THE AIRPLANE BE IN A 6 DEGREE NOSE-HIGH ATTITUDE.



Ⓐ USABLE FUEL			Ⓑ USABLE FUEL	
POUNDS	GALLONS		POUNDS	GALLONS
1944	299	NO. 1 WING TANKS	1944	299
2021	311	NO. 2 WING TANKS	2067	318
2756	424	NO. 3 WING TANKS	2782	428
1365	210	TRANSFER TANKS	1443	222
1560	240	FUSELAGE TANK	1144	176
195	30	LINES	45	7
4654	716	EXTERNAL TANKS	4654	716
9841	1514	TOTAL USABLE FUEL FULL INTERNAL FUEL CONFIGURATION	9425	1450
14,495	2230	TOTAL USABLE FUEL WITH EXTERNAL TANKS	14,079	2166

48014-1

Figure 1-8

NOTE

- When installed, the external wing tanks replenish the No. 1 tanks. Normally, transfer of fuel from the external wing tanks will not commence until the landing gear is up and locked. With the landing gear down, fuel will be used from the No. 1 tanks. After some fuel has been used from each No. 1 tank, the T tanks will replenish the No. 1 tanks at approximately engine consumption rate. When the landing gear is retracted the external wing tanks will replenish the No. 1 tanks to full capacity.
- If required, fuel can be transferred from the external tanks to the No. 1 tanks with the landing gear down by placing the external tank emergency switch to the ON position. Once actuated, the switch must remain ON until the external tanks are empty; otherwise, pressurization in the tanks will cause fuel to be vented overboard.

If refueled for a full internal and external fuel condition, after the external wing tanks are emptied and some fuel has been removed from each No. 1 tank, the T tanks replenish the No. 1 tanks at approximately engine consumption rate. When the T tanks are empty, approximately 400 pounds of fuel is transferred from the F tank to the No. 1 tanks.

NOTE

While each T tank normally replenishes its own wing No. 1 tank, it will replenish the opposite wing No. 1 tank through the transfer line should its own wing fail to feed properly.

The remainder of fuel in the No. 1 tanks is then used, followed by all of the fuel in the No. 2 tanks. Fuel is used from each No. 3 tank down to the 1200-pound level (approximately 3500 pounds total fuel) at which time the remainder of F tank fuel is transferred to the No. 3 tanks. When the fuel level in either No. 3 tank drops below the 570-pound level, the fuel scavenge system forces the residual fuel from the bottom of the F and T tanks and from the transfer line into the No. 3 tank. During a high-angle dive, the fuel line from tank No. 2 to tank No. 3 may become uncovered, disrupting normal fuel flow from No. 2 tank and permitting air to enter No. 3 tank as fuel is removed by the boost pumps. After return to level flight, the air in No. 3 tank is vented overboard and normal fuel flow is resumed.

FUEL TRANSFER SYSTEM O

The main fuel tanks in each wing, tanks No. 1, 2, and 3, are located respectively in the forward, aft-outboard and aft-inboard sections of the wings. The T tanks, one in each wing, are located aft of tanks No. 2 and 3. Two electrically driven boost pumps supply fuel from each No. 3 tank to the engine fuel control system. These pumps are located in the forward-outboard and aft-inboard sections of each No. 3 fuel tank. Boost pump inlets are located in the top and bottom of the fuel tanks to ensure fuel supply during all airplane attitudes. A fuel flow equalizer is provided to ensure symmetrical fuel usage from the left and right fuel systems. Fuel shutoff valves located in the outlet of each No. 3 tank can be operated independently (from the forward seat only) to shut off one wing tank at a time, or simultaneously (from both seats) to shut off the entire fuel supply. If the boost pumps are inoperative, they will be bypassed and the engine-driven fuel pumps will draw fuel through a dual check valve inlet (one in each No. 3 tank) located downstream of the boost pumps. Fuel tank pressurization is provided to facilitate normal fuel flow through each wing tank system, to assure adequate fuel pressure to the engine fuel control, and to prevent excessive high-altitude fuel vaporization. Air pressure is supplied from engine compressor bleed air which is pressure regulated and has passed through the air-conditioning heat exchanger. Relief and check valves are provided to protect the fuel tanks against excessive pressures and to prevent vacuum or incorrect fuel or air flow within the system. Without external tanks installed and refueled to a full internal capacity, fuel flows from tank No. 1 to tank No. 2, to the T tank and into the No. 3 tank. All F tank fuel is transferred to the No. 3 tanks at approximately engine consumption rate when some fuel has been used from each T tank. Both right and left wing tanks are replenished independently. System design ensures that No. 3 tanks are the last to empty. When installed, the external wing tanks replenish the No. 1 tanks. Normally, transfer of fuel from the external tanks will not begin until the landing gear is up and locked. With the landing gear down, fuel will be used from the No. 1 tanks. When the landing gear is retracted, the external tanks replenish the No. 1 tanks to full capacity. When the fuel level of either No. 3 tank drops below 570 pounds the fuel quantity-low warning light illuminates and the scavenge system in the F tank is automatically actuated. Air pressure is directed to open the F tank pressure regulator and the residual fuel in the F tank and F tank line is forced into the No. 3 tanks. During a high-angle dive, the fuel line from the T tank to tank No. 3 may become uncovered, disrupting normal flow from the T tank. This permits air to enter the No. 3 tank as fuel is removed by the boost pumps. After return to level flight, the air in tank No. 3 is vented overboard and normal fuel flow is resumed.

NOTE

If required, fuel can be transferred from the external tanks to the No. 1 tanks with the landing gear down by placing the external tank emergency switch to the ON position. Once actuated, the switch must remain ON until the external tanks are empty; otherwise, pressurization in the tanks will cause fuel to be vented overboard.

HOPPER TANK

A hopper tank is installed in the inboard aft corner of each No. 3 wing tank. Fuel flows into the hoppers through one-way flapper valves and traps fuel in the area around the aft bellmouth. The hopper will supply fuel for approximately 30 seconds in the event of complete boost pump failure when the airplane is nosed down, in extreme banks, and/or during sudden decelerations.

CG FUEL TRANSFER SYSTEM

The effectiveness of the airplane is improved by controlling the airplane weight distribution in such a way that during specific speeds and at specific altitudes the cg is as far aft as permissible to reduce drag. At lower speeds and altitudes, it is necessary to shift the cg forward to facilitate airplane stability. This cg control in flight is accomplished by automatic transfer of fuel between the F tank and the T tanks. This results in moving the average cg aft during the supersonic portion of the flight.

NOTE

- Fuel transfer aft to forward requires approximately 20 to 25 seconds.
- CG fuel transfer can be noted by placing the fuel quantity gage switch in the FWD position and monitoring the fuel quantity gage for an increase in fuel quantity during forward transfer, or a decrease in fuel quantity during aft transfer.

The fuel transfer signal is applied by air data computer at approximately Mach 1.2. After application of the transfer signal, some delay may occur, dependent upon which tanks (F or T) are pressurized, and the available air pressure. Forward transfer will also occur when descending through 13,000 (±500) feet. Regardless of the flight condition, if the fuel in either No. 3 tank drops to 1200 pounds, fuel will be transferred from the F tank or the wing T tanks to maintain about 1200 pounds in the No. 3 tank until all transfer fuel is used. Engine compressor bleed air is utilized to provide the motive power for all normal fuel transfer operations. After completion of each fuel transfer operation, the empty tanks are automatically depressurized.

NOTE

- In the event of loss of engine compressor bleed air while fuel is aft in the T tanks, high-pressure air from the pneumatic system will automatically transfer the fuel forward to ensure airplane stability at subsonic speeds.
- In event of dc nonessential power failure while fuel is aft in T tanks, fuel will immediately transfer forward.
- Refer to FLIGHT CHARACTERISTICS WITH AFT CG, Section VI, for additional information.

CG Control Switch

A guarded three-position cg control switch is provided to manually control the automatic fuel control transfer system. The cg control switch (figure FO-1) is located forward of the throttle quadrant on the left-hand subconsole. The switch is placarded "CG Control" or CG Cont" with AUTO, FWD and TEST positions. When the switch is in

AUTO position, fuel transfer aft and forward will automatically occur at a preset altitude and Mach as determined by the air data computer. When the switch is placed in FWD position, fuel transfer aft is prevented at all flight conditions or if the fuel is in the T tanks it will transfer forward to the F tank. When the switch is placed in the TEST position, fuel will be transferred aft and the cg transfer test failure light will illuminate on the fuel control panel if F tank pressure is low. During ground operation with the switch in the FWD or AUTO position, the cg transfer test failure light will illuminate if transfer tank pressure is low. Power is supplied by the dc nonessential bus.

CG Transfer Test Failure Light

A cg transfer test failure light placarded "Transfer Test Fail Lt," is located on the left console and indicates low pressurization in the transfer and fuselage tanks. With the engine running at a minimum of 75% rpm and with anti-icing equipment off, the light will illuminate when:

1. Transfer tank pressurization is low, with the cg control switch in either the FWD or AUTO positions, landing gear extended, the T tanks contain more than scavenge fuel, and T tank pressure is low.
2. The cg control switch is actuated to the TEST position and fuselage tank pressurization is low.

NOTE

- The light will illuminate momentarily after placing the switch to TEST until fuselage tank pressure builds up.
- At thrust settings below 75% rpm or with anti-icing equipment on, illumination of the light may be due to insufficient engine compressor bleed air.

EXTERNAL WING TANKS

Two jettisonable external wing tanks can be installed to augment the internal fuel supply. Installation provisions are made on the lower surface of each wing for the tanks which can be jettisoned by a ballistic charge. The 360-gallon tanks are mounted on ejection racks under each wing. The fuel in the external tanks is transferred into No. 1 tanks by engine bleed air pressure which is regulated at a higher pressure than that of the normal fuel system.

NOTE

- Normally, transfer of fuel from the external tanks to the No. 1 tanks will not commence until the landing gear is up and locked.
- If required, fuel can be transferred from the external tanks to the No. 1 tanks with the landing gear down by placing the external tank emergency switch to the ON position. Once actuated, the switch must remain ON until the external tanks are empty; otherwise, pressurization in the tanks will cause fuel to be vented overboard.

As the fuel level in No. 1 tanks lowers, the high-level floats within the No. 1 tanks open the external tanks shutoff valves and allow air pressure to force fuel from the external tanks into the No. 1 tanks. A combination valve dumps external pressure when the fuel is exhausted and also provides pressure relief and dumping for the external tanks during climbs and descents. Since external fuel is not indicated on the fuel quantity gage, fuel transfer from the external tanks can be noted by the fact that fuel quantity indication will not decrease until the external tanks have emptied.

NOTE

Loss of dc nonessential power to the external wing tank fuel shutoff valve will cause fuel transfer to cease.

Refer to Section V for operating limitations with external tanks installed.

External Wing Tanks Release Button

The external tanks release button (figure 1-16) is provided to jettison the external tanks. The button is located on the landing gear control panel and is placarded "Wing Tank Release." When the button is depressed, electrically fired ballistic charges unlock and separate the tanks from the ejection racks. The jettison circuit receives power from the dc essential bus.

CAUTION

If the tanks are jettisoned while the landing gear is extended, the landing gear fairing doors will be damaged as the external tanks are released.

External Tank Ground Safety Pin

A ground safety pin may be inserted into either side of the tank ejection racks. The safety pin is a ball-locking type pin. It safeties the ballistic jettison system and provides a mechanical lock to prevent inadvertent separation of the tank from the rack. The pin is equipped with a remove-before-flight streamer.

SINGLE-POINT REFUELING

The internal and external fuel tanks are serviced through a single-point refueling adapter located in the lower right engine inlet duct fairing. The tanks are refueled in a reverse manner to normal tank transfer sequence, and selective refueling of internal tanks is not possible. If the refuel selector valve is in the OPEN position all internal and external tanks will be refueled; however, if the refuel selector valve is in the CLOSED position internal tanks only will be refueled. The external tanks may also be refueled through a filler cap on each tank. External electrical power is not required during refueling operations.

Refuel Selector Valve

A manually controlled refuel selector valve is located in the right main wheel well and has two marked positions, OPEN (horizontal) and CLOSED (vertical). When the handle is in the OPEN position the internal and external tanks are refueled during the refueling process. However, when the handle is in the CLOSED position, the external tanks cannot be refueled.

FUEL SHUTOFF VALVES

Two two-position, electric motor driven, sliding gate valves are used to shutoff the fuel supply to the engine from the tanks. The valves can be controlled individually or simultaneously by the fuel shutoff switches. On all O airplanes the fuel shutoff valves are closed simultaneously by actuation of the aft cockpit fuel shutoff switch.

NOTE

Normally the valves require one second or less to rotate to the fully closed position. However, if the master electrical power switch is turned OFF during valve rotation, the sliding gate fuel shutoff valves will remain partially open.

The valves, one in each wing tank outlet fuel line, have an indicator pin that indicates the valve position. The indicator pins are visible in the respective aft engine access bay and are surrounded by a 2 inch diameter white circle with the letters "O." and "C" depicting the open and closed position. The indicator pin on the left side of the aircraft points upward to the letter "O" in the valve open position and rotates 90 degrees toward the aft side of the circle to the letter "C" in the valve closed position. On the right side of the aircraft the indicator pin points downward in the valve open position and rotates aft to the valve closed position. The indicator pin always points horizontally aft in the valve closed position.

WARNING

If an indicator pin does not point to the "O" during Preflight Exterior Inspection, verify the valve is fully OPENED prior to flight.

The fuel shutoff valves are normally open during flight and are powered by the dc essential bus. The boost pumps will continue operating when the fuel shutoff valve on the appropriate side is closed.

FUEL FLOW EQUALIZER

A fuel flow equalizer is used to regulate symmetrical fuel usage from each wing tank system. The flow equalizer is located in the fuel line between No. 3 tanks and the engine fuel control unit. A bypass condition is automatically established to ensure fuel supply in the event of boost pump failure (within one or both wings) or malfunction of the flow equalizer. Power is received from the dc essential bus.

FUEL SHUTOFF SWITCHES

WARNING

If a fuel shutoff switch is inadvertently moved to the CLOSED position by the pilot or is found in the CLOSED position during the Preflight Interior Inspection, verify that the fuel shutoff valve is fully OPENED prior to flight.

On Ⓐ airplanes, four two-position switches (figure 1-7), located on the fuel control panel, control the fuel and air shutoff valves. The two switches placarded "LH Tanks" and RH Tanks" control the respective fuel shutoff valves; and the two switches placarded "F Tank" and "T Tank" control the respective air shutoff valves. Each switch has an OPEN and CLOSE position. When either the F tank or T tanks valves are closed, the respective tank vents and fuel flow from that tank will cease. When any shutoff valve is in other than the fully open position, warning lights on both the fuel control panel and the master warning light panel will illuminate. The switches receive power from the dc essential bus.

On Ⓑ airplanes, three two-position shutoff switches are located on the forward fuel control panel and a two-position fuel shutoff switch is located on the aft fuel control panel. Two of the forward switches are placarded "LH Tanks" and "RH Tanks" and have OPEN and CLOSE positions. The two switches control the respective fuel shutoff valves. The third forward switch is placarded "F Tank" and has OPEN and CLOSE positions. It controls the F tank air shutoff valve which controls fuel flow from the F tank.

NOTE

On airplanes with the F tank emergency boost pump switch, the F tank shutoff switch should be in the CLOSED position during operation of the F tank emergency boost pump.

The aft switch has NORMAL and OFF positions. With the aft switch in the NORMAL position, the fuel shutoff valves are controlled by the forward fuel shutoff switches. When the aft fuel shutoff switch is in the OFF position, all fuel shutoff valves are closed regardless of the position of the forward fuel shutoff switches. Power is supplied from the dc essential bus.

BOOST PUMP SWITCHES

Four two-position fuel boost pump switches (figure 1-7) are located on the fuel control panel to provide individual control of the fuel boost pumps. The switches are placarded "LH Fwd Booster," "LH Aft Booster," "RH Fwd Booster," and "RH Aft Booster" with ON and OFF positions. The boost pumps will remain in operation even though the fuel shutoff valves are closed.

WARNING

Before either right or left fuel shutoff switch is placed in the CLOSE position, thereby closing a fuel shutoff valve in either tank, the respective fuel boost pump switches must be placed in the OFF position. If the boost pumps are not turned OFF, failure of the fuel equalizer absolute pressure switch may result in engine fuel starvation.

The boost pumps are powered from the ac nonessential bus or the ATG bus and the control circuit receives power from the dc essential bus.

NOTE

When all boost pumps are turned OFF, a normal increase or decrease of as much as two percent engine rpm may occur.

TRANSFER TANK SHUTOFF SWITCH Ⓐ

On Ⓐ airplanes the T tank shutoff switch (figure 1-7), placarded "T Tank," is located on the fuel control panel. The switch has OPEN and CLOSE positions. Selecting the CLOSE position depressurizes the T tanks. The switch receives power from the dc essential bus.

FUSELAGE TANK EMERGENCY PRESSURE SWITCH (SOME AIRPLANES) Ⓐ

On airplanes not equipped with an F tank emergency boost pump switch, an F tank emergency pressure switch is provided on the fuel control panel (figure 1-7). The switch is placarded "F Tank Emer Press" and has EMER ON and OFF positions. The EMER ON position permits air to flow directly into the F tank. Pressure relief valves are installed to prevent F-tank over-pressurization. After initial transfer of approximately 400 pounds of fuel from the F tank to the No. 1 tanks, the remaining fuel in the F tank will not transfer until the fuel in one of the No. 3 tanks decreases to 1200 pounds. Then the fuel remaining in the F tank is forced through a transfer line into the No. 3 tanks (L and R). After all fuel has been transferred, the switch should be returned to the OFF position to prevent continued loss of air through the pressure relief valve. The switch receives power from the dc essential bus.

FUSELAGE TANK EMERGENCY PRESSURE SWITCH (SOME AIRPLANES) (B)

On airplanes not equipped with an F tank emergency boost switch, an F tank emergency pressure switch is provided on the fuel control panel (figure 1-7). The switch is placarded "F Tank Emer Press" and has EMER ON and OFF positions. If tank pressure is low, the F tank low pressure warning light will illuminate. Placing the switch in EMER ON position will permit air to bypass the F tank pressure regulator, pressurizing the F tank and extinguishing the F tank pressure-low warning light. Pressure relief valves are installed to prevent F-tank over-pressurization. Fuel in the F tank will not transfer until the fuel in the left or right wing decreases to 2000 pounds. When the F tank is empty the F tank emergency pressure switch should be placed in the NORMAL (OFF) position. The F tank emergency pressure switch receives power from the dc essential bus.

FUSELAGE TANK EMERGENCY BOOST PUMP SWITCH (OTHER AIRPLANES)

(A)* and (B)** airplanes not equipped with an F tank emergency pressure switch have an F tank emergency boost pump switch located on the fuel control panel (figure 1-7). The switch is placarded "F Tank Boost" and has ON and OFF positions. With the switch in the ON position (and the F tank shutoff switch in the closed position) a boost pump in the F tank will supply fuel to the No. 3 tanks in the event F tank pressure fails. After all fuel has been transferred, the switch should be returned to the OFF position. The switch receives power from the dc nonessential bus.

EXTERNAL TANK EMERGENCY SWITCH

An external tank emergency switch is located on the fuel control panel (figure 1-7). The switch has ON and OFF positions and is normally left OFF. Placing the switch ON allows fuel to flow from the external tanks to the No. 1 tanks with the landing gear down. Normally, fuel will not transfer from the external tanks until the landing gear is up and locked. Placing the external tank emergency switch ON bypasses the main landing gear door-closed switch allowing the external tanks to pressurize. The switch must be left ON until the external tanks are empty; otherwise, pressurization will cause fuel to be vented overboard. The external tank emergency switch receives power from the dc nonessential bus.

FUSELAGE TANK PRESSURE-LOW WARNING LIGHT (B)

On (B) airplanes, the F tank pressure-low warning light (figure 1-36) is located on both the forward and aft warning light panels. When pressure in the F tank is low, the lights illuminate and display "F TANK PRESS," warning the forward pilot to place the F tank pressurization switch in the EMER position. After the F tank has been repressurized, the light will extinguish. The lights automatically extinguish when all fuel is used from the F tank. The warning lights receive power from the dc essential bus.

FUEL QUANTITY GAGE SELECTOR SWITCH

On (A) airplanes, the four-position fuel quantity gage selector switch (figures FO-1, FO-2, and 1-9) is located on the instrument panel. On (B) airplanes, the switch is located on the instrument panel of the forward cockpit only. The switch permits the reading of total or individual fuel tank quantities on the fuel quantity gage. If LH is selected, the fuel quantity in the left wing (No. 1, No. 2, No. 3, and T tank) will be indicated on the fuel quantity gage. If RH is selected, the fuel quantity in the right wing system will be indicated. If FWD (or F on some (B) airplanes) is selected, the fuel quantity in the F tank will be indicated; and if TOT is selected, the gage will indicate total internal fuel. However, since the individual fuel quantity indicating systems are calibrated separately from the total indicating system, and as a result of the inherent calibration tolerances in each system, an addition of the individual (LH, RH, and FWD) indicated quantities may or may not equal the total (TOT) indicated quantity. Therefore, total usable fuel aboard should be obtained in the TOT position. Power is supplied from the ac essential bus.

NUMBER 3 FUEL TANK SWITCH

On some airplanes, a No. 3 fuel tank switch (figures FO-1 and FO-2) is located above the right console. On (B) airplanes the switch is located in the forward cockpit only. The switch is placarded "Fuel Qty" and has spring-loaded RH #3 TANK and LH #3 TANK positions. With the fuel quantity gage selector switch in LH, RH, or TOT positions, the No. 3 fuel tank switch permits reading the No. 3 fuel tank quantities on the fuel quantity gage.

*(A) *54-453, -454, 56-456 thru 57-245, 57-2465, 59-087 & on.*
**(B) *57-2508 thru 57-2515, 57-2523, 59-160 & on.*

NOTE

- Do not attempt to obtain No. 3 fuel tank readings with the fuel quantity gage selector switch in the FWD position, as an erroneous indication will result.
- No. 3 fuel tank readings can be as much as 200 pounds low and still be within gage tolerances.

The switch receives power from the ac essential bus.

FUEL QUANTITY GAGE AND GAGE TEST BUTTON

The fuel quantity gage (figures FO-1 and FO-2), located on the instrument panel, indicates internal fuel quantities. The gage indicates the quantity of fuel in pounds and the system compensates for changes in fuel density.

NOTE

The fuel quantity gage readings may fluctuate momentarily when switches which utilize ac power are activated. The readings are also affected by airplane attitude and state of acceleration or deceleration; therefore, the individual system readings are more valuable as indications of proper fuel feeding than as accurate quantity readings.

On airplanes having a conventional instrument display, gage operation can be checked by a test button (figures FO-1 and FO-2) placarded "Fuel Qty Ind Test" on the instrument panel. When the test button is held depressed, the gage pointer should move toward zero, and when the button is released, the pointer should return to its original position. Failure of the pointer to move indicates a faulty system. The indicating system receives power from the ac essential bus.

FUEL QUANTITY-LOW WARNING LIGHTS

Two fuel quantity-low warning lights (figure 1-36), located on the warning light panel, illuminate and display "FUEL LOW—L" and "FUEL LOW—R" when the usable quantity of fuel in each No. 3 tank reaches approximately 570 pounds. These lights are a more accurate indication of low fuel level than the LH or RL or No. 3 tank fuel quantity readings. Fuel quantity-low warning light operation is predicated on a 6° nose high flight attitude. On the ground, the lights may illuminate with

fuel quantity checks

GROUND CONDITION

NOTE
THE FUEL QUANTITY GAGE READINGS IN THIS TABLE ARE BASED ON THE AIRPLANE BEING IN NORMAL GROUND POSITION.

(A) POUNDS		(B) POUNDS
9650 ±300		9380 ±300
4040 ±190	 	4120 ±190
1560 ±140		1160 ±135
1100 TO 1500	 	1100 TO 1500

48014-2

Figure 1-9

more than 570 pounds of fuel in the No. 3 tank. The fuel quantity-low warning circuits receive power from the dc essential bus.

NOTE

The fuel quantity-low warning lights will illuminate during maneuvers of less than 1 g.

EXTERNAL TANK EMPTY LIGHTS

Two external tank empty lights (figures FO-1 and FO-2) are installed on the instrument panel. The lights are in the **B** forward cockpit only. The lights illuminate amber, one displaying "LH EXT TANK EMPTY," and the other displaying "RH EXT TANK EMPTY." The lights illuminate when the external tanks are empty and remain on until the tanks are full. A "tanks aboard" switch prevents the lights from illuminating when the tanks are off the airplane. The lights receive power from the dc essential bus.

NOTE

Momentary negative g or uncoordinated maneuvers during flight may cause the lights to illuminate before the tanks are empty; however, the tanks will continue to transfer fuel.

FUEL SHUTOFF VALVE WARNING LIGHTS

On **A** airplanes, four shutoff valve warning lights (figure 1-7), located on the fuel control panel, illuminate when their respective shutoff valves are in any position other than fully open. On **B** airplanes, two fuel shutoff valve warning lights (figure 1-7), located on the forward fuel control panel, illuminate when their respective fuel shutoff valves are in any position other than fully open. When any one of the fuel shutoff valves is in any position other than fully open, the "FUEL VALVE CLOSED" warning light (figure 1-36), located on the master warning light panel, will also be illuminated, and will remain on until all fuel shutoff valves are in the open position. Power is supplied from the dc essential bus.

NOTE

On **B** airplanes the "FUEL VALVE CLOSED" warning light will not illuminate when the F tank shutoff switch is in the CLOSE position.

FUEL BOOST PRESSURE-LOW WARNING LIGHTS

Two fuel boost pressure-low warning lights (figure 1-36), located on the warning light panel, illuminate and display "FUEL BOOST PRESS—L" or "FUEL BOOST PRESS—R" if the left or right tank outlet pressure is low. The appropriate light will remain illuminated until the boost pump pressure is restored. The fuel boost pressure-low warning circuits receive power from the dc essential bus.

FUEL TANK PRESSURE-LOW WARNING LIGHTS

Two fuel tank pressure-low warning lights (figure 1-36), located on the warning light panel, illuminate and display "FUEL TANK PRESS—L" or "FUEL TANK PRESS—R" if the left or right No. 1 tank pressure is low. The appropriate light will remain illuminated until tank pressurization is restored. The fuel tank pressure-low warning circuits receive power from the dc essential bus.

ELECTRICAL POWER SUPPLY SYSTEM

Electrical power is supplied to airplane and MA-1 electrical systems by a single ac generator. Electrically operated equipment is listed in figure FO-4.

NOTE

This manual covers two aircraft and weapon control systems, the MA-1 incorporated in the F-106A airplane and the AN/ASQ-25 incorporated in the F-106B airplane. The text distinguishes between the two configurations only where necessary and will refer to all switches, controls, etc., in both the F-106A and F-106B aircraft weapon and control systems as the "MA-1."

The main ac generator is driven by the engine through a constant speed drive (CSD) unit. A 200-amp transformer-rectifier (TR) unit converts a portion of the generator output to dc power. An emergency 50-amp TR provides a backup dc power source in event of 200-amp TR failure. A 22-amp-hour battery is also available for emergency dc power. A hydraulically powered emergency ac generator and an air turbine motor driven ac generator (ATG) supply ac power if the main ac generator fails. Emergency systems energize automatically. External ac power is connected through a single receptacle on the left side of the airplane. The master electrical power switch controls the main generator but it does not control external power. External power takes precedence over airplane power. While external power is connected, the ac generator may be energized but is not connected to the airplane buses. Fuses/circuit breakers installed in panels protect airplane electrical circuits.

MASTER ELECTRICAL POWER SWITCH

A guarded master electrical power switch (figures FO-1 and FO-2) is located on the left console and controls electrical power to airplane buses. The switch is placarded "Master Elec Pwr" and has two positions, OFF and ON. Actuating the switch to the ON position connects the battery to the dc essential bus. With the switch in the ON position, generators can be energized. With the switch in the OFF position, all generator power is disconnected from airplane buses; however, the dc emergency bus is connected to the battery and the canopy will operate and, in emergencies, the drag chute and tailhook can be deployed. On O airplanes, bailout warning light power also is available with the switch of OFF position.

NOTE

> On O airplanes, the switches in both the forward and aft cockpits must be actuated to the ON position to connect the battery to the dc essential buses. With either switch in the OFF position, all generator and battery power is disconnected from the airplane buses and the battery is connected to the dc emergency bus.

DC ELECTRICAL POWER DISTRIBUTION

DC power is supplied by a 28-volt, 200-amp TR unit and, in event of main ac generator or 200-amp TR failure, by a 28-volt, 50-amp TR. The 200-amp TR unit is connected to the dc nonessential bus which, under normal conditions, powers the dc essential bus, the dc emergency bus, and all MA-1 28-volt dc systems. In event of 200-amp TR failure, dc power to the essential and emergency buses is provided by the 50-amp TR. If both the 200-amp TR and the 50-amp TR fail, dc power is supplied to the emergency and essential buses by a battery. The battery is charged by a charger installed in the nose wheel well and powered by the ac nonessential bus. Charging current is controlled automatically. Systems necessary for flight receive power from essential buses. Systems not necessary for flight are connected to the dc nonessential bus.

Transformer Rectifier, 200-Amp

A 200-amp TR is connected to the ac nonessential bus to convert ac power to dc power for the dc nonessential bus. If the 200-amp TR fails, the dc nonessential bus loses power and the 50-amp TR automatically assumes the load of the dc essential and emergency buses. The indications of 200-amp TR failure will be brief illumination of the dc power fail light (until the 50-amp TR assumes the electrical load) and loss of items on the dc nonessential bus including MA-1 subsystems. The 200-amp TR provides dc power automatically any time the ac nonessential bus is being powered by either the main ac generator or external power.

Transformer Rectifier, 50-Amp

A 50-amp TR supplies dc power to the essential and emergency buses in event of 200-amp TR or main ac generator failure. It is powered by the ac essential bus which is powered by the main ac generator normally or by the emergency ac generator if the main ac generator fails.

Battery

The battery is a nickel-cadmium storage battery. It is connected to the emergency bus any time external power is not applied to the airplane or when the master electrical power switch is in OFF position. When the master electrical power switch is in ON position, the battery is connected to the emergency bus through the essential bus until either 50-amp TR or 200-amp TR power is available. When TR power is available, the battery is disconnected from the emergency bus and connected to the battery charger. The battery charger operates whenever the ac nonessential bus is being powered either by external power or by the main ac generator. The battery will satisfy airplane emergency requirements during a 15-minute flight and landing profile following a 30-minute charging period of a depleted battery.

DC Power Failure Warning Light

The dc power failure warning light (figure 1-36), located on the warning light panel, illuminates and displays "DC power fail" if 200-amp TR and 50-amp TR outputs both fail and the essential bus is energized by the battery. This may occur from TR failures or input power failures.

NOTE

Failure of the 200-amp TR may result in only a momentary illumination of the dc power failure warning light until the 50-amp TR assumes the electrical load. Once the 50-amp TR has energized the dc essential and emergency buses, the light will go out. The only way the pilot can recognize loss of power to the dc nonessential bus is by either "AC POWER FAIL" being illuminated or by inoperative dc nonessential functions.

AC ELECTRICAL POWER DISTRIBUTION

AC electrical power is supplied for normal operation by a 115-volt main ac generator driven by the constant speed drive system. The generator supplies power to the ac essential, ac nonessential, and ATG buses. Systems necessary for flight receive power from the ac essential and ATG buses. Systems not necessary for flight receive power from the ac nonessential bus. The ac emergency generator supplies power to the essential bus only. A hydraulic motor that operates from the secondary hydraulic system drives the emergency ac generator. If the ac generator fails, the emergency generator starts automatically when airborne. When the emergency generator reaches operating speed, a relay connects the emergency generator to ac essential buses. An air turbine motor driven generator (ATG) is installed to provide ac power (in the event of ac generator failure) to the fuel boost pumps, pitot heat, TACAN, and ILS. It operates simultaneously with, but independently of, the hydraulic powered emergency ac generator. The ATG is driven by the low-pressure pneumatic system. An automatic changeover feature is incorporated to energize the ATG in event of main ac power failure.

NOTE

In the event of ac generator failure, the TACAN and ILS are provided ac power by the ATG in the integrated instrument aircraft and by the emergency generator in conventional instrument aircraft.

Generator Switch

The guarded main ac generator switch (figures FO-1 and FO-2) is located on the right console. On Ⓑ airplanes, the switch is located in the forward cockpit only. The switch controls the main ac generator if the master electrical power switch is in ON position. The switch is placarded "Gen" and has three positions: OFF, ON, and TEST. The TEST position provides a test for the generator but the generator is not connected to the bus. Actuating the switch from OFF to ON position with the master power switch ON energizes the main ac generator. The main ac generator then powers the ac nonessential and essential buses. The generator is reset by actuating the generator switch to OFF, then to ON.

Emergency AC Generator Switch

The emergency ac generator switch is located above the right console. On Ⓑ airplanes, the switch is located in the forward cockpit only. The switch has two positions, NORMAL and START, and is spring-loaded to the NORMAL position. With the ac generator off, placing the switch to START position energizes the emergency ac generator during ground operation. With the switch in NORMAL position, the generator starts automatically if the main generator fails in flight. The switch receives power from the dc essential bus.

ATG Switch

The ATG switch is located above the right console. On Ⓑ airplanes, the switch is located in the forward cockpit only. The switch is placarded "Emer AC Gen ATM" on Ⓐ airplanes and "ATM Gen" on Ⓑ airplanes and has TEST, OFF, and AUTO positions. The switch is spring-loaded to the OFF position. Holding the switch to TEST permits ground tests of the ATG. The switch should be in OFF during engine start and shutdown to avoid unnecessary operation of the ATG. The switch should be in AUTO during flight to energize the ATG in event of main ac power failure. The switch receives power from the dc essential bus.

AC Power Failure Warning Light

The ac power failure warning light (figure 1-36), located on the warning light panel, illuminates and displays "AC POWER FAIL" if the main ac generator fails. The light receives power from the dc essential bus.

EXTERNAL POWER

External ac power is connected to the airplane through a single external power receptacle on the left side of the airplane. External ac power takes precedence over airplane power.

TRT/GYRO SWITCH

The TRT/GYRO switch is located in the left main wheel well and supplies power to the Turn Rate

Transmitter (TRT) and Attitude Heading Reference Group (AHRG) when the aircraft is on ground power.

MA-1 ELECTRICAL POWER SUPPLY SYSTEM

The MA-1 electrical power supply system consists of one 1600 Hz, single-phase, ac power supply and one multi-dc power supply. Three-phase, 400 Hz ac power is obtained from the ac nonessential and essential buses and 28-volt dc from the aircraft essential and nonessential buses.

MA-1 Power Switch

The MA-1 power switch is location on the MA-1 power control panel (figure 1-10) on the left console. On Ⓑ airplanes the MA-1 power control panel and the MA-1 power switch are located in the forward cockpit only. The switch is placarded "Power" and has OFF, WARM, RADAR STBY, ON, RADIO SILENCE, and EMER positions. See figure 1-11 for delay times associated with the positions of the power switch. Switch functions of the MA-1 power switch are as follows:

1. OFF – No power is applied to the MA-1 system.
2. WARM – Components requiring more than two minutes warmup time are energized with the switch in this position.

NOTE

The power annunciator will indicate "OK" after 85 seconds.

3. RADAR STBY – After initial delay period, all system functions are operative except the radar transmitter and antenna servo.
4. ON – Power is supplied to all system components after delay times have elapsed.

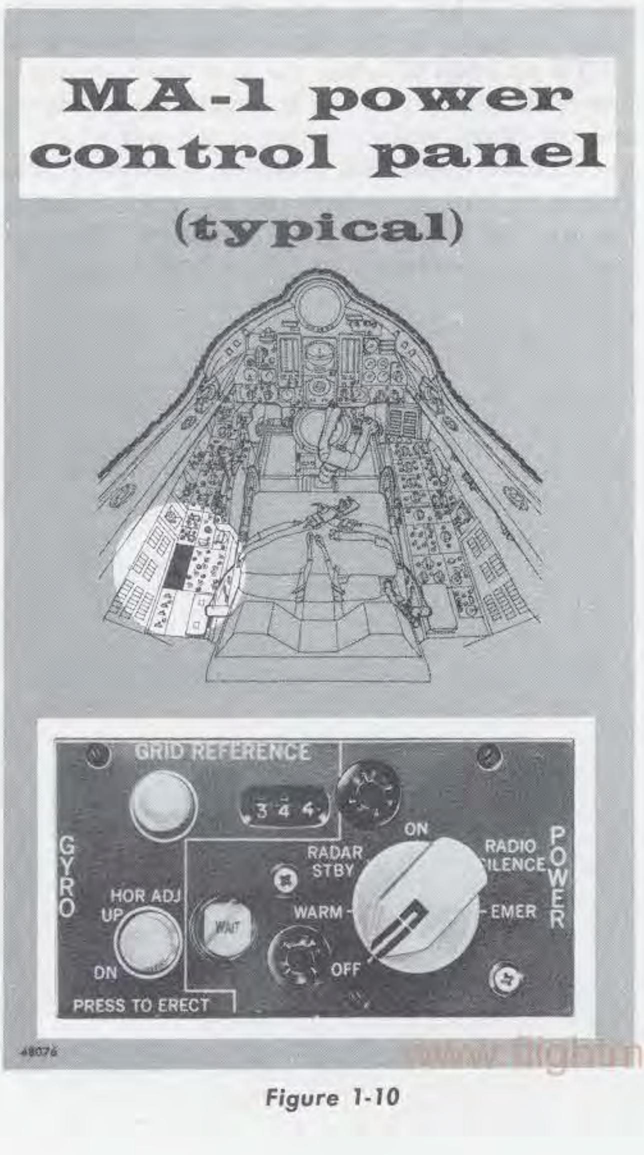


Figure 1-10

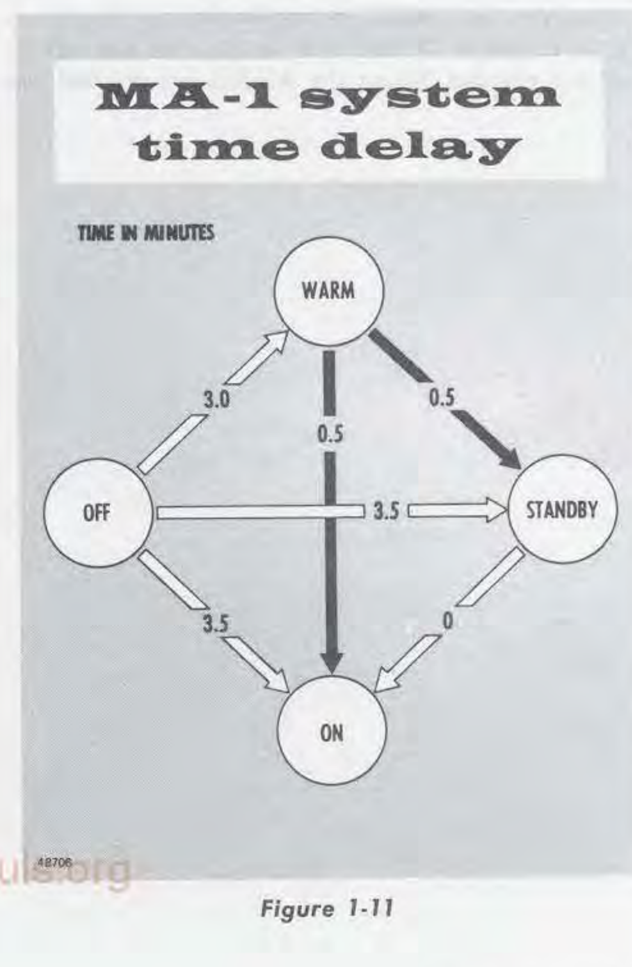


Figure 1-11

5. RADIO SILENCE — All transmitting equipment is suppressed except the UHF transmitter which can be operated in the normal manner. The radar and IFF will not be available. TACAN distance information is not available, but TACAN bearing information will be available if a valid TACAN signal is being received.
6. EMER — All MA-1 powered equipment except UHF command radio, ADF, TACAN, ILS, and ground-to-air IFF is shut off.

The MA-1 power switch receives power from the airplane dc essential bus.

Power Annunciator

The power annunciator is located on the power control panel (figure 1-10) adjacent to the MA-1 power switch. On **O** airplanes, the power control panel and power annunciator are located in the front cockpit only. The annunciator displays "TEST" if switches in the system have been left in the test position or if the AHRG test unit is installed. "TEST" may not be displayed until STBY power is received. If "TEST" is not displayed, the annunciator displays "WAIT" indicating that the AHRG has not erected. When the AHRG has erected, the annunciator displays "OK." The annunciator receives power from the MA-1 system. On aircraft power, the AHRG and cockpit displays receive power when the ac and dc essential buses are energized. For ground power operations, the TRT/GYRO switch must be set to the ON (energized) position. The AHRG initial cycle is a maximum of 85 seconds.

Gyro Erect Button

The gyro erect button is located on the MA-1 power control panel (figure 1-10) and is labeled PRESS TO ERECT. On **O** airplanes, the gyro erect button is located in the forward cockpit only. Prior to takeoff or during flight, momentary pressure on the switch causes the azimuth gyro to reference itself to the heading shown in the grid reference indicator window (vertical gyro not affected). During this interval (no more than 5 seconds), "WAIT" will appear in the power annunciator window. If the flight modes switch is at AUTO or ASSIST when the gyro erect button is depressed, the switch will automatically disengage and the flight mode selector switch will rotate to the PITCH DAMPER position. Rotation of the gyro erect button controls the vertical position of the artificial horizon on the radar scope. The gyro erect button receives power from the MA-1 system.

Grid Reference Knob and Indicator Window

The grid reference knob and indicator window (figure 1-10) are located on the MA-1 power control panel. On Ⓑ airplanes, the grid reference knob and indicator window are located in the front cockpit only. They are marked with a common placard that reads "Grid Reference." The grid reference control is used to set the MA-1 computer grid reference. The setting is read in the indicator window. If the setting in the indicator window is the same as the computer grid reference at the completion of the AHRG initial erection, the grid reference to the computer will automatically align correctly. If the setting in the window is not the same as the computer grid reference at the completion of the AHRG initial erection, the computer grid reference must be set in the window, and the grid reference erect button must be depressed momentarily. During this grid reference correction cycle (5 seconds maximum), the power annunciator will display "WAIT" and airplane heading must be held constant. When the cycle is complete, the power annunciator will display "OK."

HYDRAULIC POWER SUPPLY SYSTEM

The hydraulic power supply system (figure FO-5) consists of two separate constant-pressure type systems, the primary and secondary, which supply power to actuate most of the airplane's major operating components. Normal operation of both hydraulic systems is automatic whenever the engine is running. An emergency system is also provided to supplement the primary system in an emergency. Two gages, one for each system, provide an indication of hydraulic system pressure. A hydraulic pressure-low warning light flashes to indicate single system failure or illuminates steadily with failure of both systems. Hydraulic pressure line tubing, routed through the No. 3 fuel tanks, cools the hydraulic fluid. See figure 2-11 for hydraulic fluid specifications.

PRIMARY HYDRAULIC SYSTEM

The primary hydraulic system supplies power for operation of the flight controls and yaw damper only. The system is completely independent of the secondary system and consists primarily of the reservoir, a 3000 psi variable volume engine-driven pump, an accumulator, supply lines, and a thermal-pressure relief valve for system protection. The system contains conventional filters with bypass features. The reservoir is pressurized by the high-pressure pneumatic system. Engine bleed air is used as the emergency pressurization system in the event of high-pressure pneumatic system failure.

NOTE

Primary hydraulic reservoir pressurization provides additional hydraulic inlet pump pressure, reducing possible hydraulic pump cavitation during engine start. Primary hydraulic reservoir pressure can be checked with the primary hydraulic reservoir pressure gage in the hydraulic compartment.

A pressure gage is located adjacent to the piston-type accumulator to permit ground checking of the preload pressure. The ram air turbine will also supply pressure to the primary hydraulic system as an emergency source of pressure.

SECONDARY HYDRAULIC SYSTEM

The secondary hydraulic system supplies power for operation of the flight controls in response to control stick movement (parallels the primary system action) and pitch damper control action in response to electronic pitch signals. The system also supplies power for operation of the landing gear and doors, nose wheel steering, speed brakes, engine variable inlet ramp, air refueling slipway door and boom latches, M61A1 gun system (if installed), and the emergency ac generator. The secondary hydraulic system consists primarily of a reservoir, a 3000 psi variable volume engine-driven pump, an accumulator, supply lines, and a thermal-pressure relief valve for system protection. The reservoir is pressurized by the high-pressure pneumatic system. Engine bleed air is used as the emergency pressurization system in the event of high-pressure pneumatic system failure. A pressure gage is located adjacent to the piston-type accumulator to permit ground checking of the preload pressure.

NOTE

> Pressurization of the secondary hydraulic reservoir provides additional hydraulic inlet pump pressure to reduce the possibility of hydraulic pump cavitation during engine start. Secondary hydraulic reservoir pressure can be checked with the secondary hydraulic reservoir pressure gage located in the hydraulic compartment.

MAGNETRON HYDRAULIC SYSTEM

The magnetron hydraulic system operates independently of the airplane hydraulic power supply system. The system provides power for tuning the MA-1 radar subsystem magnetron. System components are an electric motor driven pump, a reservoir, an accumulator, and an oil cooler. A quantity gage is located inside the right engine access door. There are no separate controls for the magnetron hydraulic system.

EMERGENCY HYDRAULIC SYSTEM

The emergency hydraulic system supplies power for operation of the flight controls in event of failure of the primary and secondary hydraulic systems or when the engine fails and is "frozen." The emergency hydraulic pump is driven by a ram air turbine (RAT), which is pneumatically extended into the airstream by actuating the RAT handle. Since the emergency hydraulic system utilizes the same hydraulic lines as the primary hydraulic system, it is inadvisable to extend the RAT when only the secondary hydraulic system has failed, as this could cause damage and possible loss of the primary hydraulic system. Once extended the RAT cannot be retracted in flight. This emergency system will supply sufficient power for limited maneuvering, approach and landing. A RAT door test hook is installed on the RAT door eyebolt, to insure that the RAT door is locked. The hook is equipped with a warning streamer and must be removed prior to flight.

Ram Air Turbine (RAT) Handle

The ram air turbine (RAT) handle (figures FO-1 and FO-2), located on the left side of the cockpit, is a round grooved handle formed to resemble a turbine. The handle is used to energize the emergency hydraulic power system which supplies hydraulic pressure to the primary hydraulic system. Moving the handle down mechanically selects pneumatic pressure to extend the ram air turbine into the airstream. When the handle is moved fully down, it locks in this position. After the handle is moved down during an inflight emergency, it should remain in this position.

WARNING

> During certain circumstances (e.g., preflight checks) the handle must be pulled up to prevent injury. Never actuate the cockpit RAT control handle to the turbine-extended position unless the turbine is firmly latched in either the extended or retracted position. Failure to comply with this warning can result in injury to personnel and/or damage to the system mechanism.

NOTE

> On some **O** airplanes* the RAT handle must be pushed aft and down to extend the ram air turbine. The handle can be returned to the up position by pushing aft, then raising the handle.

HYDRAULIC SYSTEM PRESSURE GAGES

Two hydraulic system pressure gages (figures FO-1 and FO-2), located on the right-hand console, indicate the hydraulic systems pressure. One gage is

*AF 57-2516 thru 57-2519.

placarded "Primary" and indicates primary system pressure in psi. The other gage is placarded "Secondary" and indicates secondary system pressure in psi. The hydraulic pressure gages receive power from the ac essential bus.

HYDRAULIC FLUID OVERHEAT WARNING LIGHT

Some airplanes have a hydraulic fluid overheat warning light (figure 1-36) located on the master warning panel. The light illuminates and displays "HYD OIL HOT" if the hydraulic fluid in either system overheats.

NOTE

> If the light illuminates, there is no positive method of determining which system has overheated. Excessive hydraulic pressure, as noted on either hydraulic pressure gage, may be an indication as to which system has overheated.

If the light illuminates and the overheat condition persists, it can be an indication of pending flight control system oscillations or system pressure loss. The warning light receives power from the dc essential bus.

HYDRAULIC PRESSURE-LOW WARNING LIGHT

The hydraulic pressure-low warning light (figures FO-1 and FO-2) is located on the instrument panel. The light flashes, displaying "HYD FAIL," if either the primary or secondary hydraulic system pressure falls below approximately 1000 psi. Pressure loss in both systems will cause steady illumination of this light. With rising pressure in either system, the light will start flashing at approximately 1000 psi, or if pressure in both systems rises above approximately 1000 psi, the light will go out. If only one hydraulic system has failed, the flashing lights can be extinguished by pushing on the light housing. Extinguishing the flashing light will not prevent steady illumination of the warning light should both systems fail, and pressing on the light housing will not turn the light off if both hydraulic systems have failed. The hydraulic pressure-low warning light is tested together with the other lights in the master warning system and will flash when the master warning light test button is depressed during engine operation. The light receives power from the dc essential bus.

PNEUMATIC POWER SUPPLY SYSTEM

The pneumatic power supply system consists of two separate systems, low- and high-pressure, which are used for pressurizing and actuation of system components.

LOW-PRESSURE PNEUMATIC SYSTEM

The low-pressure pneumatic system obtains bleed air from the engine. Unconditioned bleed air is used for:

- elevator artificial feel,
- ATG operation,
- anti-icing and rain clearing, and
- hydraulic reservoir emergency pressurization.

Some of the bleed air is passed through a heat exchanger. This partially conditioned air is used for:

- fuel tank pressurization and fuel scavenge,
- cg fuel transfer, Ⓐ
- canopy seal pressurization,
- anti-g suit pressurization,
- CSD pressurization, and
- canopy antifog. Ⓐ

Some of the partially conditioned air is passed through a refrigeration turbine. The fully conditioned air is used for:

- cockpit pressurization and air conditioning and
- electronic compartment cooling and pressurization.

See section IV for additional information on the low-pressure pneumatic system.

HIGH-PRESSURE PNEUMATIC SYSTEM

The high-pressure pneumatic power supply system (figure 1-12) consists of several component parts which provide high-pressure air for the operation of various normal and emergency systems. Air is stored in three flasks and four landing gear drag braces. One flask is isolated from the rest of the system, and supplies air for emergency operation

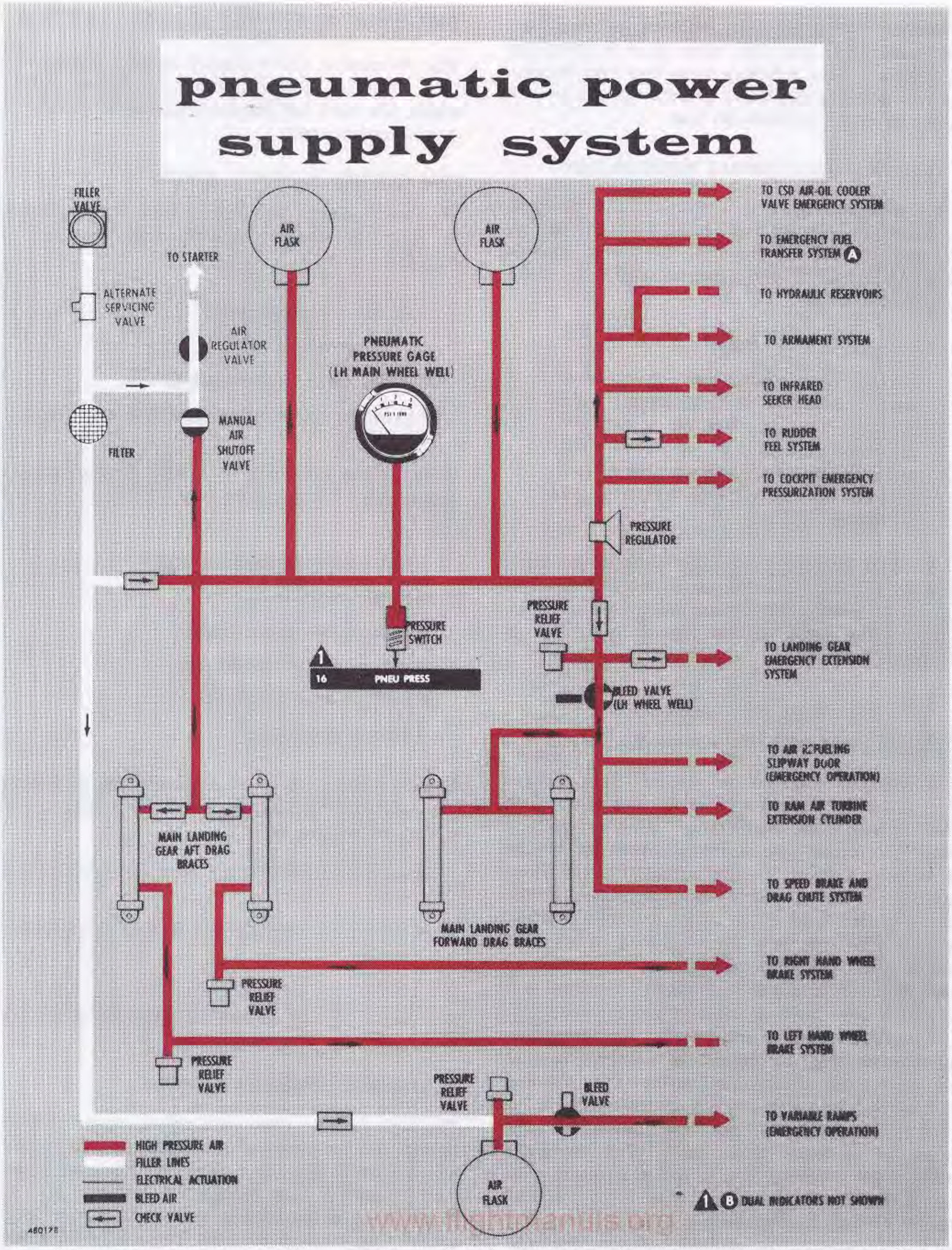

pneumatic power supply system
FILLER VALVE
ALTERNATE SERVICING VALVE
TO STARTER
AIR REGULATOR VALVE
FILTER
MANUAL AIR SHUTOFF VALVE
AIR FLASK
AIR FLASK
PNEUMATIC PRESSURE GAGE (LH MAIN WHEEL WELL)
PRESSURE SWITCH
16 PNEU PRESS
TO CSD AIR-OIL COOLER VALVE EMERGENCY SYSTEM
TO EMERGENCY FUEL TRANSFER SYSTEM A
TO HYDRAULIC RESERVOIRS
TO ARMAMENT SYSTEM
TO INFRARED SEEKER HEAD
TO RUDDER FEEL SYSTEM
TO COCKPIT EMERGENCY PRESSURIZATION SYSTEM
PRESSURE REGULATOR
PRESSURE RELIEF VALVE
TO LANDING GEAR EMERGENCY EXTENSION SYSTEM
BLEED VALVE (LH WHEEL WELL)
TO AIR REFUELING SLIPWAY DOOR (EMERGENCY OPERATION)
TO RAM AIR TURBINE EXTENSION CYLINDER
MAIN LANDING GEAR AFT DRAG BRACES
TO SPEED BRAKE AND DRAG CHUTE SYSTEM
MAIN LANDING GEAR FORWARD DRAG BRACES
TO RIGHT HAND WHEEL BRAKE SYSTEM
PRESSURE RELIEF VALVE
TO LEFT HAND WHEEL BRAKE SYSTEM
PRESSURE RELIEF VALVE
PRESSURE RELIEF VALVE
BLEED VALVE
TO VARIABLE RAMPS (EMERGENCY OPERATION)
HIGH PRESSURE AIR
FILLER LINES
ELECTRICAL ACTUATION
BLEED AIR
CHECK VALVE
AIR FLASK
1 B DUAL INDICATORS NOT SHOWN
480170

Figure 1-12

of the variable ramps. The other two flasks supply air for:

- armament system operation,
- IR seeker head,
- hydraulic reservoir pressurization,
- cockpit emergency pressurization,
- rudder feel system operating pressure,
- forward cg emergency fuel transfer ○,
- CSD emergency air-cooler valve,
- starter, and
- drag brace recharging (when pressure is lower than flasks).

The drag braces are separated from the main system by check valves which allow the braces to maintain their pressure in the event of failure of the main system. The aft drag braces supply air for the operation of the wheel brakes only. The forward drag braces supply air for:

- landing gear emergency extension,
- RAT extension,
- air refueling slipway door emergency operation, and
- normal and emergency drag chute operation.

The pneumatic system is charged on the ground through a filler valve located in the left-hand main wheel well. No provision is made for inflight recharging. Main system pressure is indicated on a pressure gage located near the ground filler valve. When fully serviced, the system pressure is 3000 psi. A pneumatic pressure-low warning light illuminates when pressure in the main system is too low to adequately supply air for the systems that rely upon the main flasks.

NOTE

- After illumination of the pneumatic pressure-low warning light, there may be insufficient air to initiate another armament cycle.
- The pressure-low warning light is not an indication of pressure available in the drag braces, since these storage areas are separated from the main system by check valves.

Pneumatic Pressure-Low Warning Light

The pneumatic pressure-low warning light (figure 1-36), located on the warning light panel, illuminates and displays "PNEU PRESS" when pressure in the two main system storage flasks drops to approximately 1700 psi. The light receives power from the dc essential bus.

FLIGHT CONTROL SYSTEM

The flight control system provides control of the airplane from low speeds through supersonic speeds. The delta wing configuration utilizes elevons instead of aileron and elevator control surfaces. The system incorporates a control stick and rudder pedals with conventional control action in response to stick movement. On O airplanes the system incorporates two mechanically linked control sticks (forward and aft) and two sets of mechanically linked rudder pedals (forward and aft). The elevons, when moved coincidentally, act as elevators and differently as ailerons. Each elevon consists of an inboard and outboard panel which function as one unit, permitting free surface movement unimpaired by normal inflight wing deflections. Pitch and yaw damper systems are installed to stabilize high-speed flight. Refer to AUTOMATIC FLIGHT CONTROL SYSTEM, Section IV. Both the elevons and rudders are actuated by two complete, independent, simultaneously operating hydraulic systems. The ram air turbine can also supply hydraulic pressure to the flight control system in emergencies. Movement of the stick and rudder pedals mechanically positions hydraulic control valves, which direct primary and secondary hydraulic pressure to the respective control surface actuating cylinders. Control surface deflection is proportioned to cockpit control movement by followup linkages which shut off hydraulic pressure to the control surface actuators. Since aerodynamic force against the control surfaces is restricted by the hydraulic action, the forces are not transmitted to the cockpit controls. An artificial feel system is therefore required to simulate the aerodynamic forces encountered. The control surfaces are not equipped with trim tabs as trimming is accomplished by changing the neutral (no-load) position of each control system which deflects the control surfaces. Elevator and rudder trim position is indicated by the no-load cockpit control position. The control stick does not move with application of aileron trim except during AFCS operation. The absence of control stick movement with application of aileron trim is attributed to the fact that trim is accomplished by varying the linkage between the feel system and the hydraulic control valve rather than repositioning the neutral (no-load) position of the feel system.

ARTIFICIAL FEEL SYSTEM

Since the forces imposed by the hydraulic portion of the flight control system are irreversible, there is no indication of existing aerodynamic forces acting on the control surfaces. An artificial feel force, therefore, is added to the flight control system to produce feel on the control stick and rudder pedals relative to airspeed and altitude. Aileron feel is provided by a feel-centering spring, and the stick force is proportional to stick deflection only. Elevator feel is provided by a centering spring and a variable feel force cylinder. A large piston in the elevator feel force cylinder is attached so that movement of the stick in either direction moves the piston against ram air pressure. This ram air pressure is controlled by a variable air pressure regulator. Ram air is obtained from a "q" intake on the vertical stabilizer. Since control surface effectiveness increases with increasing speed subsonically and decreases with increasing speed supersonically, the variable air pressure regulator controls the pressure in the feel force cylinder to provide a uniform stick force for a given airplane response throughout the flight envelope. The variable air pressure regulator obtains airspeed intelligence from a "q" intake on the vertical stabilizer, and altitude information from the main wheel well. Rudder feel is also provided by a centering spring and feel force cylinder. A small piston in the rudder feel force cylinder is attached so that movement of either rudder pedal moves the piston against pneumatic system pressure. The pressure is obtained from high-pressure pneumatic system pressure which has been regulated by the rudder air pressure regulator. The rudder air pressure regulator derives airspeed intelligence from a "q" intake on the vertical stabilizer.

TRIM SYSTEM

Flight control trim is accomplished by deflecting the control surfaces through the use of electrical trim actuators. Elevator and rudder trim actuators are installed in the flight control system to reposition the neutral (no-load) position of the cockpit controls and control surfaces; therefore, cockpit controls and control surfaces will move in response to trim changes. Elevon (aileron and elevator action) trim is controlled by a switch on the control stick, and rudder trim is controlled by a switch on the throttle quadrant. Takeoff trim can be attained automatically by depressing a button on the throttle quadrant, which will reposition aileron, elevator, and rudder trim to a preset position. A green indicator light illuminates when the proper takeoff trim positions are obtained. Manual trim changes are required to maintain level flight from minimum to maximum speed. The trim system is powered from the dc essential bus.

Elevon Trim Switch

Lateral and longitudinal trim is controlled by an elevon trim switch (figure 1-13) located on the control stick grip. The switch has NOSE UP, NOSE DOWN, LWD, and RWD positions, and is spring-loaded to the center (off) position. Holding the switch in the direction of desired trim powers the aileron or elevator trim actuator to reposition the neutral (no-load) position of the respective flight control system. When released the switch automatically returns to its spring-loaded center (off) position. When the automatic flight control system is in assist mode, the elevon trim switch can be used to make small changes in bank or pitch attitude. The trim switch receives power from the dc essential bus.

CAUTION

Should the trim switch stick in an actuated position, an extreme application of trim will result. The trim system can be overridden by control stick movement. If this condition exists on preflight inspection, the airplane should not be flown until the condition is corrected. If the switch sticks in flight it will be necessary to return to the center (off) position manually after the desired trim change is made. A sticking trim switch should be noted on Form 781.

Rudder Trim Switch

The rudder trim switch (figure 1-6), located on the throttle quadrant, controls the position of the rudder trim actuator to reposition the neutral (no-load) position of the rudder control system. The switch, placarded "Rudder Trim," has positions L and R and is spring-loaded to the center (off) position. Holding the switch to L or R applies trim in the respective direction.

CAUTION

On **O** airplanes, when the forward and aft elevon and rudder switches are used to simultaneously apply opposite trim, electrical power will be supplied to both sides of the trim actuator motor and may burn out the motor.

Figure 1-13

When released the switch automatically returns to its spring-loaded center (off) position. The trim switch receives power from the dc essential bus.

Takeoff Trim Button And Indicator Light

The takeoff trim button (figure 1-6), located on the throttle quadrant, provides for automatic trimming of the control surfaces to the proper position for takeoff. While the button is held depressed, a green indicator light will illuminate "TAKEOFF TRIMMED" when the trim system reaches the proper position for takeoff. The takeoff trim circuit receives power from the dc essential bus.

CAUTION

Do not actuate the takeoff trim system unless hydraulic pressure is available, to prevent damage to the actuator motors.

CONTROL STICK

The control stick (figure 1-13) controls the position of the elevon hydraulic control valves which direct primary and secondary system hydraulic pressure to the actuating cylinders to displace the elevon control surfaces. On B airplanes the forward and aft control sticks are mechanically interconncted. Followup linkages then reposition the control valves spool and enable control surface deflection to be in proportion to stick movement. Fore and aft control stick movements are used to obtain elevator action of the elevons. The control stick is moved right and left to obtain aileron action. The control stick has two grips mounted on a common base. The right-hand grip is the primary grip and incorporates a nose wheel steering and microphone button, elevon trim switch, manual mode trigger (momentary interrupt trigger), armament trigger, and an emergency direct manual button (EDM button). The manual mode trigger also serves as a manual disconnect switch when the air refuel switch is ON (O front cockpit only). The left-hand grip, when unlocked, serves as the radar antenna hand control and incorporates controls for the fire control system.

RUDDER PEDALS

The rudder pedals control the position of the rudder hydraulic control valve which directs primary and secondary system hydraulic pressure to the rudder actuating cylinder. On O airplanes the forward and aft rudder pedals are mechanically interconnected. Followup linkage repositions the control valve which maintains rudder deflection in proportion to pedal movement. The rudder pedals can be simultaneously adjusted fore and aft by using the rudder pedal adjustment switch. The wheel brakes are applied conventionally by toe action on the rudder pedals. Rudder pedal movement also controls nose wheel steering when the nose wheel steering system is engaged. Refer to WHEEL BRAKE SYSTEM and NOSE WHEEL STEERING SYSTEM, this Section.

Rudder Pedal Adjustment Switch

A two-position rudder pedal adjustment switch (figure 1-39), placarded "Rudder Pedals Adjust," is located on the right side of the ejection seat. The switch is used to unlock the rudder pedals, permitting independent fore and aft adjustment. The switch has an ADJ position and a spring-loaded neutral (off) position. Holding the switch in the ADJ position unlocks the rudder pedals. With the rudder pedals unlocked, spring-loaded adjustment links push the rudder pedals toward the seat. Releasing the adjustment switch when the pedals are in the desired position, locks them in that position. The switch is powered by the dc nonessential bus.

WARNING

To prevent the pedals from springing aft and striking the shins, both feet should be placed on the pedals before the rudder pedal adjustment switch is actuated.

SPEED BRAKES SYSTEM

The speed brakes (figure 1-1) are located above the tail cone. They can be used to slow the airplane at all speeds. The speed brakes are hydraulically operated and electrically controlled. A relief valve in the speed brakes hydraulic system allows the speed brakes to retract, as necessary, to prevent structural damage under excessive aerodynamic loads. Secondary hydraulic system pressure is supplied to actuate a hydraulic cylinder for each brake. A switch, located on the throttle, electrically controls the speed brakes. The speed brakes are synchronized to give equal operation, and require approximately two seconds to open or close. The speed brakes also serve as compartment doors for the drag chute, and when the drag chute is deployed the brakes cannot be closed until the chute is jettisoned. The speed brakes open automatically when the drag chute handle is pulled. An emergency opening system is installed to be used in the event of secondary hydraulic failure, to facilitate drag chute deployment. The emergency system is energized by the emergency dc power package, and bypasses the speed brakes switch on the throttle. Pneumatic system air is directed to the speed brakes when the drag chute handle is pulled out then rotated clockwise 90 degrees and pulled again.

CAUTION

If normal speed brakes extension is not possible and chute deployment is desired, emergency deployment should be delayed until on the landing roll. Inflight use of this system will result in loss of the drag chute or excessive loss of airspeed. An emergency drag chute extension must be noted on Form 781 to insure bleeding of the speed brakes system.

Figure 1-14 deleted.

SPEED BRAKES SWITCH

The three-position speed brakes switch (figure 1-6), located on the throttle grip, is used to control speed brakes operation except when drag chute is deployed. The switch is placarded "Speed Brakes" and has fixed positions of IN, OUT, and a center (off) position. On O airplanes the switch in the aft cockpit is spring-loaded to the center (off) position.

The neutral (off) position is indicated by a black alignment mark on the switch guide. When the switch is in the center position, the speed brakes are held in the selected position. Partial speed brake operation is possible by rapidly moving the switch from IN or OUT to off. The speed brakes switch receives power from the dc essential bus.

CAUTION

Return the speed brakes switch to neutral after opening or closing to prevent fluid loss in the event of line or speed brake failure.

NOTE

On **B** airplanes, aft cockpit switch action overrides the forward cockpit switch. The speed brakes remain in the position selected by the aft cockpit switch when it is released. For the forward cockpit to regain control of the speed brakes, the forward cockpit switch must be cycled through neutral.

SPEED BRAKES GROUND SAFETY LOCKS

Ground maintenance safety locks (figure 1-18) may be installed on the speed brakes actuators when the brakes are extended, primarily during repacking of the drag chute, and must be removed before flight.

LANDING GEAR SYSTEM

The tricycle landing gear and wheel well doors (figure 1-15) are electrically controlled and sequenced, and hydraulically actuated. The main gear retracts inboard into the lower surface of the wing and fuselage, and the nose gear retracts forward into the fuselage. The wheel well doors remain open when the gear is extended and fair the gear flush with the airplane contour when the gear is retracted. The main landing gear fairings are mechanically tied to the strut assembly and are actuated with gear movement. The nose gear drag brace contains a combination up-and-down lock and is unlocked by initial travel of the nose gear actuating cylinder. The main gear is locked up by the wheel well doors, and the down-lock is unlocked by initial travel of the gear actuating cylinder. Safety switches preclude normal gear retraction while the airplane is on the ground. However, an override control bypasses the safety switches to permit emergency gear retraction while on the ground or while airborne. Normal gear extension, retraction, and emergency retraction is actuated by secondary hydraulic system pressure. In the event

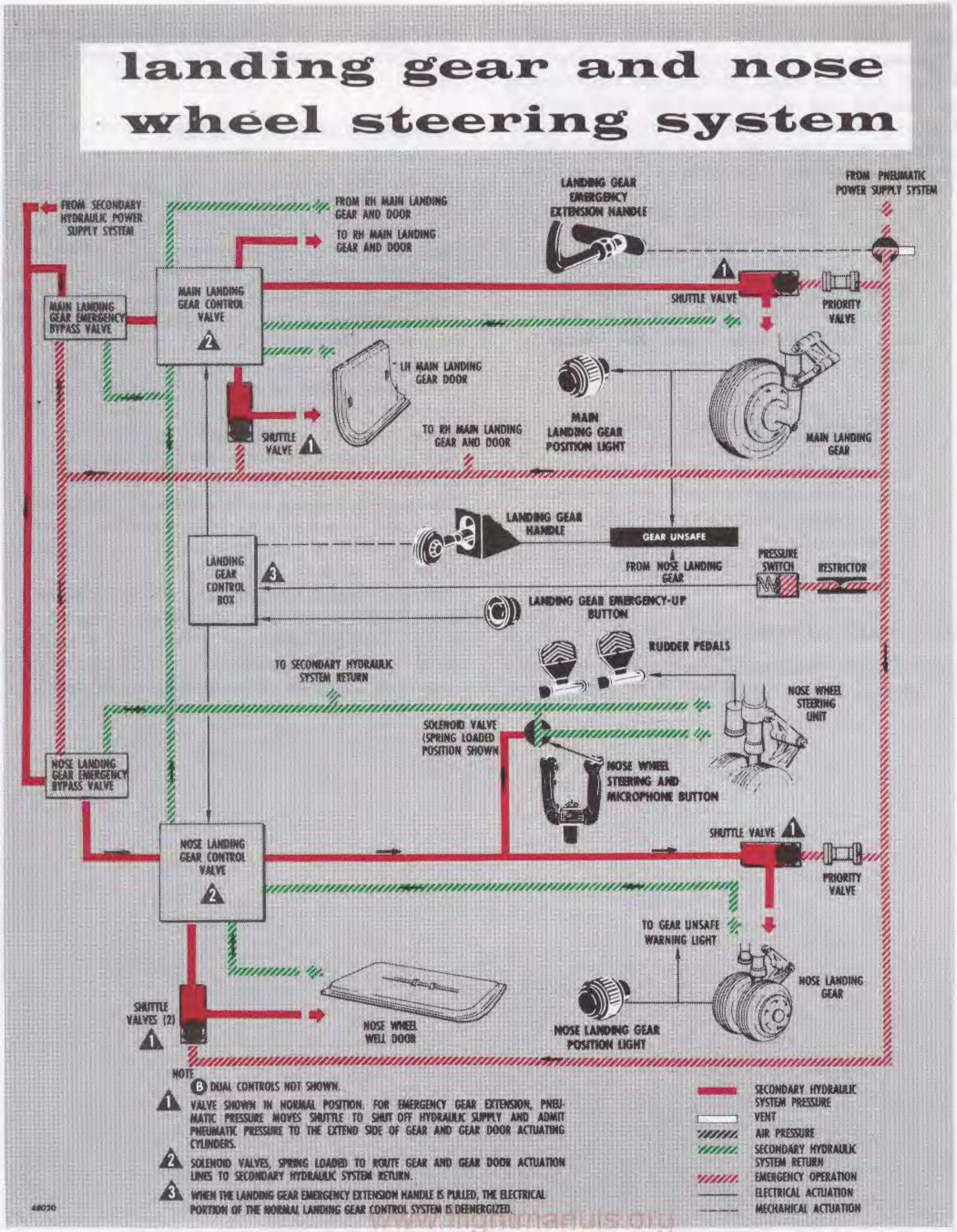

landing gear and nose wheel steering system
FROM SECONDARY HYDRAULIC POWER SUPPLY SYSTEM
FROM RH MAIN LANDING GEAR AND DOOR
TO RH MAIN LANDING GEAR AND DOOR
LANDING GEAR EMERGENCY EXTENSION HANDLE
FROM PNEUMATIC POWER SUPPLY SYSTEM
MAIN LANDING GEAR EMERGENCY BYPASS VALVE
MAIN LANDING GEAR CONTROL VALVE
SHUTTLE VALVE
PRIORITY VALVE
LH MAIN LANDING GEAR DOOR
SHUTTLE VALVE
TO RH MAIN LANDING GEAR AND DOOR
MAIN LANDING GEAR POSITION LIGHT
MAIN LANDING GEAR
LANDING GEAR HANDLE
GEAR UNSAFE
LANDING GEAR CONTROL BOX
FROM NOSE LANDING GEAR
PRESSURE SWITCH
RESTRICTOR
LANDING GEAR EMERGENCY-UP BUTTON
RUDDER PEDALS
TO SECONDARY HYDRAULIC SYSTEM RETURN
NOSE WHEEL STEERING UNIT
SOLENOID VALVE (SPRING LOADED POSITION SHOWN)
NOSE WHEEL STEERING AND MICROPHONE BUTTON
NOSE LANDING GEAR EMERGENCY BYPASS VALVE
NOSE LANDING GEAR CONTROL VALVE
SHUTTLE VALVE
PRIORITY VALVE
TO GEAR UNSAFE WARNING LIGHT
NOSE LANDING GEAR
SHUTTLE VALVES (2)
NOSE WHEEL WELL DOOR
NOSE LANDING GEAR POSITION LIGHT
NOTE
B DUAL CONTROLS NOT SHOWN.
1 VALVE SHOWN IN NORMAL POSITION. FOR EMERGENCY GEAR EXTENSION, PNEUMATIC PRESSURE MOVES SHUTTLE TO SHUT OFF HYDRAULIC SUPPLY AND ADMIT PNEUMATIC PRESSURE TO THE EXTEND SIDE OF GEAR AND GEAR DOOR ACTUATING CYLINDERS.
2 SOLENOID VALVES, SPRING LOADED TO ROUTE GEAR AND GEAR DOOR ACTUATION LINES TO SECONDARY HYDRAULIC SYSTEM RETURN.
3 WHEN THE LANDING GEAR EMERGENCY EXTENSION HANDLE IS PULLED, THE ELECTRICAL PORTION OF THE NORMAL LANDING GEAR CONTROL SYSTEM IS DEENERGIZED.
SECONDARY HYDRAULIC SYSTEM PRESSURE
VENT
AIR PRESSURE
SECONDARY HYDRAULIC SYSTEM RETURN
EMERGENCY OPERATION
ELECTRICAL ACTUATION
MECHANICAL ACTUATION
48030

Figure 1-15

of electrical or secondary hydraulic system failure, the gear can be extended by pneumatic system pressure which is routed to the normal hydraulic actuating cylinders.

During normal operation, gear extention takes approximately 7 seconds and gear retraction takes approximately 5 seconds. A steering unit is built into the nose gear assembly to provide nose wheel steering, and also serves as a conventional shimmy damper. The main wheels are equipped with pneumatically operated multiple-disc brakes. The main gear aft drag braces serve as pneumatic pressure reservoirs for the wheel brake system.

LANDING GEAR GROUND SAFETY LOCKS

Removable ground safety locks (figure 1-18) may be installed in the landing gear assemblies to prevent collapsing of the gear while the airplane is on the ground. The locks are equipped with warning streamers and must be removed before flight.

LANDING GEAR HANDLE

The wheel-shaped landing gear handle (figure 1-16), located on the landing gear control panel, electrically controls normal operation of the gear and wheel well doors.

CAUTION

> Because of the proximity of the landing gear handle to the external tank release button, use care to avoid inadvertent tank jettison when operating the landing gear handle.

On Ⓑ airplanes the forward and aft handles are mechanically interconnected and move in unison. When the airplane is airborne, moving the handle to UP position retracts the gear. When the main and nose gear are fully up, the doors close. When the doors are closed and locked, the gear actuating system is automatically depressurized.

NOTE

> When the weight of the airplane is on the gear, ground safety switches prevent gear retraction if the handle is inadvertently moved to UP position.

When the landing gear handle is moved to DOWN position, the doors unlock and open and the gears extend. Hydraulic pressure is maintained on the gear and doors when they are extended. The landing gear circuit is powered from the dc essential bus.

NOTE

> A trigger on the landing gear handle locks the handle in the UP position and must be pulled prior to placing the handle in the DOWN position. The trigger does not have to be pulled to place the handle in the UP position. On Ⓑ airplanes the trigger is on the forward landing gear handle only.

Figure 1-16

LANDING GEAR EMERGENCY-UP BUTTON

The landing gear emergency-up button (figure 1-16), located on the landing gear control panel, when depressed momentarily causes the landing gear control circuit to bypass the ground safety switches, and will retract the gear if the normal landing gear handle is in the UP position when the airplane is on the ground.

WARNING

> The landing gear emergency-up button should not be used to retract the landing gear during landing emergencies (forced landing, engine failure on takeoff, etc.) or aborted takeoffs when insufficient runway remains to stop. The landing gear should remain extended during these emergencies to absorb impact shock, minimizing airplane damage and personal injury.

The button is placarded "Emer Gear Up." In the event of ground-safety switch malfunction, the emergency-up button may be used when the landing gear handle is UP to retract the gear when airborne. Once energized, the emergency retract system cannot be deenergized except by placing the landing gear handle to DOWN position. The emergency-up button receives power from the dc essential bus.

LANDING GEAR EMERGENCY EXTENSION HANDLE

The landing gear emergency extension handle (figure 1-16), suspended below the left side of the instrument panel, is used to pneumatically extend the landing gear in the event of failure of the normal landing gear extension system. The handle is placarded "Emer Ldg. Gear" on Ⓐ airplanes and "Emer Gear Dn" on Ⓑ airplanes. Pulling the handle out fully, allows pneumatic system pressure to open the doors and extend the gear. Spring-loaded detents are provided on the shaft portions of the handle to lock the handle in the in or out position. To make an emergency landing gear extension, the handle must first be pressed down to release the inner detent and then pulled until the outer detent is felt. The emergency extension handle will extend the landing gear regardless of the position of the normal landing gear handle.

NOTE

> The normal landing gear handle should be in the DOWN position prior to landing. If the handle is in the UP position, the landing gear warning light will illuminate and the audio warning will sound.

Emergency extension of the landing gear takes approximately 5 seconds. There are no provisions for retracting the gear pneumatically. An emergency landing gear extension should be noted on Form 781, to insure bleeding of the secondary hydraulic system.

LANDING GEAR POSITION LIGHTS

The landing gear position lights (figures FO-1 and FO-2) are provided to indicate landing gear position. Three green lights are located on the left side of the instrument panel and illuminate when the corresponding landing gear is fully down and locked. The green position lights are the push-to-test type. Power is supplied from the dc essential bus.

LANDING GEAR WARNING LIGHT AND AUDIBLE WARNING

A red light on the instrument panel (figures FO-1 and FO-2) illuminates and displays "GEAR UNSAFE" when the landing gear or gear doors are not in the position selected by the landing gear handle. This light will also illuminate if the landing gear is not extended during the landing approach (when the airplane is below 10,000 feet and approximately 220 KCAS with the throttle aft of FULL MIL POWER position). The warning light has a "push-to-dim" feature and is tested together with the lights in the master warning system. The light will illuminate when the master warning light test switch is depressed. An audible warning signal through the radio receiver is provided as a second indication of a gear-unsafe condition. The audible warning signal operates simultaneously with the red warning light during the landing approach conditions outlined above. The audible warning can be shut off by means of a pushbutton (figure FO-1 and FO-2) located on the forward left subconsole. This button is placarded "Audio Warn Cutoff" and when depressed will cut out the audible signal but will not affect operation of the warning light. After the button has been depressed, the audible warning system is not reactivated until the throttle is advanced to the FULL MIL POWER position, approximately 220 KCAS is exceeded, or until 10,000 feet is exceeded. There is no means for checking the audible warning signal from the cockpit. On some Ⓐ* and Ⓑ** airplanes, the audible warning signal volume cannot be controlled from the cockpit. On other Ⓐ† and Ⓑ‡ airplanes the volume can be controlled through the command radio volume control knob. Power is supplied from the dc essential bus.

ALTITUDE WARNING SYSTEM (AWS)

The altitude warning system provides an audible warning to the pilot when the aircraft altitude is at or lower than the altitude set in the altitude warning selector. The selector is located in the forward cockpit of the F-106A/B aircraft above the right console. The selector has five digital readout windows. The first digit can be set on 0 or 1; the second, third, and fourth from 0 to 9; and the fifth is locked on 0. The maximum altitude setting is 19,990 feet. The audible warning comes through the radio receiver and can be shut off by depressing the AUDIO WARN CUTOFF button located on the left forward subconsole. System reactivation is accomplished by climbing to an altitude above that set in the altitude warning selector or setting a new warning altitude below the present aircraft altitude. Power is supplied by the MA-1 electrical power supply system. The MA-1 power switch must be set at the RADAR STBY position or above to activate the system. Lighting is controlled by the instrument panel lights powerstat on the lighting control panel.

NOTE

- The AWS should not be used as a primary reference for Decision Height or Minimum Descent Altitude when executing instrument approaches.
- When conditions exist which could cause the landing gear warning signal and AWS to activate, the landing gear warning will have priority. Correcting the landing gear condition will terminate both the landing warning signal and the AWS.
- The AWS is not initially activated until the interceptor altitude is greater than the warning altitude setting.

**AF 57-246 thru 57-2499.*

***AF 57-2516 thru -2522 & -2524 thru -2528.*

†AF 56-453, -454, -456 thru 57-245, -2500 & on.

‡AF 57-2508 thru -2515, -2523, -2529 & on.

NOSE WHEEL STEERING SYSTEM

The nose wheel steering system is provided for directional control during taxiing and for portions of the takeoff and landing roll, as desired. The system is electrically engaged, controlled by the rudder pedals, and powered by secondary hydraulic system pressure. Steering is engaged by momentarily depressing a nose wheel steering button on the control stick grip. Nose wheel steering is capable of turning the nose wheel through a range of 146° (73° left and 73° right of center). Engagement will occur regardless of the relative positions of the rudder pedals and the nose wheel as long as the nose wheel is positioned within the 146° cone.

NOTE

Nose wheel steering is inoperative when the landing gear is extended by the emergency extension system.

The nose wheel steering system prevents forces applied to the nose wheel from being transmitted to the rudder pedals. The steering unit also serves as a conventional shimmy damper.

NOSE WHEEL STEERING UNIT GROUND LOCK PIN.

The nose wheel steering unit ground lock pin (figure 1-18) may be installed to facilitate jacking of the nose wheel or to provide stability when mooring the airplane. This lock pin must be removed before flight.

NOSE GEAR TORQUE LINK DISCONNECT

The torque link or scissors assembly on the nose wheel strut is equipped with a quick-release pin which allows the torque links to be disconnected for towing operations. If the torque links are not connected, nose wheel steering and shimmy damping will not be available.

NOSE WHEEL STEERING AND MICROPHONE BUTTON

The nose wheel steering and microphone button (figure 1-13) is located on the right-hand control stick grip and is marked "NWS." Momentarily depressing the button engages the steering system. Whenever the system is engaged, the nose wheels will align to the existing position of the rudder pedals. It is not necessary to hold the button depressed to maintain steering; however, while the button is held depressed, nose wheel steering will be engaged. To disengage the system, the button should be depressed again. The system will also disengage whenever the nose wheel strut is fully extended or reaches the maximum steering limit. In flight the button keys the UHF transmitter. The nose wheel steering button receives power from the dc essential bus.

WHEEL BRAKE SYSTEM

The airplane is equipped with pneumatically operated multiple-disc type brakes (figure 1-17) which are installed on the inboard side of the main landing gear wheels. The left and right wheel brakes are individually operated by depressing the upper portion of the respective rudder pedal. On Ⓑ airplanes the brake actuating function of the forward and aft rudder pedals is mechanically interconnected. Either the forward or aft rudder pedals may be used to apply the brakes; however, braking action on both the forward and aft pedals must be released before the brakes will release. This action applies independent hydraulic pressure (closed system) which, in turn, meters pneumatic pressure to actuate the brakes. The aft main landing gear drag braces serve as pneumatic pressure reservoirs for the brake system and are connected to the main portion of the pneumatic system through check valves which maintain braking pressure if pneumatic system pressure is depleted.

CAUTION

Application of brakes while airborne may result in a locked brake with subsequent blown tire at touchdown.

NOTE

There is no method of checking brake system pneumatic pressure in flight. As the brakes are hydraulically controlled and pneumatically actuated, the feel of pressure in the rudder pedals is not a definite indication that pneumatic pressure is available to the brakes.

Relief valves are installed to protect the brake system against excessive pressure. Emergency, anti-skid, and parking brake systems are not provided.

DRAG CHUTE SYSTEM

A drag chute system is provided to reduce landing roll distance and is to be used after touchdown. The ringslot type parachute, packed in a deployment bag, is stowed in a compartment below the rudder. The speed brakes serve as compartment doors for the drag chute. The drag chute is deployed and jettisoned by a drag chute control handle which electrically controls pneumatic pressure to operate the chute deployment mechanism. If the handle is pulled and the speed brakes are closed, either secondary hydraulic system pressure or pneumatic system pressure will open the brakes for drag chute deployment. The chute pack is secured to the airplane to prevent deployment by the slipstream in flight when the speed brakes are opened. Should this feature fail and the chute accidentally deploy in flight (without pulling the drag chute control handle) the deployment mechanism will release the entire chute assembly from the airplane. The chute mechanism incorporates a shear pin to prevent structural damage if the chute is deployed at speeds in excess of its structural limit.

DRAG CHUTE HANDLE

The drag chute handle (figures FO-1 and FO-2) located on the left side of the instrument panel, is formed to resemble a parachute and is used to deploy and jettison the drag chute. Pulling the handle out actuates switches that apply secondary hydraulic system pressure to open the speed brakes and directs high pressure air to the chute deployment mechanism. When pneumatic pressure is supplied to the chute deployment mechanism, the chute risers are secured and the ripcord pin is pulled to deploy the drag chute. Mechanical sequencing prevents release of the chute until the speed brakes have opened sufficiently to clear the chute as it deploys. Pushing the drag chute handle fully in shuts off electric power to the selector valve which then releases pneumatic pressure to the deployment mechanism which jettisons the chute. On Ⓑ airplanes if both handles are pulled fully out, pushing either handle fully in will jettison the drag chute. In the event of secondary hydraulic system failure, pulling the drag chute handle out, rotating 90° to the right, then out again supplies electrical power direct from the airplane battery to power a selector valve which supplies high-pressure air to the speed brake cylinders.

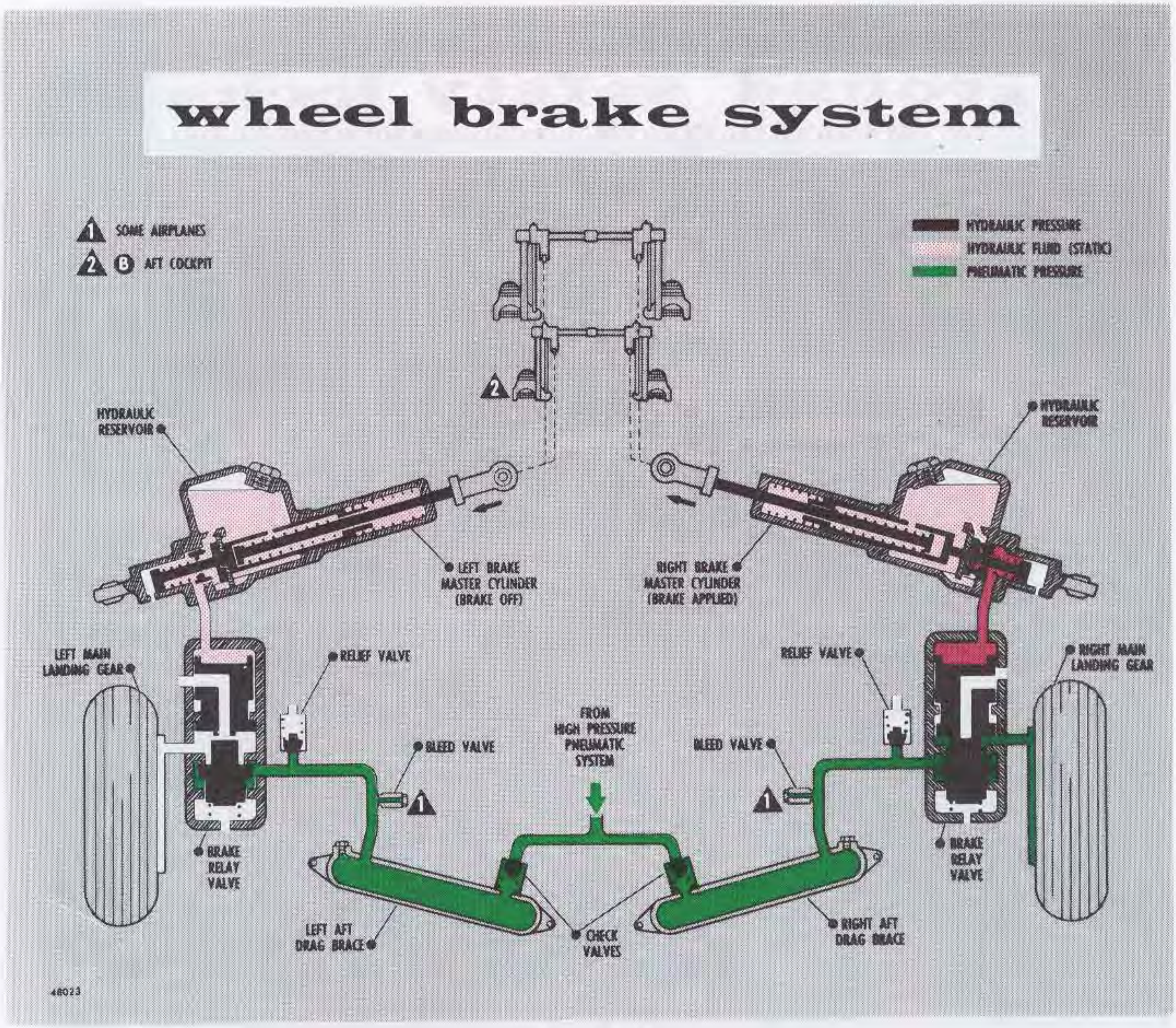


Figure 1-17

CAUTION

When the drag chute is jettisoned after emergency deployment, the drag chute handle must be rotated 90° counterclockwise to the vertical position. The rotation will disconnect power to the speed brakes emergency solenoid valve and prevent a continued load on the battery.

Speed brakes cannot close until the chute is jettisoned. If the speed brakes switch is IN when the chute is jettisoned the speed brakes will close, otherwise they will remain in the extended position.

CAUTION

To prevent loss of drag chute or to prevent chute from slowing airplane to excessively slow speeds, do not deploy drag chute in flight.

NOTE

After emergency drag chute deployment, a notation must be made on Form 781 so that secondary hydraulic system bleeding may be accomplished.

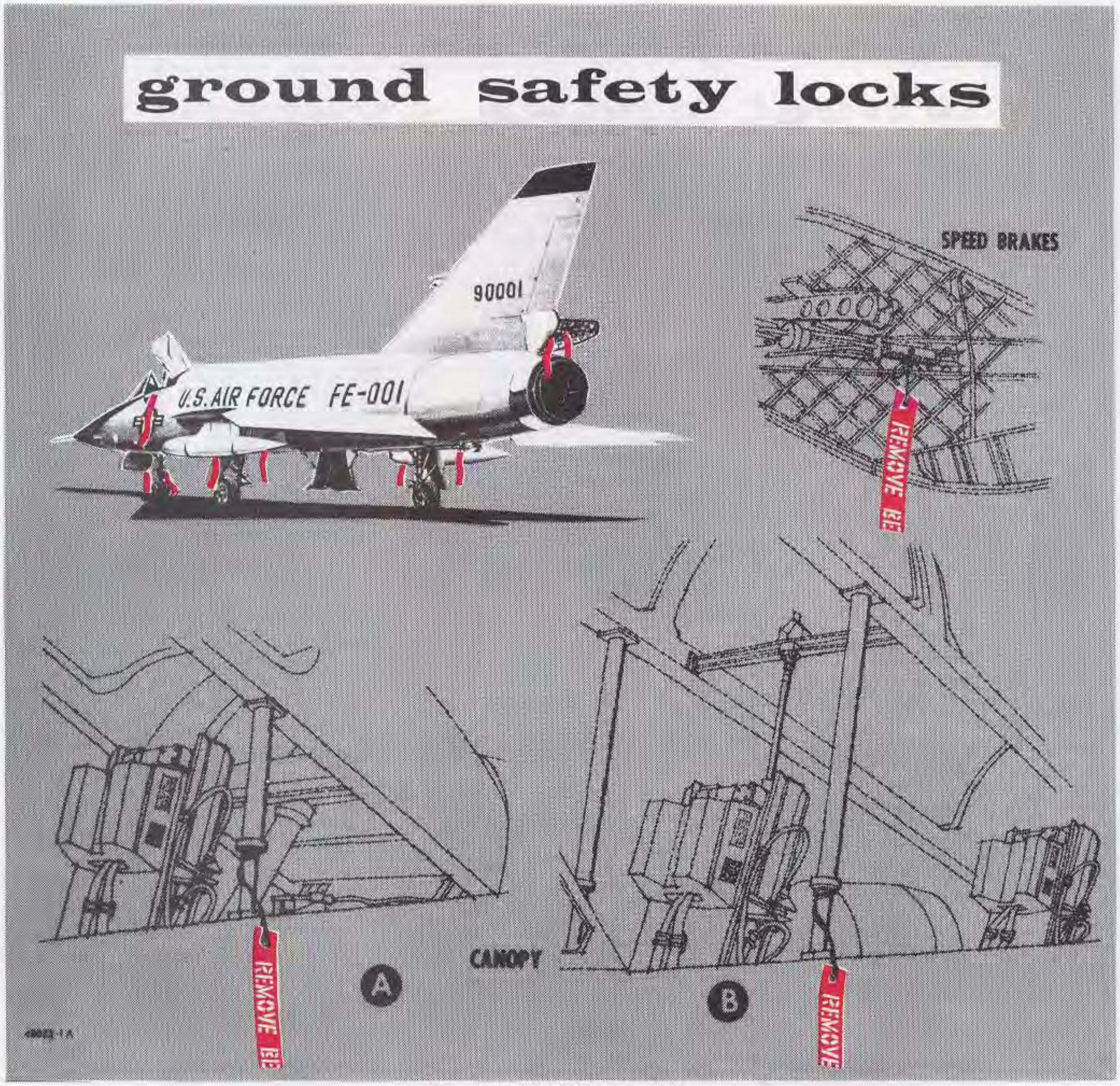


Figure 1-18 (Sheet 1 of 2)

PITOT-STATIC SYSTEM

The pitot-static system supplies pitot pressure to the airspeed indicator, the air data computer system, fuel transfer system on Ⓐ airplanes, and the EPR gage. Static pressure is applied to the airspeed indicator, the vertical velocity indicator, the air data computer system and the altimeter. The pitot-static tube is mounted on the end of the nose boom. Ram air pressure is supplied from two tubes, located on the leading edge of the vertical stabilizer, to control the elevator and rudder artificial feel systems.

AIR DATA COMPUTER SYSTEM

The central air data computer (CADC) converts airstream data into electrical signals. Input to the air data computer consists of total pressure, static pressure, stagnation temperature, and angle of attack. Computer output is fed to the pitch and

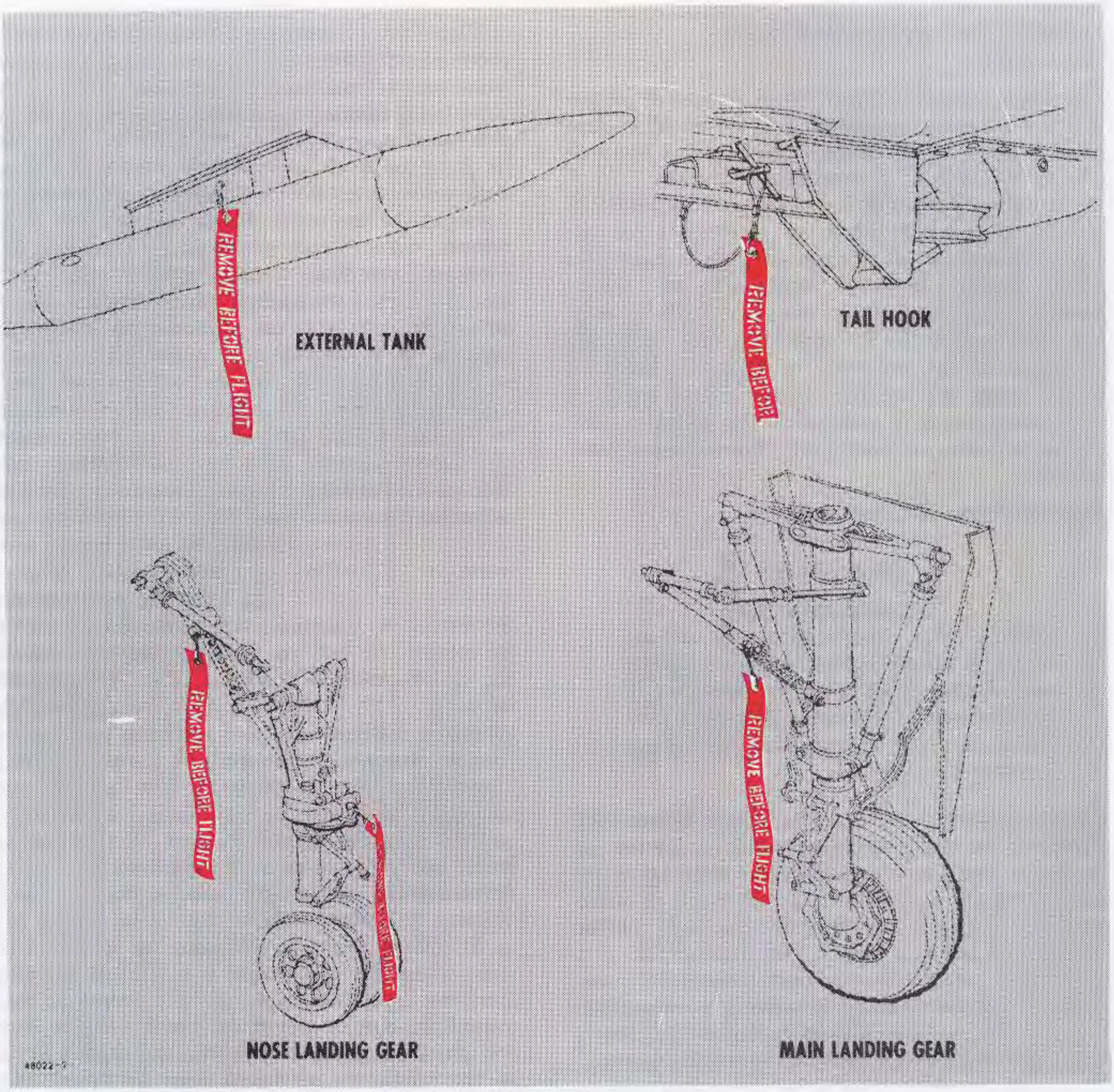


Figure 1-18 (Sheet 2 of 2)

yaw damper systems, the Mach indicator, the variable ramp control system, the landing gear warning system, fuel transfer system on Ⓐ airplanes, and the MA-1 aircraft and weapon control system. The air data computer receives power from the ac essential bus.

CADC FAILURE WARNING LIGHT

The CADC failure warning light (figure 1-36), located on the warning light panel, illuminates and displays "CADC FAIL" if the output of either the Mach module, the altitude module, or the airspeed module within the CADC fails or is out of tolerance. The light receives power from the dc essential bus.

INSTRUMENTS

NOTE

Airspeeds in this manual are shown in knots calibrated airspeed (KCAS).

CONVENTIONAL INSTRUMENT DISPLAY

Mach Indicator

The Mach indicator (figure 1-19) is located on the instrun • nt panel. A pointer indicates airplane true Mach number on a circular scale having a range of 0.4 to 2.2 Mach. A triangular command Mach marker moves around the outside of the scale to indicate command Mach as received from the digital computer. A striped maximum allowable Mach pointer presents maximum safe Mach received from the air data computer. A Mach warning flag marked "OFF" appears in the upper left quadrant of the indicator to warn the pilot of power supply failure. The flag will automatically reset when power is restored to the indicator. The Mach indicator receives power from the ac essential bus.

Airspeed-Angle of Attack Indicator

WARNING

The movable outer ring portion of the angle of attack indicator is deactivated and must not be used for reference in flight; however, the correct airspeed indication can still be read from the pointer and fixed face dial.

The airspeed-angle of attack indicator (figure 1-20) is located on the instrument panel. A pointer on the face of the instrument indicates airspeed on the fixed airspeed scale which is calibrated in increments of 10 knots from 80 to 800 knots. Displayed in a cutout on the face of the instrument is a rotating airspeed scale marked at 10-knot intervals from 0 to 100 knots and calibrated in increments of 2 knots. The airspeed indicator phase of the instrument operates directly from pitot-static pressure.

Servoed Altimeter

The AAU-19/A altimeter (figure 1-21), located on the instrument panel, is driven by the air data computer. It is a servo/pneumatic instrument consisting of a precision pressure mechanism combined with a servo repeater which is controlled by the air data computer. Altitude indications are shown as a counter-drum-pointer display. The 10,000-foot, 1,000-foot, and 100-foot counter drums provide for a direct digital readout. The pointer repeats the 100-foot indications of the drum and gives a quick indication of the rate of altitude changes. The 10,000-foot counter drum is blanked out by barber pole markings until the 10,000-foot level is reached. In servo mode of operation, the altimeter displays altitude corrected for installation error as transmitted from the computer. Electrical operation is the primary mode for this altimeter. With the air data computer operating, servo mode is achieved by moving the reset-standby lever, located on the lower right corner of the altimeter, to the RESET position. In the event of ac power interruption or an out-of-tolerance condition, the altimeter reverts to pneumatic operation and the STBY flag appears on the face of the instrument. Altitude indications are then accurate excluding installation error. Altitude corrections can be made by consulting the altimeter correction chart (T.O. 1F-106A-1-1). If no problems exist, the altimeter can be reset to servo mode by actuating the reset-standby lever to RESET. The STBY flag will disappear unless a fault remains. Pneumatic operation can be selected at anytime by holding the reset-standby lever in the STBY position until the STBY flag appears (normally 1 to 3 seconds). Servo and pneumatic altimeter readings will not normally be identical. During pneumatic operation, an internal vibrator powered by the dc essential bus operates continuously enabling the instrument to provide a smooth altitude change display. If the vibrator fails, the instrument will continue to operate pneumatically but a less smooth display will be evident. A Kollsman dial (range from 28.1 to 31.0 in. Hg) for setting the altimeter is located on the right side of the instrument face. The setting knob is on the lower left corner of the instrument. Field evaluation checks should be made in both servo and pneumatic modes using the standard ±75 feet as the maximum allowable error in either mode. During this check, the maximum allowable difference between modes is 75 feet.

Barometer Setting Control

The barometer setting control (figure 1-22), located on the instrument panel, applies a signal proportional to the barometer pressure at sea level to the digital computer subsystem. The barometer setting compensates for variations of barometric pressure at the local airport from true pressure altitude.

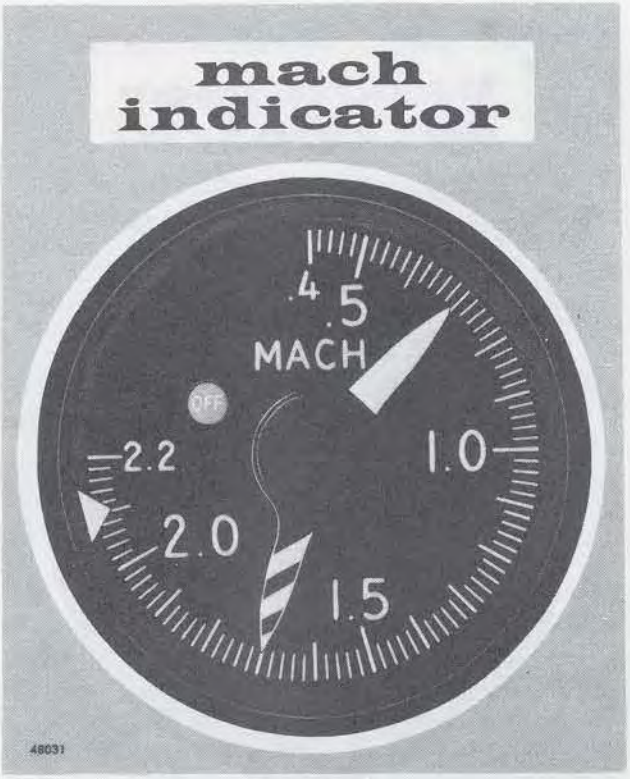


Figure 1-19

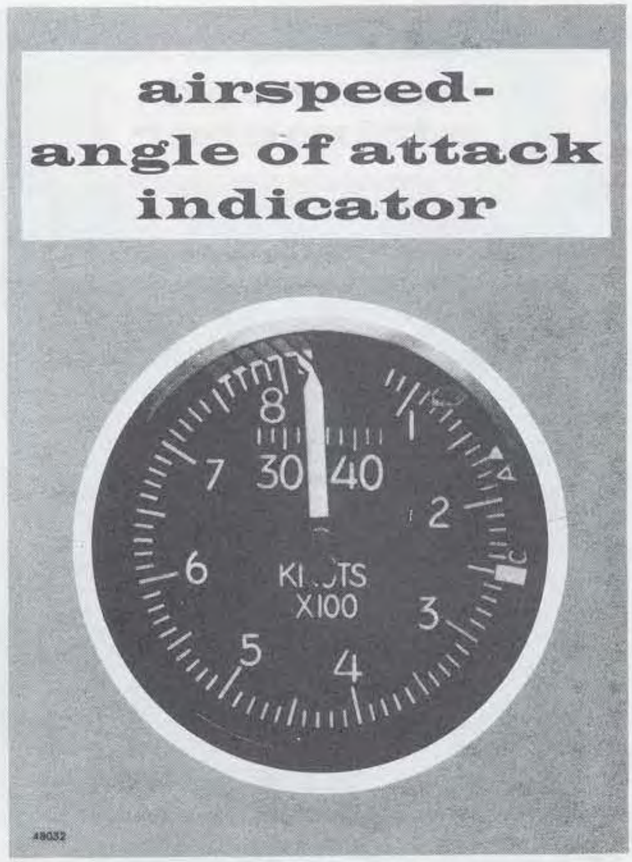


Figure 1-20

Figure 1-21

Figure 1-22

Vertical Velocity Indicator

A vertical velocity indicator (figures FO-1 and FO-2), located on the instrument panel, shows the rate of change of altitude in feet per minute. Changes in pressure due to changes in altitude are sensed by the pitot-static tube and transmitted to the indicator which is capable of indicating vertical speeds from 0 to plus or minus 6000 fpm. An overpressure diaphragm and valve prevent excessive rate of climb or descent from damaging the instrument.

Accelerometer

The accelerometer is located in the apex of the windscreen. The instrument is graduated in increments of 0.5 g and indicates flight loads from +10 to −5 g. One pointer continuously indicates the g-loading on the airplane. Two other ratchet-mounted pointers indicate the maximum positive and negative g indicated by the continuous reading pointer. Depressing the knob at the lower left of the accelerometer releases these maximum reading pointers which, when released, will indicate the current operating position in flight or will point to +1 g on the ground. The accelerometer is a self-contained instrument and operates independently of all other airplane instruments and systems.

Turn-and-Slip Indicator

The turn-and-slip indicator (figures FO-1 and FO-2) is located on the instrument panel. The indicator is rated for a four-minute turn (1-1/2° per second). The indicator is powered by the dc essential bus.

All data on page 1-51, including figures 1-23 and 1-24, are deleted.

Command and Target Altitude Indicator

The command and target altitude indicator is located on the left side of the instrument panel on aircraft with the conventional instrument display. It will display various attack, data link, or navigation information dependent on the mode of operation of the MA-1 computer. Refer to Section IV for AIRCRAFT AND WEAPON CONTROL SYSTEM (MA-1).

Horizontal Situation Indicator (HSI)

The horizontal situation indicator (figure 1-26) is centrally located on the instrument panel. The HSI integrates and visually presents information received from the TACAN, UHF, UHF signals received on the data link receiver, compass system, and certain pilot operated controls. The main electrical power source to the instrument is from the ac essential bus. The compass card will be inoperative when the airplane is receiving ground power unless the TRT/GYRO switch is ON. A description of the components of the HSI follows.

Compass Card. The compass card consists of a compass rose against which a lubber line, located at the 12 o'clock position, indicates airplane magnetic heading. An extension of the lubber line at the 6 o'clock position indicates reciprocal heading.

Heading Marker. The heading marker is a rectangular marker located just outside the azimuth ring. It indicates the selected heading and, by its angular displacement from the lubber line, the heading error angle. The marker may be set manually by means of the heading (HDG) set knob.

Figure 1-25 deleted.

Figure 1-26

Bearing Pointer. The bearing pointer is a heavy arrow head located on the outside of the compass card. Depending upon the position of the TACAN Bearing/ADF Select switch and the TSD selector switch, the bearing pointer will show bearing to a TACAN station, UHF transmitter, or UHF signals received on the data link receiver.

NOTE

With ADF Bearing selected the Deviation/DF Alarm Flag will show DF and the bearing pointer will point to the ADF source.

Course Arrow. The course arrow is located within the compass card. In the NAV and ILS display/automatic modes, the course arrow must be set manually with the course set knob to the desired course.

CDI-NAV Modes. The course deviation indicator (CDI) indicates the angular deviation from the selected course.

NOTE

In the NAV modes, each dot on the course deviation scale represents a 5° angular deviation from the selected course.

CDI-ILS Mode. The CDI indicates angular displacement from the localizer line.

NOTE

In the ILS mode, maximum deflection of the CDI from center represents 2-1/2°, or greater, angular deviation from either side of the selected course.

TO-FROM Indicator. The TO-FROM indicator, located above or below the aircraft symbol, indicates whether the selected course will direct the airplane toward or away from the TACAN station. The TO-FROM indication is in relation to the head or tail of the course arrow and not the aircraft symbol.

NOTE

When the ILS mode is selected, the TO-FROM indicator is inoperative and is out of view.

Course Selector and Range Indicator. The course selector window and the range indicator are located above the compass card on the HSI. The course indicated by the course arrow is repeated in the course selector window. The range indicator displays the nautical mile range to responding aircraft or selected TACAN stations.

NOTE

- If valid TACAN information has been received (range lock-on) and then lost, the computer will continue to present a range indication during subsequent operation. However, the accuracy of the indication will be compromised.
- The range indicator will not be shuttered and range will normally be erroneous if the range selector switch is in the 70 position and TACAN range is greater than 70 nautical miles.

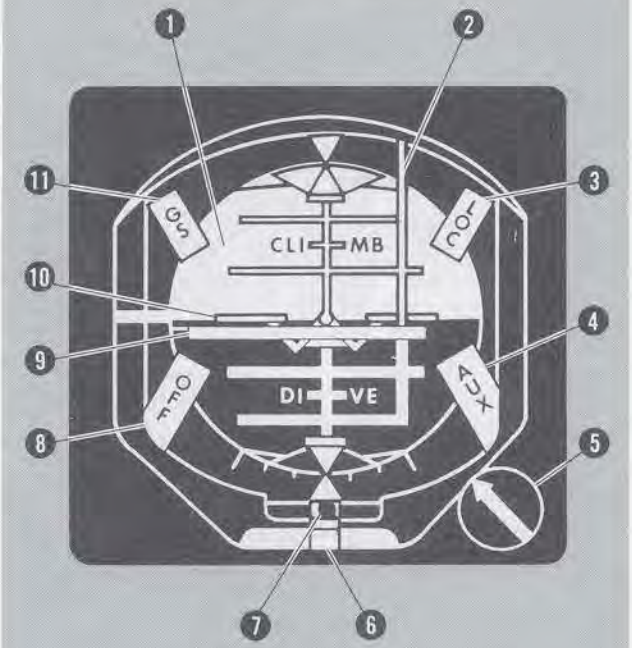
Attitude Director Indicator (ADI)

The attitude director indicator (figure 1-27) is located on the instrument panel. The ADI combines the attitude indicator, turn-and-slip indicator, and ILS localizer and glide-slope presentation. Unrestricted motion of the attitude sphere allows presentation of pitch and roll through 360°. The sphere moves behind a miniature aircraft fixed at the center of the instrument. A pitch trim knob allows manual positioning of the sphere with relation to the miniature aircraft. A pitch reference scale, located on the sphere, consists of short lines at 5°, long lines at 10°, callouts every 30°, and large dots at both poles. A bank scale at the bottom circumference of the instrument shows bank angles with 10° graduations up to 30°, and 30° graduations up to 90°. A glide-slope bar and localizer bar are superimposed on the attitude indicator to provide ILS information. The glide-slope bar indicates displacement of the airplane above or below the glide-slope and the localizer bar indicates displacement to right or left of the localizer. Information provided by the bars is raw data unlike the computerized data provided by the steering bars in other flight directors. The two bars are automatically stowed when not required, and warning flags appear to show the glide-slope or localizer signals are invalid. OFF and AUX warning flags appear when ac power to the AHRG is interrupted or the gyros are not erect. When power is initially applied to the AHRG, the flags will appear until the gyro erects (approximately 85 seconds). The ADI is powered from the ac essential bus. However, the ILS function is dependent upon MA-1 electrical power. The ADI is inoperative when the airplane is receiving ground power unless the TRT/GYRO switch is ON.

NOTE

The localizer bar will deflect off-scale to the right whenever the aircraft is more than full scale deflection left of course.

attitude director indicator



1. Attitude Sphere
2. Localizer Bar
3. Localizer Alarm Flag
4. Power Alarm Flag
5. Pitch Trim Knob
6. Rate of Turn Indicator
7. Slip Indicator (Ball)
8. Power Alarm Flag
9. Glide Slope Bar
10. Aircraft Symbol
11. Glide Slope Alarm Flag

48719

Figure 1-27

Instrument Failure

Instrument failure in the attitude heading reference group (AHRG) may be caused by loss of electrical power, individual instrument malfunction (other than electrical), or failure of system components. Individual instrument malfunction will be noted in some cases by an "OFF" flag which indicates loss of electrical power to the instrument. Failure of any other type can be detected only by observance of erroneous indications or faulty operation.

NOTE

The OFF flag and the AUX flag on the ADI are in view if power is interrupted or AHRG equipment malfunctions. If the AHRG programmer is installed, the AUX flag will be in view.

INTEGRATED FLIGHT INSTRUMENT DISPLAY

NOTE

Refer to Confidential Supplement, T.O. 1F-106A-1-2, for additional information regarding this system.

The integrated flight instrument display is designed to display flight and navigation information from one interrelated source rather than from individual, unrelated instruments. Information is displayed on four instruments: airspeed-Mach indicator (AMI), attitude director indicator (ADI), altitude-vertical velocity indicator (AVVI), and horizontal situation indicator (HSI). Arrangement of these instruments on the panel is in the form of a "T." (See figure 1-28.) The "T" arrangement establishes two lines of reference — one horizontal and one vertical. Across the horizontal reference line are the AMI, ADI, and the AVVI. Down the vertical reference line are the ADI and HSI.

Airspeed-Mach Indicator (AMI)

An airspeed-Mach indicator (Figure 1-29), located on the instrument panel, gives a vertical presentation of speed and load factor (g) information. The instrument contains four display columns. From left to right, the columns are: the angle of attack indicator, the accelerometer, the Mach indicator, and the airspeed indicator.

NOTE

Mach and airspeed information are electronically converted to true Mach and calibrated airspeed (CAS) before being transmitted to the display scales.

In addition, the AMI has a positive g readout window, a maximum allowable Mach marker, a command Mach marker and readout window with a slewing switch, and a command airspeed marker and readout window with a slewing switch. In the event of ac essential power failure to the drive motor of the AMI, an "OFF" flag will appear in the center of the airspeed scale.

NOTE

Although if "OFF" flag appears only on the airspeed scale, it indicates that all the functions of the AMI are inoperative.

The AMI is powered by the ac essential bus.

Angle of Attack Indicator. The angle of attack indicator, located on the AMI (figure 1-29), provides minimum safe speed and positive g information. The angle of attack scale contains a triangular-shaped final approach symbol marked "Final," and a minimum safe speed symbol marked "Min Safe Spd." Final approach airspeed is based on a given constant angle of attack. This approach angle of attack is a compromise between maneuverability and slowest possible flying speed. Regardless of airplane weight, the best angle of attack for approach and landing remains the same. To fly a final approach speed using the angle of attack indicator, position the lubber line on the AMI halfway down the triangle on the angle of attack indicator or through the letter "N" in the word "FINAL." By using the angle of attack indicator, the airplane can be landed safely with complete pitot system failure. This instrument is calibrated primarily to indicate angle of attack at landing speeds, but it can be used to give pilots a general indication of maximum or optimum performance at high subsonic Mach numbers. Pilots may correlate tape positions with light, moderate, and heavy buffet and optimum or maximum turn. When attempting to obtain maximum performance at high subsonic speeds, positioning the lubber line between the tip of the triangle and the base of the triangle (figure 1-30) will indicate the general area of optimum turn which can be defined as the best rate for the least

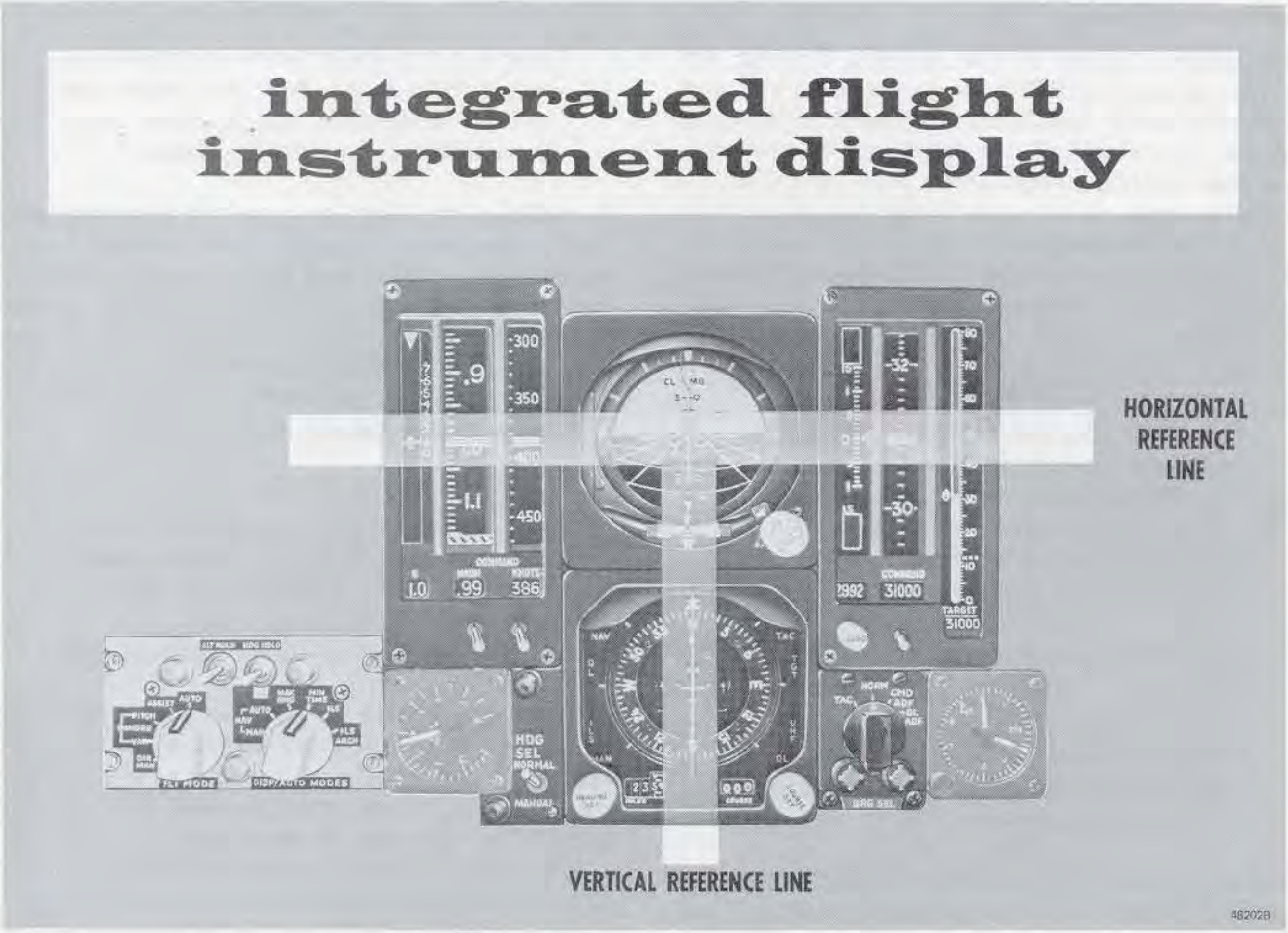


Figure 1-28

energy loss. Light to moderate buffet will be present. A lubber line position from the base of the triangle to half way up the black will indicate the general area to be used for a defensive break or maximum turn. In this area, maximum turn can be generated, but airspeed is rapidly decreasing. Sustained lubber line position beyond half way up the black will produce lateral and directional instability from which recovery procedures must be initiated to preclude entry into post stall gyration or uncontrolled flight.

Accelerometer. The accelerometer (figure 1-29) consists of a vertical, moving scale and a fixed index line adjacent to the angle of attack indicator. The index line monitors the moving scale to indicate g load from 0 to +7 g. This reading is repeated in the g readout window below the scale. There is no provision for indicating negative g, or to record maximum g during flight.

Mach Indicator. The Mach indicator in the center of the AMI (figure 1-29) indicates true Mach number. A fixed index line monitors a vertical, moving Mach scale which is calibrated in hundredths, and calls out each tenth of a Mach from 0.2 through 3.0. At speeds below 0.4 Mach, the Mach scale will continue to indicate 0.4. A striped maximum allowable Mach marker that normally rests at the bottom of the display column will climb toward the index line when maximum safe Mach is approached. A double-line command Mach marker and a command Mach readout window below the scale indicate selected command Mach.

NOTE

The command Mach marker will remain at the top or bottom of the Mach indicator until the selected command Mach reading comes into view on the moving Mach scale. At this time the marker will move with the scale toward the fixed index line. When indicated Mach equals command Mach, the command Mach marker and the index line will coincide.

Command Mach is controlled manually by the slewing switch under the Mach readout window, or automatically by the digital computer. The command system is capable of selecting speeds from 0.4 through Mach 2.2.

Airspeed Indicator. The airspeed indicator, located on the AMI (figure 1-29), gives calibrated airspeed.

NOTE

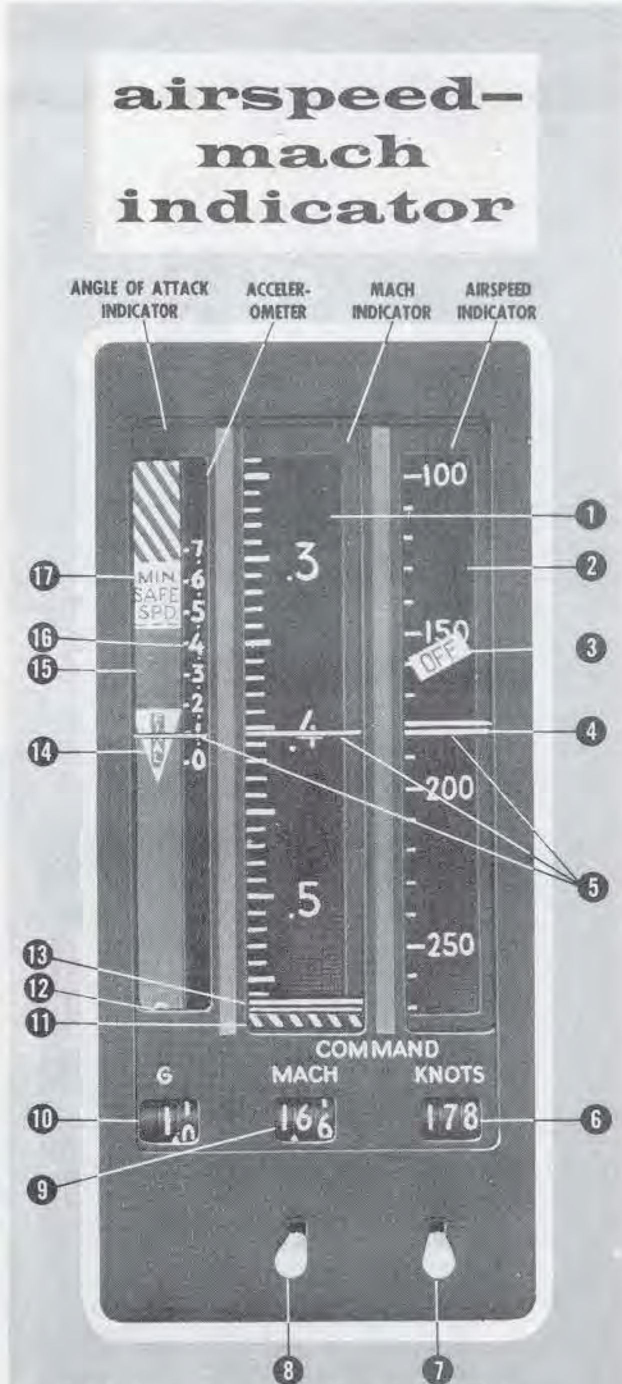
Airspeed information is electronically converted to calibrated airspeed (CAS) before being transmitted to the airspeed scale. Calibrated airspeed instrument system tolerances are a maximum of ±9 knots.

A fixed index line monitors a vertical moving airspeed scale which is graduated in 10-knot markers and calls out each 50-knot level from 50 through 1000 knots. At airspeeds below 50 knots, the airspeed scale will continue to indicate 50. A double-line command airspeed marker and a command airspeed readout window below the indicator show manually selected command airspeed in knots.

NOTE

The command airspeed marker will remain at the top or bottom of the airspeed indicator until the manually selected airspeed reading comes into view on the moving airspeed scale. At this time the marker will move with the scale toward the fixed index line. When indicated airspeed equals selected command airspeed, the command marker and the index line will coincide.

Command airspeed is always controlled manually by the command airspeed slewing switch under the command airspeed readout window and will not reflect data link or computer information.



1. Mach Scale
2. Airspeed Scale
3. Airspeed Warning Flag
4. Command Airspeed Marker
5. Fixed Index Lines
6. Command Airspeed Readout Window
7. Command Airspeed Slewing Switch
8. Command Mach Slewing Switch
9. Command Mach Readout Window
10. G Readout Window
11. Maximum Allowable Mach Marker
12. Zero Angle of Attack Symbol
13. Command Mach Marker
14. Final Approach Symbol
15. Angle of Attack Scale
16. Acceleration Scale
17. Minimum Safe Speed Symbol

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Figure 1-29

angle of attack indications

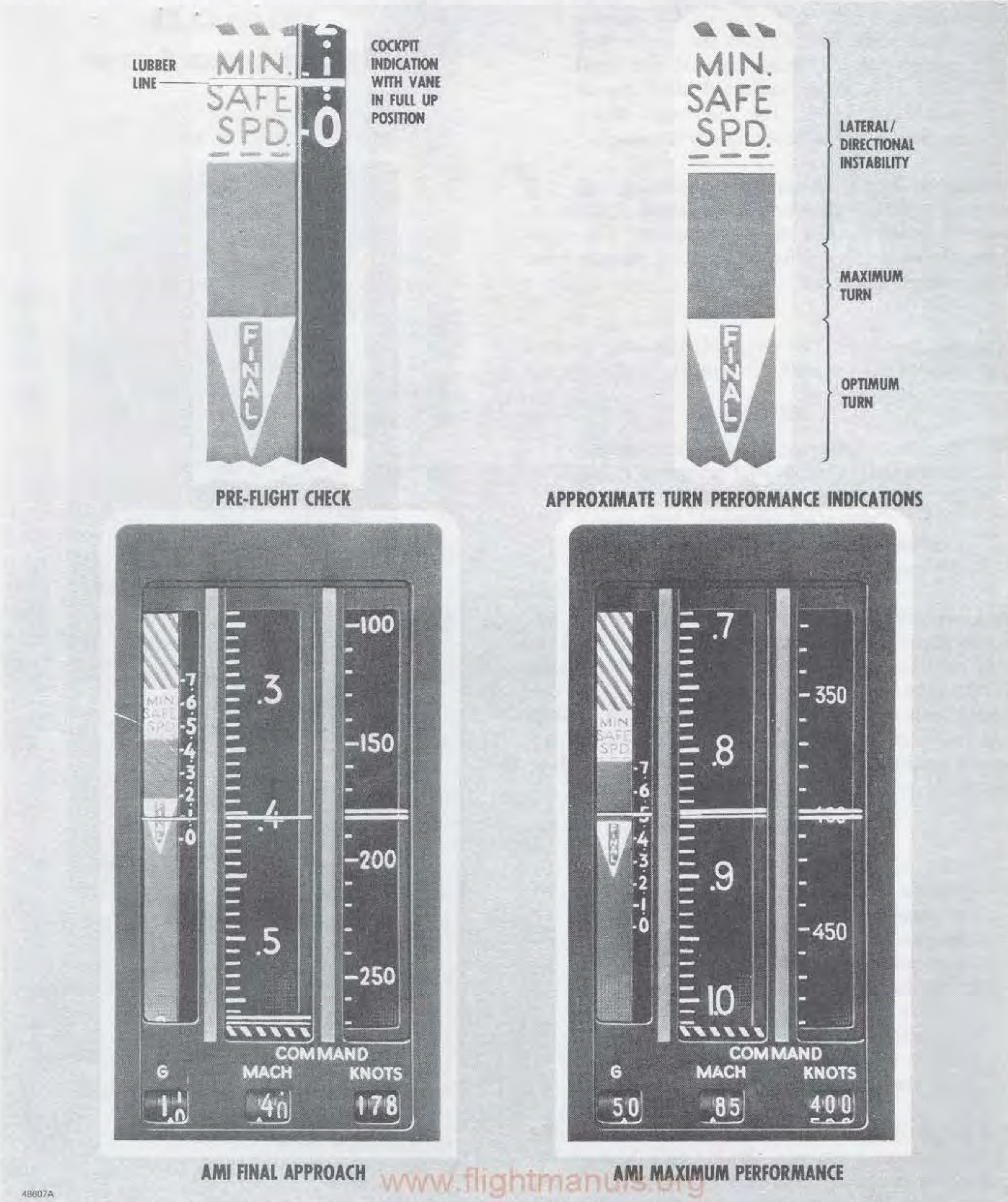


Figure 1-30

NOTE

The command airspeed slewing switch has a center detent position. Moving the switch to the right, locks the switch and enables calibrated airspeed to be read from the command airspeed readout window.

Altitude-Vertical Velocity Indicator (AVVI)

The AVVI (figure 1-31), located on the instrument panel, gives a vertical presentation of altitude information. The instrument contains three display columns. From left to right the columns are: the vertical velocity indicator, the altimeter, and the gross, cabin, and target altimeter. In addition, the AVVI has a barometric pressure readout window and set knob, a target altitude marker and readout window, a cabin altitude marker, two command altitude markers with a single command altitude readout window, and a command altitude slewing switch. The following is displayed on the AVVI target altitude readout window and marker when MAN NAV is selected:

1. With no DROT and Homing Point "T" not selected, the selected homing point altitude will be displayed.
2. With Homing Point "T" selected, temperature will be displayed.
3. With DROT and with Homing Point "T" not selected, target altitude will be displayed.

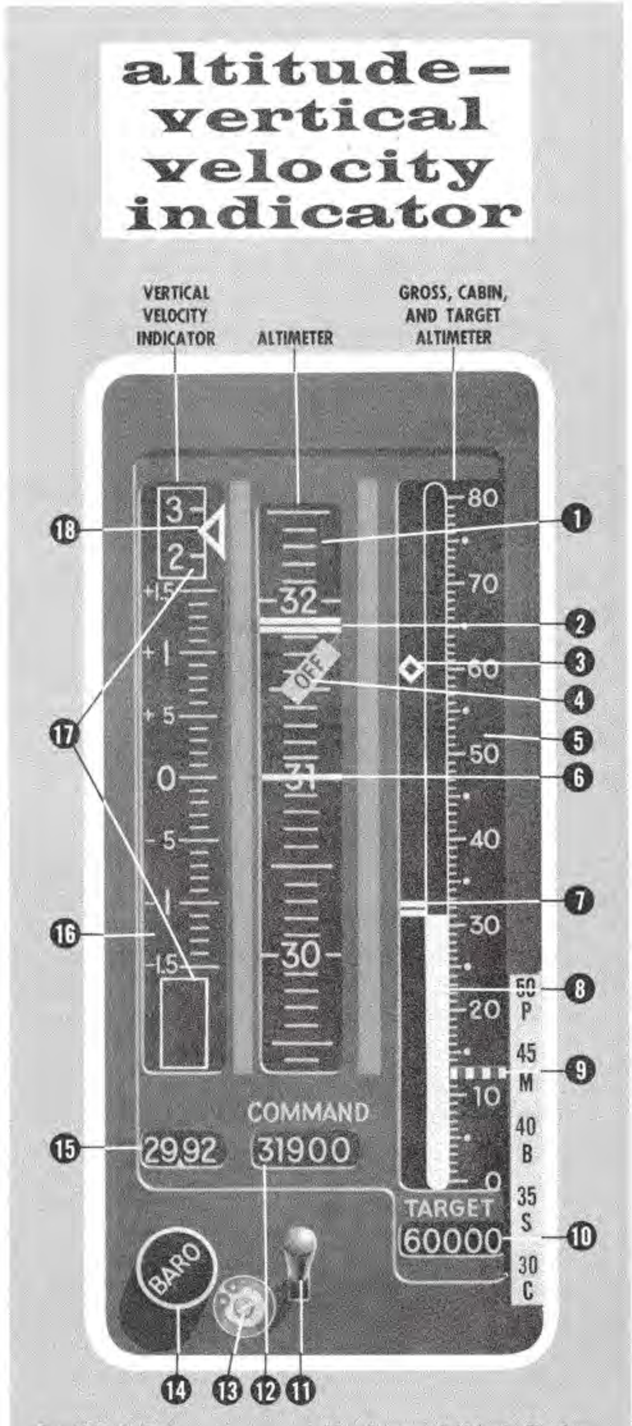
Altimeter error may be corrected by use of the adjustment screw located adjacent to the barometric pressure set knob. This is a screwdriver type adjustment and is accessible by lifting the swing away tab.

In the event of ac power failure to the drive motor of the AVVI, and altitude warning flag will appear in the center of the altitude display column.

NOTE

Although the altitude warning flag appears only in the center of the altitude scale, it indicates that all the functions of the AVVI are inoperative (except cabin altitude marker).

The AVVI is powered by the ac essential bus.



1. Altitude Scale
2. Command Altitude Marker
3. Target Altitude Marker
4. Altitude Warning Flag
5. Gross Altitude Scale
6. Fixed Index Line
7. Command Altitude Marker
8. Gross Altitude Index
9. Cabin Altitude Marker
10. Target Altitude Readout Window
11. Command Altitude Slewing Switch
12. Command Altitude Readout Window
13. Altimeter Adjustment Screw
14. Barometric Pressure Set Knob
15. Barometric Pressure Readout Window
16. Vertical Velocity Fixed Scale
17. Vertical Velocity Moving Scale
18. Vertical Velocity Index

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Figure 1-31

Vertical Velocity Indicator. The vertical velocity indicator (figure 1-31), located on the AVVI, indicates vertical velocity on a fixed scale calibrated from 0 to ±1500 feet per minute. All vertical velocities in excess of ±1500 fpm, up to ±40,000 fpm, are displayed on a moving scale and are viewed through readout windows located at the top and bottom of the indicator. The moving scale calls out only thousand-foot levels up to 10,000 feet, five-thousand-foot levels from 10,000 to 30,000 feet, and ten-thousand-foot levels from 30,000 to 40,000 feet. An index monitors vertical velocity and will move to the appropriate window as ±1500 fpm is exceeded.

Altimeter. The altimeter (figure 1-31), in the center of the AVVI, indicates true pressure altitude.

A fixed index line monitors a moving altitude scale which is graduated in hundreds of feet and displays each thousand-foot level from −1000 through 80,000 feet. A double-line command altitude marker and the command altitude readout window below the altimeter indicate selected command altitude.

NOTE

The command altitude marker will remain at the top or bottom of the altimeter until the selected command altitude reading comes into view on the moving altitude scale. At this time the marker will move with the scale toward the fixed index line. When indicated altitude equals command altitude, the command altitude marker and the index line will coincide.

Command altitude is controlled manually by the command altitude slewing switch under the command altitude readout window, or automatically by the digital computer.

The two least significant digits on the command altitude readout window are fixed at zero. When a radar lockon (DROT) exists, range rate is displayed in the command altitude window with the readout appearing in knots. If the range rate is less than 700 knots, the readout is accurate to the nearest knot. However, a scaling change occurs at 700 knots such that range rates greater than or equal to 700 knots are displayed with readouts accurate to the nearest ten knots. Opening and closing range rates are both displayed; however, there is no indication as to whether a range rate is opening or closing.

EXAMPLE:

Actual Range Rate	Readout
526.1 knots	52600
836.0 knots	08400

Gross, Cabin, and Target Altimeter. The gross, cabin, and target altimeter (figure 1-31), located on the AVVI, displays all available altitude information. A moving thermometer-type gross altitude index indicates airplane true pressure altitude by referring to a fixed gross altitude scale. The scale is graduated in thousands of feet and displays 10,000-foot levels up to 80,000 feet. A moving cabin altitude marker shows cabin altitude. Selected command altitude is shown by a double-line command altitude marker and is controlled manually by the command altitude slewing switch under the command altitude readout window or automatically by the digital computer. Target altitude is shown by a small diamond-shaped target altitude marker and by the target altitude readout window located below the scale. The target altitude displayed is remote data link target altitude, computed target altitude during radar range tracking or homing point altitude. The display cannot be adjusted manually.

In AUTO NAV, range to selected homing point is displayed in the target altitude readout window. If the data link target altitude receiver is zero, 33,300 feet will be displayed. If CC tactic is Non-Commit (CAP/RTB), then 22200 is displayed. Also, at computer turn-on, data link target altitude is initialized to 22200 feet and will remain so until data link is received.

Attitude-Director Indicator (ADI)

The ADI (figure 1-32) is located on the instrument panel. The ADI combines an attitude indicator, a turn-and-slip indicator, and a flight director and ILS glide-slope presentation. Unrestricted motion of the attitude sphere allows presentation of pitch and roll through 360°. The sphere moves behind a miniature aircraft fixed at the center of the instrument. A pitch trim knob allows manual positioning of the sphere with relation to the miniature aircraft. A pitch reference scale is located on the sphere and marked by small dots at 5°, small lines at 10°, readouts every 30°, and large dots at both poles. A bank scale at the top circumference of the instrument shows bank angles with 10° graduations up to 30°, and 30° graduations up to 90° of bank. Some ADI's have a bank index on the bottom of the instrument only. A turn-and-slip indicator is mounted at the bottom of the ADI. A deflection of one needle width indicates a four-minute 360° turn. The turn indicator receives power from the dc essential bus. A bank steering bar and a pitch steering bar are superimposed on the attitude indicator to provide steering information. The bank steering bar shows amount and direction of bank required to position the airplane on a desired heading or course. The bar will center when the airplane is at the required bank angle.

NOTE

The bank steering bar indicates command bank angles dependent upon the selection of the display/automatic mode selector switch. If either DL-MAX RNG or DL-MIN TIME is selected, command bank angles can be up to 60°; in AUTO NAV, 30°; in ILS, 30°; in ILS APCH, 15°.

The pitch steering bar indicates amount and direction of pitch angle required to position the airplane on the ILS glide-slope. The bar centers (1) when on glide-slope with proper pitch angle, (2) when pitch

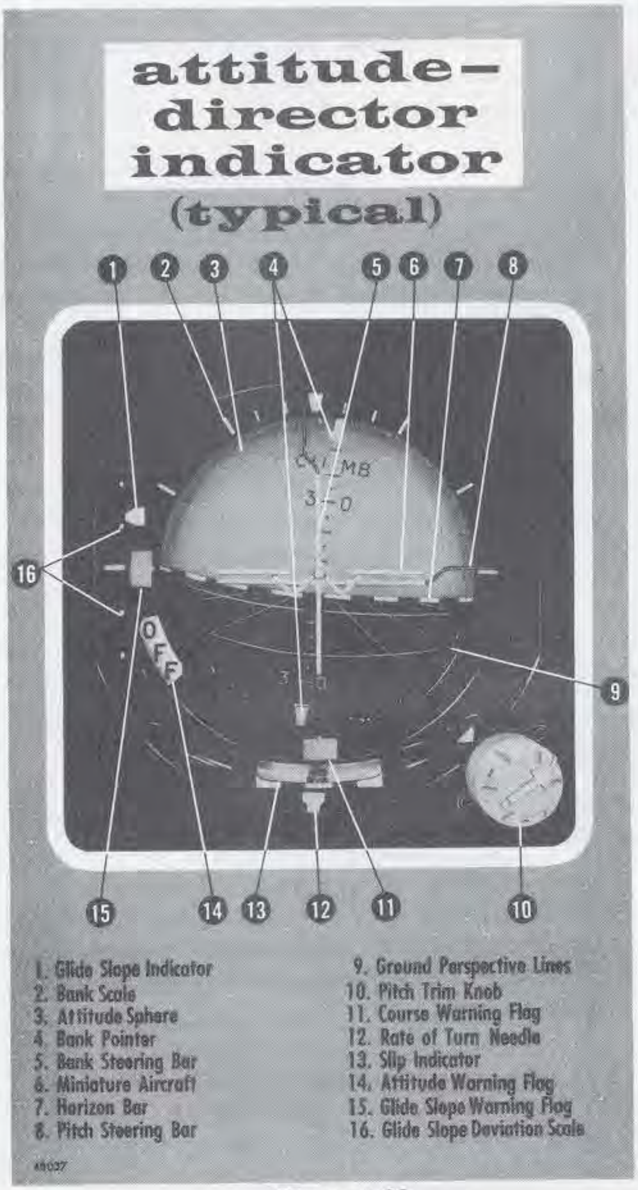

Figure 1-32

angle is correct for return to glide-slope, and (3) when pitch angle is correct for leveling out on glide-slope. The steering bars do not indicate direction or displacement from desired course or glide-slope, but rather, the corrective action required. The two bars are automatically stowed when not required, and warning flags appear to show that the glide-slope or localizer signals are invalid. The glide-slope indicator at the left center of the instrument shows actual position with reference to the glide-slope. An attitude warning flag appears in the lower left-hand portion of the ADI when ac power to the instrument is interrupted. The electrical driving power to the ADI is from the ac essential bus. The navigation and ILS functions, however, are dependent upon MA-1 electrical power. The ADI is inoperative on ground power unless the TRT/GYRO switch is ON.

WARNING

> Malfunction of the ADI attitude indicators may be due to a failure other than ac electrical failure. In such an event, the malfunction will not be indicated by the attitude warning flag, but may be determined by cross-reference to other instrument indications.

Horizontal Situation Indicator (HSI)

The horizontal situation indicator (figure 1-33) is centrally located on the instrument panel on airplanes with the integrated flight instrument system. The HSI displays information received from TACAN, UHF, and data link stations, the AHRG, the computer, and certain pilot-operated controls. The main electrical power source to the instrument is from the ac essential bus. The AHRG is inoperative on ground power unless the TRT/GYRO switch is ON. A description of the individual components of the HSI follows:

Compass Card. The compass card (figure 1-33) consists of a compass rose against which a lubber line, located at the 12-o'clock position, indicates airplane magnetic heading. An extension of the lubber line at the 6-o'clock position indicates reciprocal heading.

Heading Marker. The heading marker (figure 1-33) is a rectangular marker located just outside the azimuth ring. It indicates the selected or command heading. The marker may be set manually by means of the heading set knob, or automatically by computer or data link information.

NOTE

> The command heading marker is influenced by inaccuracies of the AHRG.

Bearing Pointer. The bearing pointer (figure 1-33) is located on the outside of the compass card. On some airplanes, a dot on the outer ring indicates

Figure 1-33

reciprocal bearing. Depending upon the position of the bearing selector switch and display automatic mode selector switch, the bearing pointer will show bearing to a TACAN station, a UHF transmitter, a data link station, or a data link target.

Course Arrow and Course Deviation Indicator. The course arrow and the course deviation indicator (figure 1-33) are located within the compass card. In the NAV and ILS display/automatic modes, the course arrow must be set manually with the course set knob. The course deviation indicator then indicates angular deviation from the selected course. In the DL modes, the course selector knob is inoperative, the course arrow is automatically positioned to target course, and the course deviation indicator indicates lateral distance from the interceptor to the target track.

NOTE

- In an ILS mode, maximum deflection of the CDI from center represents 2-1/2°, or greater, angular deviation from either side of the selected course.
- In the NAV modes, each dot on the course deviation scale represents a 5° angular deviation from the selected course.
- In the DL modes, each dot on the course deviation scale adjacent to the miniature airplane represents 15 nautical miles of lateral deviation.

A "TO-FROM" indicator above or below the aircraft symbol indicates whether the selected course, if flown, will take the airplane to or from the TACAN station. The TO-FROM indicator is in relation to the head or tail of the course arrow and not the aircraft symbol.

NOTE

When either ILS mode is selected, the "TO-FROM" indicator is not operative, and is out of view.

Mode Indicator Lights. Eight mode indicator lights (abbreviated words) are located lateral to the compass card on the HSI. The four bearing pointer indicator lights on the right side indicate the information being given by the bearing indicator by illuminating "TAC," "TGT," "UHF," or "DL." If no right-hand bearing pointer indicator light is illuminated, the bearing indicator is slaved to airplane heading. Three of the four mode indicator lights on the left side indicate the operative mode of the display as selected by the display/automatic mode switch (NAV, DL, ILS). The lower left mode indicator light (MAN) is illuminated when the heading selector switch is in the MANUAL position or the display/automatic mode switch is in the MAN NAV position.

Course Selector and Range Indicator. The course selector window and the range indicator (figure 1-33) are located below the compass card on the

HSI. The course indicated by the course arrow is repeated in the course selector window. Depending upon the mode of operation, the range indicator indicates (in nautical miles) either the range to a target, range to responding aircraft, or the distance to a selected TACAN station.

NOTE

- If valid TACAN information has been received (range lock-on) and then lost, the computer will continue to present a range indication during subsequent operation. However, the accuracy of the indication will be compromised.
- The range indicator will not be shuttered and range will normally be erroneous if the range selector switch is in the 70 position and TACAN range is greater than 70 nautical miles.

Bearing Selector Switch

A four-position bearing selector switch (figures FO-1 and FO-2), placarded "Brg Sel," is installed on the instrument panel. The switch controls the bearing pointer indicator lights on the HSI. With the switch in the TAC position, the TAC indicator light will be on and the bearing indicator (figure 1-33) will indicate the bearing to a selected TACAN station. In the NORM position, the TAC indicator will be on and the bearing indicator will indicate the bearing to a selected TACAN station when the automatic mode switch (figure 4-23) is in the AUTO NAV or MAN NAV position, or bearing to a target when the automatic mode switch is in either DL position. The bearing indicator will servo to airplane heading in the NORM position when the automatic mode switch is in the ILS or ILS APCH position. In the UHF or CMD ADF (some airplanes) position, the UHF indicator light will be on and the bearing indicator will indicate bearing to a selected UHF station. In the DL ADF position, the DL indicator light will be on and the bearing indicator will indicate bearing to the GCI transmitter to which the data link receiving equipment is tuned.

NOTE

If ac essential power is lost or if a change is made in the basic display mode (NAV, DL, ILS) with the automatic mode selector switch, the bearing selector switch will return to the NORM position.

Heading Selector Switch

A heading selector switch (figures FO-1 and FO-2), placarded "Hdg Sel," is installed on the instrument panel. The two-position switch selects the control input to the heading marker on the HSI and the bank steering bar on the ADI. With the switch in the MANUAL position, the heading marker and the bank steering bar may be set manually by the heading set knob. With the switch in the NORMAL position the heading marker will be controlled automatically.

NOTE

If ac essential power is lost, or if a change is made in the basic display mode (NAV, DL, ILS) with the automatic mode selector switch, the heading selector switch will return to the NORMAL position.

Instrument Failure

Instrument failure may be caused by loss of electrical power, individual instrument malfunction (other than electrical), or failure of system components. Individual instrument malfunction will be noted in some cases by an "OFF" flag which indicates loss of electrical power to the instrument. Failure of any other nature in these instruments, or in other instruments, can be detected only by observance of erroneous indications or faulty operation. The AMI and the AVVI may "freeze" at the last registered indication. If airplane speed and altitude changes are relatively small (as in final approach), a failure of this nature is difficult to detect. Therefore, these instruments, as well as all others, must be continually monitored and cross-checked with regard to known conditions.

NOTE

The OFF flag of the ADI will come in view if a malfunction occurs in the AHRG or if the AHRG programmer is installed.

STANDBY INSTRUMENTS

All standby instruments are outlined in yellow for easy recognition.

Standby Attitude Indicator

The standby attitude indicator (figure 1-34), located on the upper right side of the instrument

standby attitude indicator

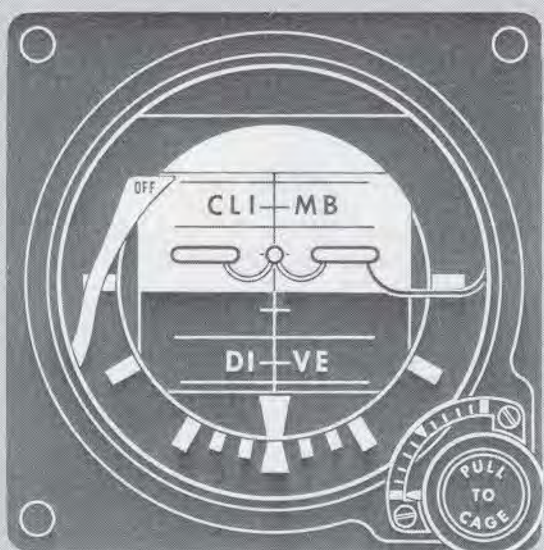

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Figure 1-34

panel, operates independently of the ADI. The indicator functions as an alternate cockpit display and may be used as a check against the ADI, or as a backup indicator in the event of ADI malfunction. The standby attitude indicator is self-contained and provides a visual indication of the bank and pitch of the aircraft. The pitch limits are 92° in climb, 78° in dive, and the roll capability is a full 360°.

The instrument has a pitch/trim knob to adjust the miniature aircraft. Pulling the knob out to the fully extended position cages the indicator. With the knob fully extended and rotated fully clockwise, the indicator remains caged until the knob is rotated counter-clockwise and released.

Approximately 3 minutes are required to erect to true vertical after power is applied to the system. The indicator should be uncaged and set following engine start, and left uncaged for the remainder of the flight. When power is interrupted or the indicator is caged, the OFF warning flag appears on the face of the indicator. Approximately 9 minutes of useful attitude information is provided after power failure. Power is supplied by the dc essential bus.

CAUTION

- The indicator may precess following sustained acceleration or deceleration periods and may tumble during maneuvering flight near the vertical.
- To avoid damage to the gyro system, ensure that the gyro is caged and locked (knob pulled out and rotated fully clockwise) prior to application of external power and prior to turning off electrical power during engine shutdown. Avoid snap-releasing the pitch/trim knob after uncaging to prevent damage to the indicator.

Standby Airspeed Indicator

On airplanes with the integrated flight instrument system, the standby airspeed indicator (figures FO-1 and FO-2) is located on the instrument panel. The indicator does not require electrical power for operation. Instrument tolerances are approximately ±5 knots at landing speeds.

NOTE

There are two types of standby airspeed indicators: 0-400 and 0-800. The 0-800 indicator is installed sideways, which may affect its readability in a critical situation.

standby altimeter

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Figure 1-35

Standby Altimeter

On airplanes with the integrated flight instrument system, the standby altimeter (figure 1-35) is located above the engine instruments and does not require electrical power for operation. The standby altimeter should be corrected for instrument and installation error. The barometric scale may be set to the desired altimeter setting by rotating the barometric pressure set knob.

CAUTION

On some altimeters, the barometric scale reference is adjusted by pulling out or pushing in on the set knob. This is a maintenance function requiring the use of a test set and should not be attempted by the pilot. The set knob should be in the center position for proper operation of the instrument.

Standby Magnetic Compass

A standby magnetic compass is mounted in the apex of the canopy. On Ⓐ airplanes, the compass must be fully extended on the telescopic mount to be usable. It should be monitored in flight to crosscheck the accuracy of navigational equipment. The maximum allowable inflight difference between the standby compass and HSI or course indicator reading is ±8 degrees.

NOTE

If the maximum allowable difference is exceeded, the HSI or course indicator should be considered in error.

The standby magnetic compass is illuminated when the instrument panel lights are on. A standby magnetic compass correction card is provided to show the compass heading the pilot should steer to fly the desired magnetic heading.

COMPASS SYSTEM

Refer to COMPASS SYSTEM, Section IV.

CLOCK

A clock (figure FO-1 and FO-2), located on the instrument panel, is an eight-day spring wound type. It contains an elapsed-time mechanism which uses a sweep-second hand. The elapsed-time mechanism is started, stopped, and reset by pushing in on the elapsed time button.

EMERGENCY EQUIPMENT

MASTER WARNING SYSTEM

A warning light panel (figure 1-36), located at the forward end of the right-hand console, has 24 individual amber warning lights which indicate malfunctions or failures of supporting equipment. Illumination of any individual light also illuminates an amber master warning light on the main instrument panel and an amber master warning light repeater on the right-hand glare shield (figures FO-1 and FO-2). On Ⓑ airplanes the repeater is located in the front cockpit only. Once illuminated, the master warning light and repeater can be extinguished (reset) by depressing the master warning light. However, the individual warning light will remain illuminated until the malfunction is cleared. Subsequent malfunction will again illuminate the master warning light and repeater. Warning lights are automatically dimmed when the instrument panel lights are on if the dimmer switch is momentarily placed in the DIM position and if the thunderstorm and augmentation lights are off. The master warning system does not include the landing gear unsafe warning light, canopy unlocked warning light, hydraulic pressure-low warning light, fire warning light, and variable ramp warning light (if located on the instrument panel).

NOTE

The landing gear unsafe, and fire warning lights can be pushed to dim. The master warning and the hydraulic pressure-low warning lights can be pushed to extinguish.

Power is supplied from the dc essential bus.

Warning Lights Test Button

A warning lights test button (figure FO-1 and FO-2), placarded "Warn Light Test," is located on the right-hand console. Depressing the button tests the system as follows: The canopy unlocked warning light, the maximum maneuver warning light, the landing gear unsafe warning light, the tailhook light, and all the lights in the master warning system illuminate, and the hydraulic pressure-low warning light flashes (with hydraulic pressure). On Ⓑ airplanes the control transfer lights and the takeoff trim indicator lights also illuminate. In addition, on Ⓑ airplanes the maximum maneuver warning light and the tail hook light (some airplanes) will illuminate in the opposite cockpit.

NOTE

Depressing the button is a functional check of lights only, not of complete warning circuits, nor of the landing gear audible warning system.

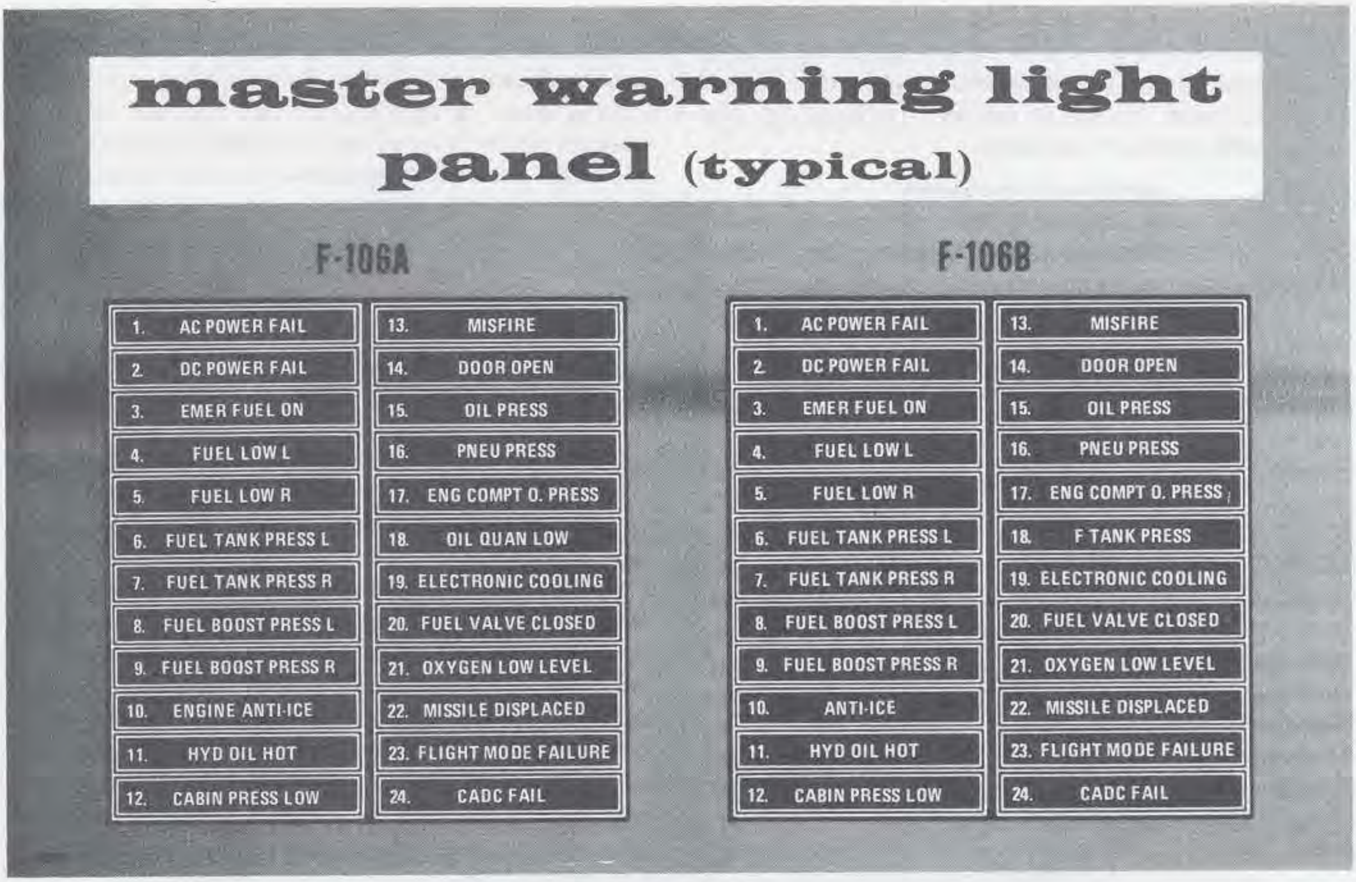


Figure 1-36

Warning Lights Dimmer Switch

A warning lights dimmer switch (figures FO-1 and FO-2) is located on the right-hand console. The switch has positions BRT and DIM. The warning lights may be dimmed by momentarily operating the switch to DIM, providing the flight instrument lights are on, the augmentation lights are off, and the thunderstorm lights are off. The light can be restored to bright by momentarily operating the switch to BRT. They will automatically return to bright if the flight instrument lights are turned off, the augmentation lights are turned on, or the thunderstorm lights are turned on. The warning lights will also return to bright if there is any power interruption to insure that the warning lights are never left on dim when the general lighting intensity is increased. The switch receives power from the dc essential bus.

ENGINE FIRE WARNING SYSTEM

The fire warning system (figure 1-37) consists of two independently routed detector loops which surround the entire engine compartment.

Engine Fire Warning Light and Test Switch

An abnormally high temperature in the engine compartment is indicated by the red fire warning light (figure 1-37) located on the instrument panel. When illuminated, the light displays "FIRE." On airplanes with a test switch marked "Fire Det Test," the zone of the fire or local hot spot is not identified. When illuminated and steady, the warning light indicates a fire. When flashing, the light indicates that only one detector loop has been affected, representing a local hot spot (a fire that is too small to affect the other loop). During ground testing, when the test switch is placed to either LOOP 1 or LOOP 2 position, the warning light should flash, indicating proper operation of the loop, detector flasher, and warning light.

NOTE

The warning light will illuminate steadily only when both circuits are closed, thus giving indication of a possible fire. No provision is made for testing the circuit for a steady illumination.

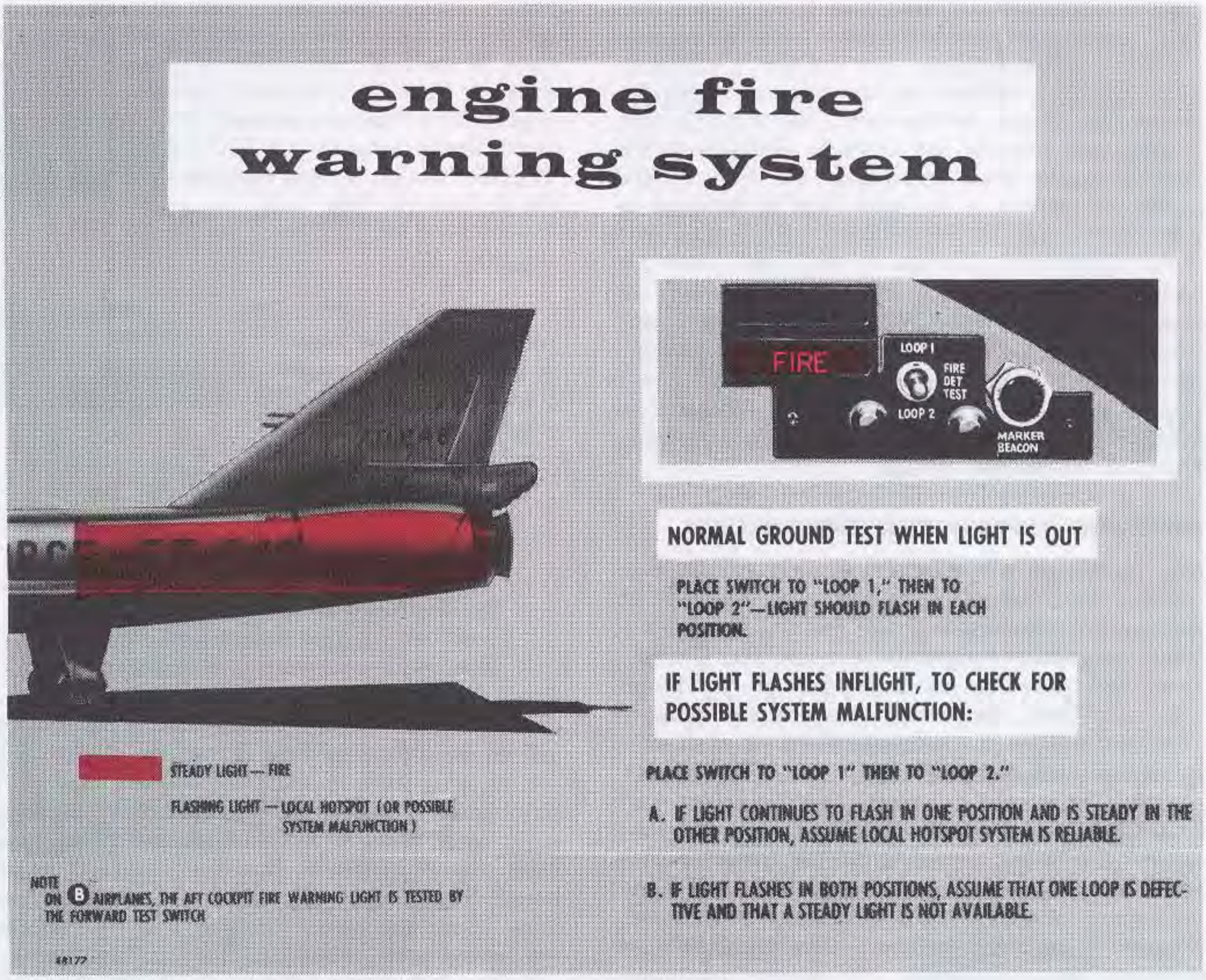


Figure 1-37

Warning light indications of fire can be confirmed by trailing smoke, high exhaust gas temperature, or visual sighting by a wingman. On **B** airplanes the fire warning test switch is located in the forward cockpit only and tests both the forward and aft warning lights. The warning system receives power from the dc essential bus.

TAILHOOK SYSTEM

The airplane is equipped with a tailhook system for use with "chain" or "rotary friction unit" type arresting cables. The system consists of a tailhook (figure 1-1) installed on the bottom aft portion of the fuselage, a tailhook uplatch and uplatch-release solenoid, and a combination release button/indicator light. The tailhook arm is a steel bar which provides spring tension to the down position. The spring tension acts as a snubbing force to minimize bounce of the hook when extended for cable engagement. A ground safety pin with a red streamer (figure 1-18) is installed on the hook arm to prevent inadvertent extension when the airplane is on the ground.

The tailhook system is for emergency use only and will not be employed for routine or "practice" cable engagement, or to test cable capability.

Tailhook-Down Button

A tailhook-down button (figures FO-1 and FO-2) is located on the instrument panel. The ring-guarded button is placarded "Tail Hook Down." The button electrically controls the uplatch release solenoid which actuates the uplatch mechanism that locks the tailhook in the retracted position. When the button is depressed, the uplatch cam rotates and releases the tailhook, and the spring tension in the hook arm places the hook in the extended position. A tailhook light is installed as an integral part of the tailhook-down button and when illuminated provides an indication that the tailhook has been extended. If the tailhook is inadvertently extended in flight, it will not introduce any problems while airborne. A safe landing can be made with the hook arm extended. There are no provisions for retracting the tailhook in flight. The tailhook-down button receives power from the dc emergency bus.

SPEED AND TEMPERATURE WARNING SYSTEM

The speed and temperature warning system provides a visual indication, on the Mach indicator, of maximum design speed or the speed at which maximum stagnation temperature is reached. The system also provides an indication of maximum maneuver limit stagnation temperature. Stagnation temperature (the temperature of the air heated by compression at the impact areas on the airplane) is measured by a temperature probe. The temperature probe feeds an electrical signal into the air data computer which in turn provides electrical switching of the maximum maneuver light and servo control of the maximum safe Mach pointer on the Mach indicator. If stagnation temperature limit is reached, the amber maximum maneuver warning light is illuminated. With the amber light illuminated, load factor limits are more restrictive (refer to ACCELERATION LIMITATIONS, Section V). Maximum stagnation temperature is reflected by the maximum safe Mach pointer on the Mach indicator. The pointer indicates the speed at which maximum stagnation temperature is reached or the maximum design speed of the airplane, whichever occurs first. The speed and temperature warning system receives power from the ac essential bus.

Maximum Maneuver Warning Light

A maximum maneuver warning light (figures FO-1 and FO-2) is located on the instrument panel. The amber light illuminates and displays "MAX MANEUVER" whenever stagnation temperature limit is reached. When the maximum maneuver warning light is illuminated, maximum allowable load factors must be reduced. For maximum load factor limits, refer to ACCELERATION LIMITATIONS, Section V. The light receives power from the dc essential bus.

SURVIVAL KIT

A survival kit (figure 1-39) is installed in the seat pan of the ejection seat. The survival kit attaches to the parachute harness by means of an adjustable strap on each side which contains quick release features.

WARNING

The straps should be adjusted to secure the kit firmly in order to prevent the kit from "riding" up the back and interfering with chute deployment during ejection.

A mode selector lever is located on the right side of the kit below the survival kit release handle. With the lever in the up (AUTO) position, the kit is automatically actuated upon parachute deployment. With the lever in the down (MANUAL) position, the automatic deployment feature is deactivated. The survival kit contains an oxygen regulator, two emergency oxygen bottles, personal equipment leads, a one-man life raft (if required), a provision kit, and a reflector located on the back side of the survival kit lid. The oxygen regulator in the kit supplies pressure oxygen to be used during normal flight, ground operation, or in the event of ejection.

In the event of ejection, the oxygen regulator regulates breathing oxygen for a period of 10 to 15 minutes. Oxygen pressure contained in the emergency oxygen bottles is indicated by a pressure gage which is visible through a small window located in the rear portion of the kit. Oxygen pressure in the emergency oxygen bottles should be 1800 psi minimum at 70°F and should be checked prior to each flight. A pressure reducer lowers the pressure from the emergency oxygen bottles to 40 to 60 psi prior to entering the oxygen regulator. The emergency bottles are actuated automatically as the ejection seat leaves the airplane during ejection or may be manually actuated any time the ship's oxygen supply is depleted or not supplying oxygen for breathing. Manual actuation of the emergency oxygen bottles is accomplished by pulling the emergency oxygen manual release (round green knob) attached to a cable which is in the personal equipment lead bundle. In the event of actuation of the emergency oxygen bottles while ship's oxygen is being supplied, oxygen from the emergency oxygen bottles will not be used until the ship's supply pressure furnished to the regulator falls below emergency oxygen pressure or the seat is ejected. Manual actuation of the emergency oxygen bottles also provides a minimum of 10 minutes breathing oxygen. The bundle of personal equipment leads is inserted into a receptacle in the right-hand corner of the kit. The receptacle contains connections for oxygen, mask defog, communications, and the green knob for manual control of the emergency oxygen bottles. The receptacle should be checked prior to each flight to determine that all leads are properly connected before the pilot connects the leads on his equipment to the opposite end of the bundle. The life raft is inflated by a carbon dioxide cylinder that is gravity actuated upon kit deployment. The provision kit is a waterproof packet strapped to the bottom of the survival kit and should contain items for survival in the area of operation.

Survival Kit Beacon Selector Switch

The survival kit beacon selector switch is located on the forward surface of the survival kit container. The selector is a rocker-type switch. When the left rocker arm (as viewed by the seat occupant) is pressed, MAN (green dot showing) is selected. When the right rocker arm is pressed, AUTO (red dot showing) is selected. In MAN position, the radio beacon will not activate at man-seat separation. In AUTO position, the radio beacon is activated at man-seat separation.

Survival Kit Operations

There are three conditions for operation of the automatic survival kit container assembly: flight emergency egress, ground emergency egress, and ground normal egress from aircraft.

Flight Emergency Egress. Following ejection from the aircraft a sequence of events occurs consisting of free fall, separation from ejection seat, and parachute and survival kit deployment. During parachute deployment, tension is applied to a cable between the crewman's parachute harness and the automatic actuator located in the survival kit. This tension causes the immediate firing of a gas cartridge. Three to five seconds after firing of the cartridge, a piston extends and forces the release mechanism to operate and the following events occur:

1. Lid unlocks.
2. Personal leads separate from kit.
3. Kit harness release assemblies separate from kit.
4. Kit falls away (attached to crew member on a 25-foot dropline.
5. Life raft inflates.
6. Release handle remains in place on survival kit.

NOTE

Incorporation of the automatic actuator in the survival kit does not in any way prevent manual deployment of the kit via the release handle located on the right side of the kit. Should the manual system be used, all events in the preceding paragraphs, steps 1 through 5, will occur.

WARNING

- In the event of automatic actuator failure do not raise survival kit emergency release handle during descent until the parachute is fully inflated to prevent the survival kit or the attaching lanyard from fouling the parachute.
- In the event of automatic actuator failure do not raise the survival kit emergency release handle until after descent to an altitude not requiring oxygen. The oxygen supply will be cut off due to personal leads release.

Ground Emergency Egress. Emergency egress from the aircraft is accomplished by stripping the release handle from the kit. This releases the left and right harness release wedges and the personal leads thus permitting the crew member to exit from the aircraft.

WARNING

Extreme caution must be exercised in the use of the emergency release handle because of its similarity and close proximity to the right ejection handgrip.

Ground Normal Egress. Normal egress from the aircraft is accomplished by releasing quick-disconnect fittings from the parachute.

CANOPY

The metal-reinforced plexiglass canopy (Ⓑ airplanes) or stretched acrylic clear top canopy Ⓐ airplanes) (figure 1-1) is an electrically operated clamshell type which is hinged at the rear and swings up to provide access to the cockpit. Manually operated latches secure the canopy in the closed position, and a warning light illuminates whenever the latches are not in the closed position. On Ⓐ airplanes operation of the canopy is controlled through an actuator-remover installation by toggle switches, which are held for the desired direction of canopy travel and may be released at any time for intermediate positions. The actuator-remover also functions to jettison the canopy in emergencies as part of the escape system. Upon closing the canopy, an inflatable canopy seal around the base of the canopy is actuated automatically by movement of the canopy latch handle to the LOCKED position, permitting pressurization of the cockpit. The canopy may also be raised manually. With the canopy latches released, the actuator-remover clutch is disengaged, allowing the canopy to be raised manually to the full open position. On Ⓑ airplanes the canopy is normally opened and closed by an electric motor. Toggle switches control power to the canopy motor. The canopy motor has a brake which holds the canopy in any desired position. When the canopy latches are locked, a cable linkage to the motor brake releases the brake, allowing canopy seal expansion during cockpit pressurization. From outside the airplane, the canopy may be raised manually after the canopy latches are unlocked and the brake released through operation of the canopy motor brake release handle. Canopy actuator power is provided by the dc emergency bus. A ballistic charge is used to jettison the canopy in emergencies. Emergency jettisoning of the canopy only is accomplished by pulling the canopy jettison handle or by pulling the canopy external jettison handle. When the ejection seat handgrips are raised to actuate the seat ejection system, the canopy is automatically jettisoned before the seat is ejected.

CAUTION

To avoid depletion of the battery, the canopy should be operated, whenever possible, with either external power or airplane power.

CANOPY SEAL

An inflatable rubber seal is installed around the base of the canopy to provide sealing of the canopy to the fuselage and windshield. Engine compressor bleed air is used to inflate the seal to permit cockpit pressurization during flight. A valve operated by the canopy latch mechanism automatically admits air pressure to inflate the seal when the canopy latch handle is moved fully forward to the LOCK position. The initial movement of the canopy latch handle to the aft position relieves pressure to the canopy seal. Actuation of the emergency cabin pressurization system also inflates the canopy seal.

CANOPY HOLD-OPEN SUPPORT

A removable canopy hold-open support(s) (figure 1-18) is provided for use during ground operations. The hold-open support(s) fits between the canopy and the canopy sill on the left side only on Ⓐ airplanes and on both sides of Ⓑ airplanes.

WARNING

The canopy hold-open support(s) should be in place before entering or leaving the cockpit to prevent the possibility of serious personal injury should inadvertent closing of the canopy occur. When the hold-open support(s) is not in position, special care should be taken to keep clear of the area between the canopy and the canopy sill.

CANOPY SWAY BRACES

On B airplanes canopy sway braces consist of a bracket mounted on the right forward ejection seat track, and an antisway guide mounted on the canopy cross member. During taxi operations, canopy side sway is eliminated by the antisway guide. The airplane can be taxied with the canopy open up to 12 inches, when the bracket is engaged by the antisway guide.

CANOPY SWITCHES

Two toggle switches, one located on the right console (figure FO-1 and FO-2) and the other in the external canopy control compartment below the left windshield (figure 1-38) permit electrical raising and lowering of the canopy. On B airplanes the canopy switch located on the right console is in the forward cockpit only. The switches have three positions: CLOSE, OPEN, and a spring-loaded STOP position. The exterior and interior switches are electrically interconnected. For canopy operation, either switch must be held for the desired direction of canopy travel and may be released at any time for intermediate positions. When the CLOSE position of the canopy switch is selected, a time delay feature is activated and the canopy will raise approximately five inches if it is not locked within three seconds after releasing the canopy switch. The canopy may be stopped at any intermediate position on the down cycle; however, it will raise approximately five inches three seconds after releasing the switch. On the up cycle, the canopy will stop whenever the switch is released, or at the full-up position, without the additional five-inch travel. The automatic up feature is inoperative when the canopy is being operated on the battery. The switches receive power from the dc emergency bus.

WARNING

If the canopy on B airplanes is inadvertently lowered on any foreign object on the canopy rail or on the canopy hold-open support, the canopy shear pin should be inspected by maintenance personnel prior to flight to determine if the pin is broken or damaged. A broken or damaged pin could cause malfunctioning of the canopy jettison and seat ejection system.

EMERGENCY CANOPY OPEN SWITCH (After T.O. 1F-106B-560) B

An emergency canopy open switch is located on the right console of the aft cockpit. The switch is guarded and has two positions: unmarked OFF (forward) and OPEN (aft). The switch is normally left in the guarded OFF position. The canopy is raised by lifting the guard and moving the switch aft to the OPEN position. The canopy can be stopped at any intermediate position by moving the switch to the forward (OFF) position. The canopy cannot be closed by the emergency canopy open switch.

NOTE

When the emergency canopy open switch is in the OPEN position, the front cockpit and external canopy switches are inoperative.

CANOPY LATCH HANDLE

The canopy latch handle (figures FO-1 and FO-2), located on the cockpit sidewall, is placarded "Canopy Latch," with positions LOCK and UNLOCK. On B airplanes the handle is located above the right console in the forward cockpit only. The handle is used to mechanically engage and release the canopy latches. When the canopy is completely closed, a forward motion of the handle to the LOCK position will engage the canopy latches, allow inflation of the canopy seal, and disengage the actuator-remover clutch to allow manual raising of the canopy (if necessary) when the latches are later released. A canopy-unlocked warning light will go out when the latches are fully engaged. Movement of the handle to the aft UNLOCKED position mechanically dumps pressure from the canopy seal, disengages the canopy latches, and illuminates the warning light. The canopy can then be raised electrically (all airplanes) or manually (A only). For manual operation of the B canopy, see CANOPY MOTOR BRAKE RELEASE HANDLE, this section.

NOTE

The canopy latch handle should not be moved to the LOCK position with the canopy open and the engine running, as the canopy seal will be damaged.

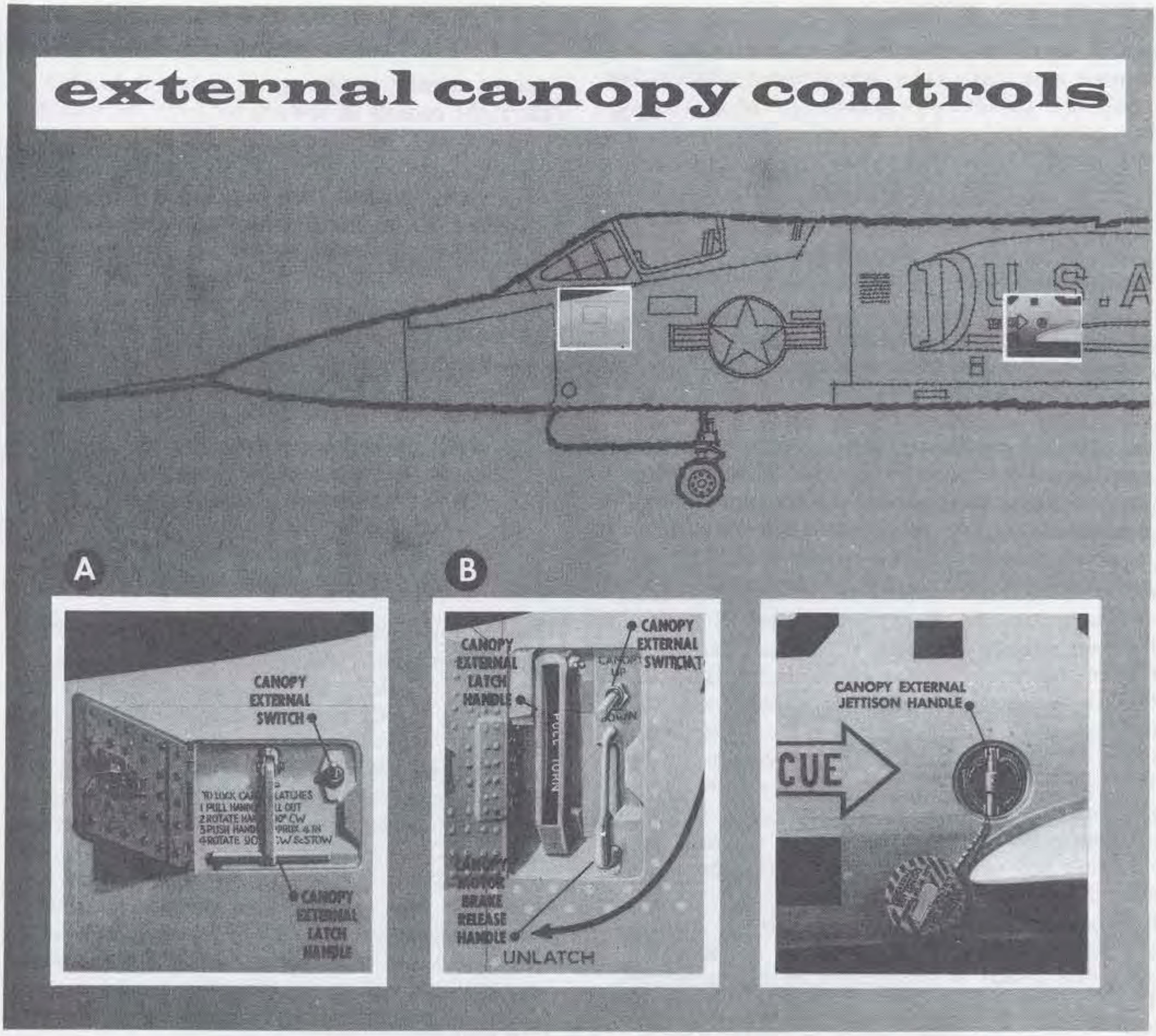


Figure 1-38

WARNING

Do not move the canopy latch handle to the LOCK position with the canopy open. If the canopy-closed switch malfunctions or is not properly adjusted, the canopy will fall when the canopy latch handle is moved to the LOCK position.

CANOPY JETTISON HANDLE

The yellow canopy jettison handle (figure 1-39) is used to jettison the canopy and is located on the left forward edge of the seat. The canopy jettison handle must be pulled out and raised upward. When the handle is raised the canopy is unlatched, then jettisoned with a ballistic charge. This system functions through a portion of the mechanisms used by the ejection seat handgrips and is used to jettison the canopy without ejecting the seat. The canopy jettison handle is safetied when the ejection seat ground safety pin is installed.

CAUTION

Insure that the left calf pocket of the flight suit is zipped closed. The canopy jettison handle may be caught in the pocket, and the canopy inadvertently jettisoned.

CANOPY EXTERNAL JETTISON HANDLE

During emergency conditions the canopy can be jettisoned (by a ballistic charge) from outside the airplane by the canopy external jettison handle (figure 1-38). The handle is located in a small compartment on the left side of the fuselage forward of the wing intersection. An access door is removed to expose the handle. Approximately six feet of excess cable is attached to the handle, allowing the operator to stand a safe distance from the airplane before jettisoning the canopy. The canopy should travel up and aft sufficiently to clear the cockpit; however, it will probably strike the airplane midsection.

WARNING

The canopy external jettison handle should not be pulled except for emergency reasons. Prior to using the canopy external jettison handle the position of the ejection seat handgrips must be checked. If the handgrips are raised, do not pull the handle or the pilot and seat will be ejected. The ground safety pin, installed in the ejection seat right handgrip linkage, prevents jettisoning of the canopy from the cockpit only.

CANOPY EXTERNAL LATCH HANDLE (A)

The canopy external latch handle (figure 1-38), located below the left windshield, can be used to either release or close the canopy latches. Access to the handle is obtained by opening an access door. The latches are released by pulling the handle directly outward approximately five inches. Pushing the handle in returns the handle to the stowed position. To close the latches, the handle must be pulled out its full travel, rotated 90° clockwise, and pushed in approximately four inches. After the latches are closed, the handle can be returned to the stowed position by turning the handle 90° counterclockwise and then pushing it fully in.

CANOPY EXTERNAL LATCH HANDLE (B)

The canopy external latch handle (figure 1-38), located below the left windshield, can be used either to open or close the canopy latches. Access to the handle is obtained by opening an access door placarded "Canopy Control." The handle is disengaged when stowed. If latches are open, the handle is engaged by pulling straight out as far as possible. If latches are closed, the handle is engaged by pulling the handle straight out as far as possible, rotating the handle aft and up as far as possible, and then pulling the handle out as far as possible. With the handle engaged, the latches are opened by rotating the handle forward and down to the vertical position and are closed by rotating the handle up and aft to a horizontal position. With the latches open, the handle is disengaged and stowed by pushing the handle straight in as far as possible. With the latches closed, the handle is disengaged and stowed by pushing the handle in, rotating the handle forward and down to the vertical position, and then pushing the handle straight in.

CANOPY MOTOR BRAKE RELEASE HANDLE (B)

A canopy motor brake release handle (figure 1-38) is located adjacent to the exterior canopy latch handle. The handle is used to disengage the canopy motor brake so that the canopy can be manually opened without use of electrical power. After the canopy latches have been unlocked, the canopy motor brake release handle can be pulled down, and a cable attached to the motor brake releases the brake, thus allowing manual operation of the canopy.

CANOPY UNLOCKED WARNING LIGHT

The red canopy unlocked warning light (figures FO-1 and FO-2), located on the instrument panel, illuminates and displays "CANOPY UNLKD" when both canopy latches are not fully engaged. The canopy unlocked warning light is tested together with the lights in the master warning system and will illuminate when the master warning light test switch is depressed. The warning light receives power from the dc essential bus.

EJECTION SEAT

EMERGENCY EGRESS SYSTEM

On (A) airplanes, emergency egress is accomplished by a one-motion ejection seat equipped with a high impulse rocket, automatic opening seat belt, seat-man-separator, survival kit, parachute actuator assembly, pilot air and seat electrical disconnect, ballistic powered inertia reel, and a ballistically deployed parachute. Gripping and raising either ejection seat handgrip will jettison the canopy and fire the two-stage rocket. The booster phase boosts the seat up the rails and the sustainer phase ignites just prior to seat/airplane separation. The nozzle angle of the rocket sustainer phase provides an upward and forward thrust to the seat allowing tail clearance and reducing the deceleration forces experienced by the pilot. The correct ejection procedure is to grasp both handgrips and pull up simultaneously. The shoulder harness inertia reel has a manual lock-unlock lever on the left side of the seat and locks automatically when a rapid pull (equivalent to 2- to 3-g deceleration force) is exerted on the shoulder harness straps. During emergency egress sequence, power retraction safely pre-positions the crew member in his seat prior to ejection. Power retraction occurs immediately after initiation and forcibly restrains the occupant

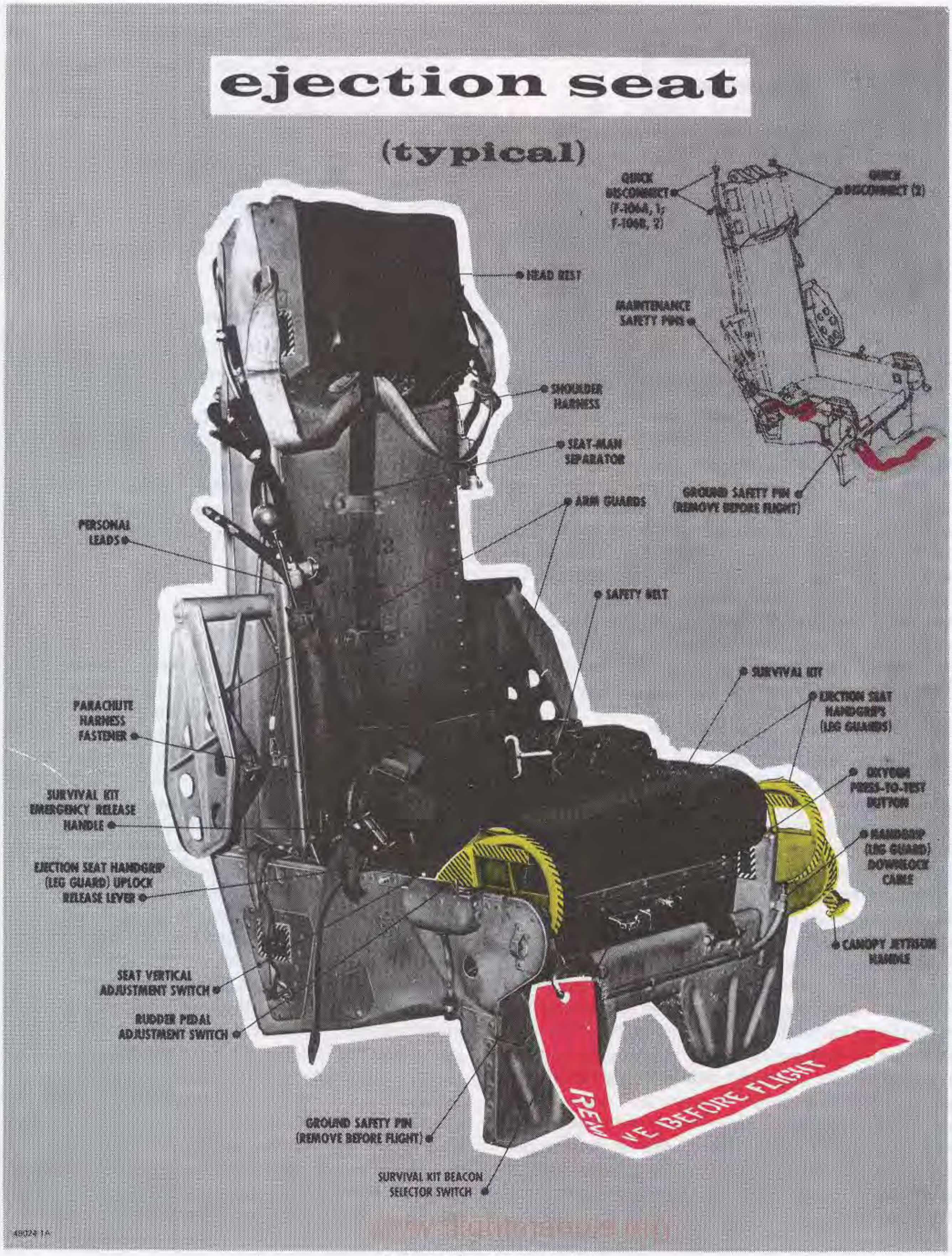


Figure 1-39 (Sheet 1 of 2)

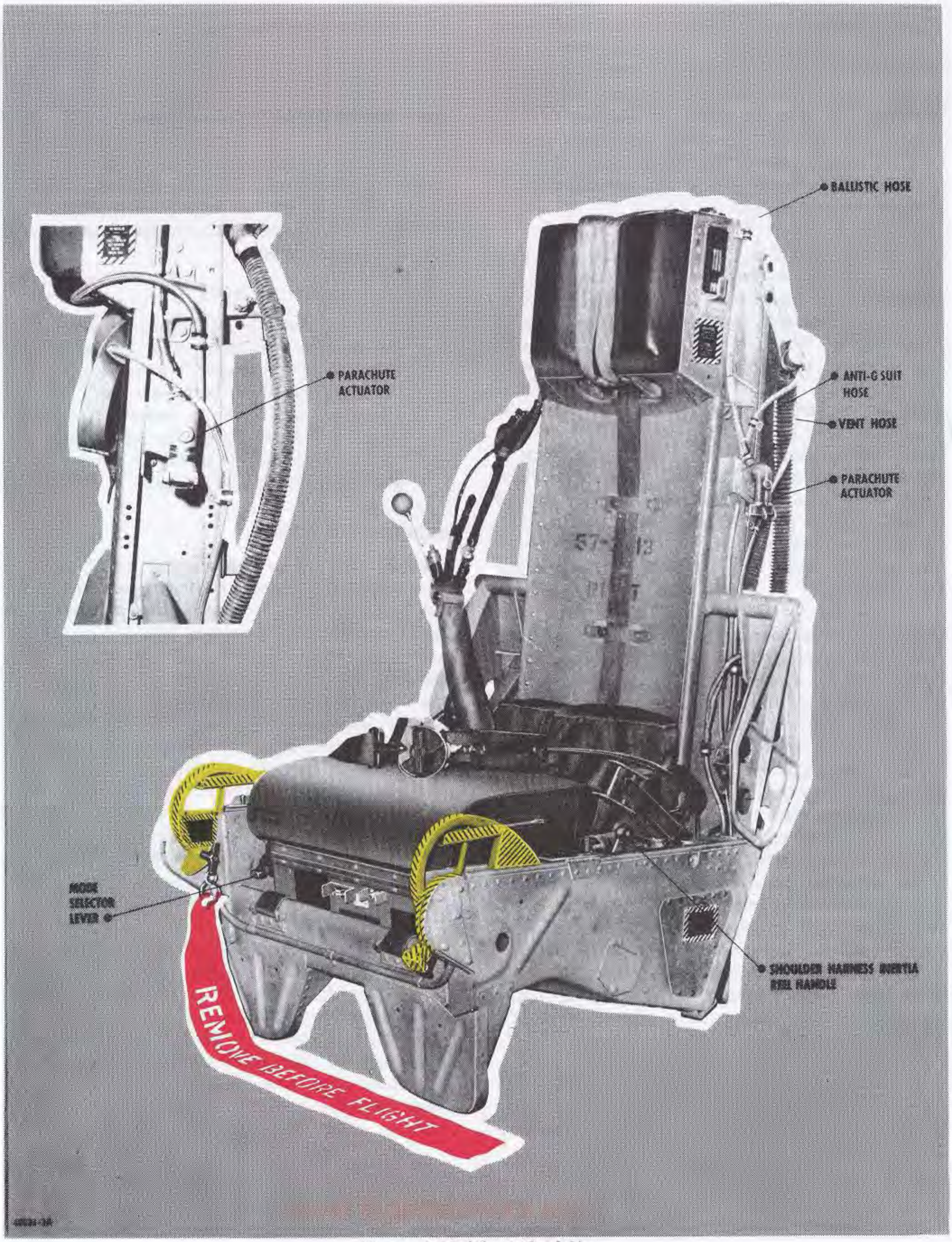


Figure 1-39 (Sheet 2 of 2)

tightly against the seat back and locks the inertia reel. The airplane-to-survival kit connections disconnect automatically during egress sequence. A limit switch is installed to disengage the AFCS allowing the stick to return to neutral so that interference between the seat, pilot and control stick will be eliminated. The arm guards are stowed until raised mechanically by the actuation of the ejection seat handgrips.

The seats installed in B airplanes look and function identically to those of A airplanes but are interlocked to ensure safe and orderly egress of both pilots should the rear pilot be unconscious or incapacitated. When the front seat ejection handgrip is raised, the canopy is jettisoned, both seats are armed, the aft and forward ballistic powered reels are locked ballistically, and the rear seat ejects, followed by the front seat. When the rear ejection seat handgrips are raised, the canopy is jettisoned, the aft inertia reel is locked ballistically, both seats are armed, and the rear seat is ejected. Unless circumstances dictate otherwise, the rear seat occupant should always initiate his own ejection to ensure proper preparation and body position.

Ground maintenance safety pins are inserted in the canopy initiator, the seat arming initiator, and the initiator for the safety-belt, seat-man separator and pressure actuator during maintenance operations. The canopy jettison and seat ejection system is safetied by a ground safety-lock pin inserted through the right handgrip linkage. On B airplanes, the seats are interlocked but safetied independently; therefore, the safety pin safeties only the seat in which it is inserted. The ground safety-lock pin does not safety the canopy jettison system if the external canopy jettison handle is pulled. This pin must be removed before flight and replaced after flight by the pilot. Stowage of the red warning streamer and the ground safety pin is provided on the bulkhead above the right console. If any of these pins are not removed, canopy jettisoning, seat ejection and/or automatic opening of the safety belt will not take place.

The seat ejection system is dependent upon the canopy jettison system. If the canopy is not jettisoned, the seat cannot be ejected. If raising the ejection seat handgrips does not jettison the canopy, the ejection seat handgrips must be returned to the stowed position by moving the uplock release lever forward and pushing the handgrips down into the detent (fully stowed) position. Then the canopy must be alternately jettisoned, either by the canopy jettison handle, or by unlocking the canopy and raising it into the airstream with the electrical switch on the right console. After the canopy has been removed, the handgrips can be raised to eject the seat.

NOTE

> Do not squeeze the handgrip release trigger at any time other than for actual ejection. If the trigger is squeezed, the downlock cable will be released and the handgrips will be in the unstowed position. During preflight, the pilot must check the handgrip downlock cable in place and the ball in the race.

EGRESS SEQUENCING

On A airplanes, when either ejection seat handgrip is raised to the full up position, a ballistic charge will retract and lock the powered inertia reel, raise both arm guards, disengage the seat firing pin pawl, and fire an initiator unit. (See figure 1-40.)If the canopy has not been jettisoned, the expanding gases will fire a thruster unit which disengages the canopy latches and fires an additional initiator unit. The resulting expanding gases are then routed to remove a pin which fires the seat rocket, ejecting the seat. If the canopy has been alternately jettisoned, raising either ejection seat handgrip will mechanically disengage the seat firing control pawl firing the seat rocket initiator. The seat rocket initiator then fires the seat rocket, ejecting the seat.

On B airplanes, the aft seat should be ejected first, followed by the forward seat. Raising either handgrip on the forward seat to the full up position raises both front arm guards, ballistically retracts and locks the forward and aft powered inertia reels, disengages the seat firing control pawls, and fires an initiator unit. (See figure 1-40.) The expanding gases are then routed to energize the canopy remover which will jettison the canopy. When the canopy leaves the airplane, a lanyard fires two initiator units. The expanding gases produced are routed to remove a seat firing control pin in the aft seat. When the firing control pin is removed, the seat firing initiator is fired. This in turn fires the rear seat rocket, ejecting the seat. One second after the canopy departs, the seat firing control pin is removed from the forward seat, and the seat firing initiator fires the forward seat rocket regardless of the rear seat position. When either aft seat handgrip is raised, the sequence is similar. However, the forward seat is armed but can be ejected only when either forward handgrip is raised. If the canopy is jettisoned, either manually or by use of the canopy jettison handle, the seat firing control pin in both seats are removed. Both seats are then armed so that when the jettison handgrips on either seat are raised, the seat firing control pawl is disengaged firing the seat rocket initiator which in turn fires the seat rocket, ejecting the seat. In this sequence, the ejection seats are interlocked so that lifting the forward seat handgrip will eject the aft seat first, then the forward seat. When the aft handgrips are raised, only the aft seat is ejected.

Low-Altitude, Low-Speed Egress Sequencing

During zero-altitude, zero-airspeed and low-altitude, low-airspeed ejections, as the rocket moves the seat up the rails, the pilot air vent tubes and seat electrical cables are separated from the airplane, the airplane oxygen supply is terminated, the survival kit oxygen supply is activated, and the rocket motor is ignited. The rocket motor burns for approximately one-half second providing sufficient thrust to propel the man-seat combination to approximately 200 to 300 feet above ejection altitude (assuming level flight ejection). Approximately one second after the seat starts up the rails, the ejection seat ballistic system initiator fires, automatically opening the seat belt, actuating the seat-man separator, arming the deployment gun, and releasing the firing lanyard from the parachute actuator assembly. Two seconds after seat-man separation (three seconds from the time the seat starts up the rails) the deployment gun fires a slug off the right shoulder of the pilot that pulls the pack pins and extracts the pilot chute and main canopy from the pack and forces them into the airstream. Full canopy is realized approximately three seconds later at an altitude of approximately 150 feet above ejection altitude and 400 feet downrange (assuming level flight ejection).

WARNING

> Do not attempt to beat the system by manually pulling the D-ring prior to automatic chute deployment by the drogue gun. At airspeeds below 150 knots, the automatic system must be depended upon for successful ground level ejection.

High-Altitude, High-Speed Egress Sequencing

Sequencing for a high-altitude, high-speed ejection is the same as the low-altitude, low-speed ejection except that the pilot free falls to approximately 15,500 feet before the barometrically controlled deployment gun fires. Full canopy is realized approximately 1.5 seconds later.

Low-Altitude, High-Speed Egress Sequencing

Sequencing for a low-altitude, high-speed ejection is the same as the low-speed ejection except that the man-seat ballistic trajectory is not as high as the low-speed ejection. However, a full canopy is realized approximately 1.5 seconds after drogue gun firing.

Automatic-Opening Seat Belt

The HBU-12 seat belt consists of two sections. The left section incorporates a manual release assembly. The right section incorporates the automatic disconnect link assembly, which is used to attach the shoulder harness straps to the seat belt.

Automatic opening is accomplished by gas pressure supplied at ejection from an automatically controlled initiator to disconnect the belt link tongue from the right section of the seat belt. The belt link tongue remains engaged with the manual release assembly (left section of the belt) as it separates from the right section of the belt. The shoulder harness loops then slip off the link end of the belt link tongue. Manual operation is accomplished by squeezing together the black and silver grips on the handle of the manual release assembly while lifting it. This action will disengage the belt link tongue.

NOTE

> Thorough testing of the automatic-opening belt has determined that the system is completely reliable and allows faster separation from the seat than does manual operation. It has also been determined that under no circumstances should the belt be manually opened prior to ejection.

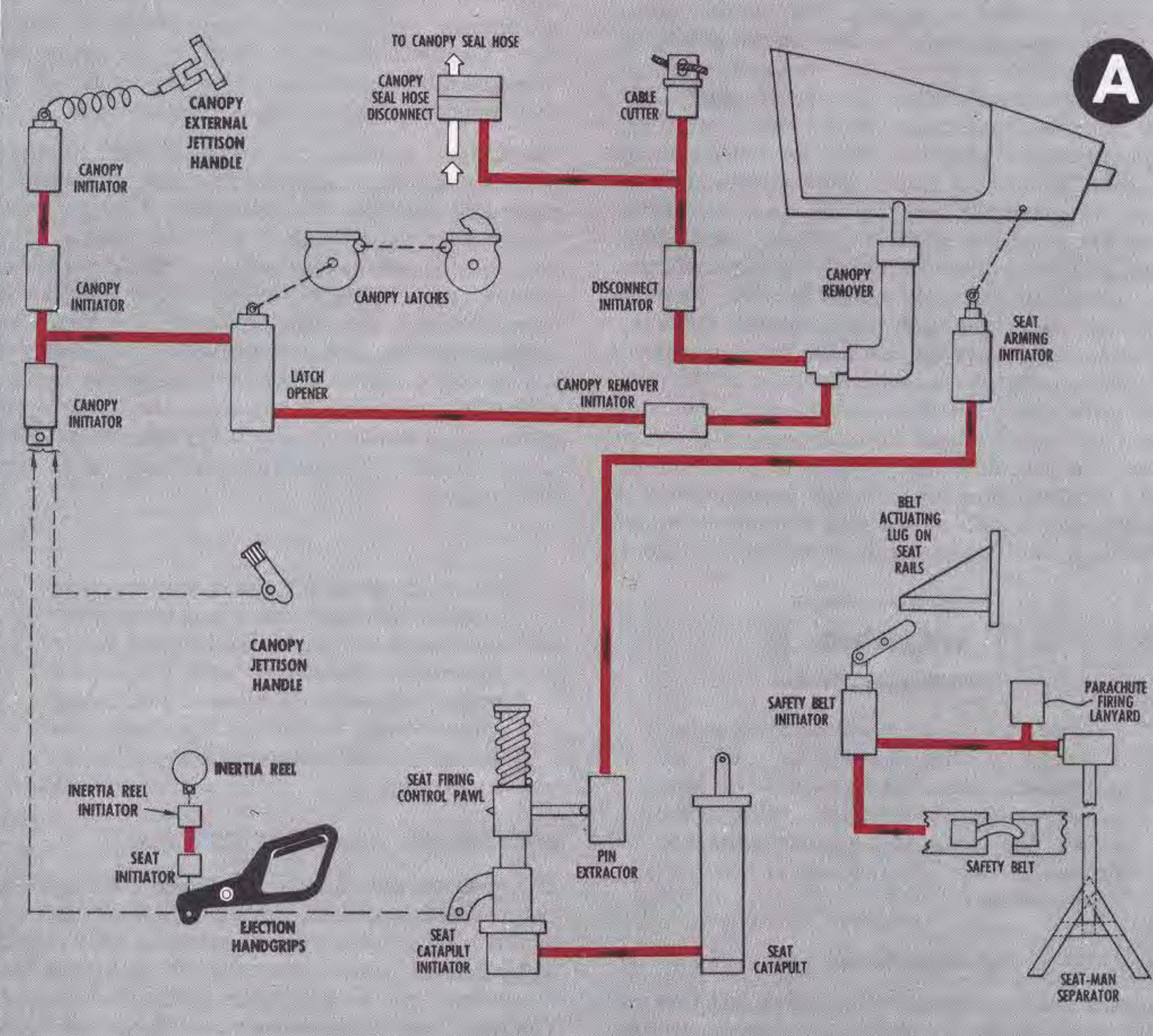
EJECTION SEAT HANDGRIP (LEG GUARD)

The ejection seat handgrips (figure 1-39) operate the one-motion ejection system. The handgrips are locked in the down (stowed) position by a detent and a handgrip downlock cable. When raised, the handgrips serve as leg guards during the ejection. The right and left ejection seat handgrips are interconnected so that unlocking and raising either handgrip will raise the other. The arm guards are mechanically positioned by raising either handgrip.

EJECTION SEAT HANDGRIP (LEG GUARD) UPLOCK RELEASE LEVER

The ejection set handgrip unlock release lever is located adjacent to the right ejection seat handgrip

canopy jettison and



NOTE

- RAISING THE EJECTION SEAT HANDGRIP AUTOMATICALLY TRIPS THE AFCS DISCONNECT SWITCH.
- ON (B) AIRPLANES, RAISING THE FORWARD EJECTION SEAT HANDGRIP FIRES BOTH THE FORWARD AND AFT EJECTION SEATS. RAISING THE AFT HANDGRIP FIRES ONLY THE AFT SEAT.

GAS ACTUATING PRESSURE
PNEUMATIC PRESSURE LINES
MECHANICAL ACTUATION
CHECK VALVE

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Figure 1-40 (Sheet 1 of 2)

seat ejection system

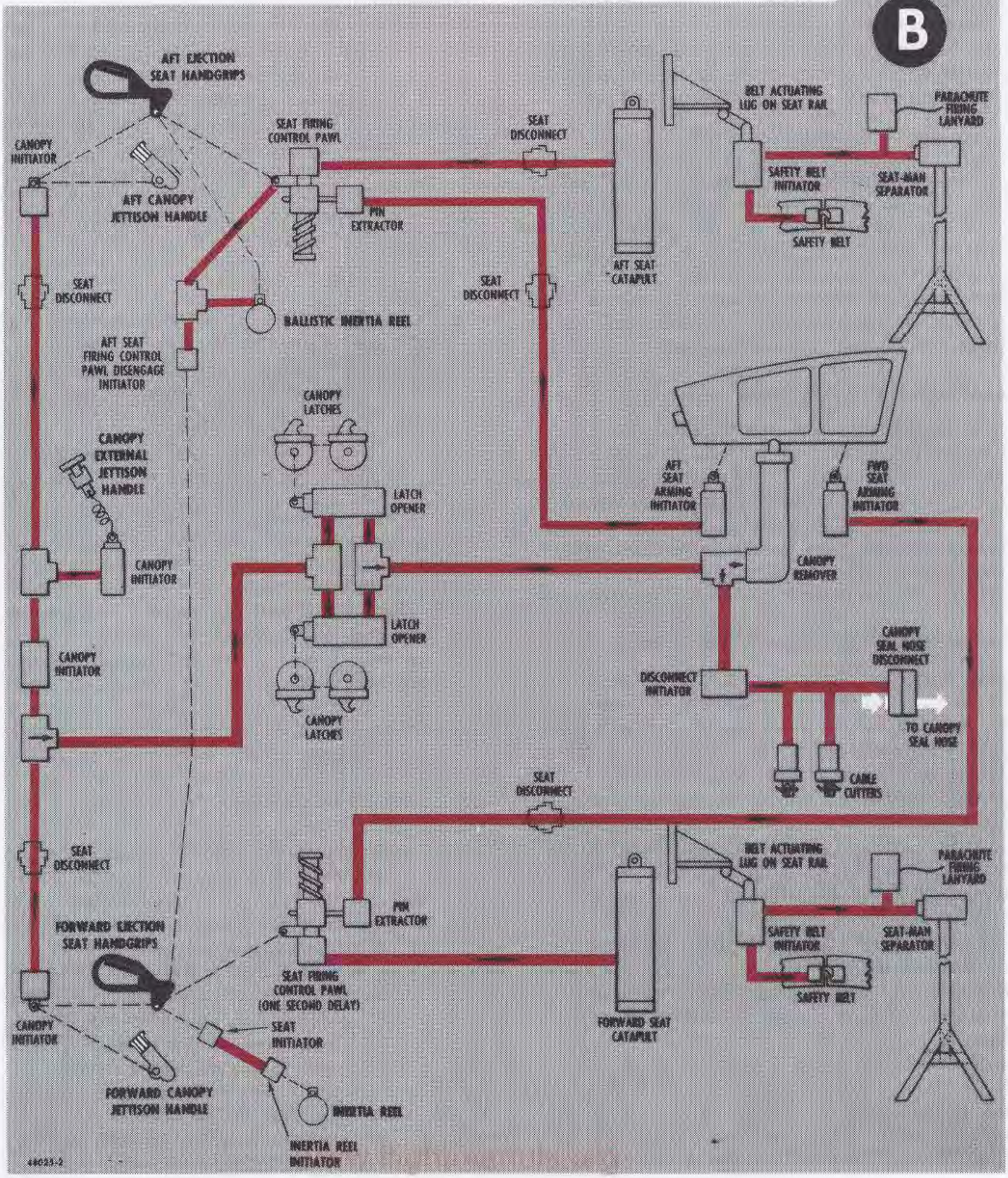

Figure 1-40 (Sheet 2 of 2)

and is placarded "Leg Guard Uplock Release." In the event the ejection seat handgrips have been raised and the canopy and seat do not eject; the lever must be moved forward and the ejection handgrips pushed to the fully down position (in detent) in order to deactivate the canopy and seat ejection system. The aft seat on Ⓑ aircraft cannot be made safe once the handgrips in either cockpit have been raised and then returned to normal.

SEAT-MAN SEPARATOR

A seat-man separator is installed on the ejection seat. The seat-man separator will separate the pilot from the seat approximately one second after the seat is ejected from the airplane. The automatic opening seat belt, the seat-man separator, and ballistically deployed parachute are sequenced to provide the most desirable operation and will be more reliable than manual operation.

SEAT VERTICAL ADJUSTMENT SWITCH

The three-position seat vertical adjustment switch (figure 1-39), located on the right side of the seat, has positions UP, DOWN, and is spring-loaded to the center (OFF) position. Holding the switch to the desired position energizes an electric motor-driven actuator which moves the seat vertically in the direction selected. The seat vertical adjustment system receives power from the dc nonessential bus.

SHOULDER-HARNESS INERTIA REEL HANDLE

Manual control of the shoulder-harness inertia reel is provided by the shoulder-harness inertia reel handle (figure 1-39), located on the left side of the seat. The handle is placarded "Inertia Reel Control Handle" and has MANUAL LOCK and AUTOMATIC positions. The handle incorporates over-center detents which restrain it from slipping out of either MANUAL LOCK or AUTOMATIC position. When the handle is in the AUTOMATIC position, the reel harness cable will extend to allow the pilot to lean forward in the cockpit. Sudden forces applied by crash landing impact, turbulence, or rapid maneuvers, which tend to rapidly separate the pilot from the seat (including forward, upward, or sideward motion), will automatically lock the harness reel. The reel locks within approximately one-half inch of cable travel. When the reel is locked in this manner, it will remain locked until the handle is moved to the MANUAL LOCK position and then returned to the AUTOMATIC position. When the handle is in the MANUAL LOCK position, the reel harness cable is manually locked so that the pilot is prevented from bending forward. The MANUAL LOCK position is used as an added safety precaution when a crash landing is anticipated. If the harness is automatically or manually locked while the pilot is leaning forward, the harness retracts with him as he straightens up, moving into successive locked positions as he moves back against the seat. To unlock the harness, the pilot must be able to lean back enough to relieve tension on the lock. Therefore, if the harness is locked while the pilot is leaning back hard against the seat, he may not be able to unlock the harness without first loosening it slightly by using the adjustment buckles.

NOTE

> A preflight check of the shoulder harness inertia reel can be made by simply giving the harness a quick jerk. The reel should lock within approximately half inch or less of cable movement.

EJECTION WARNING SYSTEM Ⓑ

The ejection warning system provides an interphone-out means of commanding ejection and a visual reference to aid in assuring that the aft seat is ejected. This sequence of ejection (aft seat before the forward seat) is necessary to prevent rocket blast from injuring the pilot in the aft seat. The system consists of two red bailout warning lights (figure FO-2), one on each instrument panel; two bailout switches (figure FO-2), one on each left console, and one switch actuated when the aft seat is ejected. Placing either pilot-operated bailout switch in the ON position causes the bailout warning light to flash, displaying "BAILOUT." When the aft seat is ejected, it automatically actuates a switch which causes the bailout warning lights to illuminate steadily. To signal for ejection, either pilot can move his bailout switch to the ON position, causing the bailout warning lights to flash. Flashing bailout warning lights indicate that the pilot in the aft seat should or will eject. The pilot in the forward seat should not eject until the bailout warning light illuminates steadily, indicating that the aft set has left the airplane. If the pilot in the aft seat ejects without actuating the bailout switch, the bailout warning lights will illuminate steadily as soon as the aft seat has been ejected. The ejection warning system receives power from the dc emergency bus.

PARACHUTE ACTUATOR ASSEMBLY

A single actuator assembly is installed on the seat to serve the dual function of arming the parachute deployment gun and to release the firing lanyard from the seat. This function forcibly ejects the terminal of the parachute lanyard while restraining the tip fitting of the cable. This resultant restraint of the tip fitting arms the barometrically controlled parachute deployment gun. It then releases, permitting the lanyard including the tip fitting to fall free.

SERVICING DIAGRAM

Refer to STRANGE FIELD PROCEDURES, Section II.

normal procedures

Section II

48055

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PREPARATION FOR FLIGHT

FLIGHT RESTRICTIONS

Refer to Section V for operating restrictions and limitations.

FLIGHT PLANNING

Refer to the T.O. 1F-106A-1-1 for information on required fuel, airspeed, thrust setting, etc., necessary to complete the mission.

TAKEOFF AND LANDING DATA CARD

Refer to T.O. 1F-106A-1-1 for takeoff and landing data card instructions, and complete cards in the Pilot's Abbreviated Checklist, T.O. 1F-106A-1CL-1.

WEIGHT AND BALANCE

Refer to Section V for weight limitations. For detailed loading information, refer to Handbook of Weight and Balance Data, T.O. 1-1B-40. Before each flight, check takeoff and anticipated landing gross weights and weight and balance clearance (Form 365F).

CHECKLISTS

The Flight Manual contains only amplified checklists; the abbreviated checklists have been issued as a separate technical order, T.O. 1F-106A-1CL-1. Refer to CHECKLISTS in the Introduction.

NOTE

The term "climatic," as used in the checklists, indicates equipment operation or settings which may be necessary for other than daylight VFR conditions. This includes IFR, night, cold weather, tropic, and desert conditions. The equipment operation or setting will vary depending on the prevailing conditions. In practice, the response to climatic items will be the required switch or control position.

PREFLIGHT CHECKS

It shall be the responsibility of the pilot to accomplish an interior and exterior visual inspection as outlined in the Flight Manual.

NOTE

- The visual inspection procedures in this Section are predicated on the assumption that maintenance personnel have completed all the requirements of the Manual of Scheduled Inspection and Maintenance Requirements, T.O. 1F-106A-6. Therefore, duplicate inspections and operational checks of systems have been eliminated, except for certain items required in the interest of flying safety.
- Checklist items coded (FP-RP) may be applicable to both Ⓐ and Ⓑ models but are coded to show the requirement for checking by the front pilot and the rear pilot in the F-106B. Items coded (RP) are the responsibility of the rear pilot.
- Actuation of all switch guards should be with a firm positive motion to assure that complete switch actuation will result.

ENTRANCE

The canopy is opened by the canopy external latch handle and canopy external switch which are reached through an access door on the left side of the fuselage below the windshield. After the canopy is opened, the cockpit is entered from the left side of the airplane by use of a ladder hooked over the left canopy sill. See figure 2-1.

BEFORE EXTERIOR INSPECTION

1. Form 781—Check.
   Check for engineering, servicing, and armament status. For detailed servicing requirements, see figure 2-11.
2. External power—OFF.
3. Canopy hold-open support(s)—In place.
4. Windshield and canopy—Check.
   Check that windshield delamination (marred windshield glass) does not extend more than two inches from the outer edge of the glass panels nor more than one inch from sectional tension straps. If delamination exceeds these limits, the windshield should be considered unsatisfactory for flight.
5. Ejection seat ground safety pin—Installed. (FP-RP)
6. Handgrip downlock cable—Check ball secure.
7. Canopy jettison handle—Down. (FP-RP)
8. Ⓐ Seat arming lanyard—Secured.
   Seat arming lanyard is not visible on Ⓑ aircraft.

WARNING

If seat arming lanyard is not properly attached to the canopy remover, jettisoning the canopy will not complete the cycle to eject the seat.

9. Personal leads bundle—Secure. (FP-RP)

WARNING

Ensure that oxygen connector is securely attached to personal leads. If the lock pins are not properly positioned in the female "J" shaped slot, the oxygen connector may become disengaged during flight.

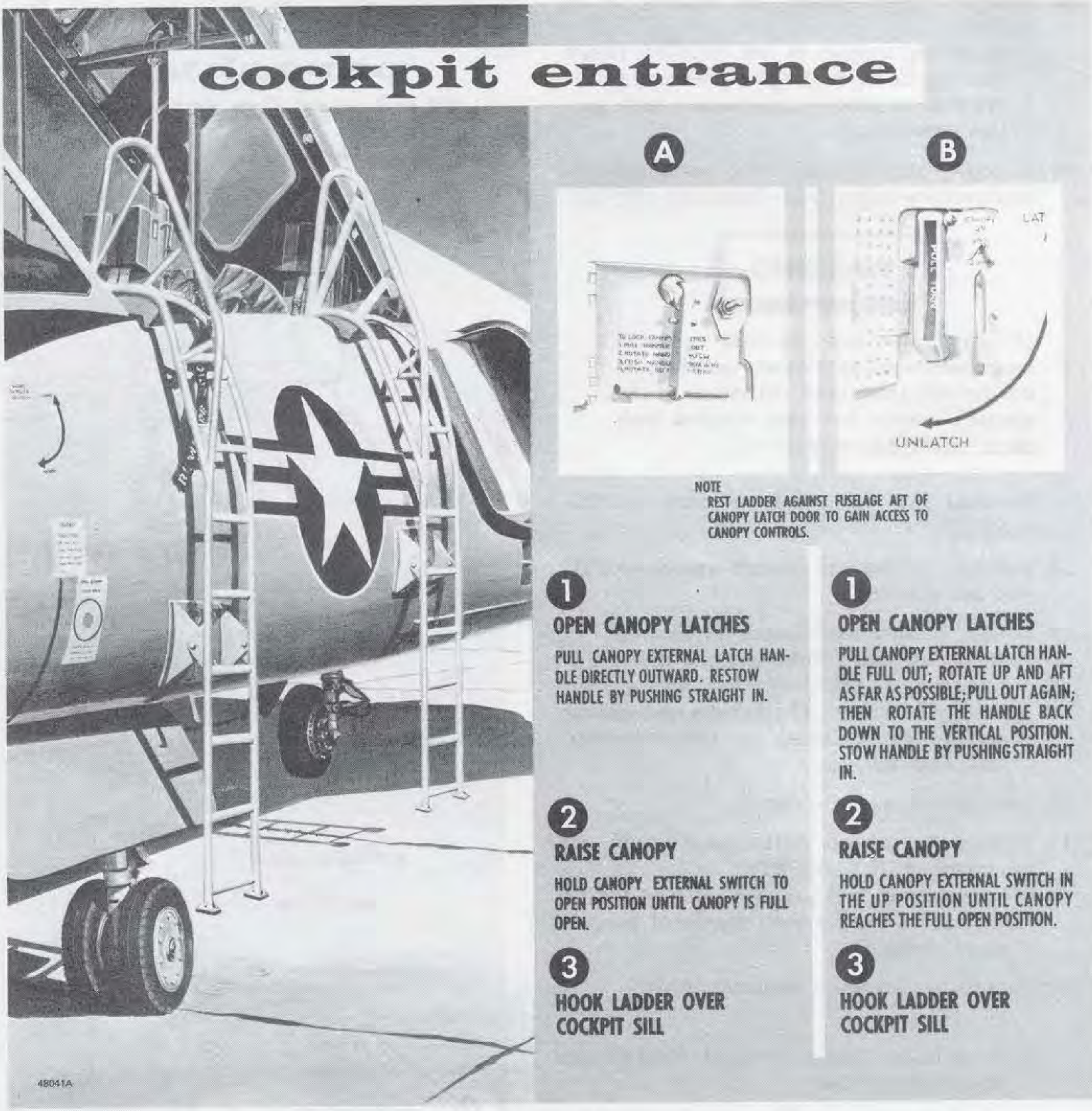


Figure 2-1

CAUTION

If the personal leads bundle becomes disconnected in flight, 100% oxygen from the converter will flow into the cockpit. Rapid loss of the normal oxygen supply will occur and emergency oxygen will not be available. UHF communications may also be lost.

10. Ejection seat quick-disconnects and ballistic hoses—Check. (FP-RP)

    Check quick-disconnects on the left and right ejection seat rails to see that the red circle around the disconnects is not exposed. Check ejection seat ballistic hoses for a smooth continuous curve from the quick-disconnects to the clamp on the seat, and see that the hoses are not twisted, flattened, or kinked.

11. Canopy support—Check for security (if installed).
    If canopy support is not installed, insure that the tie-down straps are secured to the brackets to prevent interference with ejection sequencing.
12. Canopy, survival kit and seat ground maintenance safety pins—Removed. (FP-RP)

WARNING

If any ejection system ground maintenance safety pins are installed, do not remove them until the status of the ejection system has been checked with maintenance personnel.

13. Survival kit mode selector lever—AUTOMATIC.
14. Survival kit beacon selector switch—AUTO (red dot showing).
15. Canopy breaker tool—Check for security.
    On B airplanes front cockpit, the tool is attached to the lower left side of the canopy frame. On B airplanes rear cockpit and all A airplanes, the tool is located above left console.
16. Seat belt connectors—Secure.
17. Emergency oxygen bottle gage—1800 psi minimum at 70°F. (FP-RP)
    For approximate pressure change add or subtract 3 psi for each degree of temperature change.
18. Parachute—Install in airplane. (FP-RP)
    a. Parachute firing lanyard—Install as follows (figure 2-2):
       (1) Remove safety pin and dust cap from parachute firing lanyard and secure pin by inserting through dust cap strap.
       (2) Insert terminal directly into the actuator assembly.

NOTE

The terminal will seat solidly and an audible "click" can be heard.

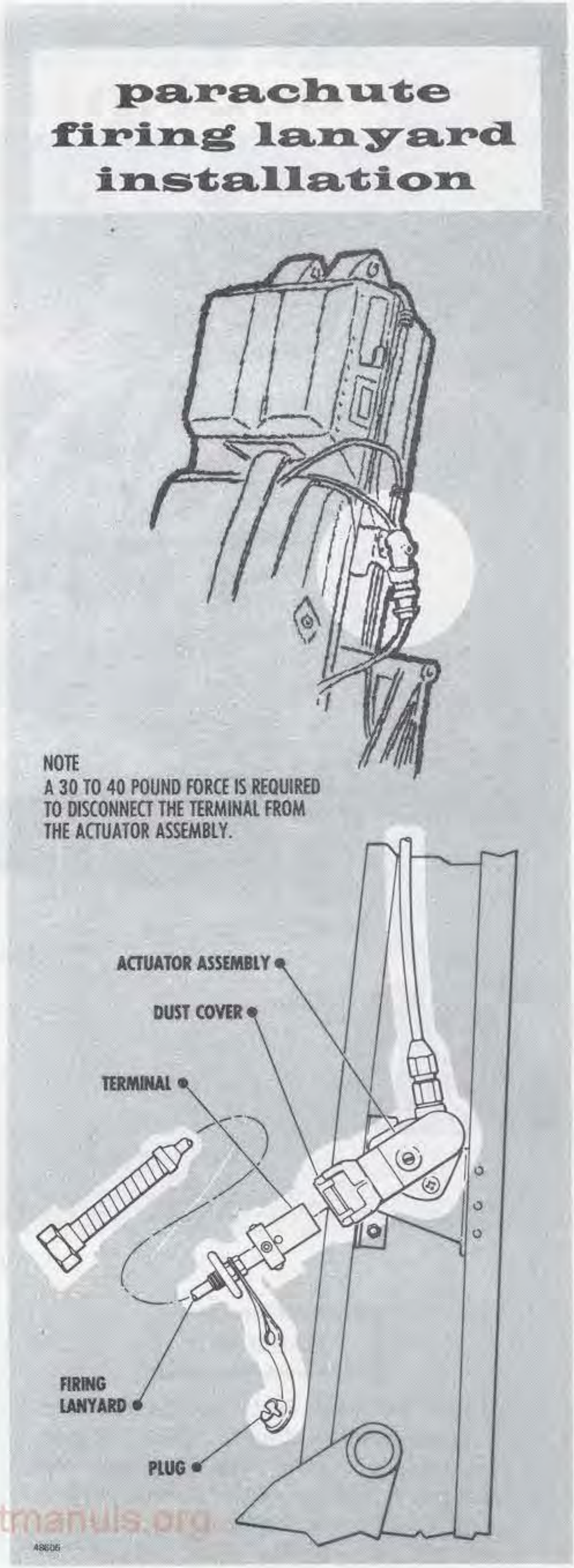


Figure 2-2

WARNING

- The firing lanyard of the parachute deployment gun must be handled with care at all times to prevent the terminal from being pulled which will cause an inadvertent firing. Movement of the tip fitting in the terminal in excess of 0.335 inch will fire the deployment gun and deploy the parachute. Firing of the deployment gun in the cockpit can cause injury or loss of life to personnel working around the aircraft.
- It is imperative that the firing lanyard be installed in front of the arm guard pivot tube. If this is not installed properly, it can cause an abortive man-seat separation which can result in pilot injury or loss of life.

b. Survival kit—Attach harness release assemblies to parachute.

19. MA-1 power switch—OFF.
20. RAT handle—UP.
21. Throttle—OFF.
    Ensure throttle is in the fully inboard OFF position.
22. Armament selector switch—VIS IDENT.
23. Arm-safe switch—SAFE.
    The guard must be safetied if armament is aboard.
24. Deleted.
25. Deleted.

25A. Standby attitude indicator—Caged and locked.

26. Master switch—ON; Battery—Check.
    Check warning lights for illumination.
27. Deleted.
28. Master electrical power switch—OFF.
29. Landing gear handle—Down.
30. Emergency landing gear extension handle—In and secured.
31. All fuses/circuit breakers—In. (FP-RP)
    Check left console, right console, and right rudder well.
32. Slipway door—Closed.

Aft Cockpit (Solo Flights) B

If the flight is to be solo, the following inspection of the aft seat, consoles, and instrument panel must be made before entering the forward seat:

1. Ejection seat ground safety pin—Installed.

NOTE

With the ground safety pin installed, the ejection seat will sequence normally from the forward cockpit.

1A. Ensure ejection seat is lowered enough so as not to bind with control stick if survival kit is installed.

NOTE

Failure to lower seat may cause pilot to feel binding during AFT stick movement.

2. Handgrip down lock cable—Check ball secure.
3. Canopy jettison handle—Down.
4. Ejection seat disconnect and hoses—Check.
   Check quick-disconnects on the left and right ejection seat rails to see that the red circle around the disconnects is not exposed. Check ejection seat ballistic hoses for a smooth continuous curve from the quick-disconnects to the clamp on the seat, and see that the hoses are not twisted, flattened, or kinked.
5. Canopy and seat maintenance pins—Removed.

WARNING

If any ejection system ground maintenance safety pins are installed, do not remove them until the status of the ejection system has been checked with maintenance personnel.

6. Survival kit—Remove or secure with restrainer strap.
7. Personal equipment leads and all loose items—Stow.
8. Seat belt and shoulder harness—Secure.
9. Fuel shutoff switch—NORMAL.
10. Variable ramp switch—AUTO.
11. Fuel control switch—NORM.

12. Throttle—OFF.
13. Oxygen supply switch—OFF.
14. Master electrical power switch—ON.
15. Landing gear handle—DOWN.
16. Landing gear emergency extension handle—In and secure.
17. Flight mode selector switch—DIR MAN.
18. Drag chute handle—In.
19. TDS light intensity rheostat—OFF.
20. TDS mode selector switch—MAN.

20A. Emergency canopy open switch—Off (guard closed).

21. Cockpit lights—Off.
22. Fuse/circuit breaker panels—Check.
23. UHF—Off.

EXTERIOR INSPECTION

Perform the following checks in accordance with figure 2-3.

NOTE

While checking the items listed below, check that doors and inspection plates are closed. Check for fluid leaks, indications of defective or insecure installations, and the general overall appearance of the airplane.

A. Forward Left Side

1. Canopy external handle access door—Secured.
2. Aircraft placarding—Check for armament status.
3. Static ports—Clear.
4. Oxygen filler valve access door—Secured.
5. Nose wheel well door hinges—Check.
6. Forward electronics bay door—Secured.
7. Angle of attack transducer and beta vanes—Condition, guards removed, free, and gently place angle of attack vane in the full up position. Leave the vane in the full up position in order to check instrument during interior inspection.

CAUTION

- The vanes must be handled with care to prevent internal damage.
- The vanes may be hot and can burn the hand if touched.

B. Nose

1. Radome—Condition and secure.
2. Mast and pitot tube—Condition and cover removed.

C. Forward Right Side

1. Forward electronics bay door—Secured.
2. Static ports—Clear.
3. Direction finder antenna—Secured.

D. Nose Wheel Well

1. Taxi light—Condition and security.
2. Nose gear door seal—Condition.
3. Control outflow valve (cabin pressure regulator)—FLIGHT position and safetied.
4. Wheel brake reservoirs—Check (some airplanes).
5. Battery and battery charger—Secured.
6. Deleted.
7. Fuses/circuit breakers—Check.
8. Nose gear ground safety pin—Remove.
9. Nose wheel steering unit ground pin—Removed.
10. Scissors linkage—Connected.
11. Strut extension—4 to 5 inches.
12. Tires—Check.
    Check for wear, cuts, inflation, and valve cap installed.

E. Right Side

1. Temperature probe—Condition and clear.
2. Lower aft electronics bay door—Secured.
3. (B) Lower mid-electronics bay door—Secured.
4. Missile bay door—Secured.
5. (A) Upper aft electronics bay door—Secured.
   Check that all fasteners are flush and tight.

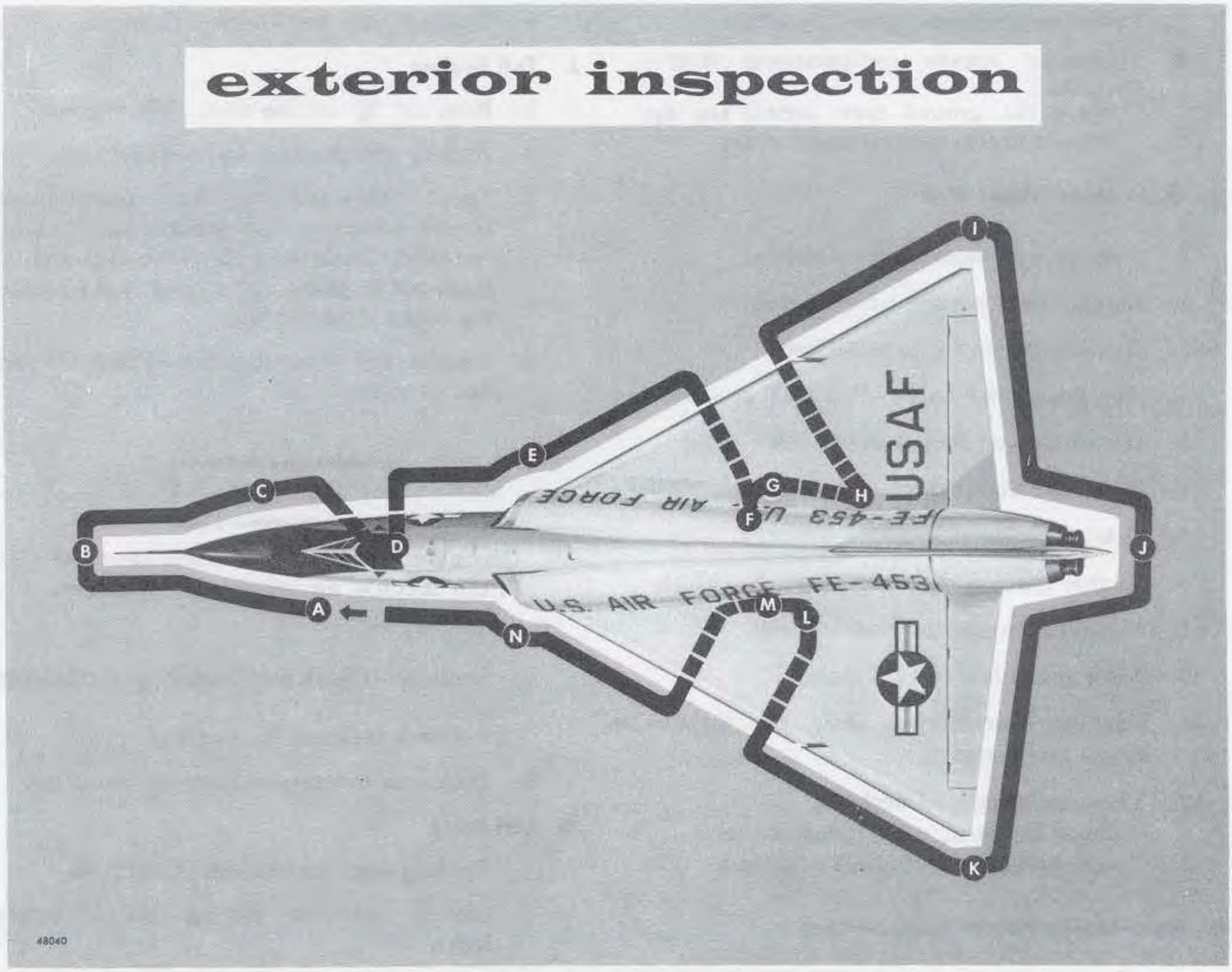


Figure 2-3

6. Air-conditioning compartment access door—Secured.
7. Boundary layer duct—Clear.
8. Variable ramp—Condition and retracted.
9. Intake duct—Condition and loose articles.
10. Fuel filler cap and access door—Secured. Check that fuel credit card is installed inside access door.

F. Hydraulic Compartment

1. RAT door—Check that pressure is relieved.
2. RAT rotor and blades—Condition and turns freely.
3. Primary and secondary hydraulic accumulator pressure—750 psi.
4. Primary and secondary hydraulic fluid levels—Not more than 3/4-inch below the full mark corresponding to temperature on reservoir temperature gage.
5. Reservoir pressure gages—Check approximately 55 psi.
6. Reservoir pressure shutoff valve—Open and pin installed.

CAUTION

The reservoir pressure shutoff valve shall be locked in the OPEN position at all times except when hydraulic system maintenance is being performed.

7. Lower anticollision light—Condition.
8. Hydraulic access compartment door—Secured.
   Have the ground crew secure the hydraulic access compartment door.

G. Right Main Wheel Well

1. Gear ground safety pin—Remove.
2. Refuel selector valve—Horizontal.
3. Armament control panel—Check.
4. Armament lock valve—FLIGHT position.
5. Hydraulic and fuel lines—Check.
6. Fuses/circuit breakers—Check.
7. Deleted.
8. Engine ignition disconnect switch—ARM.
9. Brake and hydraulic lines—Check.
10. Strut extension—5 to 6 inches
11. Landing gear fairing, door, and light—Condition and security.
12. Tires and chocks—Check.
    Check for wear, cuts, inflation, valve caps installed, and chocks in place.

H. Right Engine Access Compartment

1. Magnetron hydraulic system accumulator—1200 to 1500 psi.
2. Magnetron hydraulic system quantity gage—Full for specified level.
3. Fuel shutoff valve—FULLY OPEN.

I. Right Wing

1. External wing tank—Check (if installed).
   Check external wing tank for security, fuel quantity, cap and pylon access doors secure. Ground safety pin—remove.
2. AIS POD—Check for security (if installed).
3. Fuel ambient sense and vent ports—Clear.
4. Wing, condition and position lights—Check.
5. Elevon actuator fairing—No hydraulic leaks.
6. Trailing edge and elevon—Condition.

J. Tail Section

1. Ram air "q" intake covers—Removed.
2. Rudder and position light—Condition.
3. Speed brakes and drag chute—Check speed brakes condition and ground safety locks removed. Check drag chute stowage and release pin in place; upper drag chute retaining strap attached last.
4. Tailpipe and exhaust nozzle—Check for fuel and condition.

CAUTION

Check for fuel puddles at drain lines and in the tailpipe, as unburned fuel creates a fire hazard.

5. Tailhook—Check and remove ground safety pin.
   Check tailhook for security.
6. Data link antenna—Check for condition.

K. Left Wing

1. Trailing edge and elevon—Condition.
2. Elevon actuator fairing—No hydraulic leaks.
3. Wing condition and position lights—Check.
4. Oil cap access door—Secured.
5. Fuel ambient sense and vent ports—Clear.
6. External wing tank—Check (if installed).
   Check external wing tank for security, fuel quantity, cap and pylon access doors secure, and ground safety pin removed.

L. Left Engine Access Compartment

1. Hydraulic lines, fuel lines, and throttle linkage—Check general condition and safety-wired.
2. Engine access compartment door—Open.
   Alert airplanes may have door secured. Ground crew will normally secure engine access compartment door after start.
3. Fuel shutoff valve—FULLY OPEN.

M. Left Main Wheel Well

1. Gear ground safety pin—Remove.
2. External air—Connected.
3. Emergency ac generator—Condition and leaks.
4. Fuses/circuit breakers—Check.
5. Hydraulic and fuel lines—Check.
6. Manual air shutoff valve—CLOSED and safetied (if external air source is available).
7. Starter mode switch—As required.
8. Pneumatic system pressure gage—2000 to 3000 psi.
9. Missile bay doors—Manually opened (slow).
10. Missile bay—Check for armament.

CAUTION

- Extreme caution should be exercised when checking equipment in the missile bay area.
- Avoid movement of any of the door control valve indicator pins, as damage to the missile bay doors will result.
- If a baggage rack is installed, every effort should be made to stow all items in the rack. If the size of the item precludes its storage in the baggage rack, it should be securely tied or strapped to the baggage rack frame to avoid loss in flight or damage to the missile bay if turbulence is encountered.

11. General condition of gun—Check.
12. General condition of missile—Check.
13. Missile bay doors—Closed.
14. Pneumatic system pressure gage—approximately 3000 psi.
15. Engine hot-section analyzer data recorder—Reset to preflight condition.
16. Brake and hydraulic lines—Check.
17. Strut extension—5 to 6 inches.
18. Landing gear fairing, door and light—Check condition and security.
19. Tire and chocks—Check.
    Check for wear, cuts, inflation, valve cap installed, and chocks in place.
20. RAT door—Unlock and close by gradual increase in force. Listen for click of uplocks. Check for security.

CAUTION

To preclude damage to uplock mechanism, do not slam door.

N. Left Side.

1. Missile bay door—Condition and secured.
2. Emergency canopy jettison access door—Secured.
3. Boundary layer duct—Clear.
4. Variable ramp—Secure and retracted.
5. Intake duct—Condition and loose articles.
6. Air-conditioning compartment access door—Secured.
7. Upper aft electronics bay door—Secured.
   Check that all fasteners are flush and tight.

INTERIOR INSPECTION

NOTE

Items marked with the symbol ▲ preceding the step cannot be performed if making the interior inspection with battery power prior to battery start. These items (▲) should be checked after battery start. (Refer to INTERIOR INSPECTION AFTER BATTERY START, this Section.)

General

1. Personal equipment, seat belt, and shoulder harness—Attach and adjust (as required). (FP-RP)
   The oxygen hose and communications lead should be routed under the right

shoulder harness strap. The anti-g suit hose should be routed underneath the arm guard pivot tube for hookup when the anti-g suit is in use. When not in use, it should be routed behind the arm guard pivot tube and up to the hose support/storage strap.

WARNING

- Survival kit must be connected to the parachute harness prior to fastening seat belt, and the kit attaching straps must be properly stowed and adjusted to prevent possible entanglement. Ensure that survival kit straps are routed under, and not over or through, the seat belt.
- The survival kit attaching straps must be snugged up closely after the kit is hooked to the parachute harness. During ejection, if the kit is allowed to hang too far below the harness, it may swing up behind the parachute after seat separation and prevent or slow deployment of the parachute. Check routing of kit straps to assure that they are not between seat belt and ballistic hose.
- Failure to tighten the seat belt securely may result in the ship-to-kit disconnect failing to operate properly during ejection under negative-g conditions.

2. Canopy support—Remove.
3. Ladder—Remove.

▲ 4. External power—Connected (if available).
If external electrical power is not available, turn the master electrical power switch ON.

▲ 5. Seat and rudder pedals—Adjust. (FP-RP)

NOTE

Do not adjust seat height so that the upper portion of the instrument panel is obscured by the glare shield.

Left Hand Console

1. Cabin air selector handle—Adjust for vertical outlet. (FP-RP)
2. MA-1 test panel cover—Closed.

Ⓑ 3. Intercom volume control knob—As desired. (FP-RP)

Ⓐ 4. Emergency slipway door open switch—NORM (guard closed).

Ⓐ 5. Refuel select switch—ALL TANKS (guard closed).

Ⓐ 6. Air refuel switch—OFF (guard closed).

▲ 7. Armament recycle button—Depress for 5 seconds.
If the missile intervalometer is not reset by the ground crew or the pilot, the armament bay doors will not open on a missile attack. The armament selector switch must be in VIS IDENT before reset will occur.

8. Variable ramp switch—AUTO (guard closed). (FP-RP)
9. Fuses/circuit breakers (LH panel)—Check.
10. Fuel shutoff switches—OPEN.
Check that the fuel shutoff valve warning lights (on the fuel control panel) and fuel valve closed warning light (on the master warning light panel) are out. Press to test fuel valve indicator lights for illumination.

Ⓑ 11. Fuel shutoff switch—NORM. (RP)

▲ 12. Boost pump switches—Check, then ON.
Turn each fuel boost pump switch ON, one at a time then OFF. Check that respective fuel boost pump warning light goes out when the switch is ON. Ensure that the opposite side fuel boost pump warning light does not go out. After each pump is checked individually, turn all fuel boost pump switches ON.

CAUTION

If the warning light does not extinguish and/or the warning light extinguishes on the opposite wing, the cause should be established and corrected prior to flight.

Ⓐ 13. T tank switch—CLOSE.
The fuel valve closed warning light

(master warning light panel) will be illuminated with the T tank switch closed.

▲ 14. Fuselage tank emergency pressure or boost pump switch—OFF.

15. External tank emergency switch—OFF.

16. MA-1 power switch—Recheck OFF.

17. Grid reference knob—Set.

NOTE

The grid reference heading is obtained by adding the correction angle, obtained on the local 50-mile radius map, to the aircraft magnetic heading.

18. IFF/SIF control panel—Set (as required).

19. Fuel control switch—NORMAL. (FP-RP)

20. Throttle—OFF. (FP-RP)

21. Speed brakes switch—Center (off)

22. UHF radio—Set. (FP-RP)

23. Special weapon armed light—OFF, press-to-test.

24. Armament selector switch—VIS IDENT.

25. Arm-safe switch—SAFE.
The guard must be safetied if armament is aboard.

26. Deleted

27. Deleted.

28. Armament selection indicator—"NO."

29. Deleted.

30. ILS channel selector switch—Set as desired, volume at minimum.

31. Cockpit no-fog and ventilated suit switch—As desired.

▲ 32. Landing and taxi light switch—Check.

33. Reset/MBL switch—NORM.

Ⓑ 34. Bailout light switch—Check. (FP-RP)

Ⓐ 35. CG control switch—AUTO (guard closed).

▲ Ⓐ 36. CG transfer test failure light—ON (with full internal fuel). Press-to-test (with reduced internal fuel).

37. Idle thrust control switch—OFF.

38. Master electrical power switch—Recheck OFF (if starting with external power).

39. Oxygen system—Check as outlined in Section IV. (FP-RP)

40. RDR/IR control panel—Set as desired.

41. Landing gear emergency extension handle—In and secure. (FP-RP)

42. Deleted.

Instrument Panel

1. Flight mode selector switch—DIR MAN. (FP-RP)

1A. Display/auto mode switch—ILS.

2. Heading hold switch—OFF. (FP-RP)

3. Altitude hold switch—OFF. (FP-RP)

4. Clock—Set. (FP-RP)

5. Deleted.

6. Drag chute handle—In. (FP-RP)

7. Landing gear position lights—On. (FP-RP)

8. Landing gear warning light—Out. (FP-RP)

9. External tank empty lights—Check.
Check lights out if external tanks are full; press-to-test.

10. Computer mode indicator—Striped. (FP-RP)

11. Radar scope/ODU controls—Set.

a. Erase intensity knob—Set at 10 o'clock position (90° from full cw).

b. Attack intensity knob—Fully cw.

c. Dimmer knob—As required.

d. IF gain knob—As required.

e. Video gain knob—Fully cw.

f. Gunsight mode selector switch—Set at 1 (gunsight installed).

12. Engine fire warning loops—Test.

▲ 13. Marker beacon light—Press-to-test. (FP-RP)

14. Variable ramp warning light—Press-to-test (if installed).

15. Warning lights—On (Canopy unlocked, master warning, hydraulic pressure-low). (FP-RP)

16. Engine instruments—Check. (FP-RP)
Check tachometer, fuel flow indicator and EPR gage for zero indication, and the pressure ratio set. The EGT gage should read ambient temperature if engine is cold.

17. EGT power flag—Not displayed.

▲ 18. Fuel quantity and balance—Check.
Select TOT, RH, LH, FWD, and #3 positions with the fuel quantity gage switch(es) and check the fuel quantity gage for proper fuel quantities. Return switch to TOT position.

NOTE

No. 3 tank fuel quantity cannot be obtained with the fuel quantity gage selector switch in the FWD position.

19. RDR/IR selector panel—Set.

a. Range selector switch—4 miles.

b. IR stow switch—RDR SCAN.

c. Tune switch—SNIFF.
This insures that radar will be working outside the NORM frequency band. Scope video checks can be evaluated with less external noise in this position.

d. Nose/tail switch—Nose.

e. Chaff switch—OFF.

f. Radar mode switch—NORM.

20. Oil quantity gage—Indicating normally.

a. Press to test warning light on B aircraft.

21. Bearing selector switch—NORM (if installed). (FP-RP)

22. Heading selector switch—NORMAL (if installed). (FP-RP)

23. TSD controls—As desired. (FP-RP)

Right-Hand Console

1. Hydraulic pressure gages—Check.
2. Oil pressure gage—Check.
3. Refrigeration unit switch—ON.
4. Cabin air selector switch—OFF.
5. Generator switch—OFF.
6. TACAN function selector knob—As desired.
7. TACAN mode selector switch—As desired.
8. TACAN range selector switch—As desired.
9. TACAN control panel—Set.
10. TACAN ECM indicator light—Out.
11. Homing point selector—Not "A,", "T," "U," or "G."
This insures that data from the computer will not be called up and the test pattern can be evaluated properly.
12. Data link antenna selector switch—NORM.
13. Master warning lights—Check. (FP-RP)
Depress warning lights test button and check that all lights in the master warning system illuminate.

NOTE

The following warning lights will normally be illuminated prior to depressing the master warning lights test button: ac power failure, emergency fuel on, left and right fuel tank pressure-low (left and right fuel boost pressure-low, if fuel boost pumps are off), engine anti-ice, oil pressure-low, and flight mode failure.

14. ATG switch—OFF.
15. Canopy latch handle—Unlock (fully aft).
16. Map reading light—Check (if required).

17. Altitude warning selector—Set.
18. Windshield anti-icing, antifog switches—On.
19. Deleted.
20. TACAN bearing/ADF select switch—As desired (if installed).
21. Emergency ac generator test switch—NORMAL.
22. Deleted.
23. Data link panel—Set (as required).
24. Rain removal switch—OFF.
▲ 25. Thunderstorm lights switch—Check, then as desired.
26. Warning lights dimmer switch—As desired.
▲ 27. All external and internal light switches—Check and set, as required (FP-RP)
    Turn lights on and confirm proper operation and dimming with aid of crew chief, then turn off if not required.
28. Formation navigation lights switch—NAV ON.
▲ 29. Pitot heat switch—Check, then OFF.
30. Canopy antifog switch—Climatic.
    Place canopy antifog switch ON if required to heat canopy glass panels.
31. Surface and engine anti-icing switch—AUTO ON.
32. Cabin temperature control knob—AUTOMATIC.
33. Deleted.
34. Compass system controller—Set.
    a. Latitude—Set.
    b. Function selector—SLAVE.
    c. MAG-VAR—Set.
    d. N-S switch—Proper hemisphere.

CAUTION

The synchronization knob may be used at any time, but should not be operated if the pitch is more than 5°; otherwise, an erroneous synchronization will occur.

O 35. Air refuel switch—OFF (guard closed).
O 36. Refuel select switch—ALL TANKS (guard closed).
O 37. Emergency slipway door open switch—NORM (guard closed).
38. Fuses/circuit breakers—Check. (FP-RP)

BEFORE STARTING ENGINE

An external air and electrical power source are normally used to start the engine. On O airplanes engine start is made from the front cockpit.

CAUTION

Before starting engine, determine that wheels are firmly chocked, and hold wheel brakes on. Parking brakes are not installed on the airplane.

WARNING

Determine that danger areas fore, aft, and under the airplane are clear of personnel, aircraft, and vehicles. Refer to figure 2-4. Suction at intake ducts is sufficient to kill or seriously injure personnel pulled against or drawn into the ducts. The danger area aft of the airplane is created by the exhaust velocity and temperature.

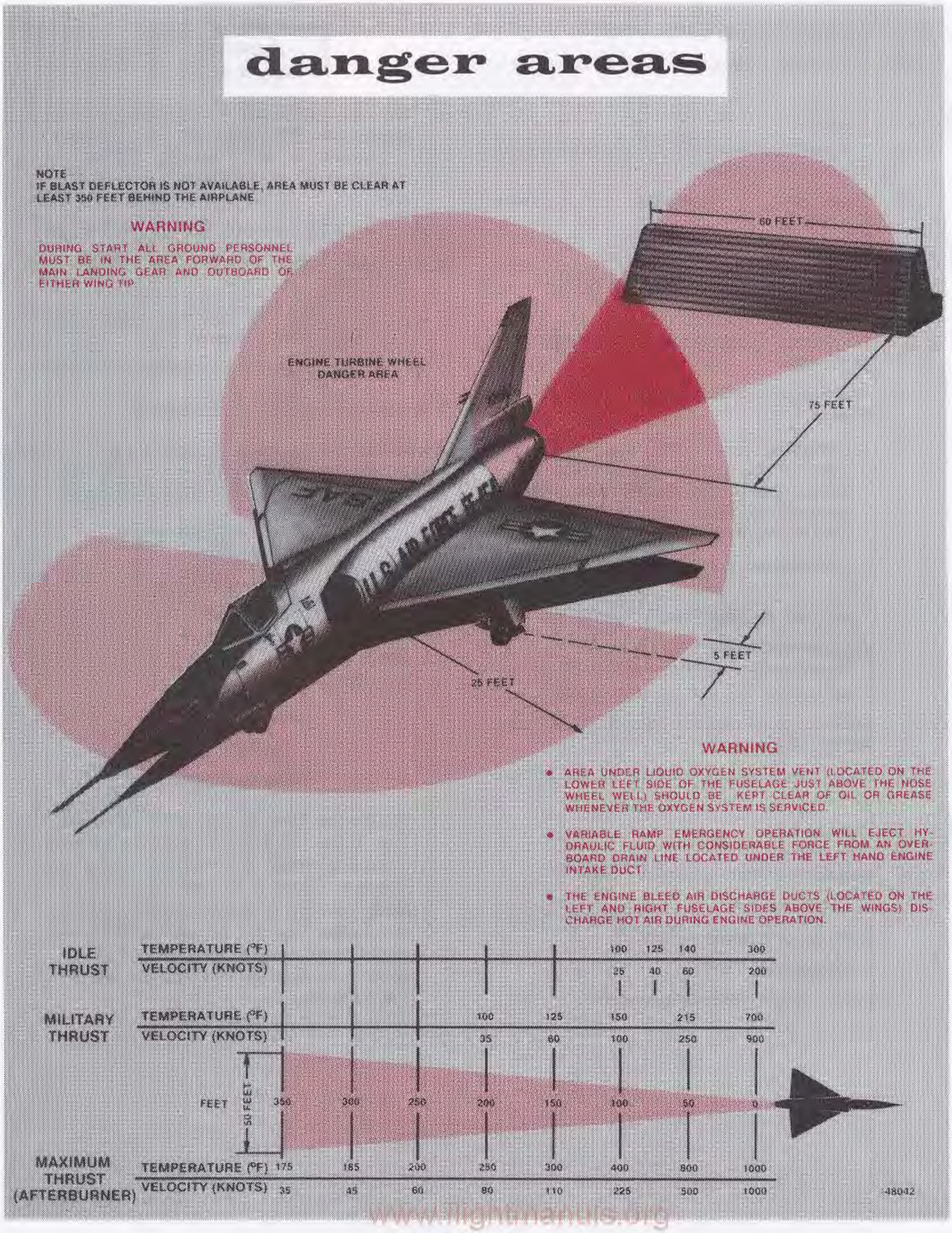

danger areas
NOTE
IF BLAST DEFLECTOR IS NOT AVAILABLE, AREA MUST BE CLEAR AT LEAST 350 FEET BEHIND THE AIRPLANE
WARNING
DURING START ALL GROUND PERSONNEL MUST BE IN THE AREA FORWARD OF THE MAIN LANDING GEAR AND OUTBOARD OF EITHER WING TIP.
60 FEET
ENGINE TURBINE WHEEL DANGER AREA
75 FEET
5 FEET
25 FEET
WARNING
• AREA UNDER LIQUID OXYGEN SYSTEM VENT (LOCATED ON THE LOWER LEFT SIDE OF THE FUSELAGE JUST ABOVE THE NOSE WHEEL WELL) SHOULD BE KEPT CLEAR OF OIL OR GREASE WHENEVER THE OXYGEN SYSTEM IS SERVICED.
• VARIABLE RAMP EMERGENCY OPERATION WILL EJECT HYDRAULIC FLUID WITH CONSIDERABLE FORCE FROM AN OVERBOARD DRAIN LINE LOCATED UNDER THE LEFT HAND ENGINE INTAKE DUCT.
• THE ENGINE BLEED AIR DISCHARGE DUCTS (LOCATED ON THE LEFT AND RIGHT FUSELAGE SIDES ABOVE THE WINGS) DISCHARGE HOT AIR DURING ENGINE OPERATION.
IDLE THRUST
TEMPERATURE (°F) 100 125 140 300
VELOCITY (KNOTS) 25 40 60 200
MILITARY THRUST
TEMPERATURE (°F) 100 125 150 215 700
VELOCITY (KNOTS) 35 60 100 250 900
FEET 350 300 250 200 150 100 50 0
50 FEET
MAXIMUM THRUST (AFTERBURNER)
TEMPERATURE (°F) 175 185 200 250 300 400 800 1000
VELOCITY (KNOTS) 35 45 60 80 110 225 500 1000
48042

Figure 2-4

STARTING WITHOUT GROUND SUPPORT EQUIPMENT

The start may be accomplished by using the airplane battery and the airplane high-pressure pneumatic system or cartridge.

NOTE

- Cartridge mode requires the starter mode switch to be in the CARTRIDGE position.
- Pneumatic mode requires the starter mode switch to be in the PNEUMATIC position, and the manual air shutoff valve open. The valve should be closed after engine is started to prevent loss of pneumatic pressure through leakage.
- All preflight check items that require electrical power should be checked after the engine has started. Refer to After Battery Start.
- After the throttle is moved to idle, place emergency ac generator switch to START.

Pneumatic Start

Pneumatic starts are normally used for engine starting.

WARNING

Ensure there is no cartridge in the starter breech before proceeding with a pneumatic start.

1. Starter mode switch—PNEUMATIC.
   Have ground crew place the start mode switch to PNEUMATIC.

NOTE

An external compressed air source is normally used for all pneumatic starts.

2. Use normal start procedure.

NOTE

A maximum of three pneumatic starts may be made in a 15-minute period.

Cartridge Start

1. Starter mode switch—CARTRIDGE.
   Have ground crew place start mode switch to CARTRIDGE.
2. Use normal start procedure.

NOTE

Cartridge and pneumatic starts may be interspersed. The total number of starts is limited to three in a 15-minute period; however, the limit of two cartridge starts in a 60-minute period must be adhered to.

STARTING ENGINE

NOTE

Items marks with the symbol ▲ preceding the step cannot be performed if starting with the battery.

1. Clear to start—Check. (FP-RP)

WARNING

Prior to any ground start make sure that all ground personnel are forward of the main landing gear and outboard of either wing tip (figure 2-4) before moving the throttle out of the OFF position. Ground crew should not re-enter the wheel well area until the starting cycle is completed.

2. Engine ignition button—Depress and hold.

CAUTION

To avoid closing the starter pneumatic regulator valve and terminating ignition, once depressed, the engine ignition button must be held depressed until the starting sequence is complete. If ignition button is inadvertantly released, the throttle must be returned to OFF. This is true only during ground operation since ignition for an air start is obtained immediately upon depressing the engine ignition button.

3. Throttle—START, OFF (Wait until 10% RPM), then IDLE.

CAUTION

Do not jockey the throttle. The starting fuel schedule is automatically controlled by the fuel control unit. Jockeying the throttle will interrupt this schedule.

▲ 4. Fuel flow—Check for indication (approximately 1500 to 2000 pph).

NOTE

Fuel flow above 2000 pph may be the first indication of a hot start.

5. Exhaust gas temperature rise—Check.
During a satisfactory start, a lightup occurs within 20 seconds after throttle is advanced to IDLE. Lightup can be noted by an indication of exhaust gas temperature.

CAUTION

Due to the time lag in the exhaust gas temperature system, a hot start is defined as 400°C. During the initial starting surge, the actual tailpipe temperatures may be as much as 200°C higher than the indicated temperature. When a hot start occurs, record on Form 781 the maximum exhaust temperature reached, and the time during which the exhaust temperature exceeded 400°C. In the event of a hot start, shut down the engine using the unsuccessful start procedure, this Section.

6. Hydraulic pressure-low warning light—Out (approximately 8 to 10% rpm).
7. Engine ignition button—Release, at approximately 30% rpm.

CAUTION

If the engine does not light up within 20 seconds after throttle is advanced to IDLE, the start should be aborted. Shut down the engine by using the UNSUCCESSFUL START procedure, this Section.

8. Check idle rpm—59 to 61% rpm.

NOTE

With the exhaust nozzle open, rpm will increase approximately 2%.

9. Oil pressure-low warning light—Out.
For cold weather operation, refer to COLD WEATHER PROCEDURES, Section IX.
10. Exhaust gas temperature—Stabilized.
Check that exhaust gas temperature rises within limits.

▲11. Compressed air and electrical power—Disconnected.

NOTE

If airplane pneumatic power was used in starting, the starter manual air shutoff valve should be closed after engine is started to prevent loss of pneumatic pressure through leakage.

UNSUCCESSFUL STARTS

Pneumatic Mode Starting Malfunctions

Failure to start in the pneumatic mode may be caused by a malfunction in the external air source, the starter, or the engine. Malfunctions are classified as hungstart and slow start.

Hungstart — failure of rpm to increase after light up with EGT remaining within limits. If the engine fails to accelerate to idle after ignition and starter cutoff, shut it down.

Slow start — slow but continuous acceleration of rpm to idle after light up. When a slow start is experienced, shut down the engine.

Unsuccessful Start Procedure (Pneumatic Mode)

1. Throttle—OFF.
2. Engine ignition button—Release.
3. Signal ground crew to disconnect external air.
4. Check for fire.
5. Master electrical power switch—OFF.

WARNING

- If start was aborted, do not inspect inside of tailpipe until engine and tailpipe are cool.
- A minimum waiting period of five minutes must be used before attempting a new start.

Cartridge Mode Starting Malfunctions

Failure to start while in cartridge mode may be caused by a malfunction in the cartridge, the starter, or the engine. Malfunctions are classified as misfires, hangfires, and hangstarts.

Misfire — failure of the cartridge to fire. A misfire may be detected by the absence of engine rotation and absence of smoke at starter exhaust port. When a misfire occurs, follow the Unsuccessful Start Procedure.

Hangfire/hangstart — engine fails to accelerate normally after initiation of cartridge start. A hangfire is a cartridge malfunction where main propellant grain does not burn or only partially ignites. In either case, ignitor squib fires, as evidenced by a small amount of smoke at starter exhaust and engine rotation to a low rpm. If main propellant grain partially ignites, it may smolder until enough pressure has built up in starter breech for complete ignition to occur. A hangstart is a start in which engine rotation is produced but the engine does not accelerate to idle rpm.

Since the symptoms of a hangfire and a hangstart are similar and difficult to distinguish from each other, the following common procedure is established. If rpm hangs up below idle, complete the first two steps of Unsuccessful Start Procedure. Be alert for possible engine rotational acceleration and re-initiate starting procedures as applicable, once sustained rotation is assured. If rotation ceases and there is not evidence of burning, complete the Unsuccessful Start Procedure.

Unsuccessful Start Procedure (Cartridge Mode)

1. Throttle—OFF.
2. Engine ignition button—Release.
3. Check for fire.
4. Master electrical power switch—OFF.

WARNING

- Wait a minimum of five minutes before opening starter breach and attempting a new start.
- To preclude a catastrophic failure due to a malfunctioning starter, do not attempt a second cartridge start until a successful pneumatic start has been accomplished. If pneumatic start or second cartridge start is unsuccessful, starter must be removed and inspected.
- If start was aborted, do not inspect inside of tailpipe until engine and tailpipe are cool.

NOTE

An unsucessful start must be recorded in AF Form 781.

CLEARING ENGINE

Refer to EXCESSIVE EGT OR FIRE IN TAILPIPE DURING GROUND OPERATIONS, Section III, for clearing engine.

BATTERY STARTING

1. All generators—OFF.
2. Boost pumps—ON.

3. Master electrical power switch—ON.
4. Fire warning system—TEST.
5. Move throttle through normal starting sequence.
6. After throttle is moved to IDLE, place emergency AC generator to START.
7. After engine is started, perform the Electrical Power Supply System Check and Interior Inspection after Battery Start.

ENGINE GROUND OPERATION

After the engine stabilizes at idle, it may be operated at full thrust; however, cooling limitations (ground operations) must be observed.

NOTE

Refer to ENGINE COOLING, Section V, for ground cooling limitations.

CAUTION

Insufficient tire traction requires the use of an airplane restraining bridle when using afterburner above the minimum afterburner range if the airplane is to remain in a stationary position on the ground.

BEFORE TAXIING

Make ground tests with external power disconnected.

ELECTRICAL POWER SUPPLY SYSTEM CHECK

1. Master electrical power switch—ON.
   Check that ac and dc power failure warning lights are illuminated.
2. Emergency ac generator—Check.
   a. Emergency ac generator switch—START.
      Momentarily place the emergency ac generator switch to START. It is not necessary to hold the switch in START position.
   b. DC power failure warning light—Out.
      If the warning light remains illuminated, the 50-amp TR unit is not providing power to the DC essential bus. This is the only positive indication of the 50-amp TR unit failure.
   c. AMI and AVVI warnings flags—Retracted.
3. Idle thrust control switch—ON.
4. ATG—Check.
   a. Throttle—75%.

WARNING

Perform check as quickly as possible. Check area behind airplane to see that personnel and equipment are clear of jet blast.

   b. ATG switch—AUTO.
   c. Fuel boost pressure-low warning lights—Out.
5. Generator switch—ON.
   a. AC power failure warning light—Out.
   b. Throttle—IDLE.

CAUTION

- To preclude damage to throttle mechanism, do not slam throttle against idle stop.
- If the OFF flag (integrated display) or the OFF and AUX flags (conventional display) remain in view on the ADI for more than 85 seconds after the generator is turned on, the AHRG programmer may still be installed. This condition must be corrected before further operation.

6. MA-1 power switch—STBY.
   Do not select ON until ready to perform Radar/IR Ground Checkout Procedure, and area in front of airplane is clear of personnel.

NOTE

The flight mode selector switches and automatic mode selector switches must be in the same positions in both cockpits for the transfer annunciators to display "YES" or "OK." The transfer function is then operable.

7. Deleted.
8. Radar scope switch—ON.
9. Altimeter—RESET (conventional instrument display).
10. Altitude warning selector—Set.
11. G suit test button — Depress (if applicable).

INTERIOR INSPECTION AFTER BATTERY START

Except for the following items, the interior check should have been completed prior to starting the engine. The following checks should be performed:

1. Armament recycle button—Depress for 5 seconds.
2. Boost pump switches—Check, then ON.
   Turn each fuel boost pump switch ON, one at a time, then OFF. Check that the respective fuel boost pump warning light goes out when the switch is ON. Ensure that the opposite side fuel boost pump warning light does not go out. After each pump is checked individually, turn all fuel boost pump switches ON.

CAUTION

If the warning light does not extinguish and/or the warning light extinguishes on the opposite wing, the cause should be established and corrected prior to flight.

3. Deleted.
4. CG transfer test failure light—Press-to-test.
5. Landing and taxi light switch—Climatic.
6. Oxygen quantity—Check.
7. Marker beacon light—Press-to-test. (FP-RP)
8. Fuel quantity and balance—Check.
   Select TOT, RH, LH, FWD, and #3 positions with the fuel quantity gage selector switch(es) and check the fuel quantity gage for proper fuel quantities. Return the switch to the TOT position.

NOTE

No. 3 tank fuel quantity cannot be obtained with the fuel quantity gage selector switch in the FWD position.

9. All external/internal and warning lights—Check/Test then Climatic.
10. Pitot heat switch—Check, then OFF.
11. Seat and rudder pedals—Adjust. (FP-RP)

HYDRAULIC AND FLIGHT CONTROL SYSTEM CHECK

1. Throttle—IDLE.
2. Speed brakes switch—IN, then center (off).
   Retract speed brakes and check with crew chief for proper brake operation. Secondary hydraulic system pressure may drop momentarily but must return to normal.
3. Hydraulic Pressure—Check approximately 3000 psi.

CAUTION

Any constant pressure over 3100 psi, when there is no demand on the system, indicates possible hydraulic system component failure.

4. Flight mode selector switch—PITCH.
   Note that engagement has no noticeable effect on controls or surfaces.
5. System check.
   a. Control surface movement.
      Check for control surface movement. With the stick in the full aft position, check elevon surfaces. Move stick to the full forward position and check for binding in either stick or elevator movement. Verify each control surface movement. Check full rudder application in both directions to insure that full control is available and that brakes are not being inadvertently depressed during rudder pedal movement.
   b. Hydraulic system recovery.
      Check operation of hydraulic system by moving the control stick from the left forward corner to the right aft corner in

approximately three seconds. If system pressure drops, the hydraulic pressure gages must return to system pressure within two seconds or less after control stick movement has stopped. Repeat the procedure by moving the stick from the aft left corner to the forward right corner in approximately three seconds and check for normal system pressure within two seconds. If the hydraulic system does not recover within two seconds or less the flight should be aborted.

c. Turn coordinator system.
With flight mode selector switch in YAW, confirm rudder deflection with aileron input.

6. Emergency direct manual button—Depress.
Check that flight mode selector switch returns to DIR MAN.

7. Manual mode trigger—Depress.
Note that the flight mode failure warning light extinguishes.

8. Trim—Check and set for takeoff trim.
Trim nose down, check for forward stick movement; trim RWD with stick full depressed to the right and check for left control pressure; trim LWD with stick full depressed to the left and check for right control pressure, rudder trim; then depress takeoff trim button. Rudder should return to neutral. Control stick should move aft to the takeoff position and the takeoff light should illuminate. Check light out when button is released.

NOTE

An airplane with an inoperative takeoff trim light may be flown after determining that the flight controls are in fact in the takeoff position.

AIR REFUELING SYSTEM CHECK (AIR REFUELING PLANNED)

Prior to any planned air refueling mission, the following operational ground check of the air refueling system should be performed. Operation of the slipway door, boom latches, and slipway lights must be visually verified.

NOTE

The items for visual check can be accomplished by the crew chief while standing on the ladder.

WARNING

Care must be taken by personnel operating near engine inlet ducts to avoid injury or foreign object damage while the engine is running.

1. Air refuel switch—ON.
   a. Slipway door—Fully open.
   b. Boom latches—Retracted.
   c. Slipway lights—On.
   d. Ready light—On.

NOTE

- On Ⓐ airplanes, tank pressure blow down results in illumination of the F tank and T tank shutoff valve warning lights, "FUEL VALVE CLOSED" warning light, and master warning light. These lights will remain on until the air refuel switch is turned off.
- On Ⓑ airplanes, with fuel in the F tank, tank pressure blow down results in illumination of the "F TANK PRESS" warning light and the master warning light. These lights will remain on until the air refuel switch is turned off.
- On Ⓑ airplanes, if the F tank is empty, the fuel low level float switch prevents illumination of the "F TANK PRESS" warning light and master warning light. During inflight refueling, when fuel enters the F tank, the "F TANK PRESS" warning light and master warning light will illuminate.

2. Reset/MBL switch—MBL.
   a. Boom latches—Extended.
   b. Ready light—On.

3. Manual disconnect switch—Depress and hold.
   a. Boom latches—Retracted.
   b. Ready light—On.
   c. Disconnect light—On.
4. Manual disconnect switch—Release.
   a. Boom latches—Extended.
   b. Ready light—On.
   c. Disconnect light—Off.
5. Reset/MBL switch—NORM.
   a. Boom latches—Extended.
   b. Ready light—On.
   c. Contact light—On.
6. Manual disconnect switch—Momentarily depress.
   a. Boom latches—Retracted.
   b. Ready light—Off.
   c. Contact light—Off.
   d. Disconnect light—On.
7. Reset/MBL switch—RESET.
   a. Boom latches—Retracted.
   b. Ready light—On.
   c. Disconnect light—Off.
8. Air refuel switch—Off.
   A delay of a few seconds will occur between the time that the switch is placed in OFF and refueling receptacle door closure. During this delay, the disconnect light will be on and the ready light will be off.
   a. Slipway door—Closed.
      Check that all indicator and warning lights show that the fuel system has been returned to normal operation.

GENERAL

1. Engine anti-ice warning test button—Depress and hold for approximately three seconds.
   The warning light requires approximately three seconds to illuminate, and will extinguish after the test button is released. The test must be performed with the surface and engine anti-ice switch in AUTO ON or MAN ON.

CAUTION

Avoid use of engine anti-ice in the MAN ON position during ground operations. It will cause heat damage to engine components and Q inlets.

2. Rain removal switch—ON, then OFF.
   Place the rain removal switch ON and check for positive air flow, then move the switch to OFF. Power may have to be advanced slightly to provide enough airflow to be felt at the canopy rail.

CAUTION

If airflow is not detected after advancing power, hot air bleed line/duct separation/failure may have occurred. This condition should be thoroughly inspected before continuing the mission.

3. Canopy—Check, then as required.

WARNING

If the canopy on **O** airplanes is inadvertently lowered on any foreign object on the canopy rail or on the canopy hold-open support, the canopy shear pin should be inspected by maintenance personnel prior to flight to determine if the pin is broken or damaged. A broken or damaged pin could cause malfunctioning of the canopy jettison and seat ejection system.

CAUTION

- On Ⓑ airplanes the canopy must be closed to within 12 inches of the canopy sill to engage the canopy sway braces, prior to taxiing.
- Refer to OTHER OPERATING LIMITATIONS, Section V, for maximum taxi speed with canopy open.
- If binding is evident when actuating the canopy latch handle, an entry should be made on Form 781. Continued operation could damage the latching mechanism sufficiently to preclude unlatching of the canopy hooks either manually or during emergency canopy jettison.

4. Flight instruments—Check and set. (FP-RP)
   a. Check the following instruments on the conventional instrument display:
      (1) Altimeter reading corresponds to pressure conditions.

WARNING

It is possible to misset the altimeter by 10,000 feet and still have the correct indication on the barometric scale. This happens when the barometric set knob is continuously rotated after the barometric scale is out of view until eventually the numbers reappear in the barometric scale. If the correct altimeter setting is then established, the altimeter will read 10,000 feet in error. To avoid the possibility of this error, pay particular attention to the ten-thousand foot pointer when setting the altimeter.

(2) Vertical velocity indicator, airspeed-angle of attack indicator, Mach indicator, accelerometer, and turn-and-slip indicator, indicating proper static conditions.

(3) Heading indicator (slaved) stabilizing (azimuth ring on the course indicator).

(4) Standby attitude indicator.
Uncage by pulling out and rotating pitch/trim knob counter-clockwise and releasing gently. Set miniature aircraft 5° low.

(5) ADI.
Check OFF and AUX flags out of view in 85 seconds and horizon bar is free from oscillation and has proper attitude and response to trim knob. Set 5° low.

WARNING

If the warning flags require longer than 85 seconds to retract and the power annunciator displays "TEST," the AHRG test unit may be installed. Ensure that this condition is corrected by maintenance personnel before further operation. If any oscillations are noted after the attitude indicator warning flag retracts, a malfunction exists and the attitude indicator will not be reliable for flight.

(6) Set altimeter to field elevation.

b. Check the following instruments in the integrated flight instrument system:

(1) Compass card—Slaved to airplane heading.

(2) AMI, AVVI, and turn-and-slip indicator, indicating proper static conditions. With angle of attack vane full up, check lubber line between words MIN and SAFE on angle of attack indicator.

(3) Set altimeter to field elevation.

(4) Standby altimeter—Set.

(5) ADI.
Check attitude warning flag retracts within approximately 85 seconds and horizon bar is free from oscillation and has proper attitude and response to trim knob. Set 5° low.

WARNING

If the attitude indicator warning flag requires longer than 85 seconds to retract and the power annunciator displays "TEST," the AHRG test unit may be installed. Ensure that this condition is corrected by maintenance personnel before further operation. If any oscillations are noted after the attitude indicator warning flag retracts, a malfunction exists and the attitude indicator will not be reliable for flight.

5. Barometer setting indicator—Set to altimeter setting. (FP-RP)
6. Engine pressure ratio gage—Set. (FP-RP)
7. Ejection seat ground safety pin—Remove and stow. (FP-RP)
8. Power annunciator—"OK."
9. Chocks—Removed.

STARTING ENGINE (SCRAMBLE)

1. Normal start.
2. All personal equipment—Attach. (FP-RP)

TAKEOFF CHECK TABLE

TEMPERATURE °F	°C	PRESSURE RATIO SETTING
113	45	1.93
108	42.5	1.95
104	40	1.96
99	37.5	1.98
95	35	2.00
90	32.5	2.01
86	30	2.03
81	27.5	2.05
77	25	2.06
72	22.5	2.08
68	20	2.09
63	17.5	2.11
59	15	2.13
54	12.5	2.14
50	10	2.16
45	7.5	2.17
41	5	2.19
37	2.5	2.21
32	0	2.22
27	−2.5	2.24
23	−5	2.25
18	−7.5	2.27
14	−10	2.28
9	−12.5	2.29
5	−15	2.31
0	−17.5	2.32
−4	−20	2.34
−8	−22.5	2.35
−13	−25	2.36
−18	−27.5	2.38
−22	−30	2.39
−27	−32.5	2.40
−31	−35	2.41
−35	−37.5	2.43
−40	−40	2.44

ELECTRICAL POWER SUPPLY SYSTEM (SCRAMBLE)

1. External power—Disconnected.
2. Master electrical power switch—ON.
3. Emergency ac generator—Check.
4. ATG—Check.
5. Generator switch—ON.

NOTE

There is no minimum time before taxi; however, 85 seconds must elapse before the cockpit displays indicate the system is safe for flight.

6. MA-1 power switch—ON.
7. Altimeter—RESET (conventional instrument display).

HYDRAULIC POWER SUPPLY SYSTEM (SCRAMBLE)

1. Speed brakes—Closed.
2. Hydraulic and flight control systems—Check.
3. Takeoff trim button—Depress.

BEFORE TAKEOFF (SCRAMBLE)

WARNING

If the OFF flag (integrated display) or the OFF and AUX flags (conventional display) remain in view on the ADI, the AHRG programmer may still be installed. Correct this condition before flight.

1. Ejection seat ground safety pin—Remove. (FP-RP)
2. Canopy—Close, lock, light out, and hooks over rollers.
3. T tank switch—OPEN.
4. Idle thrust control switch—OFF.
5. Oxygen mask connected and oxygen supply switch—ON. (FP—RP)
6. Standby attitude indicator—Uncaged and set 5° low.
7. Cabin air selector switch—PRESS.
8. Pitot heat—ON.
9. Warning lights—Out.
10. Emergency fuel—Check.

RADAR/IR GROUND CHECKOUT PROCEDURES

1. MA-1 power switch—ON.

WARNING

Do not point the antenna at personnel as excessive microwave radiation can be dangerous to life or parts of the body.

2. IR seekerhead—Check extension.
   As standby power is applied, the seekerhead will extend. The radar scope should illuminate within 30 seconds. To see the attack displays, close and lock the canopy or depress the scope ON button for about three seconds to get the attack displays on. Using the latter method, the attack displays will remain on the scope for three minutes and then disappear. The cycle will then have to be repeated to regain the displays.
3. Photographic recorder—Check for proper operation.
   On Ⓠ airplanes with gunsight, set f-stop control on 16 for bright days and lower for overcast conditions.
4. Search and attack displays—Check centering.
   With ILS selected, the B-sweep should appear at 0° azimuth. If it appears in another position, this will be the position on the scope that a target dead ahead will appear. Check the left hand side of the Z-marker for vertical centering with the scope etching. If it is too high or low, the firing bar will be displayed in error by an equal amount. There is a built-in problem with parallax, since the etchings are displaced well in front of the tube face.
5. DISP/AUTO MODE switch—MAN NAV or AUTO NAV.
6. Artifical horizon—Adjust 5° high.
7. Firing ranges—Check.
   a. Armament selector switch—RAD.
   b. LC/PUR switch—Depress momentarily.
   c. Firing range bar—0.4 mile.
   d. Nose/tail switch—Nose.
   e. Firing range bar—1.7 miles.
   f. Range switch—16 miles.
      The firing bar should still be in the vicinity of two miles.
   g. LC/PUR switch—Depress momentarily.
      Note the disappearance of the firing bar.
8. Boresight switch—BORS.
   Note that B-sweep centers and the right side of the Z-marker positions down 4.5° with ANT ELEV control in detent.
9. Boresight switch—NORM/TRACK.
   Note that normal radar track display (without lockon) appears.
10. Auto search button—Depress momentarily.
11. Radar scope—Adjust.
    a. Erase intensity, adjust and verify desired rate of target erasure. Attack intensity, adjust to minimum viewing level.

CAUTION

Excessive attack intensity will cause damage to the MMST.

Adjust dimmer for desired brightness level. The IF gain should normally be fully cw. The video gain should normally be fully cw. With excessive background noise level turn the video gain knob ccw slightly.

    b. B-sweep appearance—Check intensity in 4, 16, and 40 mile ranges while in search, supersearch and manual search.
    c. Tune switch—F-MAX, M-MIN, NORM.
       Be sure that the video does not break up or disappear.

12. Radar lockon—Accomplish.

a. CADJ switch—On. (Check for reduced steering dot activity.)

b. Chaff switch—GATE then ALL.
Note that the radar remains locked-on and when ALL is engaged check that the CADJ switch drops OFF.

c. Radar mode switch—HOM, check ATOT sensitivity.
Engage half action and move the gate off the target. If the ATOT sensitivity adjustment is too high, the lead collision extrapolate display will appear immediately. If the lead collision extrapolate display does not appear due to ATOT sensitivity, the data link after offset display should appear with the target marker circle and antenna elevation marker indicating previous target position if the DISP/AUTO MODE switch is in the AUTO NAV position.

d. Radar mode switch—Norm.

e. Radar lockon—Reaccomplish.

f. Radar mode switch—MAN IF.
Slowly rotate IF gain knob counterclockwise on radar scope and observe first B-sweep lightening followed by a break lock. Rotate IF gain knob fully clockwise and reaccomplish radar lockon.

g. Radar mode switch—NORM.
Note AGC action after approximately one second.

h. Auto search button—Depress momentarily.

13. Gunsight display—Check (gunsight installed).

a. Armament selector switch—GUN.

b. Gunsight mode selector switch—Set to 7 and check display reference alignment. If required, calibrate the reference display unit using mode 8.

c. Gunsight mode selector switch—Set to 5 and check display in close proximity to upper bezel dot. If required, calibrate using boresight board and mode 6.

d. Gunsight mode selector switch—Set to 2 and check for three crosses (no lock-on) or two crosses (lock-on).

e. Check cross sizes with homing point selector switch changes.

f. Gunsight mode selector switch—Set to 1.

14. RDR/IR select button—Depress and release.
Note the appearance of the az-el dot sweeping in broad scan (±50°). Visually check the ANT ELEV control in the detent position. The C-scan should bracket the center etchings on the scope (two bars of the four-bar scan either side of the etchings). The top bar should be approximately 2.5° above the etchings and the bottom bar approximately 2.5° below them. The field of view of the four-bar scan is 7.5°, 3.75° above and 3.75° below the etchings; but the display reflects the boresight axis of the IR seekerhead which should be 5.1° with the top bar approximately 2.5° above the center etchings and the bottom bar 2.5° below the center etching. If the elevation scan is wider than this, it could mean that the scan rasters are too far apart and do not overlap. The az-el dot should leave a stored trace of about one bar in broad scan.

15. Elevation scaling—Check.
With the hand control in the azimuth detent, depress full action switch and move the vernier to the full up position. The az-el dot should go to 45° up. Then move the vernier to the full down position. The az-el dot should go 30° down.

16. IR tone and video—Adjust.
IR tone volume should be turned cw to a comfortable level. The tone threshold should then be turned cw through the null and stopped at a low growl on the other side. Turn the IR video threshold cw until a small amount of "grass" appears on the C-scan. Check for IR targets. (Targets will not be visible if seeker head cooldown is insufficient.)

17. IR lockon—Accomplish.
   a. Note that the short firing bar appeared at full action switch depression and the IR range mark jumped to the top left side of the scope.
   b. IR track display—Check.
      The IRT display will appear when the action switch is released during the lockon process. A long firing bar, steering dot, and reference circle will appear at this time. The expanded C-display will be present for 8.5 seconds. A flat base line would indicate no lockon and the tone would be lower in pitch.
   c. Return to IR search—Reaccomplish IR lockon.
      Depress RDR IR EXP momentarily and note the appearance of the B-sweep when RDR IR EXP is released (prior to end of 8.5 second delay). Expanded C-display will return only when RDR IR EXP is depressed.
   d. RDR SCAN display—Check.
      The broad scan limits are now ±45°.
   e. RDR SLVD—Select.
      If a radar target is visible in the sweep, engage half-action and put the gate on the target. The range scale light should illuminate at ROT. At release of action switch, the gate should remain visible. Recall the expanded C-display. It should appear at the elevation of the seekerhead.
18. RDR/IR select button—Depress and release.
   If locked on from the previous step, a lead-collision display should appear at crossmode. If no lockon was possible in IR, return to search before crossmoding. Obtain radar lead collision lockon. Note the presence of IR tone as a function of target return. Check the lead collision displays for calibration. Check the B-sweep centering and length. These adjustments can seriously affect the use of the firing bar. Also, check the TTG circle for roundness and size. Attack display size can affect the firing bar range. Z-marker left side should be adjacent to the center etchings and the right side should be within several degrees of target elevation. If the Z-marker is not properly calibrated, apply the error when using the elevation scale of the scope.
19. Auto search button—Depress momentarily.
   Note that the B-sweep is searching (±50°). Check that the antenna elevation marker is stepping on the 4-bar scan.
20. IR seekerhead—Stow.
   Note that no IR tone is present.
21. Armament selector switch—VIS IDENT.
22. MA-1 power switch—STBY.

RADAR GROUND CHECK—WSEM ABOARD

1. With VIS IDENT selected, armament recycle button—Depress and hold for 5 seconds.
2. Armament selection indicator—OK (for RAD and ALL).
3. Taxi and takeoff—VIS IDENT selected.

NOTE

Armament switches will not be safety wired with WSEM aboard.

TAXIING

WARNING

If taxiing with the canopy partially open, do not place arms or hands on the canopy sill. Should the canopy fall, serious injury could result.

CAUTION

- Aircraft should not be taxied with a known nosewheel steering malfunction.
- When taxiing the airplane with fully fueled 360-gallon external tanks, the following should be closely observed to prevent damage to the landing gear structure.

    a. Taxi speed should be held to the minimum practical.

    b. Do not apply wheel brakes during turns. Slow the airplane prior to reaching the turn point.

    c. All turns should be made with as large a radius as practical and at a reduced speed.

    d. Do not apply wheel brakes in such a manner as to skid the tires on the pavement.

NOTE

For minimum turning radius and ground clearances, see figure 2-5.

1. Idle thrust control switch—As desired.
2. Brakes and nose wheel steering—Check.
3. Flight instruments—Recheck and set (if necessary). (FP-RP)
4. Navigation equipment—Check. (FP-RP)
   Check operation of MA-1 navigation equipment and heading indicator (slaved) for turn indication during taxiing. Compass should conform to actual heading changes.
5. Antenna stabilization and range gate drift—Check.
   While taxiing out, MA-1 power switch ON momentarily and run the radar antenna up in hand control. Release the action switch and note that the antenna remains stable in azimuth and elevation for at least 15 seconds. The range gate should not drift in or out.

BEFORE TAKEOFF

AIRPLANE CHECK

1. Oxygen supply switch—ON. (FP-RP)

minimum turning radius and ground clearances

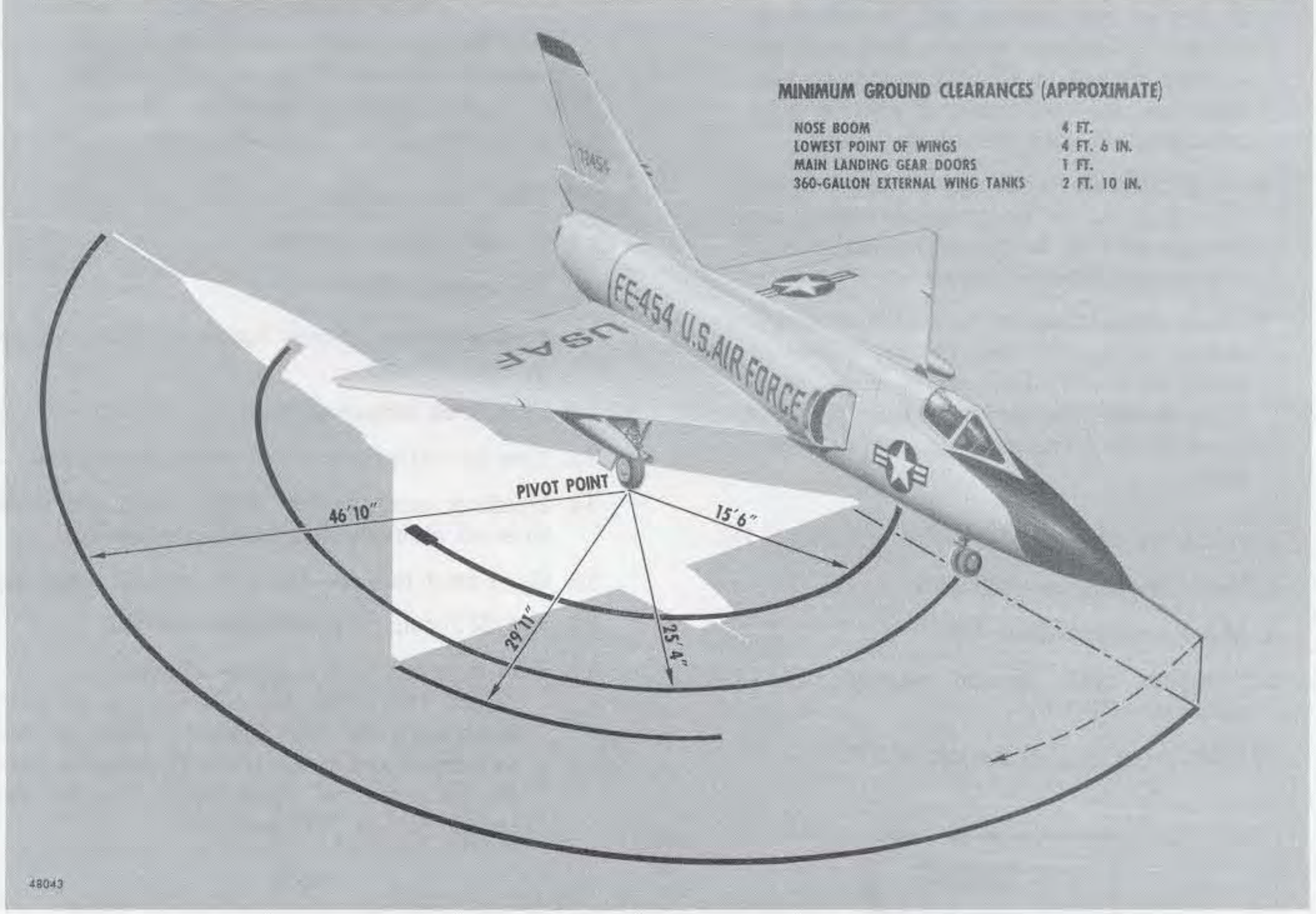


Figure 2-5

CAUTION

When using oxygen through the survival kit regulator, do not turn the oxygen supply switch to ON until immediately after the oxygen mask is fastened in place. If oxygen supply is on without the system being fully connected, the free flowing oxygen will result in low temperatures which may damage oxygen system components or cause personal injury.

2. Canopy—Close, lock, light out, and hooks over rollers.

   On Ⓐ airplanes check the canopy clutch disengaged by listening for the "clunk" when the lock handle is actuated. On Ⓑ airplanes, notify the other crew member that the canopy is to be closed and wait for confirmation that he is clear before closing the canopy.

CAUTION

- To prevent breakage of the canopy shear pin, do not close the canopy in one complete motion. Hold the canopy switch at CLOSE until the canopy is within two inches of the canopy sill, momentarily release the canopy switch, then hold the canopy switch at CLOSE until the canopy has stopped moving and is completely flush with the canopy sill.
- On Ⓐ aircraft, if canopy clutch does not disengage when the canopy is locked, the canopy cannot be raised manually with the canopy latches released.
- On Ⓐ aircraft, do not fly with the canopy clutch engaged. The canopy actuator shear pins will shear when climbing to altitude with the cockpit pressurized and upon landing the canopy may not open fully.

3. Radar mode switch—NORM (not MAN IF).
4. Cabin air selector—PRESS.
5. MA-1 power switch—ON.
6. Ejection seat ground safety pin—Check removed. (FP-RP)
7. Idle thrust control switch—OFF.

WARNING

Positively ensure that the idle thrust control switch is in the OFF position. Failure to close the exhaust nozzle will result in excessive thrust loss and ground roll during a military thrust takeoff. Although afterburner (maximum) thrust is not affected by the idle thrust control switch, the switch must be placed OFF to permit the nozzle to close in event afterburner blowout occurs during an A/B takeoff and takeoff is continued using military thrust.

NOTE

The idle thrust control switch must be OFF before preflight engine checks to obtain correct pressure ratio and EGT.

WARNING

With the idle thrust control switch ON, a significant loss of thrust will occur at FULL MIL POWER when the weight of the airplane is on the landing gear.

8. Flight mode selector switch—DIR MAN.
9. Ⓐ T tank switch—OPEN.
10. All warning lights—Out.
11. Formation-navigation lights switch—As required.
12. Pitot heat switch—ON.
13. Line up with nose wheel steering engaged.
14. Heading push-to-sync knob—Press and hold to erect attitude indicators (if required).
15. Gyro erect button—Press to erect (if required).
16. IFF/SIF control panel—As required.
17. Fuel quantity and balance—Check.
    Select TOT, RH, LH, FWD, and #3 positions with the fuel quantity gage selector switch(es) and check the fuel quantity gage for proper fuel quantities. Return the switch to the TOT position.

NOTE

No. 3 tank fuel quantity cannot be obtained with the fuel quantity gage selector switch in the FWD position.

ENGINE CHECK

1. Throttle—IDLE.
2. Fuel control emergency system—Check.
    a. Fuel control switch—EMER and check fuel control warning light on.
       During changeover from NORMAL to EMER, a momentary fuel flow fluctuation will occur.

b. Idle fuel flow—Check 1150 pph (minimum) to 1750 pph.
RPM decay to below 53% will cause the main ac generator to drop off the line and MA-1 power to dump to off.

c. Throttle—Advance slowly to 85% rpm monitoring EGT.

CAUTION

If the throttle is advanced abruptly, engine damage from overtemperature can occur without a corresponding overtemperature reading on the EGT gage due to lag in the thermocouples.

d. Fuel control switch—NORM and check fuel control warning light out.

e. Throttle—IDLE.
Retard the throttle to idle and note fuel flow decrease to 650 pph minimum.

CAUTION

Do not slam the throttle to idle from the rear cockpit of Ⓑ aircraft. The throttle reduction/minimum fuel flow check is valid from the rear cockpit; however, the throttle rigging will be damaged if the throttle is slammed to IDLE.

3. Throttle—FULL MIL POWER.
Check that acceleration time to full military power is 16 seconds maximum. Allow engine to stabilize.
4. EGT and rpm—Monitor.
5. EGT spread button—Depress and check that EGT overtemperature warning light illuminates as EGT reading decreases. Note EGT spread. If spread is greater than 120°—abort and record reading in Form 781.

NOTE

An EGT spread of 0 degrees indicates probable failure of the EGT spread computer and should be investigated by maintenance prior to flight.

6. Oil quantity gage—Check.
7. Engine instruments—Check. (FP-RP)
Check tachometer, EGT gage, and fuel flow indicator for normal operating limits. Check EPR gage pointer within the arc of the takeoff thrust index marker.
Ⓐ 8. CG transfer test fail light—Out.

NOTE

If light remains on, T-tank fuel may not feed.

TAKEOFF

WARNING

Avoid wake turbulence. Allow a minimum of two minutes before takeoff behind a heavy aircraft or helicopter and four minutes behind aircraft such as C-5A and Boeing 747. With effective crosswinds of over five knots, the interval may be reduced, but attempt to remain above and upwind of the preceding aircraft's flight path.

NORMAL TAKEOFF

A typical takeoff is illustrated in figure 2-6. Refer to T.O. 1F-106A-1-1 or the checklist for takeoff charts showing distances required at varying gross weights, temperatures, and field elevations. Use the following procedures for normal takeoff:

1. Throttle—FULL MIL POWER.
2. Brakes—Release.
3. Nose wheel steering—Check.
Move rudder pedals until it is ascertained that nose wheel steering is engaged.

CAUTION

Nosewheel steering must be engaged prior to starting takeoff roll. Lack of nosewheel steering could cause loss of aircraft control or indicate a malfunction which could result in failure of normal nose gear extension.

4. Throttle—AFTERBURNER.
Afterburner should light within two seconds.

takeoff
(typical)

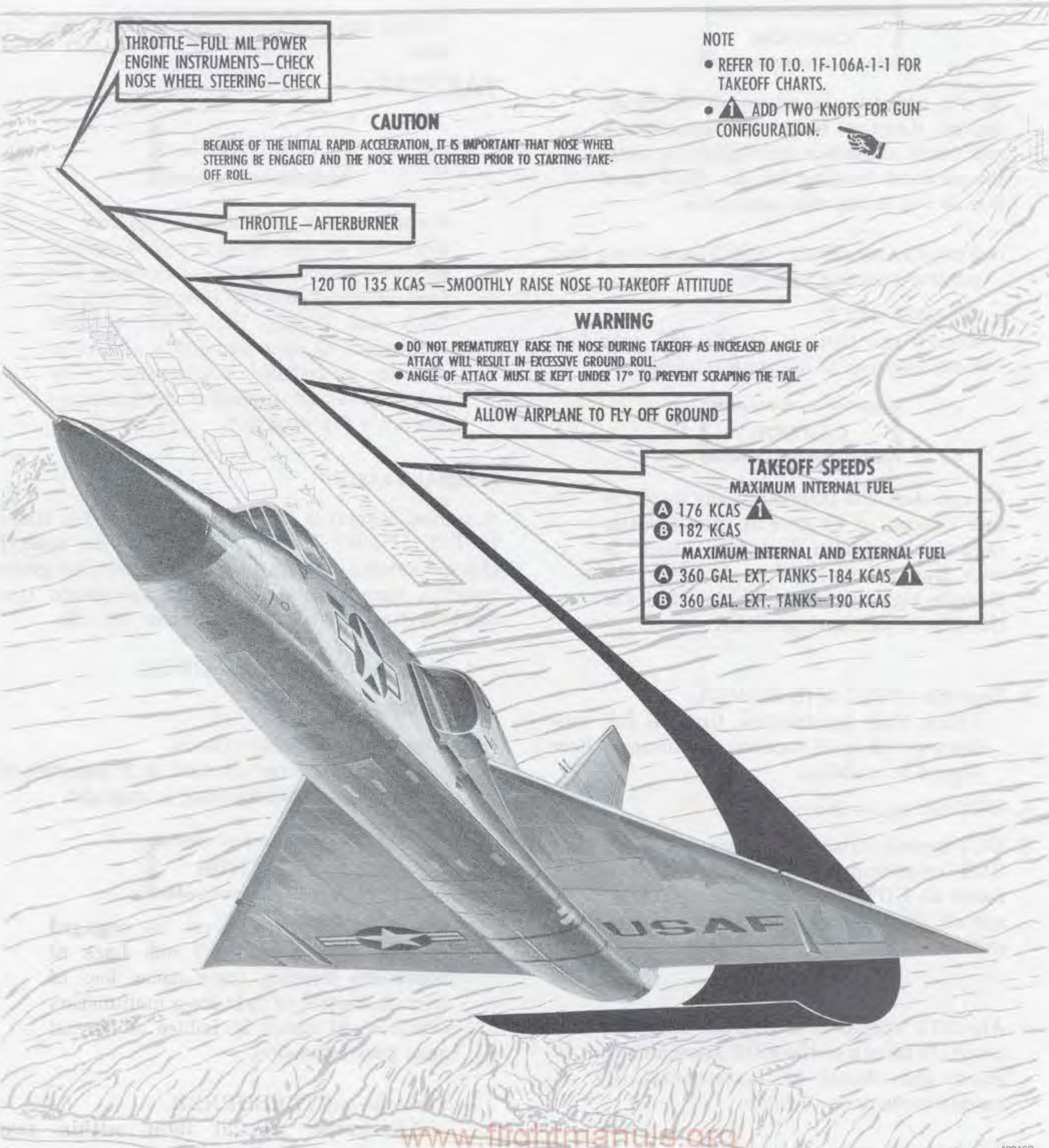


Figure 2-6

WARNING

- When the engine is not in alignment, yaw may occur either gradually or abruptly between 50 and 350 KCAS and should be corrected with rudder application, not with rudder trim. The yaw condition is more noticeable during cold weather and during high angles of attack. If the yaw condition becomes aggravated, reduce to military thrust and note the condition on Form 781 upon completion of the flight.
- Takeoff should be aborted immediately if any directional change is noted when the afterburner is ignited. A directional change at this time could indicate possible afterburner nozzle malfunction which could cause side forces to be applied to the extent that rudder would be insufficient to control the airplane immediately after leaving the ground.

CAUTION

- When making an afterburner takeoff, check that the EPR gage returns to the takeoff reading after dropping momentarily.
- Angle of attack must be kept under 17° to prevent scraping the tail and inadvertent tailhook engagement.

NOTE

Nose wheel shimmy may be encountered at speeds between 50 and 80 KCAS. If shimmy is encountered, disengage nose wheel steering and maintain directional control with rudder if takeoff is continued. If nose wheel shimmy becomes excessive, abort the takeoff and use rudder and brakes for directional control.

5. 120 to 135 KCAS—Smoothly raise nose to takeoff attitude and allow aircraft to fly off ground. For a maximum thrust takeoff, nose should be raised to horizon, or slightly below horizon for military thrust takeoff. Lower angles of attack will result in high speed and longer ground rolls. Higher angles of attack will result in lower airspeeds and lower rates of climb immediately after takeoff. While still on the runway with the nose on the horizon, the angle of attack will be approximately 12°. The airplane should be allowed to fly off the ground, with lift-off occurring at the following speeds:

TAKEOFF SPEEDS

Full Internal Fuel	Full Internal Fuel Plus External Fuel
Ⓐ 176 KCAS*	Ⓐ 184 KCAS*
Ⓑ 182 KCAS	Ⓑ 190 KCAS

*Add Two Knots for Gun Configuration

WARNING

Do not prematurely raise the nose during takeoff as increased angle of attack at low speed will result in excessive ground roll.

6. Attitude Indicator—10° nose-up indication. After landing gear is retracted, maintain positive climb until intercepting the climb schedule.

CAUTION

With afterburner thrust, care must be exercised to avoid exceeding gear limit speeds before landing gear is fully retracted. Gear retraction time is approximately 5 seconds.

MILITARY THRUST TAKEOFF

If takeoff is to be made without the use of the afterburner, normal takeoff procedures should be utilized up to the point of breaking ground. Due to the possibility of increasing drag excessively by a high angle of attack immediately after takeoff, the nose should be raised to a point just below the horizon and the airplane allowed to fly off. When using military thrust for takeoff, it is relatively easy to scrape the tail if the nose is raised excessively just prior to breaking ground. After breaking ground, the airplane should be allowed to accelerate until certain the airplane will remain airborne before retracting the landing gear.

MINIMUM RUN TAKEOFF

A minimum run takeoff can be accomplished by using the normal takeoff procedures and engaging afterburner as soon as possible after brake release.

CAUTION

Angle of attack must be kept under 17° to prevent scraping the tail and inadvertent tailhook engagement.

CROSSWIND TAKEOFF

Crosswind takeoffs present no particular problems in this airplane. In addition to the Takeoff Distances and Speeds Charts, check the Takeoff and Landing Crosswind Chart in T.O. 1F-106A-1-1 or the checklist to determine the crosswind component and minimum nose wheel lift-off speed. After lift-off, establish the crab angle necessary to maintain the desired flight path.

CLIMB

When airplane is definitely airborne:

1. Landing gear handle—UP and check lights.

CAUTION

To prevent airloads from inflicting structural damage, the landing gear should be raised and checked up and locked before exceeding gear limit speed. Refer to AIRSPEED LIMITATIONS, Section V.

NOTE

- If the landing gear is not up and locked prior to reaching 250 KCAS, air loads may trap the landing gear doors and cause the landing gear warning light to illuminate.
- Care should be taken to prevent inadvertent speed brake actuation when raising the landing gear handle. The pilot's elbow is positioned directly over the speed brake switch when reaching for the gear handle.

2. Standby flight instruments—Check.
3. Flight mode selector switch/damper check.
   a. With DIRECT MANUAL selected, trim for hands off condition.
   b. Induce yaw and engage YAW damper. Uncoordinated yaw should stop within two oscillations.
   c. Induce pitch and engage PITCH damper. Stable pitch should occur within two oscillations.
   d. Check for transients when pitch and yaw dampers are engaged.
   e. If dampers malfunction, select DIRECT MANUAL for the remainder of the mission.
4. Armament safety check—Accomplish (if applicable).

WARNING

If at any time the missile bay doors begin to open, release trigger (if pressed), select VIS IDENT, wait a minimum of 75 seconds, then close missile bay doors. With armament on board, return to base and do not depress the trigger.

a. With missiles, hot gun, or both loaded:

(1) Arm-safe switch—SAFE. The guard must be safety wired if armament is aboard.

(2) Armament selector switch—MISSILES RAD.

(3) LC/PUR switch—Depress.

(4) Radar Scope—Check for firing bar.
Wait for 12 seconds minimum and check for illumination of the confirm "5" light.

WARNING

Illumination of the confirm "5" light indicates a malfunction of the Arm-Safe switch and the armament safety check will be terminated.

(5) Armament selector switch—VIS IDENT.

NOTE

On gun live firing training missions, also perform these additional checks.

(a) Armament selector switch—GUN.

(b) Arm-Safe switch—SAFE.

(c) Armament trigger—Squeeze.

WARNING

Insure aircraft is pointed away from any populous area, boat, other aircraft, etc., prior to squeezing the trigger. If gun barrel rotates or fires, select VIS IDENT and terminate mission.

b. With a cold gun and no missiles:

(1) Armament selector switch—GUN.

(2) Arm-Safe switch—ARM.

(3) Armament trigger—Squeeze.

WARNING

Insure aircraft is pointed away from any populous area, boat, other aircraft, etc., prior to squeezing the trigger. If gun barrel rotates or fires, this indicates a malfunction of the gun safing system. Select VIS IDENT and do not select GUN for the remainder of the mission.

c. With a clean aircraft (no gun or missiles) or if loaded only with WSEMs, armament safety check is not required.

5. Oxygen quantity/pressure—Check.
6. Cabin altitude marker—Check (above 12,000 MSL).
7. Altimeter—Set as required.

CRUISE

1. Fuel quantity and balance checks—Accomplish.
   Select TOT, RH, LH, FWD, and #3 positions with the fuel quantity gage selector switch(es) and check the fuel quantity gage for proper fuel quantities. Return the switch to the TOT position.

NOTE

- Fuel quantity checks should be made only when airspeed is stabilized and while in level flight.

NOTE

As the number 3 tanks are the only fuel tanks that provide fuel to the engine, it is imperative to frequently check the amount of fuel in each number 3 tank. Failure of the other fuel tanks to feed into the number 3 tanks can create an extremely low fuel condition. The first indication will be premature depletion of the number 3 tank followed by illumination if a fuel low level light when approximately 570 pounds of fuel remain in the respective number 3 tank.

Ⓐ a. Check initial F tank feeding at approximately 8000 pounds.

At approximately 8000 pounds of total fuel remaining, initial F tank feeding should be checked (about 1000 pounds will remain in the F tank after completion of initial feeding). Initial F tank feeding is an indication that the T tanks have emptied.

Ⓑ b. Check for F tank feeding at approximately 5000 pounds.

F tank quantity should be decreasing.

NOTE

On Ⓐ airplanes, fuel system "hammering" may occur during the fuel transfer sequence (at approximately 8000 pounds total fuel) and may last until first F tank feeding has been completed. The "hammering" is caused by pressure surges in the system and may be described as a series of "thumps" near the aft portion of the cockpit, where the F tank is located. Although loud and startling, the "hammering" is normal.

Ⓐ c. Check second sequence F tank feeding at approximately 3500 pounds.

At approximately 3500 pounds of total fuel remaining, the F tank should be checked for proper feeding into the left and right No. 3 tanks.

NOTE Ⓐ

The F tank should be empty at approximately 2500 pounds of total fuel remaining. Feeding of this fuel from the T tanks during supersonic flight is indicated by No. 3 tank quantity remaining constant.

2. Radar airborne check—Accomplish.
   a. ANT ELEV—Check for level sweep.
      (1) Miles vs altitude (15 miles—15,000 feet) above the terrain.

      If a satisfactory antenna elevation check was not accomplished on the ground, check it in the air. Ground clutter should appear on the bottom sweep of the raster on the basis of approximately 1 mile to each 1,000 feet of altitude. At 15,000 feet above the terrain using the bottom bar of the four-bar pattern, ground return, not the altitude line, should appear on the scope at slightly less than 15 miles.

      (2) Level with other aircraft—Target on both sweeps, 2-bar.

      Adjust the antenna until system paints evenly on both bars of the two bar pattern. Note the displacemen of the ANT ELEV knob index and the Z-marker position. Use this as the center position throughout the flight.

      (3) Level with and to rear of other aircraft—Boresight switch to BORS.

      Position aircraft to point antenna (4.5 below center) directly toward other aircraft. Note presence of IR tone as a function of target return. Return boresight switch to NORM/TRACK and depress auto search button momentarily.

   b. Antenna—Depress.

   During automatic search, depress the antenna scan pattern so that ground return is visible. Check whether the dark ground return area moves in a straight line across the scope even if aircraft is in a turn. Uneven or sudden drops can cause blank areas in the search pattern.

   c. Radar horizon—Check.

   A small amount of tilt can reduce contact ranges appreciably because the antenna may be sweeping above or below the target. If time permits, reset grid reference and erect gyro with aircraft wings level in unaccelerated flight. If time does not permit, press erect button only. This renders any subsequent data link or auto nav steering information inaccurate. When an attack is complete, set the correct grid reference and reerect. If the tilt is no more than 6°, compensate during search by using the ANT ELEV knob and moving the antenna up or down as required.

NOTE

With the wings level in unaccelerated flight, press the heading push-to-sync knob on the compass system controller until the artificial horizon on the radar scope is correct.

d. Range gate drift—Recheck.
If the ground check showed range gate drift, recheck drift. Use the same procedure as for the ground check. If the drift is in, lock on from the top. Conversely, if drift is out, lock on from the bottom.

e. Antenna tracking.
Lock on in a turn or make a turn if straight and level. Check that the B-sweep moves with the target position on scope. Check for correct dot movement.

f. Computer operation—Check throughout flight.

WARNING

If the computer has been operating in an intermittent manner in the NAV/DL mode as evidenced by erroneous displays (i.e., frozen DL line, improper NAV commands), computer malfunctions in the attack mode should be expected. These attack mode malfunctions (no 20-second time, no F-pole, no fire signal) could and do occur with no warning. Knowledge of these critical ranges (20 seconds, firing range) is mandatory if the pilot is to recognize and cope with a malfunctioning computer. The pilot must constantly monitor range to the target on the B-sweep. When within four miles, the pilot should go to the 4-mile scope. That is the best way to avoid hitting the target. If radar range is not available because of ECM, clutter, or confusion then the pilot should not continue the attack without visual contact with the target. If radar lock-on is lost in any radar dominant attack mode, the target marker circle, antenna elevation marker and all normal cockpit data link target displays will indicate previous target position and will aid in re-locking on. This information will be based on last known target velocity vectors and update by interceptor maneuvers.

3. IR airborne check—Accomplish.

a. IR STOW switch—RDR SLVD or RDR SCAN.

b. Auto search button—Press and release.

c. Armament selector switch—Not VIS IDENT.

d. RDR/IR select button—Press and release.

e. IR threshold video control—Readjust.
This control may require readjustment when passing over different types of terrain to allow for changes in background radiation. Adjust so that small deflections due to stray IR radiation appear on the C-scan. The change in radiation level may also require a readjustment of the IR threshold tone control.

f. IR lockon—Accomplish.
When a target appears visible on the C-scan, press the action switch to the first detent during the scan of the bar on which the target appeared. Check that the target appears on the supersearch display. A lateral adjustment of the hand control may be necessary if the target was outside the 33° limits of the supersearch scan. Press action switch to second detent, spotlight target, and release to accomplish lockon. Check that the IR expanded C-scan appears for 8.5 seconds. After 8.5 seconds, the IR expanded C-scan should be replaced by the B-sweep. The motion of the B-sweep will be dependent upon the position of the IR STOW switch. The 8.5-second delay may be bypassed by momentarily depressing the RDR/IR EXP button after lockon.

g. Auto search button—Press and release.

h. RDR/IR select button—As desired.

4. Navigation—Accomplish.

a. Heading indicator cross-reference check—Accomplish.

b. AHRG check—Accomplish.

c. Aircraft position—Verify.

5. Cabin altitude marker—Check (above 12,500 MSL).
6. Oxygen quantity/pressure—Check.
7. Engine instruments, oil quantity gage, and hydraulic system—Check.

TACTICAL PROCEDURES

WARNING

If MA-1 power is lost during an attack and any armament has been selected, SAFE and VIS IDENT must be selected to recycle the system and prevent inadvertent door operation which would result in loss of armament attack capability.

NOTE

When switching from GUN to MISSILE MODES or vice versa, assure that the switch positively detents in the VIS IDENT position.

VISUAL IDENTIFICATION PROCEDURE (STERN—within ±60° of target's tail)

1. Arm-safe switch—SAFE.
2. Armament selector switch—VIS IDENT.
3. DISP/AUTO MODE switch—Any position except ILS or ILS APCH.
4. Radar range lockon—Accomplish.
5. Flight mode selector switch—As desired.
6. Radar scope—Monitor.
   In VI mode, the steering dot is positioned by the radar antenna and represents the azimuth and elevation position of the target with respect to the interceptor. Steering dot will remain centered in azimuth and elevation for 5 seconds after lockon.

WARNING

During a VIS IDENT pass, the steering dot represents target position and not the course to be flown. If flying manually at ranges of 6000 feet and less, offset the steering dot to the perimeter of the VI command azimuth circle. The offset causes the interceptor to miss the target by 500 feet.

7. Steering dot—Moves to the perimeter of the VI command azimuth circle from the radar scope center at ranges of 6000 feet and less.
   If in manual flight at ranges of 6000 feet and less, fly the interceptor to offset the steering dot to the perimeter of the VI command azimuth circle. This manual steering action positions the interceptor on a course that provides 500 feet of clearance when the interceptor passes the target. Any desired combination of azimuth and elevation angle components can be chosen. Example: If the pilot wishes to look up and left at the target, he maintains the dot on the VI command azimuth circle between the 9 and 12 o'clock positions. If AUTO AFCS is engaged after VI lockon, the AFCS positions the interceptor at any one of four positions depending upon the steering dot position with respect to the center of the scope when the AFCS was engaged. All four interceptor positions are on course lines that provide 500 feet of clearance when the interceptor passes the target. Two of the positions are 200 feet above with one to the right and one to the left of the target. The other two positions are 200 feet below with one to the right and one to the left of the target. If AUTO AFCS is engaged before VI lockon, the AFCS will automatically offset the interceptor down and to the right of the target. Because the steering dot represents the target position, the steering dot moves away from the center of the scope as the target is approached. At ranges greater than 6000 feet, center the steering dot within the VI command azimuth circle.
8. VI Range Circle—Moves down as range decreases.
   If range is greater than 6000 feet, the VI range circle will be on the right side of the

scope adjacent to the scribe marks and will be scaled from 0 to 10 nautical miles. At ranges less than 6000 feet, the VI range circle will be on the left side of the scope adjacent to the scribe marks and will be scaled from 0 to 4000 feet. The VI range circle will remain at the top for ranges between 4000 and 6000 feet.

9. VI command azimuth circle (range greater than 6000 feet)—Circle is fixed in size and designates scope center.
10. VI command azimuth circle (range less than 6000 feet)—Circle centered and increases in size as range decreases to provide a reference for proper steering dot offset from scope center.
11. Closing rate—Adjust to 50 knots or less.
12. VI warn, master warning, and flight mode fail lights—Monitor.

    At a target range of approximately 1500 feet, VI warn, master warning, and flight mode fail lights illuminate and the flight mode selector switch steps down to ASSIST.

WARNING

After the flight mode selector switch steps down to ASSIST, the aircraft attitude at the moment of stepdown will be maintained. Because of last minute corrections by the AFCS, this could result in a collision hazard. Take immediate manual control of the aircraft.

13. Flight mode selector switch—Monitor for stepdown to ASSIST.

VISUAL IDENTIFICATION PROCEDURE (FRONT—Not within ±60° of target's tail)

1. Arm-safe switch—SAFE.
2. Armament selector switch—VIS IDENT.
3. DISP/AUTO MODE switch—Any position except ILS or ILS APCH.
4. Radar range lockon—Accomplish.
5. Flight mode selector switch—Any position except AUTO.
6. Radar scope—Monitor.

    In front VI mode, the azimuth steering dot represents the offset course required for a front-to-stern conversion with 18,000 feet rollout in trail and limited to a maximum space-stabilized antenna angle of ±45°. Elevation steering represents the space-stabilized elevation angle. Steering dot will remain centered in azimuth and elevation for 5 seconds after lockon.

7. Steering dot—Provides course guidance to the Stern Conversion Point (SCP).

    The SCP is the tangent point on the turn circle based on a predicted 45° roll angle if not supersonic or 60° roll angle if supersonic. At the SCP, the dot steers the pilot to the stern based on the predicted roll angle. When within ±60° of target's tail, steering dot represents target position.

8. VI Range Circle—Moves down as range decreases.

    If range is greater than 6000 feet, the VI range circle will be on the right side of the scope adjacent to the scribe marks and will be scaled from 0 to 10 nautical miles. At ranges less than 6000 feet, the VI range circle will be on the left side of the scope adjacent to the scribe marks and will be scaled from 0 to 4000 feet. The VI range circle will remain at the top for ranges between 4000 and 6000 feet.

9. VI command azimuth circle (range greater than 6000 feet)—Circle is fixed in size and designates scope center.
10. VI command azimuth circle (range less than 6000 feet)—Circle centered and increases in size as range decreases to provide a reference for proper steering dot offset from scope center.
11. Closing rate—Adjust to 50 knots or less.
12. VI warn, master warning, and flight mode fail lights—Monitor.

    At target range of approximately 1500 feet, VI warn, master warning, and flight mode fail lights illuminate and the flight mode selector switch steps down to ASSIST.

All data on pages 2-40 through 2-45, including figures 2-7, 2-8, and 2-9, are deleted.

WARNING

After the flight mode selector switch steps down to ASSIST, the aircraft attitude at the moment of stepdown will be maintained. Because of last minute corrections by the AFCS, this could result in a collision hazard. Take immediate manual control of the aircraft.

13. Flight mode selector switch—Monitor for stepdown to ASSIST.

AIM MISSILES ATTACK PROCEDURES

Missile Armament Selection

In subsequent procedures in this section, when instructed to select missile armament, accomplish the following steps:

1. Arm-safe switch—SAFE.

NOTE

Before changing the position of the armament selector switch, ensure that the arm-safe switch is in SAFE position.

2. Armament selector switch—MISSILES RAD, ALL, or IR.
3. Armament selection indicator—"OK."
4. Arm-safe switch—ARM.

Missile Post-Attack Procedures

In subsequent procedures in this section, when instructed to perform missile post-attack procedures, accomplish the following steps:

NOTE

Wait 15 seconds after releasing armament trigger before setting the arm-safe switch to SAFE or the armament selector switch to VIS IDENT to prevent an unscheduled reopening of the missile bay doors.

1. Auto search button—Press and release.
2. WSEMs loaded—Wait 25 seconds.
3. Arm-safe switch—SAFE.

NOTE

If during a pursuit attack, the remaining missiles are to be fired after firing the first bay, it is not necessary to switch to SAFE or VIS IDENT in order to reinitiate the timing signals.

WARNING

- A rapid refire should not be attempted if a misfire occurs on the forward bay.
- If AIM 4F's are fired and rapid refire is desired, do not squeeze the trigger until missile results are determined. When the trigger is squeezed the second time, MA-1 will tune away from the missile frequency and precision PRF causing a no-guide condition for previously launched radar missiles.
- A hot trigger condition can exist with the rapid refire capability. If both bays are loaded with the same type missiles and a single bay is fired, the remaining bay will automatically become hot when the trigger is activated a second time. A second missile selection by the flight crew is not required to set up this hot condition.

4. Armament selector switch—VIS IDENT.

Missile Lead Collision Attack

1. Missile selection—Accomplish.
2. Radar range lockon—Accomplish.

CAUTION

The action switch should not be held pressed except when required to effect lockon. Indiscriminate use of the action switch causes needless missile preparation. Approximtely 20 minutes of continuous preparation can result in overheating the missiles.

3. Attack steering—Accomplish.
4. Armament trigger—Press to second detent and hold.

   At 20 seconds before time to fire, indicated by the time-to-go circle beginning to shrink, press the armament trigger to the second detent and hold. This will complete missile preparation and allow the fire signal to be supplied to the missile launching system by the computer.
5. Radar scope—Monitor for "X" fire signal.

6. Pullout maneuver—Accomplish.
   Refer to MISSILE PULLOUT MANEUVERING PROCEDURES.
7. Armament trigger—Release.
8. Missile post-attack procedures—Accomplish.

Missile Radar Pursuit Attack

1. Missile selection—Accomplish.
2. LC/PUR switch—Press and release.
3. RDR switch—NORM.
4. Radar range lockon—Accomplish.
5. Attack steering—Accomplish.
6. Armament trigger—Press to second detent and hold at cycling firing bar indication.
7. Radar scope—Monitor for "X" fire signal.
   Appearance of the fire signal indicates that the selected missiles have been launched. The signal will remain for the computed missile time of flight.
8. Pullout maneuver—Accomplish.
   Refer to MISSILE PULLOUT MANEUVER PROCEDURES.
9. Armament trigger—Release.
10. LC/PUR switch—Press and release.
11. Missile post-attack procedures—Accomplish.

Missile Radar Pursuit Attack, HOM Mode

1. RDR switch—HOM.
   If jamming is detected and is too severe to permit radar range lockon, set mode selector switch to HOM to permit ATOT.
2. Missile selection—Accomplish.
3. Radar angle lockon—Accomplish.
4. Attack steering—Accomplish.
5. Target at firing range bar—Observe on radar scope.
   If the target can be detected through jamming, observe target coincident with firing range bar.
6. Armament trigger—Press to second detent and hold.
   When the target coincides with the firing range bar, press the armament trigger to the second detent and hold.
7. Radar scope—Monitor for appearance of "X" fire signal.
   Appearance of the fire signal indicates that the selected missiles have been launched. The signal will remain for the computed missile time of flight.
8. Pullout maneuver—Accomplish.
   Refer to MISSILE PULLOUT MANEUVER PROCEDURES.
9. Armament trigger—Release.
10. Missile post-attack procedures—Accomplish.

Missile IR Pursuit Attack

1. RDR switch—As desired.
2. IR STOW switch—RDR SCAN or RDR SLVD.
3. Missile selection—Accomplish.
4. IR lockon—Accomplish.
5. Attack steering—Accomplish.
   In the IR pursuit attack there is no provision for automatic flight.
6. Armament trigger—Press to second detent and hold, when at proper range.
7. Radar scope—Monitor for fire signal.
8. Pullout maneuver—Accomplish.
   Refer to MISSILE PULLOUT MANEUVER PROCEDURES.
9. Armament trigger—Release.
10. Missile post-attack procedures—Accomplish.

Missile IR/Radar Pursuit Attack

1. Steps 1 through 5 of MISSILE IR PURSUIT ATTACK—Accomplish.

NOTE

At this point the IR STOW switch must be set to RDR SLVD. The antenna will then be slaved to the IR seeker head and radar lockon will be possible.

2. Lockon—Accomplish.
   If radar target becomes visible, accomplish radar lockon in DROT and/or ATOT.
3. Steps 6 through 11 of MISSILE RADAR PURSUIT ATTACK—Accomplish.

Missile Pursuit Attack Without MA-1 Range Information

If the target can be detected visually and range can be determined by means other than MA-1 system, the following procedures may be used:

1. Missile selection—Accomplish.
2. LC/PUR switch—Press and release.
3. Attack steering—Fly manually to position interceptor.
4. Armament trigger—Press to second detent and hold.
   The missiles will be launched 2.3 seconds later provided 10 seconds of missile preparations have been accomplished.
5. Radar scope—Monitor for fire signal.
6. Pullout maneuver—Accomplish.
   Refer to MISSILE PULLOUT MANEUVER PROCEDURES.
7. Armament trigger—Release.
8. LC/PUR switch—Press and release.
9. Missile post-attack procedures—Accomplish.

Missile Angle Ranging Pursuit Without Radar Range

Angle Ranging Pursuit is a degraded attack mode that results from and ATOT or IRT lockon, and no manual pursuit. The IRAM computer derives range and rate using the space-stabilized antenna elevation angles. Perform the following steps:

1. Missile selection—Accomplish.
2. Attain target altitude by either of these two methods:
   a. Fly through the target altitude.
   b. Fly co-altitude with the target and complete the sequence of tail-nose-tail within 6 seconds.
      Target altitude will be displayed and the Steering Reference Circle (SRC) will position to $-9°$ in elevation and centered in azimuth.
3. Fly the command altitude.
   SRC will uncage 13 seconds after command altitude is reached and represents the optimum look angle at trigger time. Target Velocity Vector (TVV) is also displayed at this point.
4. SRC will center 12 seconds prior to trigger time. Center the steering dot in the SRC.
5. Armament trigger—Press to second detent and hold when the firing bar cycles.
   The missiles will be launched between 2.3 to 4.3 seconds later provided 10 seconds of missile preparations have been accomplished.
6. Radar scope—Monitor for fire signal.
7. Pullout maneuver—Accomplish.
   Refer to MISSILE PULLOUT MANEUVER PROCEDURES.
8. Armament trigger—Release.
9. Missile post-attack procedures—Accomplish.

MISSILE PULLOUT MANEUVER PROCEDURES

1. Level turn—Initiate a smooth turn at missile launch.
   The turn should be smooth and gentle to avoid pulling the radar antenna off the target in any heavy ground clutter or chaff environment. The turn should be small enough to avoid driving the antenna into the bumper ring prior to missile impact.

NOTE

When radar missiles are fired, the interceptor's radar must illuminate the target for missile guidance until impact.

2. Modified split-S—Accomplish.
   When missiles are fired in a fly-up configuration, the pullout procedure should include a modified split-S.

WSEM ATTACK

WARNING

When using the WSEM, no armament will be aboard. If armament panel safety wire has not been removed prior to flight, the pilot must not break any wire or seals. The flight must be conducted as if the aircraft is loaded.

The WSEM attack pass is flown exactly as is the missile attack except that at firing time the pilot should observe and record the following:

a. Target/interceptor altitude.

b. Interceptor Mach.

c. Closing rate.

Do not disarm or select VIS IDENT for 25 seconds after doors have closed to insure zero calibrate. This will permit adequate WSEM tape evaluation. A return to search without selecting VIS IDENT will not interrupt the WSEM until 25 seconds have elapsed from fire time. If search is selected before 25 seconds have elapsed, the system will remain in post-fire but an abnormal display will appear on the radar scope. Following an attack pass after 25 seconds, accomplish the following: Return to search, (if not already in search) set the arm-safe switch to SAFE, select VIS IDENT, and press and hold the armament recycle switch for 5 seconds, then release.

CAUTION

Do not make WSEM pursuit passes of greater than 4 minutes duration or excessive heating will damage the WSEM. After each pass, allow 20 minutes cooling time for the WSEM before beginning another attack. To preclude wasting WSEM tape capability, ensure ARMED is not selected for an extended period of time before initiation of missile preparations.

The WSEM has a usable tape capability of approximately 2 minutes. A normal pass uses approximately 30 to 45 seconds of tape. Firing the WSEM in the minimum time of 12.3 seconds can cause a failure of the WSEM to qualify due to inadequate WSEM warm up.

ABORTED ATTACK PROCEDURES

Immediately after an aborted attack, accomplish the following procedures:

NOTE

To preclude reopening of the missile bay doors, wait 15 seconds after releasing armament trigger before placing arm-safe switch to SAFE or armament selector switch to VIS IDENT.

1. Armament trigger—Release.
2. Auto search button—Press.
3. Arm-safe switch—SAFE.
4. Deleted.
5. Deleted.
6. Armament selector switch—VIS IDENT.

NOTE

If an attack is aborted after doors open, the thermal batteries are expended; therefore, armament internal power is not available for a second attack. Make appropriate entry on Form 781.

DESCENT

1. Fuel quantity and balance—Check.
   Select TOT, RH, LH, FWD, and #3 positions with the fuel quantity gage selector switch(es) and check the fuel quantity gage for proper fuel quantities. Return the switch to the TOT position.

NOTE

No. 3 tank fuel quantity cannot be obtained with the fuel quantity gage selector switch in the FWD position.

2. G meter—Check.
3. Altimeter—Reset as required.
4. AAU-19/A altimeter (if installed)—Check servoed mode accuracy.
   Crosscheck servoed mode reading against pneumatic mode. If above 20,000 feet MSL and altitude difference exceeds 250 feet, operate with reset-standby lever in STBY. If during landing approach the difference exceeds that observed during before takeoff ground checks, use STBY position. Differences greater than noted above should be entered in the Form 781 after landing.
5. Altitude warning selector—Set.
6. Standby flight instruments—Check.
7. Boost pump switches—ON.
8. Armament control panel—Recheck SAFE.
9. Canopy antifog switch—As required.

10. Idle thrust control switch—Check OFF.
    Although there is no necessity to actuate this switch during flight, make a positive check, before landing, that it has not been inadvertently moved from the OFF position.

WARNING

If the idle thrust control switch is ON and main landing gear touchdown occurs, the exhaust nozzle will open. Should this occur during a military thrust go-around, the resulting thrust loss will seriously affect the success of the go-around.

BEFORE LANDING

The normal VFR landing pattern airspeed is 325 KCAS on Initial. At the break, speed brakes may be extended if desired. Fly the downwind leg at a minimum of 220 KCAS and maintain prescribed altitude. Prior to turning base, extend the landing gear and check for a safe indication. As the base turn is started, establish a descent and allow airspeed to reduce to 200 KCAS minimum. Refer to the Landing Distances Charts in T.O. 1F-106A-1-1 or the checklist for recommended final approach, prior to flare, and touchdown speeds. See figure 2-10 for normal landing pattern.

1. Landing gear handle—DOWN and check lights. (FP-RP)
   Put the landing gear down and check landing gear green lights illuminated, landing gear red warning light out, and audio warning off.
2. Landing and taxi light switch—LANDING LIGHTS.
3. Flight mode selector switch—DIR MAN.
   Actuate the rudder pedals to check for normal response. Hard feel and/or restricted travel indicates a possible rudder feel force regulator failure. If this occurs, be prepared for possible directional control problems during landing.

WARNING

A malfunction in the turn coordination system may cause an unexpected yaw and roll if a landing is attempted with YAW DAMPER selected. Should this occur, recovery may be impossible.

4. Speed brakes—Extended.

NOTE

Refer to Section V for maximum landing gear extension speeds and tire ground limit speeds.

LANDING

CAUTION

Avoid wake turbulence. Allow a minimum of 2 minutes separation before landing behind a heavy aircraft or helicopter and 4 minutes behind aircraft such as C-5A and Boeing 747. With effective crosswinds of over 5 knots, the interval may be reduced, but attempt to remain above and upwind of the preceding aircraft's flight path. Wake turbulence is most dangerous during the approach and flare prior to touchdown with calm or light crosswinds.

LANDING WITH EXTERNAL WING TANKS

Landings can be safely accomplished with external tanks full or partially full. Pay close attention to sink rate and keep rate of descent at touchdown below 300 fpm.

NORMAL LANDING

If airspeed becomes excessively low, a high sink rate may develop, resulting in a hard landing. During the flare, thrust is reduced to idle and touchdown is made with approximately 12° angle of attack (nose on the horizon). See figure 2-10 for typical landing pattern. The following procedures should be used:

1. Throttle—IDLE during flareout.
2. Touchdown speed—As required.

CAUTION

- Angle of attack must be kept under 17° to prevent scraping the tail and inadvertent tailhook engagement.

- During touchdown with higher than recommended rates of descent, the tail section or tailhook guards may scrape the runway at angles of attack less than 17°. This could cause inadvertent tailhook engagement of the arresting cable.

WARNING

Be careful not to inadvertently depress the brake pedals as locked brakes and blown tires may result from very slight brake application on touchdown.

3. Drag chute handle—Pull.
   The drag chute may be deployed as soon as the airplane touches down; the chute requires approximately 3 seconds for deployment.

CAUTION

Be careful not to depress the tailhook down button while deploying the drag chute.

4. Lower nose wheel to runway.
   The nose wheel should be lowered to runway at approximately 115 KCAS while elevator control remains effective. For other considerations when lowering the nose, refer to CROSS-WIND LANDING, LANDING ON SLIPPERY RUNWAYS, and MINIMUM RUN LANDING.

WARNING

Avoid using nose wheel steering until needed on the landing roll. While the nose wheel steering may be engaged after nose wheel touchdown, a malfunction of this system could cause full deflection of the nose gear, which may be uncontrollable at higher speeds. Rudder is effective for directional control during the early high-speed portion of the landing roll.

NOTE

- Lower nose gear to runway before applying brakes.
- If nose wheel shimmy is encountered, disengage nose wheel steering, and maintain directional control with rudder and brakes. (Nose wheel steering may be re-engaged below 50 KCAS if shimmy has ceased.)

5. Idle thrust control switch—ON.

WARNING

The switch must not be placed ON until it is positively determined that go-around will not be attempted.

6. Braking—As necessary.

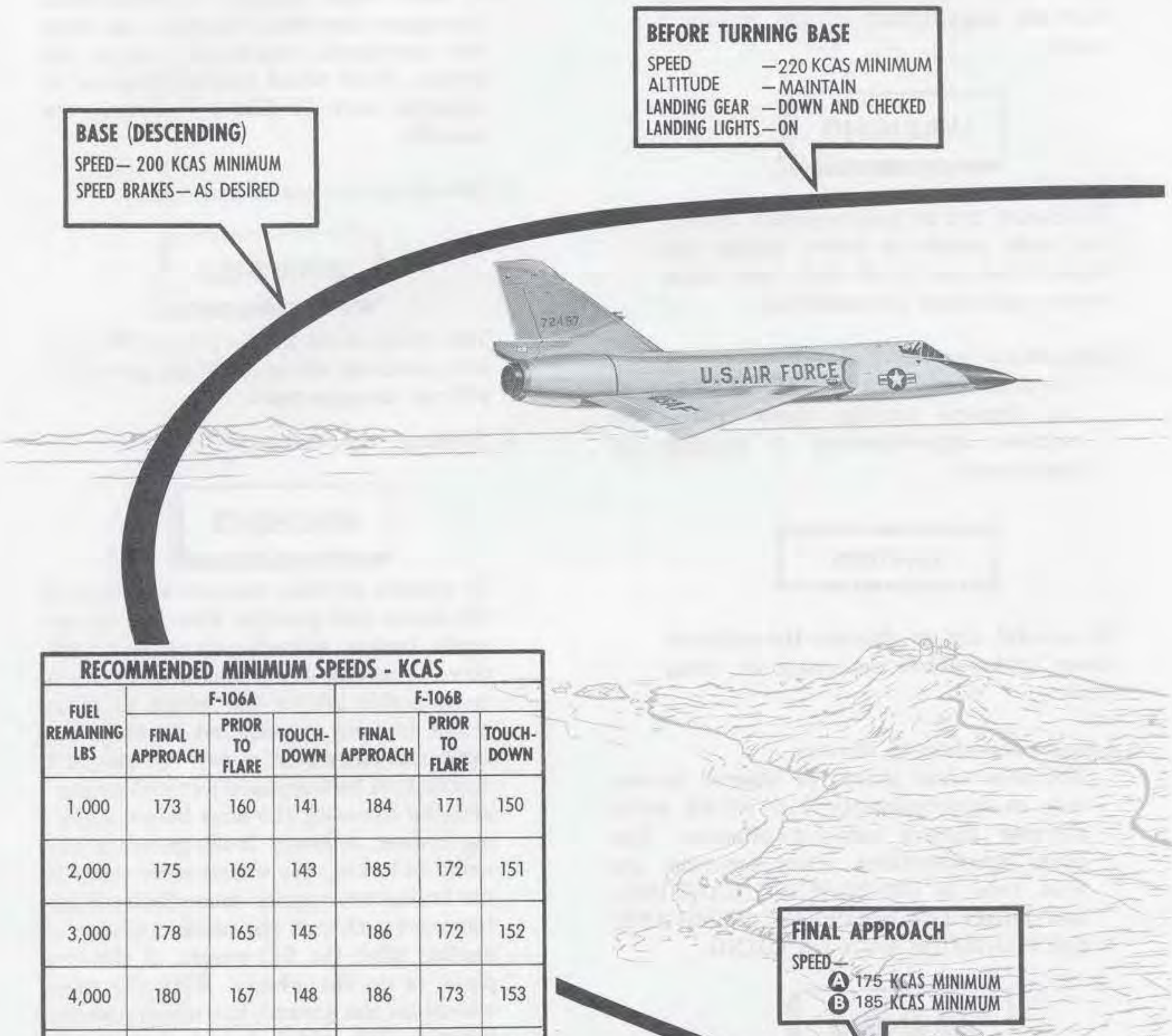
WARNING

To prevent skidding the tires and causing flat spots and possible blowout, do not apply brakes immediately after touchdown or at any other time when there is considerable lift on the wings. If maximum braking is required immediately after touchdown on a dry runway, lift should first be decreased as much as possible by lowering the nose before applying brakes. A heavy brake pressure can result in locking the wheels more easily if the brakes are applied immediately after touchdown than if the same pressure is applied after the full weight of the airplane is on the wheels. With the nose wheels on the ground, the wings provide negative lift which forces the wheels down against the runway, thus decreasing the possibility of locking the wheels by heavy braking.

Directional Control During Landing Roll

Rudder, wheel brakes, and nose wheel steering should normally be used for directional control during the landing roll. However, directional control during the landing roll can be maintained by use of the ailerons. After the main landing gear is firmly on the runway, the airplane will turn in the direction of aileron selection.

normal landing



RECOMMENDED MINIMUM SPEEDS - KCAS						
FUEL REMAINING LBS	F-106A			F-106B		
	FINAL APPROACH	PRIOR TO FLARE	TOUCH-DOWN	FINAL APPROACH	PRIOR TO FLARE	TOUCH-DOWN
1,000	173	160	141	184	171	150
2,000	175	162	143	185	172	151
3,000	178	165	145	186	172	152
4,000	180	167	148	186	173	153
6,000	185	171	152	187	174	154
8,000	189	175	155	196	181	160
10,000	193	179	159	202	187	166
12,000	197	183	163	206	191	169
14,000	201	186	166	210	194	172

NOTE
- ADD 6 KNOTS FOR MISSILE, GUN AND AMMO.
- ADD 3 KNOTS FOR MISSILES
- ADD 3 KNOTS FOR GUN WITH NO MISSILES OR AMMO.

48044-18

Figure 2-10 (Sheet 1 of 2)

pattern (typical)

BASED ON 2000 POUNDS OF TOTAL FUEL

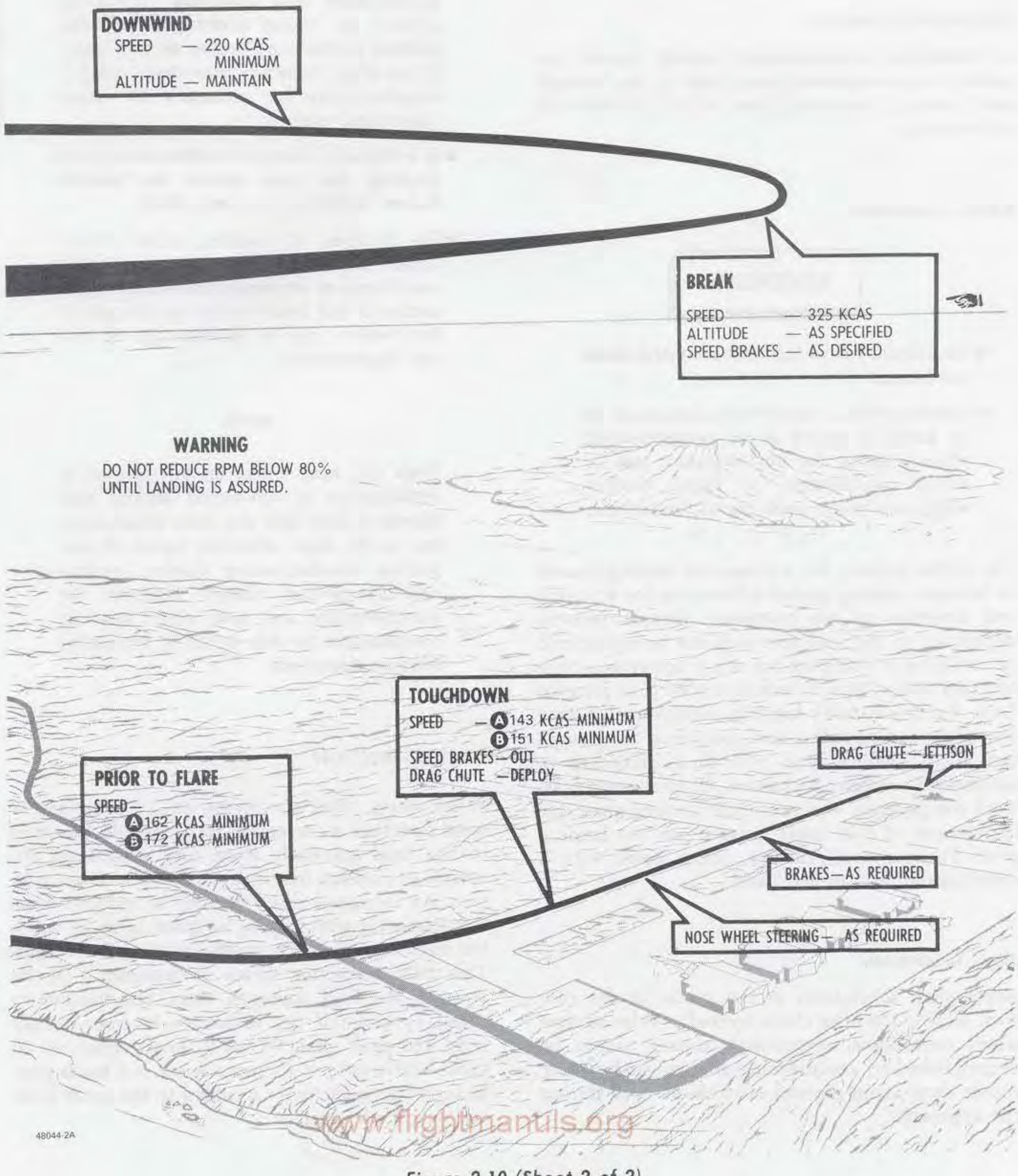


Figure 2-10 (Sheet 2 of 2)

NOTE

Push stick full forward for more positive nose wheel steering and to afford more aileron control.

CROSSWIND LANDING

To determine recommended landing speeds for various crosswing conditions, refer to the Takeoff and Landing Crosswind Chart in T.O. 1F-106A-1-1 or checklist.

Before Touchdown

WARNING

- Anticipate restricted lateral control stick movement.
- Landing with a crosswind component of 15 knots or above is not recommended when wearing the anti-exposure suit or arctic combination of flight clothes which can cause stick travel limitations.

The traffic pattern for a crosswind landing should be normal, making proper allowances for strength and direction of the crosswind. Proper runway alignment on the final approach can be maintained by crabbing or dropping one wing; however, a combination of the two is recommended just prior to flare. For dry runway landing, remove crab before touchdown using wing low technique to prevent side drift. Reduce sink rate to a minimum to accomplish smooth touchdown. At increased crosswind components, sink rate must be minimized due to increase of side loads imposed on the landing gear. For slippery runways, touch down with a combination of crab and bank.

After Touchdown

Accomplish touchdown in the center of the runway. Deploy the drag chute normally. Prior to nose wheel touchdown, directional control should be accomplished by coordinating ailerons with rudder rather than using crossed controls as used during the approach.

CAUTION

- If excessive weathervaning is encountered after touchdown, lower the nose immediately and maintain directional control by using nosewheel steering, aileron, rudder, and brakes as necessary. If the drag chute has been deployed, jettisoning may be necessary to retain directional control.
- If extreme crosswind conditions exist on landing, the nose should be lowered before deploying the drag chute.
- Be cautious of possible rudder travel/brake application interference. Under conditions of extreme crosswinds, application of full brakes after application of full rudder may be difficult due to rudder displacement.

NOTE

With the nose wheel on the ground, a combination of downwind aileron (left aileron to turn left) and nose wheel steering is the most effective means of correcting weathervaning during landing roll. Downwind aileron corrects for weathervaning and nose wheel steering compensates for side drift and maintains runway alignment.

GUST CORRECTION

When gusty wind conditions exist, regardless of wind direction, a correction factor should be added to the final approach, flare, and touchdown airspeeds to prevent inadvertent increase of the sink rate. An increased sink rate may be induced when correcting for gusts if the airspeed is at or below the minimum approach speeds for the gross weight. This gust correction factor is determined by increasing the final approach, flare, and touchdown speed by one-half the difference between steady wind and peak gust. (Wind 10 knots, gusts to 20 knots—difference = 10 knots × 1/2 = 5 knots gust factor.) This gust factor is added to the gross landing weight airspeed.

NOTE

- The gust factor is added to provide a safety margin to maintain a desired sink rate while flying the airplane through a series of accelerations. The accelerations can be equally severe whether they are produced by headwind, crosswind, or tailwind.
- Since the frequency of timing of gusts cannot be estimated with practical accuracy, it is possible for the airplane to arrive at the flare point with gust corrections added during an interval when gusts have stopped momentarily. Under such conditions, the touchdown point may occur further down the runway than planned. Therefore, wherever a correction factor is added for gusts or other accelerations, be prepared to accept a correspondingly higher flare speed with increased landing distance.

LANDING ON SLIPPERY RUNWAYS

Prior to landing on a slippery runway, determine the corrected stopping distance using the latest RCR (runway condition reading).

NOTE

- If no RCR is available, use representative values of 23 for DRY runways, 12 for WET runways, and 5 for ICY runways.
- For ICAO reports, use RCR values of 23 for GOOD, 12 for MEDIUM, and 5 for POOR.

Maximum deceleration forces after touchdown are obtained during the landing roll by holding the nose high touchdown attitude, utilizing maximum aerodynamic braking until forces available from wheel braking become greater than the aerodynamic drag. The use of speed brakes or drag chute does not significantly affect the speed at which the nose should be lowered. Therefore, to obtain minimum ground roll, the landing technique is the same with or without a drag chute or whether the runway is wet, dry, or icy. The only variable is the nose lowering speed which is determined by runway condition. The highest practical angle of attack that can be used without scraping the tail is 16°. Assuming 16° angle of attack is reached and the RCR is 12 or greater, minimum ground roll is obtained by lowering the nose at 115 KCAS and applying maximum braking. If the RCR is less than 12, the nose high attitude should be held as long as possible—approximately 80 KCAS for Ⓐ airplanes and 100 KCAS for Ⓑ airplanes—to utilize maximum aerodynamic braking. After the nose wheel is on the runway, begin maximum braking. Since the landing touchdown angle of attack is approximately 12° at normal landing weight, 16° angle of attack must be obtained by gradually raising the nose after touchdown as the airplane decelerates. If slippery runway conditions are aggravated by a large crosswind component, the additional problems of sidedrift (due to hydroplaning) and weathervaning must be considered. Usually, the best course of action in this circumstance is to proceed to a more suitable alternate.

Wet Runways

Minimum run landing on a wet runway is obtained by using the same procedure as for a dry runway provided the RCR is 12 or above. If RCR is below 12, the nose high attitude should be maintained as long as possible after touchdown to utilize maximum aerodynamic braking. Maintain directional control with rudder and aileron adding nose wheel steering after the nose wheel is on the runway. During wet runway landings, dynamic and viscous hydroplaning becomes a factor to be considered. In order to develop dynamic hydroplaning, the runway must be covered or puddled with at least 0.1 to 0.3 inch of water. With the right conditions the tire can actually ride on the surface of the water and render braking and nose wheel steering completely ineffective. The dynamic hydroplaning speed is basically a function of tire pressure; therefore, the higher the tire pressure, the higher the speed required to hydroplane. With the tire design and pressures used, hydroplaning speed is well above the 115 KCAS maximum recommended braking speed used for wet runways. Above this speed, the rudder is still effective for maintaining directional control. Partial hydroplaning may occur at lower speeds, but due to the high tire pressures, the dynamic hydroplaning problem is significantly reduced. Viscous hydroplaning is controlled by the slickness of the runway surface. It can occur at any speed with very small amounts of moisture on the runway. It is a factor in the touchdown area of the runway where a rubber buildup has made the runway surface relatively slick. Braking effectiveness may be intermittent and control difficulties may develop, even at very low ground speeds.

Icy Runways

The procedure for an icy runway (RCR below 5) landing is that used for a wet or dry runway minimum run landing. However, since wheel braking effectiveness is reduced further from that for wet runway, maximum aerodynamic braking down to 80 KCAS provides the shortest stopping distance. Therefore, use maximum aerodynamic braking by maintaining the nose high attitude, 16° maximum, until the control stick is in the full aft position. Hold the full aft position until the nose lowers to the runway at approximately 80 KCAS for Ⓐ airplanes and 100 KCAS for Ⓑ airplanes. Begin optimum braking after the nose wheel contacts the runway.

NOTE

- With the nose wheel off of the runway, good directional control is available by using rudder and ailerons for normal crosswind conditions.
- With the nose wheel on the runway, directional control may be more difficult due to reduced nose wheel steering and control surface effectiveness. Combinations of nose wheel steering, aileron deflection, rudder and wheel braking may be required.

HEAVY-WEIGHT LANDING

There is no maximum landing gross weight; however, expect an increase in rollout distance at higher gross weights.

Use of Tail Hook

Although the tail hook is primarily an emergency system, it should be used without hesitation anytime that runway length, braking conditions, or heavy gross weights combine to extend landing rollout distances. It is far safer to engage the cable squarely with the airplane under control than to blow a tire by excessive braking. The hook should be extended approximately 2000 feet from the cable.

MINIMUM-RUN LANDING (DRY RUNWAY)

Use normal approach pattern and speeds. Retard the throttle to IDLE during flare. The drag chute may be deployed the instant before touchdown. After touchdown, place the idle thrust control switch ON. Maintain landing attitude angle of attack (16° maximum) to obtain maximum aerodynamic braking. At 115 KCAS, lower the nose wheel to the runway and apply optimum braking. After the nose wheel is on the runway and optimum braking is applied, additional aerodynamic braking is obtained by holding maximum back stick (without raising the nose wheel from the runway).

CAUTION

- Braking is permitted above 100 KCAS; however, caution should be used to prevent wheels from sliding, as brake action is extremely difficult to feel above this speed.
- Excessive use of the brakes at high speeds will cause overheating of the brakes and tires. If the heat is great enough it will cause the tires to deflate.

TOUCH-AND-GO LANDINGS

Touch-and-go landings should be held to a minimum because of excessive tire wear.

WARNING

During touch-and-go landings, ascertain that the idle thrust control switch is OFF. If the switch is ON when main landing gear touchdown occurs, the exhaust nozzle will open. The resulting thrust loss will seriously affect the success of a subsequent military thrust takeoff.

GO-AROUND

A go-around may be made from any point in the approach. Inasmuch as a relatively high engine rpm is maintained throughout most of the pattern, thrust will usually be readily available when the throttle is advanced. However, this may not be true when go-around is initiated after thrust has been reduced to near idle. Under this condition, or at any time when the go-around is initiated after landing flare has been started, the application of thrust may not be able to overcome the sink rate that has been established and the airplane may be committed to a touchdown. If such is the case, normal flare and touchdown speeds should be maintained resulting in a normal touchdown followed by a normal takeoff after go-around thrust has adequately increased airspeed. No appreciable trim change is experienced when applying thrust or retracting landing gear. If the drag chute handle was pulled, the handle must be pushed in (to jettison the drag chute) and the speed brakes should be retracted when the throttle is advanced.

1. Throttle—Full military or afterburner.

WARNING

- If go-around is initiated during the flare or after thrust has been reduced to near idle, any attempt to hold the airplane off the ground may result in critical angle of attack and unsafe airspeed. This condition will be shown on the angle of attack indicator (approach symbol below the lubber line) and can result in excessive sink rate or possible loss of airplane control. The same considerations apply if the airplane is prematurely pulled off the runway during a go-around after touchdown. If committed to touch down, maintain normal approach and touchdown speeds, accomplish a normal touchdown, lower the nose to allow airspeed to increase adequately, and continue with a normal takeoff. Use smooth and deliberate control applications throughout this phase of the go-around. Refer to STALLS, Section VI, for additional information.
- In ground effect (from ground level to approximately 40 feet), it is possible to lift off at speeds which can result in a critical angle of attack as the airplane leaves ground effect. If this situation develops, there may be insufficient time to reduce up-elevator adequately to avoid excessive sink rate or post-stall gyrations. Refer to Section II, T.O. 1F-106A-1-1 for recommended takeoff speeds at various gross weights. After initiating a go-around, do not increase altitude until the appropriate takeoff speed (or higher speed) has been achieved. This will assure that control during climbout can be maintained after leaving ground effect.

2. Drag chute handle—In.
3. Speed brakes—Closed.
4. Idle thrust—OFF.
5. Landing gear—UP (when airplane is definitely airborne).

NOTE

Approximate fuel required for go-around in which a distance of nine miles is traveled is 500 pounds for maximum thrust, or 300 pounds for military thrust. The amount of fuel required is based on maintaining the specified thrust until traffic pattern altitude and speed are attained; after which reduced thrust is used.

AFTER LANDING—CLEAR OF RUNWAY

1. Drag chute—Jettison.

NOTE

If drag chute is retained during taxi, use caution to prevent entanglement.

2. Ejection seat ground safety pin—Install. (FP-RP)
3. Parachute—Disconnect and safety. (FP-RP)

WARNING

Rear pilot should assure that front pilot has installed his ejection seat ground safety pin.

   a. Pull firing lanyard from actuator assembly.
   b. Plug—Install in terminal of firing lanyard.
   c. Safety pin—Install through two small holes in terminal.
      Visually check proper pin engagement through large hole in terminal.
   d. Firing lanyard—Stow in snap tab on harness.

4. Mode 4 selector knob—HOLD for 2-3 seconds, if required.
5. IFF/SIF master control knob—OFF after 15 seconds.

6. Takeoff trim button—Depress.
7. RAT—Extend.

WARNING

The ram air turbine should be extended prior to reaching the parking area to preclude possible injury to ground personnel.

8. RAT handle—Up.

CAUTION

Wait 10 seconds before pulling RAT handle to the UP position after extending the handle.

WARNING

The handle should be returned to the "up" position to prevent injury to ground personnel when the RAT door is closed.

9. Deleted.

WARNING

If missiles are retracted after an aborted attack, advise the ground crew of the possibility of trapped missile power plant exhaust fumes in the missile bay. The exhaust fumes are toxic and must not be inhaled.

10. Cockpit no-fog and ventilated suit switch—OFF.
11. Landing and taxi light switch—Climatic.
12. Oxygen—OFF (immediately before removing mask). (FP-RP)
13. MA-1 power switch—Standby.
14. Cabin air selector switch—OFF.
15. Canopy—As desired.
16. Formation-navigation lights switch—NAV ON.
17. Anti-icing, antifog, rain removal and pitot heat switches—OFF.
18. Standby attitude indicator—Cage and lock.

ENGINE SHUTDOWN

To shut down engine, proceed as follows:

CAUTION

Whenever the engine has been operated at high thrust settings for an appreciable length of time, it must be operated at idle for up to 5 minutes prior to shutdown to prevent seizure of the rotors.

1. Wheel chocks—Installed.
2. Compressed air—Connected or selected.
   External air will be connected by the crew chief. If not available, the crew chief will select internal air prior to engine shutdown.

NOTE

In the event of engine fire during shutdown, compressed air will be necessary to motor the engine.

3. Canopy—Fully open.
4. ATG switch—OFF.

4A. Fuel quantity and balance—Check and record.

5. MA-1 power switch—OFF.

NOTE

Turn MA-1 power switch to OFF prior to engine shutdown to prevent MA-1 electrical power system surges which may trip system circuit breakers.

6. Boost pumps—OFF.

NOTE

With a low fuel condition in either No. 3 tank the engine may flame out. (This is due to the uncovering of the AFT fuel intakes during the nose low condition existing in ground operations.)

Ⓐ 7. T tank shutoff switch—CLOSE.

CAUTION

Excessive air pressure in the fuel pressurization system due to the tripping of the emergency air pressure regulator may cause structural damage to the wing if the T tank switch is not closed prior to engine shutdown.

8. Idle thrust control switch—OFF.
9. Generator switch—OFF.
10. Emergency ac generator switch—START.
11. Throttle—OFF.
    Check fuel flow for zero reading to insure that the fuel has been completely shut off. A fuel flow indication during engine shutdown would be the first indication of possible fire.

NOTE

Under no-load conditions, the emergency ac generator should remain on the line until engine rpm falls below 17 to 15.5%.

a. Observe the "OFF" flag on the attitude indicator.
b. Monitor fuel quantity gage.

NOTE

Check that engine decelerates freely by listening for any excessive engine noises during shutdown.

12. Comm/Nav equipment—OFF.
13. Master electrical power switch—OFF.

NOTE

If the master electrical power switch is left in the ON position, battery power will be depleted.

BEFORE LEAVING AIRPLANE

Before leaving the airplane, check the following:

1. Ejection seat ground safety pin—Check installed. (FP-RP)
2. Parachute firing lanyard—Check released and safetied.

NOTE

The parachute should not be left in the airplane with the firing lanyard connected to the actuator assembly unless the airplane is on alert status.

3. All electrical switches—As required.
4. Canopy hold-open support—Installed.
   Before leaving the airplane the canopy hold-open support must be properly installed by ground personnel.

WARNING Ⓑ

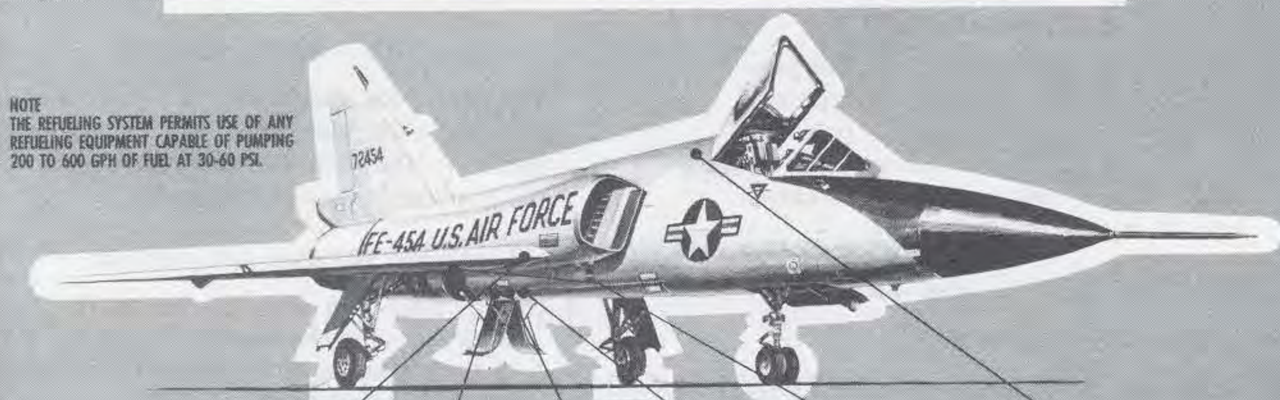
The canopy hold-open support does not prevent momentary upward movement of the canopy. If the shear pin has failed and a wind gust (such as caused by prop or jet wash) strikes the canopy, the canopy could be moved off the actuator rod and hold-open support and fall to the sill.

5. Oxygen connector dust cover—install.
6. Anti-g suit hose—Stowed (if used).
   The anti-g suit hose should be routed behind the arm guard pivot tube up to the hose support/storage strap.

STRANGE FIELD PROCEDURES

If it is necessary to land at an airfield where normal ground support is not available, the pilot will be responsible for performing or closely supervising the required airplane servicing. There are several items which must be serviced immediately after engine shutdown, and additional items of servicing and inspection are required prior to takeoff. During cold weather operation, it may be necessary to store the battery in a warm place if a suitable electrical power source is not available for starting. It is recommended that pilots become familiar with the servicing procedures for all items listed on the Servicing Diagram, figure 2-11. Detailed information is available in Ground Handling, Servicing, and Airframe Group Maintenance Manual. Installation of the drag chute is covered in the Flight Control Systems Maintenance Manual. The following check list supplements the normal operating

servicing diagram



NAME	Fuel Tanks	Hydraulic System Accumulator (Primary and Secondary Systems)	Hydraulic System Reservoir (Primary System)	Hydraulic System Reservoir (Secondary System)	Constant Speed Drive Oil Tank	Refrigeration Unit
REPLENISHING AGENT	Fuel	Dry Nitrogen or Clean Dry Air	Red or Blue Hydraulic Fluid	Red or Blue Hydraulic Fluid	Oil	Oil
SPECIFICATION	MIL-T-5624 Grade JP-4 △1		MIL-H-5606 or MIL-H-83282 H-515/H-537 △3	MIL-H-5606 or MIL-H-83282 H-515/H-537 △3	MIL-L-7808 △3 0-148	MIL-L-6085
CAPACITY	Refer to Fuel Quantity Data Table	750 PSI	1.72 U.S. Gallons	1.9 U.S. Gallons	2.2 U.S. Gallons	Maintain Level Between "ADD" and "FULL"
SERVICING LOCATION	Right Side Under Engine Inlet Duct △2	Forward Bulkhead Hydraulic Compartment	Left Side Hydraulic Compartment	Right Side Hydraulic Compartment	Right Main Wheelwell	Refrigeration Compartment

48028-1

Figure 2-11 (Sheet 1 of 2)

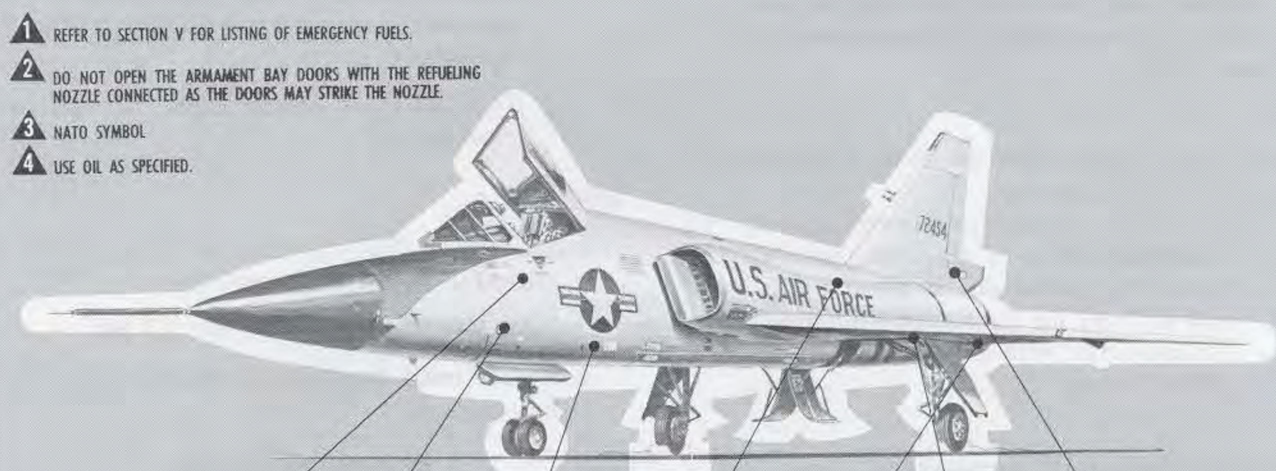
procedures and includes items that would normally be handled by the ground crew.

NOTE

Insure the security of the airplane (ground safety pins, including external tank ground safety pins, chocks, etc.) before leaving the area.

IMMEDIATELY AFTER ENGINE SHUTDOWN

1. Engine oil level—Approximately 2 inches below filler neck. (Service with oil MIL-L-7808 or MIL-L-23699 according to season.)



Emergency Oxygen Bottles	Oxygen	External Power	Engine Oil Tank	Air Turbine Generator	Air Flasks (High Pressure Pneumatic System)	Drag Chute
Gaseous Oxygen	Liquid Oxygen	115 Volt AC 400 Hz 3-Phase	Oil	Oil	Dry Nitrogen or Clean Dry Air	Drag Chute Pack
MIL-0-27210 Grade A Type 1	MIL-0-27210 Grade A Type II		MIL-L-7808 △4 △3 0-148 MIL-L-23699 △4	MIL-L-7808 △3 0-148		Pack in Accordance with T.0.14D1-3-112
1800 PSI	10 Liters		Fill to 2" Below Top of Filler Neck	Fill to Full Mark on Sight Glass	3000 PSI	
Survival Kit or Ejection Seat Assembly	Fuselage Left Side, Just Aft of Forward Electronics Compartment	Fuselage Left Side Below Cockpit	Upper Fuselage, Left Side at Leading Edge of Vertical Fin	Left Aft Fuselage	Wing Section of Left Main Wheel Well	Above Tail Cone, Enclosed by Speed Brakes

48028-2A

Figure 2-11 (Sheet 2 of 2)

NOTE

If this check is delayed, oil will drain from the tank and it will be impossible to obtain an accurate reading. If the level is to be checked on a cold engine, it will be necessary to operate the engine for approximately two minutes. An accurate reading can then be obtained immediately after engine shutdown. Oils MIL-L-7808 and MIL-L-23699 are compatible and can be mixed. However, these oils should never be mixed as a routine practice; mix them only in an emergency for one flight.

2. Constant speed drive oil level—Check service level on sight gages.

   Normal servicing level prior to depressurization is the area between the top of the yellow dot in the underfill gage and halfway up the red overfill sight gage. Pressure fill with MIL-L-7808 IAW T.O. 1F-106A-2-4.

3. Hydraulic system reservoirs.

   a. Relieve system pressure by operating flight controls.

   b. Hydraulic accumulators—750 (±25) psi precharge.

   c. Fluid level—Not more than 3/4 inch below the full mark corresponding to temperature on reservoir temperature gage.

   d. Service with MIL-H-5606/MIL-H-83282.

      Close the reservoir pressure shutoff valve. Relieve reservoir air pressure by depressing button on filler cap. Remove cap and fill to mark corresponding to reservoir temperature gage.

   e. Open the reservoir pressure shutoff valve; the reservoir pressure gage should indicate 55 psi. Check the bleed indicator, and if bleed is indicated, open the bleed fitting on the reservoir servicing panel. When clear fluid flows, tighten the bleed fitting.

4. Engine hot-section data recorder—Check and reset.

   a. Check recorder for recorded engine temperature performance data; enter in Form 781.

   b. Energize dc essential bus. Check that EGT gage power failure flag is not on display.

   c. Remove recorder reset button caps; reset recorder overtemperature flags and clocks as required.

   d. Reinstall reset button caps; turn off electrical power.

REFUELING

1. Fuel—JP-4 (Refer to Section V for listing of alternate and emergency fuels.)
2. Refueling truck pressure—50 ±5 psi.
3. Refuel until truck gage indicates that flow has stopped.

CAUTION

While fuel is flowing into the tanks, check for air flow from the vent outlet in the bottom of each wing. If air is not detected flowing from each vent, shut off fuel flow and investigate the trouble.

4. Disconnect fuel hose.

TIRE SERVICING

1. Nose tires—140 to 150 psi (all weights).
2. Main tires—290 to 305 psi (all weights).

LIQUID OXYGEN

1. Service with liquid oxygen MIL-O-27210A, Grade A, Type II.

HIGH-PRESSURE PNEUMATIC SYSTEM

1. Use Besler 56150-17 quick-disconnect assembly and MC-11 or equivalent compressor. If quick-disconnect assembly is not available, disconnect tubing aft of quick-disconnect fitting in airplane and connect compressor or tubing. Some airplanes incorporate a tee fitting in the servicing line for alternate servicing. Remove cap to service.
2. Charge pneumatic system to 3000 psi.

DRAG CHUTE INSTALLATION (Figure 2-12)

1. Check drag chute handle—Pushed in.
2. Insert D-ring between mechanism jaws and release locking pawl. Insure proper locking.

CAUTION

Failure to release locking pawl may result in automatic jettisoning of the drag chute.

3. Insert pin in jettison switch (pin should fit snugly).
4. Insert drag chute into canister with riser lying flat under the deployment bag and pilot chute closing flaps positioned at a 45° angle from the vertical.
5. Check that the riser keeper is on the top riser and under the pilot chute section of the deployment bag (not extending out beyond the deployment bag).

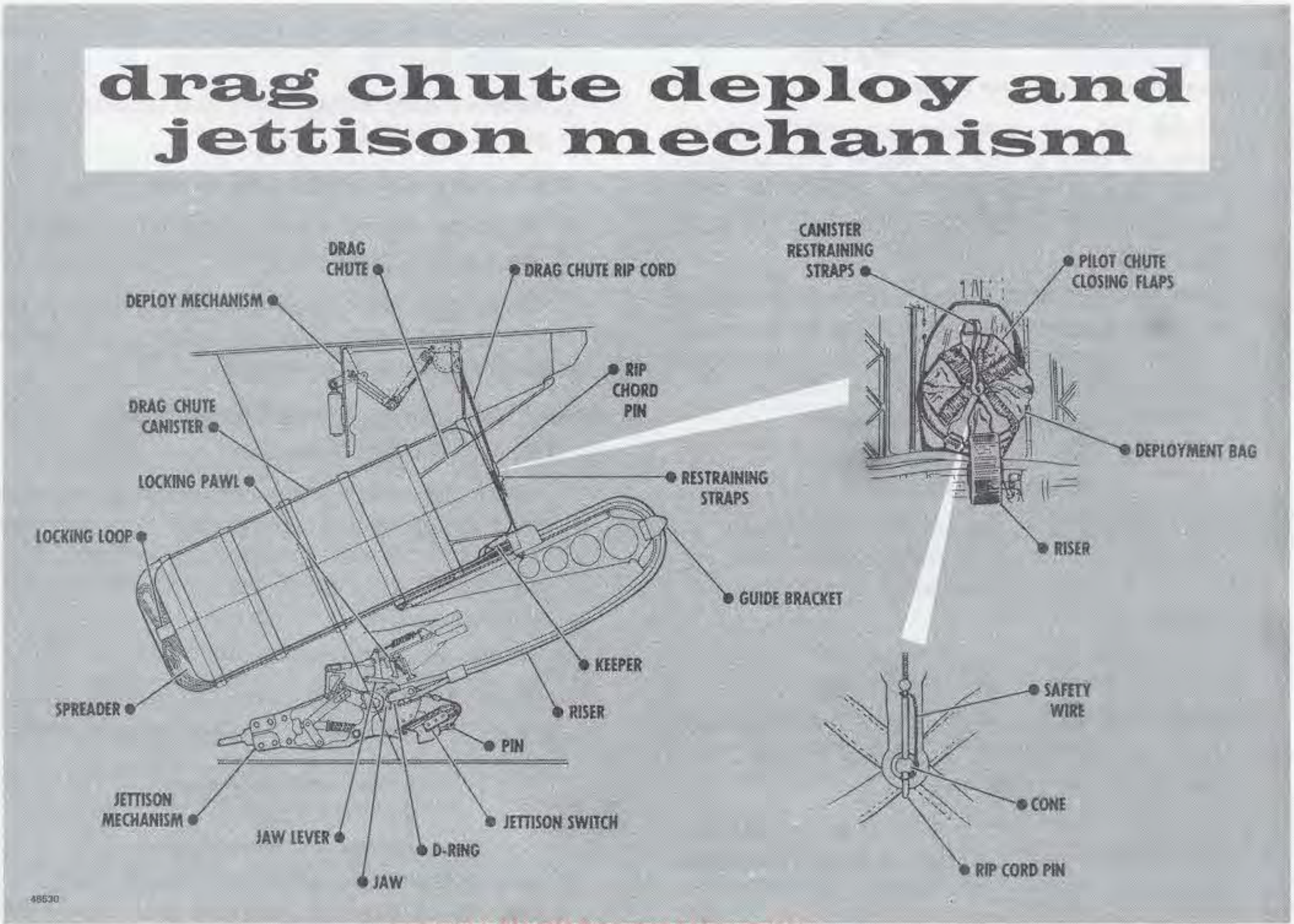


Figure 2-12

6. Check that the riser is positioned in the guide bracket with slack removed and riser taut in guide.
7. Position canister restraining straps over pilot chute cone with the upper strap placed on last and insert ripcord pin.
8. Safety wire drag chute ripcord pin to the pilot chute cone, using 0.020-inch diameter copper (breakaway) safety wire as follows:
   a. Loop one end of the wire around the cable between top end of the ripcord pin and swaged ball on cable.
   b. Using double twist method, twist wire down to the pilot chute cone.
   c. Loop one strand of wire around the cone between the ripcord pin and the restraining straps.
   d. Twist wire ends together and trim excess.
9. Remove pilot chute spring pin and streamer.

MISSILE BAY DOORS — SLOW OPERATION

To Open Missile Bay Doors (Slow)

1. Check the high-pressure pneumatic system pressure gage in the left wheel well, to determine that system pressure is between 2000 and 3000 psi. Charge the pneumatic system if necessary.
2. Clear the missile-bay area and post personnel to warn others that doors are to be operated.

CAUTION B

Do not operate the missile bay doors with the aft electronic compartment door open. Damage to the electronic door may result.

3. Place the manual door-control valve handle (left main wheel well bulkhead) in the OPEN position.
4. Lock the manual door-control valve handle in the OPEN position with the red streamered ground safety pin, if available.
5. Install door safety locks on all door actuating cylinders, if available.

WARNING

If door safety locks and valve handle ground safety pin are not available, use extreme caution when inside the exposed missile bay area.

CAUTION

Avoid movement of any of the door control valve indicator pins, as damage to the missile bay doors will result.

To Close Missile Bay Doors (Slow)

1. Check the high-pressure pneumatic system pressure gage in the left wheel well to determine that system pressure is between 2000 and 3000 psi. Charge the pneumatic system, if necessary.
2. Check that the manual door-control valve handle is in the OPEN position.
3. Remove door safety locks and ground safety pin, if installed.
4. Clear the missile-bay area of personnel.
5. Place the manual door-control valve handle in the CLOSE position.
6. Check that pneumatic system pressure is between 2000 and 3000 psi. Charge the pneumatic system, if necessary.

MISSILE BAY DOORS — FAST OPERATION

To Open Missile Bay Doors (Fast)

1. Check the high-pressure pneumatic system pressure gage in the left wheel well to determine that system pressure is between 2000 and 3000 psi. Charge the pneumatic system, if necessary.
2. Master electrical power switch—ON.
3. Clear the missile bay area and post personnel to warn others that doors are to be operated.

CAUTION B

Do not operate missile bay doors with the aft electronic compartment door open. Damage to the electronic door may result.

3A. Check that the launcher uplock warning light is not illuminated (press-to-test).

WARNING

Do not electrically open armament bay doors if both the missile displaced warning light in the cockpit and the launcher uplock warning light in the wheel well are on.

4. Actuate the door switch on the armament control panel (right main wheel well bulkhead) to the OPEN position. After missile bay doors open, move the forward, then aft rail switches to the OPEN position.
5. Place the armament lock valve (right main wheel well bulkhead) in the LOCK position.
6. Place the manual door-control valve handle (left main wheel well bulkhead) in the OPEN position.
7. Master electrical power switch—OFF.
8. Install door safety locks on all door actuating cylinders, if available.

WARNING

If door safety locks are not available, use extreme caution when inside the exposed missile bay area.

CAUTION

Avoid movement of any of the door-control valve indicator pins, as damage to the missile bay doors will result.

To Close Missile Bay Doors (Fast)

1. Check the high-pressure pneumatic system pressure gage in the left wheel well to determine that system pressure is between 2000 and 3000 psi. Charge the pneumatic system, if necessary.
2. Remove door safety locks, if installed.
3. Master electrical power switch—ON.
4. Place the manual door-control valve handle in the CLOSED position.
5. Place the armament lock valve in the FLIGHT position.
6. Clear the missile bay area of personnel.
7. Place the aft, then the forward missile rail switches to the UP position. After the rails are retracted, place the door actuator switch to the CLOSED position.
8. Master electrical power switch—OFF.
9. Check that pneumatic system pressure is between 2000 and 3000 psi. Charge the pneumatic system, if necessary.

RETRACTING AND LATCHING TAILHOOK

The tailhook is manually retracted and latched. The latching procedure generally requires two men and a special tailhook retracting tool (8-96515). However, the special tool may not be available, and the following alternate retraction method may be used:

1. Disconnect battery.
2. Position a man on each side of extended tailhook.
3. Raise and hold the tailhook in the retracted position.

WARNING

To prevent serious injury to personnel, do not allow any part of the body to extend into tailhook extension area.

4. Engage the latch shaft with a 5/8-inch open end wrench, and rotate latch shaft approximately 60° aft (clockwise, looking up). Listen for a definite, audible click which occurs as the latch lever seats in the trigger. (If click is not heard, lock may not be fully engaged. Check mechanism for binding, defective solenoid, etc.)
5. Remove wrench from latch shaft, and check that shaft remains in latched position.
6. Slowly ease off pressure applied to tailhook, until it can be determined that tailhook is firmly latched, then release tailhook.
7. Install the tailhook safety pin.
8. Check that tailhook shoe is held against upper stop with safety wire.

LANDING GEAR STRUT SERVICING

NOTE

The P/N MS28889-1 high-pressure air valve is being issued in place of AN6287-1 valve on attrition basis. The MS28889-1 valve has a 3/4-inch hex swivel nut and does not have a valve core as a secondary seal. Prior to inflating or deflating shock strut determine which valve is installed.

WARNING

Make sure that all personnel are clear of airplane. Determine that all obstructions, which might cause damage if airplane is to be lowered, are removed from under fuselage and wings. Do not inflate shock struts in order to install or remove jacks. Do not inflate shock struts when jacks are installed; serious injury to personnel and/or structural damage to the airplane may result.

Servicing Main Gear Shock Strut With Air

The distance between torque arm centers on the main landing gear shock strut should be 5-5/16 inches. To inflate or deflate the main gear shock struts to the 5-5/16-inch dimension use the following procedure:

a. Remove dust cap from air valve at top of strut (see figure 2-13).

CAUTION

The MS28889-1 valve does not contain a valve core. Loosen dust cap about one turn to allow air, which may be trapped between the metal-to-metal seal of the valve and cap, to escape; then remove cap.

NOTE

Oscillate the wing, when inflating or deflating shock struts, to minimize piston friction.

b. To inflate main gear shock strut:

(1) Attach dry air or nitrogen supply hose to valve.

CAUTION

Use a regulated source of air pressure; inflate strut slowly. The maximum servicing pressure, with the airplane gross weight resting on the strut, is 1300 psi. Do not service a fully extended strut to more than 203 psi.

(2) Loosen 5/8-inch hex swivel nut (top nut) installed on AN6287-1 air valve or 3/4-inch hex swivel nut (top nut) installed on MS28889-1 valve to a maximum of 3/4 turn.

NOTE

To keep the 3/4-inch safetied valve body (bottom nut) from turning, hold valve body with another wrench.

(3) Inflate slowly to 5-5/16-inch dimension.

(4) Tighten 5/8-inch or 3/4-inch swivel nut (top nut), to 50-70 inch-pounds torque.

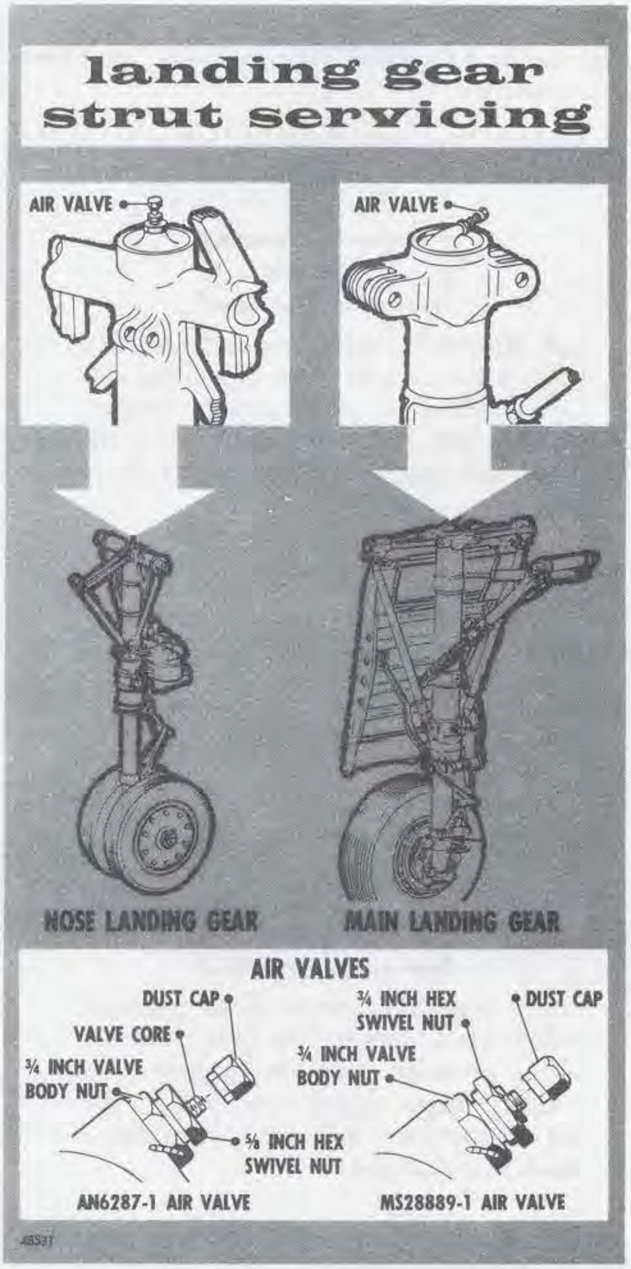


Figure 2-13

(5) Remove dry air or nitrogen supply hose from valve.

(6) Replace and tighten valve cap to extreme finger tightness.

c. To deflate main gear shock strut:

(1) On AN6287-1 valve, loosen 5/8-inch hex swivel nut (top nut) 1/10 of a turn and depress valve core. On MS28889-1 valve, loosen 3/4-inch swivel nut (top nut) slowly. The amount the 3/4-inch nut is loosened will govern the rate of air discharge.

NOTE

To keep the 3/4-inch safetied valve body (bottom nut) from turning, hold valve body with another wrench.

(2) Deflate shock strut below the 5-5/16-inch dimension and tighten the swivel nut.

(3) Inflate shock strut using procedures in step b.

Servicing Nose Gear Shock Strut With Air

Due to airplane cg variations caused by different airplane weight configurations, it is necessary to check shock strut air pressure as well as extension distance. To service the nose gear shock strut proceed as follows:

a. Remove dust cap from air valve and attach dry air or nitrogen service line, with 0 to 1000 psi air pressure gage (see figure 2-13).

CAUTION

The MS28889-1 valve does not contain a valve core. Loosen dust cap about one turn to allow air, which may be trapped between the metal-to-metal seal of the valve and cap, to escape; then remove cap.

NOTE

Use a regulated source of air pressure; inflate the strut slowly. The maximum servicing pressure, with the airplane gross weight resting on the strut, is 1100 psi on Ⓐ airplanes and 850 psi on Ⓑ airplanes. Do not service a fully extended strut to more than 75 psi.

b. Loosen 5/8-inch hex swivel nut (top nut) installed on AN6287-1 air valve or 3/4-inch hex swivel nut (top nut) installed on MS28889-1 valve to a maximum of 3/4 turn. Take a pressure reading and tighten hex swivel nut.

NOTE

To keep the 3/4-inch safetied valve body (bottom nut) from turning, hold valve body with another wrench.

c. Find a pressure, on the inflation chart mounted on the shock strut, that corresponds to the gage reading and note proper strut extension for that pressure.

d. Measure the distance between torque arm centers. The distance should be within 1/4-inch of the noted chart distance. If measurement is not within tolerance, inflate or deflate the strut to the proper distance.

e. Tighten hex swivel nut to torque of 50-70 inch-pounds and remove servicing line. Install valve cap and tighten to extreme finger tightness.

STARTER CARTRIDGE LOADING PROCEDURE

1. Stray voltage check.

   a. Apply power to the aircraft (battery or external source)

   b. Place the starter mode switch in CARTRIDGE.

   c. If the light on the starter mode switch panel illuminates, do not install cart.

1A. Open access panel 779 Ⓐ, 651 Ⓑ (on fuselage above left wing). Remove cartridge storage container.

2. Remove cartridge from container.

3. Inspect cartridge. Any of the following conditions is cause for rejecting the cartridge.

   a. General.

      (1) Igniter ground contact missing or damaged.

      (2) Igniter firing pin (spring loaded) will not retract or extend freely.

      (3) particle screen cocked.

   b. Rubber case cartridge.

      (1) Rubber case punctured, torn, or flawed.

      (2) Rubber case not properly crimped around the perimeter of particle screen.

   c. Steel case cartridge.

      (1) Case dented, split, or otherwise damaged.

      (2) Breech sealing band missing, torn, or too large (does not fit snugly in steel band groove).

WARNING

Do not puncture mylar weatherseal under cartridge screen. Puncturing could cause dangerous malfunction when cartridge is fired.

4. Place starter mode switch to TEST.

5. Open starter access door.

6. Disconnect starter electrical connector from breech receptacle.

7. Remove breech from starter by squeezing trigger on handle, rotating counterclockwise, and pulling breech upwards.

8. Release trigger and check that lock pin returns to its original position. Remove spent cartridge, if installed.

9. Check inside dome chamber of breech and remove any fragments of previously fired cartridge.

10. Remove W-shaped shorting clip on cartridge, or if non-removable, hinged, fold-back type clip is installed, fold clip back.

11. Insert cartridge into breech, screen side up. Press and rotate the cartridge 90° to remove any accumulated dirt from the firing pin.

CAUTION

- Cartridges dropped in excess of 4 feet will not be used.
- If cartridge cannot be installed in the breech cap without abnormal force, it will be rejected.

12. Install breech by squeezing trigger on handle while pushing in and rotating handle approximately 60° clockwise. Exert a slight forward and aft turning force on lower breech to make sure that locking pin has engaged and locked into upper breech after trigger handle is released.

CAUTION

With cartridge installed, if breech cap cannot be locked in the starter breech without abnormal force, cartridge will be rejected.

13. Re-connect starter electrical connector to breech receptacle.
14. Place starter mode switch to CARTRIDGE.

WEATHER PROCEDURES

Canopy

The canopy and compartment doors should be kept closed whenever the airplane is unattended, to prevent the entry of sand and dust, even though the inside temperature may be 10 to 20 degrees lower with them open. When attended by maintenance personnel, the canopy and compartment doors may be opened for ventilation and to prevent heat warping of delicate equipment.

Fuselage

All openings such as engine air intake ducts, tailpipe, vents, exhaust outlets, pitot and artificial feel system intake heads, should be covered and protected with tight-fitting covers to keep out all sand and dust.

ELECTRICAL POWER REQUIREMENTS

1. MD-3 and MD-4 provide sufficient power for starting and operation of the MA-1 system.

NOTE

For AHRG operation when using ground power, the TRT/GYRO switch must be ON.

2. MD-3 with adapter cable 8-96052-801 (6115-690-4050) provides sufficient power for starting only.

CAUTION

Insure that the MD-3 or MD-4 have three phase ac power only. If single phase power is applied, the airplane electrical system can be seriously damaged.

NOTE

If the above units are not available, a battery start will be necessary. If the airplane is to be parked for more than approximately one hour in freezing temperatures, and a battery start is expected, it will be necessary to store the battery in a warm place until ready to start.

emergency procedures

Section III

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INTRODUCTION

This section includes procedures to be followed to correct an emergency condition. The procedures, if followed, will insure safety of the pilots and aircraft until a safe landing is made or other appropriate action is accomplished. Multiple emergencies, adverse weather, and other conditions may require modification of these procedures. Therefore, it is essential that pilots determine the correct course of action by use of common sense and sound judgment. Procedures appearing in bold face capital letters are considered critical action. Procedures appearing in small letters are considered noncritical action. Each is defined as follows:

Critical Actions: Those actions which must be performed immediately without reference to a checklist if the emergency is not to be aggravated and injury or damage is to be avoided. These critical steps will be committed to memory.

Noncritical Actions: Those actions which contribute to an orderly sequence of events, and where there is time available to consult a checklist. To assist the pilot when an emergency occurs, three basic rules are established which apply to most emergencies occurring while airborne. They should be remembered by each pilot. The rules follow:

1. **Maintain aircraft control.**
2. **Analyze the situation and take proper action.**
3. **Land as soon as practical.**

GROUND OPERATIONS

ENGINE FIRE DURING START

If the engine fire warning light illuminates or there is visible evidence of fire during starting, proceed as follows:

1. **THROTTLE—OFF.**
2. Fuel shutoff switches—Close.
3. Master electrical power switch—OFF.

EXCESSIVE EGT OR FIRE IN TAILPIPE

Excessive EGT is indicated by the exhaust gas overtemperature warning light. If excessive EGT is observed or if excessive fire occurs in the tailpipe during start or shutdown, proceed as follows.

1. Throttle—Off.
2. Compressed air—Connected.

NOTE

In the event a ground cart is not available, air for motoring the engine may be taken from the airplane pneumatic pressure supply by opening the manual shutoff valve in the main wheel well.

3. Fuel shutoff and boost pump switches—OFF.
4. Master electrical power switch—ON.

5. Starter mode switch—PNEUMATIC.
6. Engine ignition button—Depress and hold.
7. Throttle—START.
   Move the throttle to START and hold, check for positive rpm.
8. Engine ignition button—Release.

   Release ignition button when external air is expended or 30% rpm.
9. Throttle—OFF.
10. Master electrical power switch—OFF.

EJECTION DURING TAXI AND GROUND ROLL

The egress system provides safe escape capability under most conditions on the ground with the canopy closed, i.e., static, taxi, and ground roll prior to takeoff and after landing. In addition to normal attitude, successful static tests have been accomplished with a simulated aircraft attitude of a collapsed nose gear and a combination of both the nose gear and the right main gear collapsed. Refer to INFLIGHT for ejection procedures.

WARNING

- The canopy must be closed to ensure safe removal during the automatic ejection sequence.
- Before a ground level ejection is attempted, a ground egress should be considered.
- Do not attempt to beat the system by manually pulling the D-ring prior to automatic chute deployment by the drogue gun. At airspeeds below 150 knots, the automatic system must be depended upon for successful ground level ejection.

EMERGENCY GROUND EGRESS

The following procedure prescribes the fastest method of egress from a disabled airplane on the ground. It also provides additional pilot protection from fire. After the airplane is stopped, proceed as follows:

1. **OXYGEN—OFF.**

NOTE

On some airplanes, the oxygen supply switch is a small toggle switch instead of the large plastic lever. The small switch could be more difficult to locate during an emergency egress.

2. **SURVIVAL KIT HANDLE—PULL.**

WARNING

Extreme caution must be exercised in the use of the emergency release handle because of its similarity and close proximity to the right ejection handgrip.

3. **SEAT BELT—RELEASE.**

WARNING

Avoid entanglement with shoulder harness straps during egress.

4. Canopy—Jettison/open/break.

WARNING

- The canopy jettison handle is safetied when the ejection seat ground safety pin is installed.
- If the canopy is electrically opened in the D model aircraft, care should be taken to ensure it is fully raised before the front cockpit crew member egresses. If the canopy is not fully raised, the rear cockpit crew member will have to use the emergency canopy switch.
- If the canopy is to be jettisoned, it must be in the closed position.

5. Firing lanyard—Disconnect.

WARNING

- During emergency ground egress, the pilot should stand up and lean straight forward to release the firing lanyard. Pulling to either side could bind the lanyard and possibly delay or hinder the egress.
- If the nose gear is extended, there is approximately an 8 foot drop to the ground. Exercise caution to prevent an incapacitating injury.

Should canopy opening or removal methods fail and ground egress is necessary, proceed as follows:

a. Ejection seat ground safety pin—Install.

b. Release seat belt and shoulder harness and remove parachute.

c. Remove the canopy breaker tool from its brackets and firmly grasp the handle with both hands.

d. Chop a hole in the upper forward area of the canopy plexiglass (see figure 3-1).

e. Insert the point of the canopy breaker tool in the hole and begin a sawing motion using short, rapid strokes (see figure 3-1). Cut a hole approximately 12 inches high and 20 inches wide.

CAUTION

Attempting to break off large pieces of the canopy instead of sawing as directed will increase the time required for escape and will quickly fatigue the pilot.

f. Rub the jagged edge of the opening with the serrated portion of the canopy breaker tool handle to remove as much of the sharp edge as possible.

g. Egress through the hole.

EMERGENCY ENTRANCE

The procedure to be used by rescue personnel assisting a disabled pilot from the airplane following a crash landing is contained in figure 3-2.

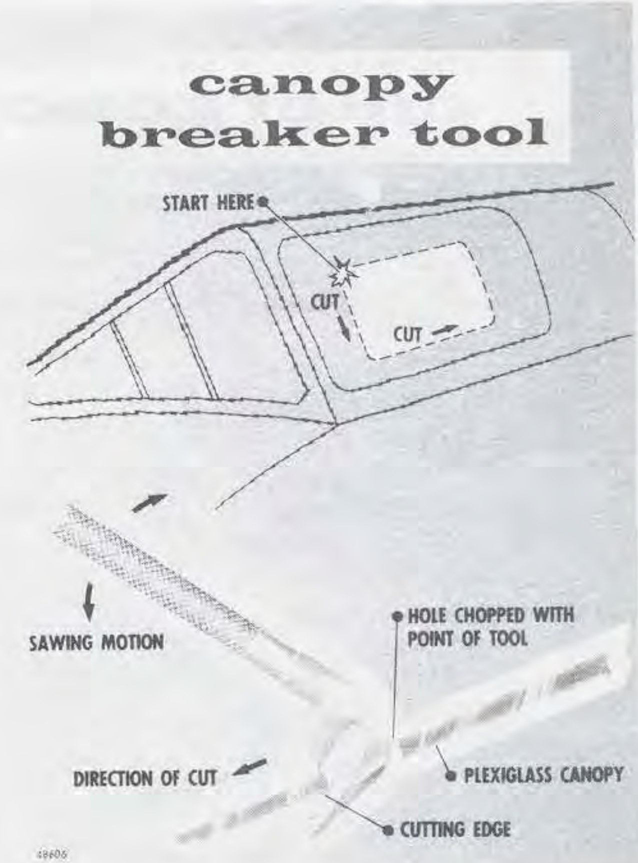


Figure 3-1

TAKEOFF

ABORT

An aborted takeoff should always be made with the landing gear extended and in accordance with those procedures necessary to stop the airplane.

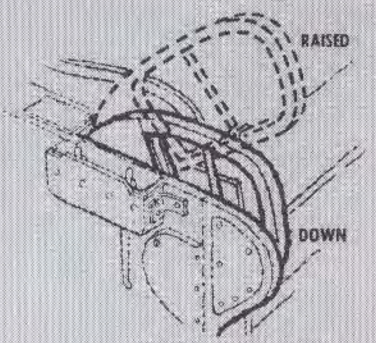
1. **THROTTLE—IDLE.**

NOTE

- With the throttle in the OFF position, nose wheel steering will not be available and normal drag chute deployment may not be possible.
- If the airplane leaves the runway, stopcock the throttle.

2. **CHUTE—EMERGENCY DEPLOY.**
3. **HOOK—DOWN** (if necessary).
   If a cable engagement is anticipated, extend the tailhook at least 2000 feet from the cable if possible.

emergency entrance



COCKPIT ENTRANCE

BEFORE ATTEMPTING TO ENTER COCKPIT CHECK POSITION OF EJECTION SEAT HANDGRIPS FOR DOWN AND STOWED POSITION

WARNING

IF THE HANDGRIPS ARE RAISED, DO NOT PULL THE CANOPY EXTERNAL JETTISON HANDLE OR THE PILOT AND SEAT WILL BE EJECTED.

IF EJECTION SEAT HANDGRIPS ARE DOWN.

1. REMOVE CANOPY EXTERNAL JETTISON HANDLE ACCESS DOOR.
2. GRASP CANOPY EXTERNAL JETTISON HANDLE AND PULL OUTBOARD APPROXIMATELY 6 FEET TO FIRE CANOPY.

NOTE
THE CANOPY SHOULD TRAVEL UP AND AFT SUFFICIENTLY TO CLEAR THE COCKPIT. HOWEVER, IT WILL PROBABLY STRIKE THE AIRPLANE MIDSECTION.

WARNING

SPARKS FROM THE CANOPY JETTISON CHARGE MAY IGNITE FUEL SPILLED IN OR NEAR THE AIRPLANE.

3. IF CANOPY FAILS TO JETTISON BY BALLISTIC CHARGE, OR IF PRESENCE OF FUEL FUMES MAKES JETTISON INADVISABLE, USE PROCEDURES AS GIVEN BELOW.

IF EJECTION SEAT HANDGRIPS ARE RAISED.

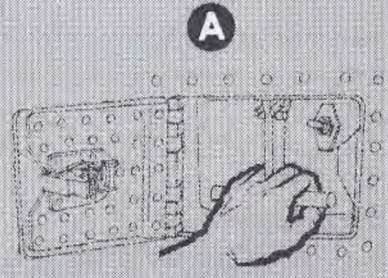
1. OPEN EXTERNAL CANOPY CONTROL ACCESS DOOR LOCATED JUST BELOW THE LEFT WINDSHIELD.

(A) 2. GRASP CANOPY EXTERNAL LATCH HANDLE AND PULL OUTBOARD APPROXIMATELY 6 INCHES TO RELEASE CANOPY LATCHES.
(B) PULL LATCH RELEASE HANDLE FULL OUT; ROTATE UP AND AFT AS FAR AS POSSIBLE; PULL OUT AGAIN; THEN ROTATE HANDLE BACK DOWN.

(A) 3. RAISE THE CANOPY MANUALLY.
(B) HOLD THE SPRING-LOADED TOGGLE SWITCH IN THE UP POSITION UNTIL THE CANOPY IS OPEN AS FAR AS DESIRED. IF CANOPY DOES NOT OPEN WHEN THE SWITCH IS HELD IN THE UP POSITION, PULL THE "CANOPY MOTOR BRAKE RELEASE HANDLE" DOWN THROUGH AN ARC OF 60 DEGREES, THEN MANUALLY OPEN THE CANOPY.

WARNING

IF THE HANDGRIPS ARE RAISED, EXERCISE CAUTION TO PREVENT INJURY IN THE EVENT THE CANOPY JETTISON CHARGE FIRES WHILE THE CANOPY IS BEING REMOVED.



CAUTION (A)

DO NOT ATTEMPT TO OPEN THE CANOPY WITH THE EXTERNAL CANOPY SWITCH, AS POSSIBLE DAMAGE TO THE CANOPY ACTUATOR OR LOSS OF ELECTRICAL POWER DURING THE OPENING CYCLE WOULD RESULT IN THE CANOPY JAMMING PARTLY OPEN.

IF UNABLE TO OPEN CANOPY

1. SHATTER PLEXIGLASS ALL THE WAY AROUND THE CANOPY FRAME, AS NEAR THE FRAME AS POSSIBLE.
2. CUT DEFOG PANEL FROM EDGE OF CANOPY FRAME USING AXE OR SHARP HOOK KNIFE.

Figure 3-2 (Sheet 1 of 2)

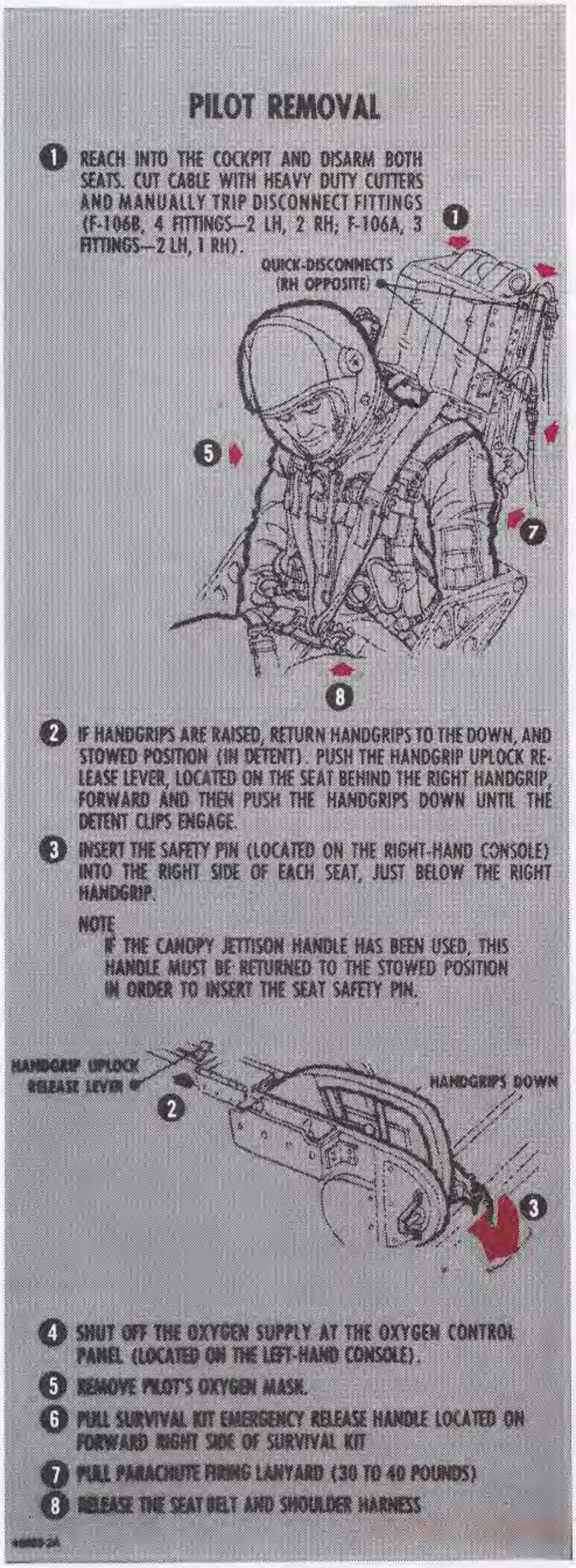


Figure 3-2 (Sheet 2 of 2)

CAUTION

Do not delay extension of the tailhook when fire is suspected in the aft section. Fire damage to the tailhook solenoid may prevent tailhook extension.

4. **TANKS—JETTISON** (if necessary).
   External tanks containing fuel should be jettisoned as soon as the emergency is known to allow the tanks to clear the vicinity of the airplane. Empty tanks should be retained.

5. Idle thrust control switch—ON.

6. Brakes—As necessary.
   Lower the nose wheel to the runway and brake as required. Hold maximum possible backstick (up elevons) without raising the nose wheel from the runway, to obtain additional braking. If abort is for a flat tire, refer to FLAT TIRE ON LANDING for braking procedure.

CAUTION

- Avoid use of wheel brakes above 115 KCAS since braking action is difficult to feel and a blown tire could cause loss of directional control.
- Excessive braking prior to cable engagement should be avoided to reduce the possibility of a tire blowout which could cause loss of directional control and possibly prevent cable engagement.

7. Shoulder harness inertia reel handle—MANUAL LOCK. (FP-RP)
8. Canopy—Retain.

WARNING

This airplane contains a one-motion ejection seat system. Do not raise either ejection seat handgrip to jettison the canopy as such motion will also eject the seat.

WARNING

- If canopy is to be jettisoned, make sure it is jettisoned before the airplane comes to a complete stop. Otherwise, sparks from the canopy remover may cause a fire if fuel is spilled in the vicinity of the airplane.
- If the canopy is jettisoned below 175 KCAS (airplanes without clear top canopy) or 210 KCAS (airplanes with clear top canopy) while airborne, it may strike the vertical stabilizer. If the canopy is to be jettisoned, it must be in the closed position.
- If the canopy is not jettisoned, do not unlock the canopy until the airplane stops. On rough terrain the aft canopy mounts may become damaged, making canopy raising difficult.

WARNING

- Because of the height of the cockpit above the ground (approximately 8 feet), care should be exerted when abandoning the airplane without a ladder.
- Unless circumstances warrant shutting down the engine, do not stopcock the engine, but maintain idle rpm until fire equipment arrives. Stopcocking the engine allows fuel to vent near the wheel brakes, thus creating a fire hazard.
- After an aborted takeoff, wheel brakes will reach high temperatures and tire explosion may result. Park airplane in an isolated area to minimize damage to ground crews and other airplanes. Refer to USE OF WHEEL BRAKES, Section VII.

RUNWAY OVERRUN CABLE ENGAGEMENT

The tailhook system is installed for use with the BAK-9 or BAK-12 overrun cable or the MA-1A modified barrier. The MA-1A barrier (webbing) has been modified to include an additional "across-runway" cable for tailhook arrestment and may be used as a backup for the BAK-9 and BAK-12 cables. If the arresting system includes both the landing gear barrier webbing cable and the tailhook "across runway" cable, the tailhook cable will provide the most reliable operation. Normally, the webbing should be lowered for engagement to preclude the possibility of a one-strut engagement after a successful tailhook arrestment. In event of a high speed abort, jettison external tanks as soon as the need for cable engagement is known. Avoid excessive braking to reduce the possibility of tire blowout which could cause loss of directional control and possibly prevent cable engagement. Deploy the tailhook 2,000 feet from the cable if possible and steer toward the center of the cable. Lower the nosewheel smoothly to the runway prior to arrestment. The tailhook is designed to arrest the aircraft in a level attitude with all wheels in runway contact. If engagement is accomplished with a broken nose strut piston, tailhook failure is possible. There is no minimum speed for tailhook engagement. During arrestment, aircraft behavior is satisfactory and nosewheel steering or braking may be used for directional control.

WARNING

- Do not hold the brake on a blown tire prior to cable engagement. This may cause damage to the underside of the wing, but it will insure that the cable will not be severed by the flat tire rim, thus increasing the success of cable engagement.
- To reduce the possibility of fire if landing with a blown tire or tires, do not stopcock the throttle until signaled to do so.

Cable Engagement Procedures

1. Call for barrier webbing to be lowered.
2. Tailhook down button—Depress (at least 2000 feet from cable).
3. Steer airplane toward center of cable and follow ABORT procedures.

ENGINE FAILURE DURING TAKEOFF

If engine failure occurs during takeoff but after becoming airborne, an immediate touchdown may be practical if sufficient runway remains. If there is not sufficient runway, an immediate relight may be possible with the emergency fuel control and all-points ignition. The course of action depends on remaining runway, altitude at time of failure, automatic escape equipment capabilities (refer to EJECTION), and terrain features of the overrun landing area.

IF DECISION IS MADE TO STOP:

1. Abort.

IF TAKEOFF IS CONTINUED:

1. **TANKS—JETTISON.**
2. **ZOOM AND EJECT.**

ENGINE FIRE DURING TAKEOFF

IF DECISION IS MADE TO STOP:

1. Abort.

IF TAKEOFF IS CONTINUED:

1. **THROTTLE—MAXIMUM.**
   Maintain maximum thrust until safe ejection altitude is reached.
2. Tanks—Jettison (if necessary).
3. If on fire—Eject.
   Check for positive indication of fire such as trailing smoke or flame or request a visual check from another aircraft or from the ground.

IF FIRE CANNOT BE CONFIRMED:

4. Throttle—Minimum practical thrust.
5. Land as soon as possible.

EJECTION DURING TAKEOFF

The zero-zero egress system provides safe escape capability under all conditions at and immediately after takeoff within an envelope defined by a nose high airplane and up to 40° of bank. At 150 feet altitude with a nose high airplane, safe ejection can be accomplished at up to 65° of bank. At 500 feet altitude, safe ejection can be accomplished at up to 85° of bank. Refer to INFLIGHT for ejection procedures.

FLAT TIRE DURING TAKEOFF

If a tire is blown on takeoff and decision is made to abort, using abort speed criteria, follow abort procedures (Refer to FLAT TIRE ON LANDING). If decision is made to continue then leave the landing gear extended.

WARNING

Do not raise the gear as further damage to the airplane may be incurred.

External tanks (if installed) should not be jettisoned unless the damage incurred on takeoff necessitates an immediate landing. Plan to land at minimum gross weight. Directional control is more difficult, and braking efficiency is greatly reduced at high gross weights; therefore, an approach end cable engagement is the recommended landing procedure. Proceed as directed in FLAT TIRE ON LANDING.

AFTERBURNER FAILURE DURING TAKEOFF

Afterburner failure is noted by a sudden loss of thrust.

IF DECISION IS MADE TO STOP:

1. Abort.

IF TAKEOFF IS CONTINUED:

1. **THROTTLE—MIL.**

WARNING

- If the takeoff is to be continued with an afterburner blowout, the throttle must be moved inboard immediately to enable the afterburner nozzle to close. Nonafterburner engine operation with the nozzle in the open position will result in an appreciable loss of thrust.
- If field length is critical, consideration should be given to jettisoning the external tanks.

AFTERBURNER EXHAUST NOZZLE FAILURE DURING TAKEOFF

If the afterburner exhaust nozzle fails to open at the time of afterburner ignition, a rapid rise in exhaust gas temperature, a reduction of rpm, and engine compressor stall will occur.

If an EPR drop or loss of thrust does not occur when afterburner is selected:

1. Throttle—Inboard, and abort takeoff.

LANDING GEAR WARNING AND POSITION LIGHTS REMAIN ILLUMINATED ON GEAR RETRACTION

If all three green landing gear position lights remain illuminated when the landing gear handle is placed in the up position, it is possible that the landing gear doors have remained open and the landing gear have remained in the down and locked position. This condition must be verified by a visual inspection. It may be caused by a failure of one or both of the main landing gear ground safety switches.

WARNING

With a right ground safety switch malfunction, normal airstart ignition is not available. However, the automatic ignition system will provide ignition automatically upon sensing compressor discharge pressure decay, or the alternate airstart procedure may be used to obtain a relight.

CAUTION

It is possible for the landing gear to remain down and locked (all three green landing gear position lights remain illuminated) and the gear doors to close. An attempt to make a normal landing gear extension or to recycle the landing gear will result in damage to the landing gear and doors by retracting the gear into the closed doors.

NOTE

With a left ground safety switch malfunction, the afterburner exhaust nozzles will open in flight if the idle thrust control switch is activated. Also, the automatic start feature of the emergency ac generator will be inoperative and the generator must be manually started in the event of ac generator failure.

NOTE

With both ground safety switches malfunctioning, cockpit pressurization will not be available.

1. Airspeed—Below 285 KCAS.
2. Landing gear control handle—Leave in UP position.
3. Landing gear emergency extend handle—Check fully in (a small extension of the handle may be enough to electrically deenergize the normal system).
4. Obtain a visual inspection to confirm position of inner gear doors.
5. If visual inspection reveals landing gear and doors extended, landing gear handle—DOWN then UP.

   When the landing gear handle is returned to the down position, a safe indication will be obtained, and retraction may again be attempted.

   a. If the landing gear retracts—Continue the mission.

   b. If the gear remains extended and the doors open and the misison is essential or a fuel emergency or an extenuating circumstance exists, depress the landing gear emergency-up button. If the gear retracts and a safe gear-up indication is obtained, the mission may be continued. Consider the airplane systems not available with an inoperative landing gear ground safety switch.

   c. If landing gear retraction is unsuccessful:

      (1) Landing gear handle—DOWN.

      (2) Land as soon as practical. If external tank fuel is required, place external tank emergency switch ON.

6. If visual inspection reveals landing gear down and doors closed or partially closed, or if unable to obtain a visual inspection—Use LANDING GEAR EMERGENCY EXTENSION procedures.

CAUTION

If it desirable to burn down fuel before landing, (gear malfunction occurred immediately after takeoff) fuel should be burned down prior to extending the gear with the LANDING GEAR EMERGENCY EXTENSION procedures. When blowing down the landing gear with a functioning secondary hydraulic system, it is possible to induce a secondary hydraulic system failure due to introduction of air into the system.

LANDING GEAR WARNING LIGHT REMAINS ILLUMINATED ON GEAR RETRACTION OR ILLUMINATES ABNORMALLY DURING FLIGHT

If a partial or abnormal gear retraction is suspected or the landing gear warning light comes on abnormally during flight:

1. Airspeed—Below 285 KCAS.
2. Landing gear control handle—Leave in UP position.
3. Obtain a visual inspection to confirm position of gear and doors.
4. If visual inspection reveals:
   a. Landing gear retracted—Recycle the landing gear handle.
      If unable to obtain a safe gear-up indication, obtain a visual inspection, extend the landing gear and land as soon as practical.
   b. One (or more) landing gear extended or partially retracted in proper sequence with the gear doors—Extend the landing gear and land as soon as practical.
   c. All gear down and doors open (normal gear down configuration)—Depress the landing gear emergency-up button if the mission is essential or a fuel emergency or another extenuating circumstance exists..
      If the gear retracts and a safe gear-up indication is obtained, the mission may be continued. Consider the airplane systems not available with an inoperative landing gear ground safety switch.
   d. Main landing gear extended and gear doors closed, or if unable to obtain a visual inspection—Use LANDING GEAR EMERGENCY EXTENSION procedures.
      This ensures positive door-open and gear down-and-locked position.

CAUTION

An attempt to make a normal landing gear extension or to recycle the landing gear with a gear-down, door-up configuration will result in damage to the landing gear and doors by retracting the landing gear into the closed doors.

NOTE

If gear is down and external fuel is required, place external tank emergency switch ON.

LANDING GEAR POSITION LIGHT REMAINS ILLUMINATED ON GEAR RETRACTION WITH NO ACCOMPANYING GEAR WARNING LIGHTS

The anticipated sequence of events for this malfunction is that cockpit gear indicators will all extinguish momentarily when the gear handle is raised and the affected gear position indicator will then reilluminate just before the red bar extinguishes.

If this malfunction occurs:

1. Leave the landing gear retracted—do not recycle.
2. Do not perform excessive maneuvering.
3. Use external tank fuel and maximum practical internal fuel prior to extending the landing gear.
4. Extend gear using normal system.
5. If practical, an approach end cable engagement is recommended for this type malfunction.

CAUTION

With this type of malfunction, the gear may collapse outward. If external tanks are installed, they may prevent the gear from totally collapsing.

CANOPY RETENTION VERSUS JETTISONING

The canopy should be retained during landing emergencies, aborted takeoff, and cable engagements. Under such emergency conditions, probability of survival is enhanced with canopy retention. The canopy is protection against being saturated with flaming fuel and is temporary protection against the direct effects of fire; also, retention of the canopy may prevent barrier cables and wires from entering the cockpit. Following an emergency in which the canopy is retained, normal opening should first be attempted with jettisoning used as an alternate method. The application of these considerations does not preclude the pilot from exercising sound judgment in jettisoning the canopy when he deems it necessary.

INFLIGHT

BEFORE EJECTION (IF TIME AND CONDITIONS PERMIT)

1. Inform other pilot of ejection necessity by use of intercom.
2. Aim airplane toward uninhabited area.
3. Give location to nearest radio facility and turn IFF master control knob to EMER and select mode 3/A.

Canopy ejection activates emergency IFF if the master control knob is in any position except OFF.

4. Stow all loose equipment. (FP-RP)
5. Actuate bailout oxygen bottle (if applicable) (FP-RP).
6. Cabin air selector switch—RAM
7. Helmet visor—Down. (FP-RP)
8. Airplane—Trim for level flight.

WARNING

If the airplane is not trimmed for level flight it may pitch down when the control stick is released for ejection.

9. Sit erect, place feet on rudder pedals and elbows tightly against body while grasping the ejection seat handgrips. Position head back firmly against headrest.

EJECTION

NOTE

Every emergency in which ejection is considered will have its particular set of circumstances involving such factors as airplane speed, attitude and control, altitude, and sink rates. The information presented below indicates capabilities under various combinations of these circumstances and some desirable techniques and procedures to improve the probability of a successful ejection. It must be emphasized, however, that the decision to eject must be based on the particular circumstances at hand and not just on the specification 0-0 to 450 KCAS limits of the system.

The escape system is designed for ejection in a zero altitude—zero speed condition to 450 KCAS with certain limitations under various combinations of critical attitudes and sink rates. Pitch attitude has the most influence on the recovery capability. Ejection while the nose of the airplane is above the horizon, results in a more nearly vertical trajectory of the seat, thus providing more altitude and time for seat separation and parachute deployment. With an airspeed of 180 KCAS and wings level, the escape system will provide safe ejection under an additional 1500 feet/minute sink rate if the nose is rotated from $-10°$ pitch to $+10°$ pitch. Therefore, when at all possible, maintain sufficient airspeed to employ the "zoom-up" maneuver and eject with the nose above the horizon (limit $+50°$ pitch) while there is still a positive rate of climb. Any bank angle conditions other than zero or a wings level airplane will degrade the escape system capability. Computer studies indicate that with a nose high airplane, the wings level ejection capability is degraded by 20% with a 20° bank angle and 60% with a 40° bank angle.

The ejection seat should be used to abandon the airplane in flight. The airplane should be slowed down as much as possible if at high airspeeds, as forces on the body and injury hazard are decreased when airspeed is reduced. In addition, the ballistically deployed parachute lends itself to better performance at lower airspeeds. The maximum speed for an inflight ejection is 450 KCAS. Slow the airplane to below 450 KCAS prior to ejection if possible. The "zooming" maneuver is encouraged at all points in the flight envelope. The zoom will exchange airspeed for altitude which will result in the desired condition of a nose high/minimum speed ejection. Inflight capabilities are as follows:

General

Conditions	Minimum Safe Ejection Altitude
Sink Rate: 0 to 10,000 feet per minute Pitch Attitude: 0 to −12° Bank: 0 to 85° Airspeed: 0 to 450 KCAS	**2000** feet above terrain

Specific Examples:

a. The absolute minimum ejection altitude using the maximum capability of the system for an airplane with a relatively slow forward velocity of 180 KCAS, −10° nose down, wings level, and with a 5000 ft/min sink rate is 200 feet above ground level.

b. With at least a +10° pitch attitude, 180 KCAS velocity and a wings level airplane, ejection can be accomplished at any altitude with a sink rate of 3500 ft/min or less.

WARNING

- When the airplane is uncontrollable and cannot be leveled, ejection should not be delayed as this will reduce the probability of success.
- When in the landing configuration below 2000 feet AGL, do not delay ejection by attempting to airstart a failed engine. Eject immediately unless landing is assured. There is not enough time available for the engine to accelerate from windmilling RPM to military power prior to ground impact.
- Under spin or dive conditions or any uncontrollable maneuver, eject at least **10,000** feet above the terrain whenever possible.

The egress system has been extensively tested and has been demonstrated to be a reliable system. The automatic system featuring the automatic opening seat belt, seat-man separator, and ballistically deployed parachute are sequenced in operation to provide the desired results more reliably than manual operation. Therefore, to assure survival from both low- and high-altitude ejections, the automatic features of the equipment must be used and depended upon. Refer to figure 3-3 for ejection parameters during flameout landing.

WARNING

On B airplanes, if the front pilot initiates ejection, the aft seat will eject immediately after canopy separation whether or not the ground safety pin is installed. The front seat will eject one second after canopy separation, regardless of the aft seat position. The aft seat arm guards will not be raised. Unless circumstances dictate otherwise, the rear seat occupant should initiate his own ejection to ensure proper body position and arm guards raised. If normal intercockpit communications are degraded, the bailout warning light should be actuated.

WHEN DECISION IS MADE TO EJECT:

1. Handgrips—Raise.

WARNING

- To prevent injury to arms during ejection, keep arms tightly against body when raising handgrips.
- Exert a positive pull on the handgrips to insure they reach the full up and locked position.
- Continue to hold the handgrips throughout the ejection to prevent arms from flailing.

IF CANOPY FAILS TO JETTISON:

1. Handgrips—Return to normal down position.

NOTE

Push the handgrip uplock release lever to return the handgrips to the down (in detent) position.

WARNING

The handgrips must be returned to the normal (down and in detent) position so the seat is safe (will not eject) when the canopy is manually jettisoned. However, the aft seat on the B aircraft cannot be made safe once the handgrips in either cockpit have been raised and then returned to normal. In this situation, the aft seat will eject when the canopy is jettisoned by any means. If the aircraft has a canopy malfunction and is subsequently crash landed, it is advisable for the aft crewmember to leave his handgrips raised to alert crash rescue personnel that the seat is armed.

2. Canopy jettison handle—Pull and raise.

IF CANOPY AGAIN FAILS TO JETTISON:

1. Canopy latch handle—Unlock.
2. Canopy—Push open.

NOTE

On B airplanes, the canopy cannot be manually pushed open from inside the cockpit.

flameout landing ejection capabilities

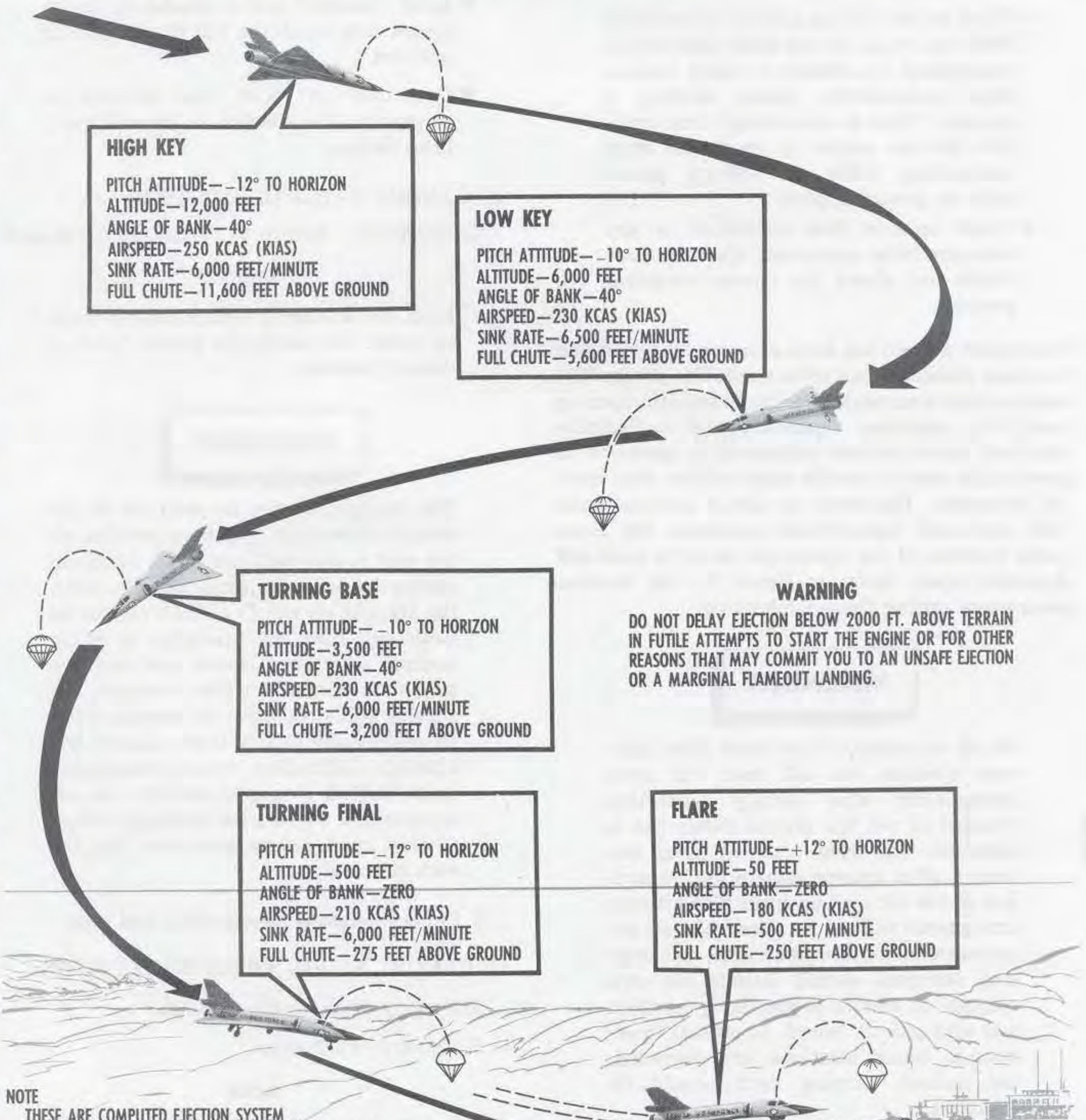


Figure 3-3

3. Canopy switch—Open (if necessary)
4. Handgrips—Raise.

AFTER EJECTION

NOTE

- The zero-zero egress system is a reliable, completely automatic system from the time the pilot pulls the ejection handgrips until there is a full canopy. A failure in the automatic system after ejection can be identified by the following:

  a. Failure of the seat belt to open.

  b. Failure of the seat-man separator to reel in the strap pushing the pilot away from the seat.

- The seat belt should open and the seat-man separator should be reeled in within two seconds after ejection. if these events do not occur, manual activation of the system shall be accomplished as follows:

  a. Pull parachute firing lanyard free from actuator assembly.

  b. Open seat belt and push away from the seat.

  c. Pull D-ring.

WARNING

- Always pull firing lanyard free from actuator assembly before opening the seat belt.
- Do not pull D-ring until at or below 14,000 feet.
- If automatic actuator malfunctions do not release the survival kit until after parachute deployment to prevent the kit or lanyard from fouling the parachute. However, the survival kit should be released as soon as the parachute is stabilized to prevent possible injury when contacting the ground with the survival kit attached.

WARNING

If automatic actuator malfunctions do not raise emergency release handle until after descent to an altitude not requiring oxygen. The oxygen supply will be cut off when the survival kit is released.

OVER-THE-SIDE BAILOUT

In an attempted ejection, when all possible means to eject the seat have failed, an "over-the-side" bailout can be attempted as an alternative to a forced landing. An "over-the-side" bailout should be accomplished in the following manner:

WARNING

Bailout should be accomplished above 2000 feet above the terrain.

NOTE

To insure successful bailout, the decision to bail out should be made at 10,000 feet or above, and not unnecessarily delayed.

a. Establish a glide speed (if possible) between 200 and 250 KCAS.

b. Pull survival kit emergency release handle. Pulling the handle releases the personal leads bundle and the parachute attaching wedges, thereby completely separating the pilot from the survival kit.

NOTE

The oxygen supply in the survival kit will be cut off when the survival kit is released.

c. Pull parachute firing lanyard free from actuator assembly and release the seat belt and shoulder harness.

d. Retract speed brakes (if extended).

e. Trim rudder full right or full left (the resulting yaw will aid in clearing the vertical stabilizer). Trim nose full down while holding airplane attitude with control stick back pressure. If altitude permits, the airplane should be rolled to the inverted position. Roll should be toward the direction that the rudder is trimmed, with positive g forces maintained during the roll.

f. Release the control stick and push away from the airplane.

g. After bailout and descent to 14,000 feet, pull D-ring.

NOTE

Pulling the D-ring does not fire the deployment gun. In this case the parachute is deployed by the pilot chute.

ENGINE ACCESSORY DRIVE FAILURE

Failure of the accessory drive shaft (tower shaft) will cause failure of all engine-driven components. Indications are a rapid drop of RPM to zero, engine flameout, and loss of generators. Fuel flow and hydraulic pressure readings may freeze or drop to zero, depending upon the type failure. Since the engine RPM is operated off the accessory drive, the RPM (tachometer) will read zero with a windmilling engine. This failure is not accompanied by vibration, rough engine, or unusual noises normally associated with other types of structural failure. Engines failing from accessory system loss cannot be restarted. If this type of failure occurs, attention should be directed to ejection or successful flameout landing as repeated airstart attempts will be futile.

WARNING

- Pilot's discretion should determine the action to be taken following an engine failure. Refer to EJECTION VS FLAMEOUT LANDING.
- Airstarts should not be attempted when engine damage is apparent; i.e., overtemperatures, increasing fuel flow, no throttle response, rapid engine deceleration, and scraping or minor explosion noises. Major explosion or airplane disintegration may result.

WARNING

- With failure of engine accessory drive system, the only source of electrical power is the battery.
- With failure of the engine accessory drive system, it is necessary to extend the ram air turbine to obtain hydraulic pressure for flight control operation.

1. Throttle—OFF.
2. Airspeed—250 KCAS.
   Establish a glide speed of 250 KCAS with gear up and speed brakes closed.
3. RAT—Extend.
4. Fuel shutoff and boost pump switches—Off.
   Check that all fuel shutoff valves are closed and all boost pump switches are off.

FROZEN ENGINE

Any failure which results in a frozen engine should normally be a progressive type failure and may be noticed by indications such as no or low engine oil pressure, or engine vibrations. Should engine vibration become moderate to heavy, complete engine failure is only seconds away and the engine should be shut down to preclude destructive failure that would jeopardize a successful ejection or forced landing.

WARNING

- When engine failure results in a frozen engine it is necessary to extend the ram air turbine to obtain hydraulic pressure for flight control operation.
- If airspeed is above RAT maximum extension speed and the engine is frozen, do not extend the speed brakes to slow the airplane. Speed brake extension will cause immediate depletion of remaining secondary hydraulic system pressure. Deceleration should be accomplished by moving the flight controls a minimum amount to establish a flight attitude which provides deceleration.

WARNING

- During glide with a frozen engine, ac power will not be available. The battery will be the only source of electrical power.
- Under actual flameout conditions caused by engine seizure, sink rates may exceed those encountered during SFO practice. Caution should be used not to deplete airspeed below 174 KCAS prior to touchdown. (RAT is only source of hydraulic pressure for flight controls.)

With a frozen engine, the battery is the only source of electrical power and the turn-and-slip indicator and standby attitude indicator are the only electrically powered flight instruments that will operate. If a forced landing is to be made, the emergency landing gear and drag chute systems must be used.

ENGINE FAILURE DURING FLIGHT AT LOW ALTITUDE

In the event of engine failure during flight at low altitude, and with sufficient airspeed available, the airplane should be pulled up (zoom-up) to exchange airspeed for an increase in altitude. This will allow more time for accomplishing subsequent emergency procedures (airstart, ejection, establishing forced landing pattern, etc.).

WARNING

If the flameout is due to temporary interruption of fuel flow from the fuel tanks, restart may take up to 4 minutes and may preclude the possibility of a low-altitude airstart. This condition can be detected by the absence of fuel flow indication when the throttle is open.

NOTE

The point at which climb should be terminated will depend on whether the pilot intends to eject or whether he intends to continue attempting airstarts, establish forced landing pattern, etc. In any event, it is recommended that airstart be attempted immediately upon detection of engine flameout and repeated as many times as possible during the zoom-up. If the decision is to eject, the airplane should be allowed to climb as far as possible. Ejection should be accomplished while the nose of the airplane is above the horizon but prior to reaching a stall or sink.

In the zoom-up maneuver, more altitude can be gained if external tanks are jettisoned. Maximum altitude gain can be achieved by jettisoning external tanks prior to zoom-up. However, when jettisoning tanks consideration must be given to factors such as sufficient airspeed to allow time for pilot reaction, and the proximity to populated areas where tanks will fall. In any event, the decision to jettison or retain external loads must be made on the basis of an evaluation of the above factors and conditions existing at the time of the emergency.

FLAMEOUT

If there is no indication of mechanical failure within the engine, an airstart should be attempted as soon after flameout as possible, altitude permitting. Refer to figure 3-4 for airstart envelope and figure 3-5 for maximum glide time and distance.

WARNING

If a flameout occurs when the airplane is in the landing configuration at less than 2000 feet above ground level, EJECT if landing is not assured. Do not attempt an airstart as there will not be sufficient altitude available to allow time for the engine to accelerate to military thrust prior to ground impact.

airstart envelope

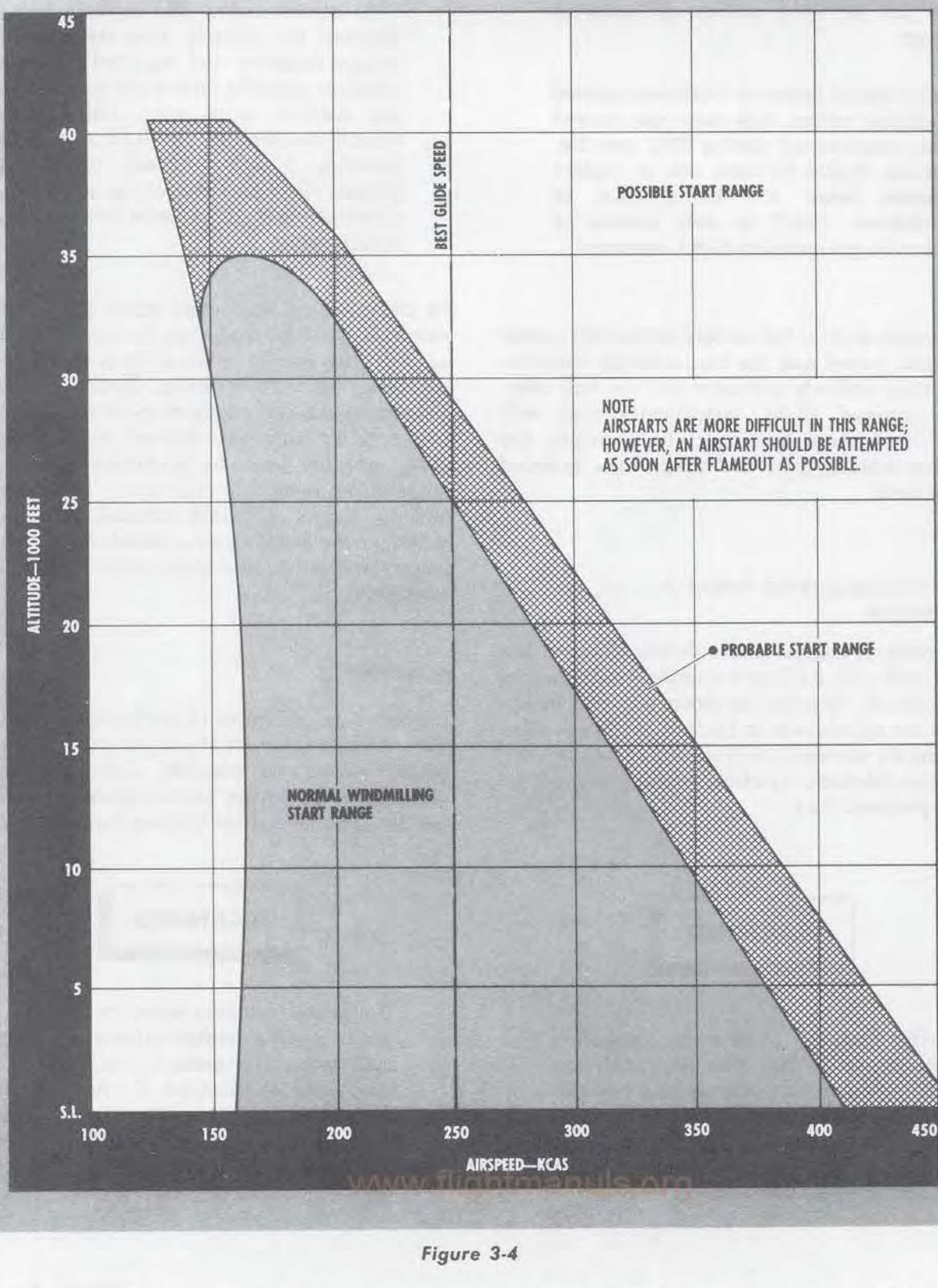


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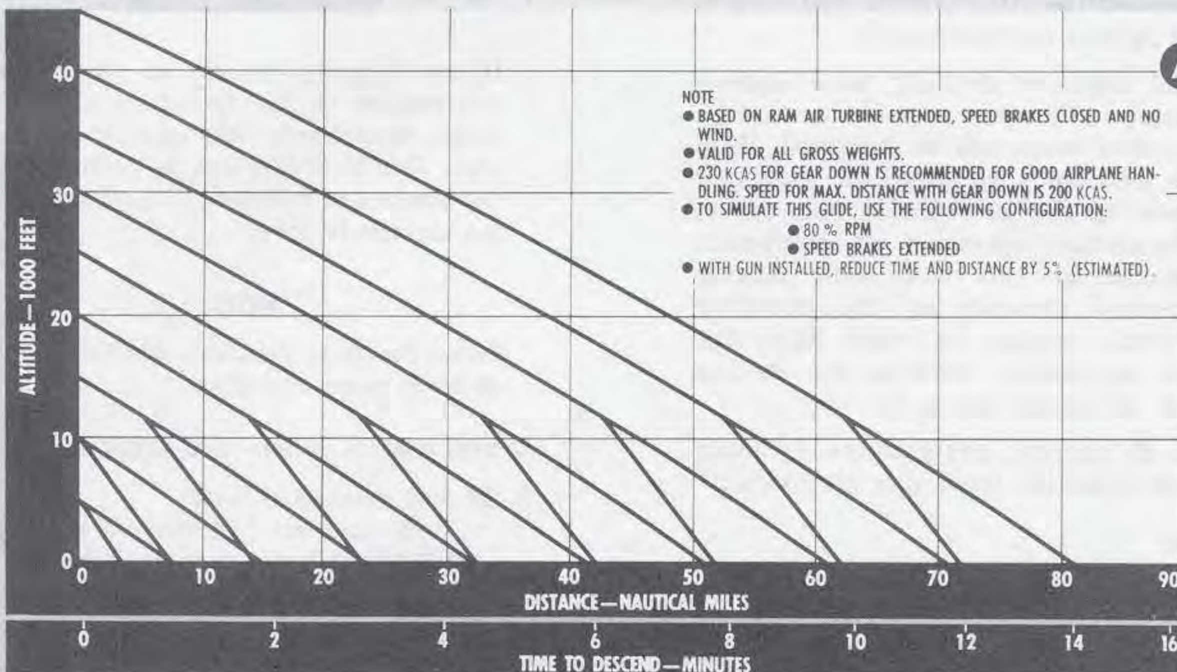
Figure 3-4

maximum glide time and distance

DATE: 1 SEPTEMBER 1961
DATA BASIS: FLIGHT TEST

GEAR UP • BEST GLIDE SPEED 250 KCAS NOT TO EXCEED .9 MACH
GEAR DOWN (BELOW 12,000 FEET) • GLIDE SPEED 230 KCAS • STANDARD DAY

WINDMILLING OR FROZEN ENGINE



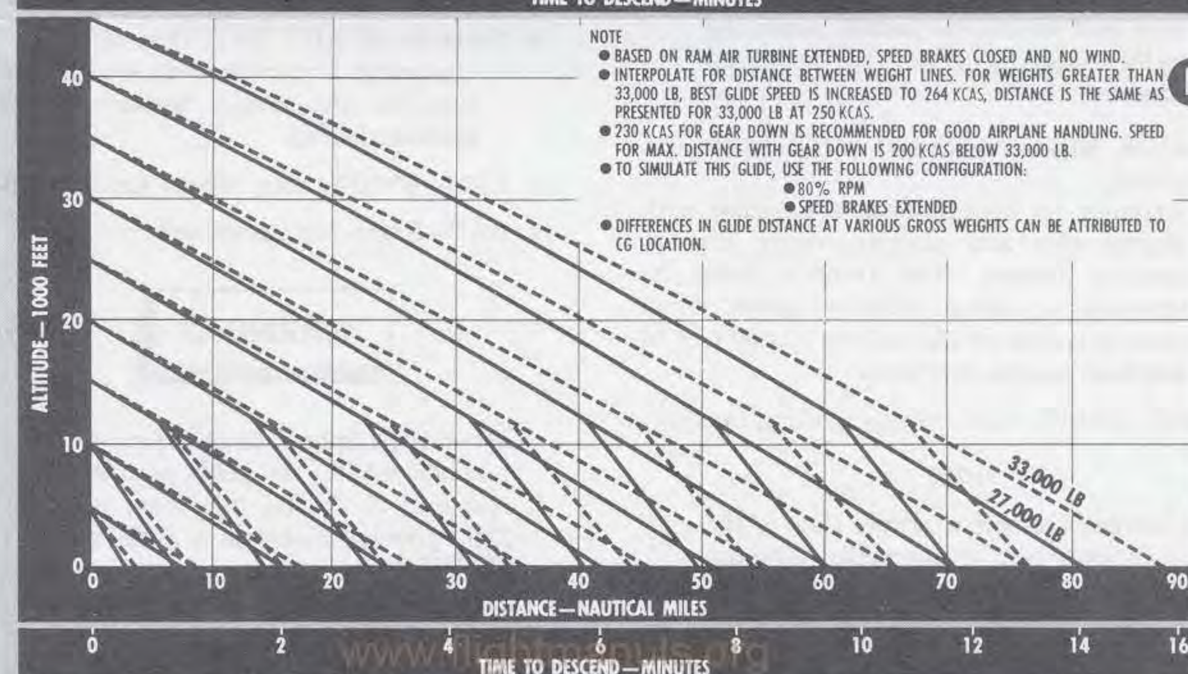


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Figure 3-5

NOTE

- If rpm decay has occurred without experiencing a total flameout but with no response to throttle movement in either normal or emergency fuel, additional thrust may be available by selecting afterburner.
- During glide with engine windmilling above approximately 53% rpm, all normal electrical power should be available provided the AC POWER FAIL warning light is not illuminated.
- With engine windmilling below approximately 53% rpm, only the ac and dc essential buses will be energized. With the emergency ac generator supplying power to the ac essential bus, expect intermittent operation of equipment powered by this bus, while making excessive demands on the secondary hydraulic system; i.e., rapid flight control movements, lowering the landing gear by normal means, etc.
- On B aircraft, airstarts can be made from either the forward or aft cockpit.

AIRSTART

1. **FUEL CONTROL—EMERGENCY.**

NOTE

If time and conditions permit, move the throttle inboard prior to selecting emergency fuel.

2. Ignition button depressed and throttle—As required.
   Attempt to match throttle position with engine rpm and simultaneously depress ignition button. The throttle must be retarded to below military power when attempting an airstart above 30,000 feet to preclude engine overtemp.
3. RPM—60-80%, then release ignition button.

NOTE

- An increase in rpm and fuel flow is the first indication of a successful airstart, since the exhaust gas temperature system has a relatively low response rate.
- Retard the throttle to OFF if during an airstart lightup does not occur within 20 seconds when there is a positive fuel flow indication, or if the engine fails to accelerate to idle rpm within approximately 45 seconds after lightup.

IF IMMEDIATE RELIGHT IS NOT OBTAINED:

4. Throttle—OFF.

WARNING

If the flameout is due to temporary interruption of fuel flow from the fuel tanks, restart may take up to four minutes. This condition can be detected by the absence of fuel flow indication when the throttle is open.

NOTE

Loss of main ac generator will cause loss of boost pump operation.

5. Fuel control switch—EMERGENCY.
6. All fuel systems—Check.
   Check that all fuel shutoff switches are OPEN and boost pump switches are ON.
7. Airspeed—250 KCAS.
8. Ignition button—Depress and hold.
9. Throttle—START, OFF, then IDLE.
   Use ground start procedure to insure ignition in the event ignition circuit is malfunctioning.
10. RPM—60-80%, then release ignition button.
11. RAT—Extend (if necessary).

WARNING

When the engine fails and rpm has dropped below 53%, the boost pumps will be inoperative. If the fuel level is below 2800 pounds, maintain a glide speed of 250 KCAS to assure uninterrupted fuel flow for a restart. Avoid unusual or uncoordinated maneuvers, and do not lower the landing gear or open the speed brakes.

NOTE

If the engine cannot be restarted on the normal or emergency fuel system, consideration should be given to ejection. Refer to EJECTION VS FLAMEOUT LANDING.

ENGINE FIRE—STEADY OR FLASHING WARNING LIGHT

1. Throttle—Minimum practical thrust.
   Reduce thrust to the minimum necessary to maintain safe ejection altitude and check for fire. If fire cannot be confirmed, continue flight at minimum safe thrust and land as soon as practical.

IF FIRE IS CONFIRMED:

2. Throttle—Off.
3. Fuel shutoff switches—Close.
4. RAT—Extend.
5. If fire continues—Eject.

IF FIRE EXTINGUISHES, DO NOT ATTEMPT A RESTART.

EXHAUST GAS OVERTEMPERATURE WARNING LIGHT ILLUMINATED

1. Thrust—Reduce (when practical).
   The EGT overtemperature warning light is set to illuminate at 630 °C. A reduction in thrust should extinguish the light.
2. If the overtemperature is momentary and the light extinguishes:
   Continue the mission and monitor the exhaust gas temperature and other engine instruments.
3. If the light stays on:
   Monitor the exhaust gas temperature and other engine instruments. If the exhaust gas temperature remains above 635 °C and/or the other engine instruments indicate a malfunction, land as soon as practical.

NOTE

Illumination of the exhaust gas overtemperature warning light in flight could be caused by several factors. Among these are engine fuel control failure, afterburner exhaust nozzle failure, compressor stall, or improper throttle management under certain flight conditions. As dictated by other engine instrument indications or the flight condition at the time of overtemperature, refer to ENGINE FUEL CONTROL FAILURE, this section, AFTERBURNER FAILURE, this section, or COMPRESSOR STALL, Section VII.

ELECTRICAL FIRE

There is no system to warn of electrical fire in this airplane. Fuses/circuit breakers protect most of the circuits and tend to prevent electrical fire.

NOTE

In the event of a TSD fire, turn the TSD light intensity rheostat off.

If an electrical fire occurs, however, and its source cannot be readily determined visually, attempt to isolate and eliminate the fire as follows:

1. MA-1 power switch—EMER.
2. If fire continues, generator switch—OFF.
   Turn the generator switch OFF to eliminate electrical power to the nonessential buses. The essential buses will automatically become energized through the emergency system.
3. If fire still persists, master electrical power switch—OFF.
   With the master electrical power switch OFF, the drag chute (through the emergency system), the bailout warning light B, and the tailhook will be available.
4. If fire continues and becomes severe—Eject.
5. If fire subsides—Land as soon as practical.

NOTE

The gear can be lowered by the emergency system when the master electrical power switch is OFF; however, to check for a gear-down indication, the master electrical power switch must be turned ON momentarily.

SMOKE OR FUMES

Accomplish those procedures necessary to eliminate smoke or fumes.

1. Cabin air selector switch—RAM (below 25,000); OFF (above 25,000).
2. Start immediate descent to 25,000 or below (if practical).
3. MA-1 power switch—EMER.
4. Cabin temperature control knob—MAN COLD.
5. When smoke or fumes are eliminated, cabin air selector switch—PRESS.
6. MA-1 power switch—ON (If not cause of smoke or fumes).

NOTE

If smoke or fumes become severe, consider jettisoning canopy.

FOG

1. Cabin air selector switch—RAM.
2. Cabin air selector switch—PRESS, when cockpit clears.
3. Cabin temperature control knob—HOT.

NOTE

The cabin temperature control knob is bypassed and cannot be used to select cockpit temperature if the cockpit no-fog and ventilated suit switch is ON. However, selecting MAN on the temperature control knob will override the cockpit no-fog and vent suit switch.

CONTROL LOSS

The reasons for control loss can be broken into two general sub-groups; control loss caused by exceeding the aircraft aerodynamic limits, or control loss caused by a flight control malfunction. A flight control malfunction that results in significant uncommanded deflection of flight control surfaces may compound the initial loss of control by forcing the aircraft through the aerodynamic limits as well. In this case, correction of the flight control malfunction is required before recovery from the aerodynamic control loss is possible.

CONTROL LOSS (STALL, POST-STALL GYRATION, AND SPIN RECOVERY)

At the first sign of a stall, post-stall gyration, or spin, neutralize the ailerons and unload the airplane to approximately zero g. (See MANEUVERING FLIGHT CHARACTERISTICS, Section VI.) The canopy g-meter should be used as a reference to achieve a zero g condition. If the aircraft does not recover:

1. **STICK—CENTERED AND FORWARD.**
   Hold control stick centered and forward of neutral until recovery is evident or a spin develops.

WARNING

- Do not attempt to oppose roll oscillations that occur during a post-stall gyration. A small aileron deflection may force the airplane into a spin in a direction opposite to control stick movement.
- Do not apply full forward stick. Full forward stick may cause the airplane to roll inverted into a negative stall or an inverted spin. Should this occur, use procedures for negative stall/inverted spin recoveries.

2. **DAMPERS—OFF.**

NOTE

- Monitor airspeed, angle of attack and turn needle to verify recovery from the out-of-control condition.
- Recovery will be characterized by the aircraft regaining lateral-directional stability, airspeed increasing and angle of attack returning to normal flight indications.

IF A SPIN DEVELOPS:

3. **THROTTLE—IDLE.**
   Retarding the throttle to IDLE reduces the possibility of engine overtemperature and compressor stalls.

WARNING

Long period oscillations in roll and yaw associated with a post stall gyration can create the sensation of being in a spin. A spin is characterized by a constant rotation in one direction about the yaw axis. If possible, establish the presence of spin by noting singular direction of rotation for 360 degrees of turn and airspeed indications of less than 100 KCAS. The turn needle and outside visual references can be used to determine the direction of rotation. When high yaw rates and lateral oscillations exist, the turn needle may be the only means to determine direction of rotation.

4. **STICK—FORWARD AND FULL WITH SPIN** (Turn Needle).

   Hold full aileron in the direction of spin rotation, maintaining forward stick until the spin is broken or ejection altitude is reached.

WARNING

- Do not input the wrong recovery controls. If the direction of rotation cannot be definitely established, it is more desirable to keep the control stick centered forward of neutral than to input the wrong recovery controls.
- After applying recovery controls, four or more turns may be required to effect recovery. If spin rotation is not stopped by 10,000 feet above the terrain—EJECT.

NOTE

Termination of the spin is characterized by an abrupt nose down pitch change to the near vertical attitude and airspeed increasing above 140 KCAS.

WHEN SPIN IS BROKEN:

5. Neutralize ailerons—Maintain dive attitude until airspeed reaches 140 KCAS.

NOTE

- A rolling motion may accompany the recovery and may appear to be a continuation of spin rotation. As airspeed builds, the rolling motion will cease after ailerons are neutrailzed.
- After recovery from a spin during which excessive exhaust gas temperatures may have been encountered, the airplane should be recovered using minimum thrust to maintain flight. If the airplane has been fully stalled or spun, a writeup is required on the Form 781 so the engine can be inspected for possible damage.

NEGATIVE STALL/INVERTED SPIN RECOVERY

A negative stall or an inverted spin can be recognized by a sustained negative load factor. Should this occur:

1. **CONTROLS—NEUTRAL.**
2. Allow airspeed to build to 140 KCAS or above.
3. If required, roll upright, using rudder only.

WARNING

Any aileron input at this point may force the airplane back into a control loss condition.

NOTE

Rudder inputs, under negative-g conditions, will result in a roll opposite to the direction of rudder application.

FLIGHT CONTROL SYSTEM MALFUNCTIONS

Failure of flight control system components may be accompanied by a partial or full deflection of the rudder or elevons. Control may be regained as the failed component is disconnected electrically by following the prescribed emergency procedure. Heavy control stick forces may be encountered which must be overcome physically by the pilot. A system failure that causes an intermittent control surface deflection can create an extremely hazardous situation by allowing the pilot to regain control only to lose it again during a critical phase of the flight.

A disconnected, bent, or broken segment of the mechanical flight control linkage may induce a rapid continuous rolling, pitching, or yawing moment which is not controllable with normal control inputs. Loss of one function of the elevons (aileron or elevator) does not alway affect functioning of the other, making it possible to use one function to compensate for the other. For example, rolls caused by failure in the aileron linkages may be stopped by application of forward or aft stick movement which reduces elevon asymmetry. Similarly, uncommanded elevator inputs may be counteracted by left or right aileron inputs. Depending on how far up the malfunctioning control surface has driven, it may be possible to overcome the resulting maneuvers by full application of remaining controls. When a flight control malfunction is encountered, it may be necessary to remove electrical power and reduce airspeed, if possible.

Flight control oscillations are primarily caused by failure of the damper system, trim system, or artificial feel system. Gradual failure of either hydraulic system may be accompanied by generation of excessive heat within the system. Elevon surface oscillations can result from overtemperature of the hydraulic fluid at the elevon control valve. If the oscillations are caused by overtemperature, there will be movement of the control stick; however, if the oscillations are caused by the damper system, there will be no accompanying movement of the control stick.

When control of the aircraft cannot be regained or the malfunction occurs with insufficient time or altitude for analysis and corrective action, ejection is the only alternative.

FLIGHT CONTROL MALFUNCTIONS, OSCILLATIONS, AND/OR HYDRAULIC FLUID OVERHEAT WARNING LIGHT ILLUMINATED

If uncommanded movement of the flight controls is felt, or uncommanded maneuvers or oscillations are encountered, or the hydraulic fluid overheat warning light illuminates, proceed as follows:

1. **DAMPERS—OFF.**

   Ensure that flight mode switch is in DIR MAN position.

NOTE

Pilot induced oscillations, which may occur at transonic speeds when the flight mode selector switch is in the DIR MAN position, are a phenomenon not related to flight control system oscillations.

IF UNCONTROLLABLE MANEUVERS OR SEVERE OSCILLATIONS CONTINUE:

2. **GENERATOR—OFF.**
3. Airpseed—Reduce to 230 KCAS.

IF CONTROL IS NOT REGAINED:

4. Master electrical power switch—OFF (climatic conditions permitting).
5. If control is still not regained—Eject.

IF CONTROL IS REGAINED:

6. Perform a controllability check in landing configuration at approach and landing speeds.
7. If oscillations continue:

   Activate alternate flight modes (yaw and pitch damper modes) and remain in the flight mode that gives the best stability.

WARNING

Do not extend the ram air turbine. Extension of the ram air turbine will serve only to increase fluid temperatures in the primary hydraulic system.

NOTE

- To aid in reducing hydraulic system fluid temperatures, use minimum control movements at all times. If oscillations occur, they may be more rapidly reduced in magnitude by releasing the control stick than by correcting for the oscillations by stick input.
- The heat exchanger utilizes fuel in the No. 3 tank to cool the hydraulic fluid; therefore, to maintain the most effective cooling during low fuel conditions (1000 pounds or less), the airplane should not be flown in a 5° or greater nose-low attitude except as required for descent to a landing.
- It is possible that an overheated system may cool if flight is continued under conditions dictated by the above procedures.

VARIABLE RAMP FAILURE

During normal operation, the variable ramps should automatically retract when the airplane is slowed below Mach 1.2. If the ramps do not automatically retract, as indicated by illumination of the variable ramp warning light, use the following procedure:

1. Speed—Decrease to less than Mach 1.1 (or 500 KCAS).
2. RPM—IDLE if below 25,000 feet.
3. Variable ramp switch—EMER OPEN (Retracted).
4. Check other systems for failure:
   a. AC and dc power—Check.
   b. Secondary hydraulic pressure—Check.
   c. Air data computer—Check "OFF" flag in Mach indicator, or airspeed-Mach indicator (denotes possible failure).
5. Fuel flow—Monitor for range considerations.
6. Land as soon as practical maintaining a minimum of 200 KCAS until starting flare.

WARNING

- Should the variable ramps malfunction and remain in the fully extended position, a thrust loss will occur. The maximum altitude which can be maintained with full military thrust will be approximately 20,000 feet.
- Afterburner use may be required to maintain level flight and final approach glide path if variable ramps remain in fully extended position.

NOTE

- The emergency retraction system is designed only to retract the variable ramps. The variable ramp switch must be left in EMER OPEN (retracted) position and use of the ramps should not be attempted during the remainder of the flight. After landing, make emergency ramp retraction entry on Form 781.
- With variable ramps in the fully retracted position a thrust degradation will exist at velocities in excess of Mach 1.4 due to subcritical inlet operation. The characteristic sound of subcritical duct pressure fluctuations will increase in intensity with flight velocity. The engine compressor stall margin is generally sufficient to permit operation as attainable in level flight.

AFTERBURNER FAILURE

If the afterburner exhaust nozzle fails to open at the time of afterburner ignition, a rapid rise in exhaust gas temperature and a reduction of rpm will be noted. If the afterburner exhaust nozzle does not open as soon as the afterburner starts to operate, discontinue afterburning immediately to prevent engine overtemperature. If the afterburner exhaust nozzles fail to close, a drop in exhaust gas temperature and a rise in rpm will be noted. The throttle should be adjusted to maintain exhaust gas temperature. Nonafterburner operation with the exhaust nozzles open will result in approximately a 30% loss of thrust and a 30% increase in fuel consumption. Occasional afterburner mislights may be expected between 40,000 and 50,000 feet. If the afterburner fails to ignite when the throttle is moved outboard:

1. Throttle—Inboard.
   Move the throttle inboard to shut off fuel to the afterburner and close exhaust nozzles.
2. Wait five seconds to clear afterburner.
3. Throttle—AFTERBURNER (if desired).
   Place throttle outboard to ignite the afterburner.
4. If afterburner again fails to light within five seconds, throttle—Inboard.

NOTE

Above 45,000 feet, the throttle should be retarded approximately one fourth in the afterburner range prior to a second attempt to ignite the afterburner.

AFTERBURNER CUTOFF FAILURE

In the event of an electrical system failure or if the afterburner cannot be cut off through use of normal throttle motion, retard the throttle to a point aft of the aft afterburner stop to terminate afterburner operation. Nonafterburning thrust can then be used as desired. When the emergency cutoff procedure has been used to terminate afterburning, a relight cannot be obtained unless electrical power has been restored. If the failure is of a temporary nature, an afterburner relight may be made by advancing the throttle above the minimum afterburner actuating position and moving the throttle outboard.

ENGINE OIL SYSTEM FAILURE

Failure of the engine oil system to supply sufficient operating pressure is indicated by the oil pressure gage and illumination of the oil pressure-low warning light (master warning system). If an oil system malfunction has caused prolonged oil starvation of engine bearings, the result will be a progressive bearing failure, engine roughness, oil seal failure and loss of oil, and possible subsequent engine seizure. This progression of bearing failure starts slowly and will normally continue at a slow rate up to a certain point, at which time the progression of failure accelerates rapidly to complete bearing failure. The time interval from the moment of oil starvation to complete failure depends on such factors as bearing condition prior to oil starvation, operating temperatures of bearings, and bearing loads. A good possibility exists for several minutes of operation after experiencing a complete loss of lubricating oil. 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 chances of a successful ejection or no-thrust landing will be increased by shutting down the engine. The end result of oil starvation is engine seizure.

OIL QUANTITY LOW OR OIL LOW WARNING LIGHT ILLUMINATED

The oil quantity low warning light on Ⓐ aircraft or oil low warning light on Ⓑ aircraft illuminates when usable oil in the oil tank decreases to approximately one-fourth full. Oil loss may be due to high oil consumption, oil line failure, engine bearing or seal failure, or other oil system malfunctions. If the oil quantity low or oil low warning lights illuminate during flight or oil quantity decreases below one-fourth full, follow the procedure entitled OIL-PRESSURE-LOW WARNING LIGHT ILLUMINATED procedure.

OIL-PRESSURE-LOW WARNING LIGHT ILLUMINATED

If the oil-pressure warning light illuminates, or loss of oil pressure is indicated by the oil pressure gage, attempt to forestall engine seizure as long as possible as follows:

1. Thrust—Minimum required for flight.
   High thrust setting should be avoided if at all possible in order to keep bearing loads at a minimum. Upon detection of an oil system malfunction, a minimum thrust setting should be established depending on airplane configuration, gross weight, and altitude. This setting should be sufficient to maintain level flight and allow for safe approach maneuvers (subsequent thrust variations should be avoided if possible).
2. Airspeed—Below 350 KCAS.
   Airspeed should be reduced below the maximum ram air turbine speed in the event the engine freezes and it is necessary to extend the ram air turbine.
3. External tanks—Jettison (if necessary).
4. G forces—Minimize.
   Avoid all abrupt maneuvers causing high g forces.
5. If engine vibrations become excessive, shut down engine.
6. Land as soon as possible; use flameout landing pattern if practical and minimum thrust.
   If engine seizure does not occur, shut down the engine immediately after taxiing off the active runway.

WARNING

- If a high thrust setting is required to climb to a higher altitude, minimum afterburner will impose less bearing loads than a full military thrust setting.
- If engine oil system fails and engine seizes, battery power and hydraulic pressure from the RAT will be the only available power sources.

WARNING

Complete engine failure will normally be indicated by a steadily increasing vibration. At this indication, the engine should be shut down to preclude such a destructive failure as to jeopardize a successful ejection or forced landing.

ENGINE FUEL CONTROL FAILURE

Engine fuel control failure may be recognized by a drop or rise from normal in exhaust gas temperature, rpm, and fuel flow. If fuel control system fails during takeoff, the takeoff should be aborted if conditions permit (runway length, overrun condition, cable availability, etc.). If, however, the takeoff has progressed to the point that an abort is not feasible, or if fuel control fails at any time, use the following procedure:

1. Throttle—As required.
   Attempt to match throttle position to engine rpm.
2. Fuel control switch—EMER.
3. Land as soon as possible.

WARNING

- Avoid rapid throttle movements.
- Following an inflight normal fuel control failure, do not return to NORMAL for the duration of the flight as flameout will result.

If there is no engine response to throttle movement in normal or emergency fuel, additional thrust may be available by selecting afterburner.

NOTE

Engine fuel control may be indicated by a lack of engine response with throttle movement and may not be associated with fluctuating EGT, RPM, or fuel flow. This malfunction may resemble a throttle linkage failure. If this occurs, select emergency fuel to verify normal fuel control failure. If engine response is not regained, reselect normal fuel control and proceed with THROTTLE HANG-UP/LINKAGE FAILURE procedures.

AFTERBURNER OR ENGINE STAGE FUEL PUMP FAILURE

When operating in afterburner, failure of one of the afterburner stage fuel pumps or the engine stage fuel pump is indicated by a 0.3 to 0.5 pressure ratio drop. Afterburner operation will continue with a thrust loss of about 23% at sea level on a standard day.

FUEL VALVE-CLOSED WARNING LIGHT ILLUMINATED

When any one of the shutoff valves (except F tank on Ⓑ airplanes) is in any position other than fully open, the fuel valve-closed warning light will illuminate. Should this occur, proceed as follows:

1. Check the fuel control panel to determine which valve is closed.
2. Check air refueling switch—OFF.
3. Check for asymmetrical fuel feeding.
4. Land as soon as possible.
5. If fuel on the side of the closed valve has stopped feeding and this fuel is required for safe recovery:
   a. Boost pumps (for the side indicating a closed fuel valve)—OFF.
   b. Fuel shutoff switch (for valve that indicates closed)—CLOSE.
   c. After 5 seconds; fuel shutoff switch—OPEN.

WARNING

Valve reaction to switch position is not instantaneous. Placing the fuel shutoff switch to open in less than 5 seconds may result in the valve remaining closed.

   d. If light does not go out, depend on the other wing and fuselage tank fuel only.
   e. If the light goes out, turn on all boost pumps, monitor fuel to insure that the affected wing is now feeding and balance fuel as necessary with boost pumps.

FUEL BOOST PRESSURE-LOW WARNING LIGHT ILLUMINATED

Since the boost pump control system is completely independent of the fuel valve control and indicating system, illumination of a fuel boost pressure-low warning light confines the problem to the boost pump system only. In the event of warning light illumination during flight the following procedures should be followed:

1. Fuel quantities—Monitor.
   Check for fuel feeding from the left and right sides.
2. If fuel flow is symmetrical, assume an erroneous warning indication.
3. If fuel flow is asymmetrical, this confirms boost pump failure on one side.
4. Land as soon as possible using fuel available on the side with operating fuel boost pumps.
5. If sufficient fuel is not available on the side with operating boost pumps for recovery, all fuel boost pumps should be turned OFF. With all boost pumps off, the fuel flow equalizer will be in bypass and more fuel will be taken from the side with higher tank pressure. If this is the side with higher quantity, and it becomes the lower quantity side, fuel balance can be maintained by periodically turning on the boost pumps on the high quantity side. Whether or not this procedure is effective, the procedure for COMPLETE FUEL BOOST PUMP FAILURE should be followed.

WARNING

To avoid uncovering the aft fuel intakes in No. 3 tanks, fly the airplane in a nose high attitude. Avoid combinations of large thrust changes, speed brakes and landing gear extensions. The recommended glide speed of 250 KCAS (gear up and speed brakes closed) and normal traffic pattern attitudes provide safe conditions.

COMPLETE FUEL BOOST PUMP FAILURE

In the event complete boost pump failure is experienced during takeoff, but fuel tank pressurization can be maintained, maximum engine and afterburner thrust can be sustained at any altitude from sea level to 36,000 feet. With complete fuel boost pump failure the airplane must be operated in a nose-high attitude. Nosedown conditions and uncoordinated or unusual maneuvers should be avoided, to prevent uncovering the open fuel line in the aft end of No. 3 tanks.

NOTE

- Unless the ATG is operating, a complete boost pump failure will occur with loss of ac nonessential power.
- The fuel flow equalizer will automatically go into a bypass condition in the event of boost pump failure.
- With the fuel flow equalizer in bypass, fuel will be taken from the side of higher tank pressure which may or may not be the side of higher fuel quantity.

In the event of complete boost pump failure, the following procedures should be followed:

1. ATG switch—Check AUTO.
2. Operate in a nose-high attitude.
   Normal cruise attitude, recommended glide speed attitude (250 KCAS, gear up and speed brakes closed), and traffic pattern attitudes, will be within safe limits.
3. Avoid negative g maneuvers.
4. Avoid uncoordinated maneuvers.
5. Avoid rapid decelerations (combinations of large thrust changes, speed brakes and landing gear extensions).
6. Fuel quantities—Monitor.
7. When asymmetrical fuel feeding occurs, close the fuel shutoff valve on the low side when fuel quantity on that side reaches approximately 200 pounds. With complete boost pump failure, this procedure will prevent flameout in case the absolute pressure switch in the fuel flow equalizer has failed.
8. Land as soon as practical.

WARNING

To avoid uncovering the aft fuel intakes in No. 3 tanks, fly the airplane in a nose-high attitude. Avoid combination of large thrust changes, speed brakes and landing gear extensions. The recommended glide speed of 250 KCAS (gear up and speed brakes closed) and normal traffic pattern attitudes provide safe conditions.

FUSELAGE TANK FAILS TO FEED

Failure of components in the fuel transfer system other than the F tank pressure regulator could prevent fuel transfer from the F tank. For this reason, frequent fuel quantity checks should be made to insure proper feeding. At approximately 8000 pounds of total fuel remaining, if initial F tank fuel sequence (about 400 pounds) has not transferred, plan on usable fuel in tanks No. 1, No. 2, and No. 3 only. On airplanes with the emergency F tank pressure switch or emergency F tank boost pump switch, an attempt should be made to transfer the fuel from the F tank to the wing tanks using the procedure below.

NOTE

Transfer of F tank fuel is predicated on proper feeding and depressurization of the T tanks. Therefore, some analysis may be obtained by shutting off the T tanks, then checking for F tank feeding, prior to attempting F tank emergency transfer.

1. Airplanes with F tank emergency pressure switch:
   a. F tank shutoff switch—Check OPEN.
   b. If F tank does not feed, T tank shutoff switch—CLOSE.
   c. F tank emergency pressure switch—ON.
      Leave switch ON as long as fuel is transferring. Return to the OFF position when F tank is empty, or if fuel fails to transfer.

At approximately 3500 pounds of total fuel remaining, if the remaining fuel in the F tank (approximately 1000 pounds) fails to feed into the No. 3 tanks, use the following procedure:

2. Airplanes with F tank emergency boost pump switch:

   a. F tank shutoff switch—Check OPEN.

   b. If F tank does not feed, T tank shutoff switch—CLOSE.

   c. F tank shutoff switch—CLOSE.

   d. F tank emergency boost pump switch—ON. Leave switch ON as long as fuel is transferring. Return to the OFF position when F tank is empty, or if fuel fails to transfer.

NOTE

- Fuel transfer is slower than normal when using the emergency system.
- On airplanes with the emergency F tank boost pump, initial F tank sequence will not occur when using the emergency boost pump. The emergency boost pump will only transfer fuel from the F tank when the fuel level in either No. 3 tank reaches approximately 1200 pounds.

3. Apply positive and negative g's to the airplane in an attempt to free any vent valves that may be stuck in an open or partially opened position.

3A. Check air refueling switch—OFF.

4. If after accomplishing the above, the F tank still fails to transfer:

   a. T tank shutoff switch—OPEN.

   b. F tank emergency boost pump/pressure switch—OFF.

   c. F tank shutoff switch—OPEN.

   d. CG control switch—TEST and hold.

NOTE

If CG aft transfer occurs at this point, the F tank fuel will transfer to the T tanks and then replenish the No. 3 tanks. If one or both fuel quantity low warning lights are illuminated, the fuel will transfer directly to the appropriate No. 3 tank(s) thru the scavenge system. It may be necessary to repeat step 4d until all fuel is transferred to the No. 3 tanks.

5. If after accomplishing the above, the F tank still fails to transfer, only the fuel remaining in the No. 3 tanks will be available and the flight should be planned accordingly.

FUSELAGE TANK FAILS TO FEED

Failure of components in the fuel transfer system other than the F tank pressure regulator could prevent fuel transfer from the fuselage tank. For this reason, frequent fuel quantity checks should be made to insure proper feeding. When total fuel quantity remaining decreases to 5000 pounds, place the fuel quantity gage to the FWD position and determine if fuselage fuel is transferring. If the F tank pressure-low warning light illuminates, or if the F tank is not feeding when total fuel quantity reaches 5000 pounds, proceed as follows:

1. Airplanes with F tank emergency pressure switch:

   a. F tank shutoff switch—OPEN.

   b. F tank emergency pressure switch—ON. Leave the switch ON as long as fuel is transferring. Return it to the OFF position when F tank is empty, or if fuel fails to transfer.

2. Airplanes with F tank emergency boost pump switch:

   a. F tank shutoff switch—CLOSE.

   b. F tank emergency boost pump switch—ON. Leave the switch ON as long as fuel is transferring. Return it to the OFF position when F tank is empty, or if fuel fails to transfer.

NOTE

Fuel transfer is slower than normal when using the emergency system.

3. Apply positive and negative g's to the airplane in an attempt to free any vent valves that may be stuck in an open or partially opened position.

3A. Check air refueling switch—OFF.

4. If, after accomplishing the above, the F tank still fails to transfer, F tank fuel will not be available, and the flight should be planned accordingly.

NOTE

If the F tank pressure-low warning light illuminates and the F tank is empty, assume an erroneous indication.

WING TANK PRESSURIZATION FAILURE

If wing tank pressurization fails, normal fuel transfer cannot be expected. Some fuel may transfer into No. 3 tank, but the quantity which transfers will depend on flight attitude, altitude, etc. Therefore, from the time of pressurization failure, only the fuel in No. 3 tank can be used. Wing tank pressurization failure is indicated by illumination of the appropriate (L and R) fuel tank pressure-low warning light. Should either warning light illuminate, proceed as follows:

1. Land as soon as practicable.
2. On the side of the illuminated warning light, depend on No. 3 wing tank fuel only.
3. Monitor fuel quantity-low warning lights and fuel quantity in each wing.
4. Boost pump switches—OFF, on the pressure failed side when the fuel quantity low warning light illuminates.

WARNING

To avoid uncovering the aft fuel intakes in No. 3 tanks, fly the airplane in a nose-high attitude. Avoid combinations of large thrust changes, speed brakes and landing gear extensions. The recommended glide speed of 250 KCAS (gear up and speed brakes closed) and normal traffic pattern attitudes provide safe conditions.

IMPROPER FUEL FEEDING

If any individual system is not feeding properly, as detected from the fuel quantity gage, the total (TOT) reading on the gage will give total fuel aboard, but not total fuel that can be used.

NOTE

Monitor the No. 3 tank fuel quantity to determine usable fuel remaining.

WARNING

- If a fuel quantity-low warning light illuminates but the respective individual system fuel quantity gage reading is considerably greater than 570 pounds, assume the light is accurate and that improper feeding has occurred in that system. Rapid depletion of fuel in the respective No. 3 tank will result.
- If the LH, RH, or No. 3 quantity gage readings indicate less than 570 pounds prior to illumination of the fuel quantity-low warning light, assume that a malfunction has occurred in the low-level fuel warning system.

In any event, upon detection of improper fuel feeding, land as soon as practicable.

FUEL QUANTITY-LOW WARNING LIGHT ILLUMINATED

When the usable quantity of fuel in a No. 3 tank reaches approximately 570 pounds, the appropriate fuel quantity-low warning light will illuminate. Should this occur, proceed as follows:

1. Check for asymmetrical fuel loading.
   a. If an asymmetrical fuel condition exists, refer to FUEL IMBALANCE.
2. Land as soon as possible.

WARNING

To avoid uncovering the aft fuel intakes in No. 3 tanks, fly the airplane in a nose-high attitude. Avoid combinations of large thrust changes, speed brakes and landing gear extensions. The recommended glide speed of 250 KCAS (gear up and speed brakes closed) and normal traffic pattern attitudes provide safe conditions.

FUEL IMBALANCE

Minor fuel imbalance can result from improper operation of the fuel flow equalizer and can be expected during flight. Indications of fuel imbalance are wing heaviness, one external tank failing to feed, or fuel quantity gage readings. If the imbalance progresses to a 500-pound differential, corrective action should be taken to insure that a more serious malfunction has not occurred. Fuel flow equalizer or fuel shutoff valve failure or a fuel line restriction may stop the flow from one wing and efforts to balance fuel may not be successful. Early detection of this problem is imperative to preclude the aircraft proceeding to a point where recovery is not possible with the fuel remaining. A failure of this nature can be confirmed on the fuel quantity gage at 7500 pounds of fuel remaining in Ⓐ aircraft (8800 pounds in Ⓑ aircraft) when a 500 pound imbalance will develop. If this occurs, plan on only the remaining F tank and low side wing fuel being available and land as soon as practical. When a fuel imbalance reaches 500 pounds differential, attempt to balance fuel by the following procedure:

NOTE

If fuel imbalance is due to one external tank not feeding, do not attempt to balance internal fuel, as this will aggrevate the weight imbalance problem. Refer to External Tank Feeding Malfunctions.

1. Fuel quantity—Check.
   In the event the fuel quantity-low warning light illuminates on one side only, or abnormal wing heaviness is noted, LH, RH, or No. 3 fuel quantity should be verified by the fuel quantity gage.
2. Boost pump switches—OFF (on the side with the lowest fuel).
   If it is found that the fuel level is low on one side while there is a relatively large quantity of fuel on the opposite side, move the boost pump switches on the low side to OFF, permitting high side to reduce the unbalanced condition.
3. Boost pump switches—ON (on the side with the highest fuel).
   The boost pump switches on the side having the larger fuel quantity should be ON to force fuel usage from this side.
4. Fuel quantity—Monitor LH, RH, or No. 3 tank selections to insure that the high side fuel decreases and the low side quantity remains constant. If the low side continues to decrease with the boost pump inoperative, suspect failure of one wing to supply fuel. If the high side fuel is required for safe recovery, proceed as follows:
   a. Boost pump switches—OFF (on the side with the highest fuel).
   b. Boost pump switches—ON (on the side with the lowest fuel.
   c. High side fuel shutoff switch—CLOSE.
   d. After five seconds, high side fuel shutoff switch—OPEN.

   WARNING

   Valve reaction to switch position is not instantaneous. Placing the fuel shutoff switch to open in less than 5 seconds may result in the valve remaining closed.

   e. All boost pumps—ON.
   f. Monitor fuel in high side.
   g. If the high side does not feed, depend on low side wing and fuselage tank fuel only. Land as soon as practical.
   h. If high side feeds, balance fuel as necessary with boost pumps.
5. When fuel quantities are balanced or when the fuel quantity-low warning light on the high side illuminates turn all boost pump switches—ON.

WARNING

- Unless a fuel shutoff valve is closed, all boost pump switches should be turned ON prior to landing regardless of the fuel quantity or asymmetrical fuel loading, to insure positive fuel supply in the event of a go-around.
- The respective fuel boost pump switches must be placed in the OFF position prior to closing the fuel shutoff valve. If the fuel boost pumps are not turned OFF, failure of the equalizer absolute pressure switch may result in engine fuel starvation.

WARNING

- If operation with a known empty tank is anticipated, turn the boost pump switch on the empty side OFF, then close the shutoff valve on the empty side to minimize pump operation without fuel cooling and to preclude possible engine flameout. When the fuel boost pumps are used on the side with the fuel quantity-low warning light illuminated, an empty No. 3 fuel tank is indicated when the fuel boost pressure-low warning light is illuminated.
- To avoid uncovering the aft fuel intakes in No. 3 tanks, fly the airplane in a nose-high attitude. Avoid combinations of large thrust changes, speed brakes and landing gear extensions. The recommended glide speed of 250 KCAS (gear up and speed brakes closed) and normal traffic pattern attitudes provide safe conditions.

FUEL SEQUENCING/FEEDING MALFUNCTIONS

External Tank Feeding Malfunctions.

Fuel system sequencing or feeding malfunctions are normally first noticed during the numerous fuel quantity and balance checks performed by the pilot. A non-feeding or slow feeding external tank is indicated when internal fuel quantity continues to decrease after the landing gear is retracted. Since the non-feeding or slow feeding tank does not fill the respective No. 1 fuel tank, internal feeding and sequencing will continue. With a non-feeding external tank, a fuel imbalance will develop. Do not balance fuels with boost pumps, because the wing with the lower indications on fuel weight is actually the heavy wing due to trapped drop tank fuel. Balancing will tend to make the weight differential worse. Activating the external tanks emergency feed switch may not correct the non-feeding drop tank; however, if the external tanks emergency feed switch is activated then turned to off, the trapped fuel may vent overboard correcting the weight differential. Landing speed calculations should take into account the weight of the full external tank.

With a slow feeding tank, a fuel imbalance will develop and should be corrected. When the opposite external tank empties, the fuel balance will continue to be affected but the side with the lower quantity will be reversed until the slow feeding external tank is empty. After both external tanks are empty, fuel quantities, once balanced, should remain balanced. If the external fuel does vent overboard, correct the fuel imbalance using differential fuel boost pump operation.

NOTE

If a non-feeding external tank is confirmed, cycling the external tanks emergency feed switch may vent the fuel overboard.

If both tanks fail to feed, activating the external tanks, emergency feed switch may cause the tanks to feed.

Trapped Fuel in Transfer Tank(s) Ⓐ

Internal fuel sequencing may mask a feeding malfunction. A long delay in opening the T tank switch after engine start will cause first F tank feeding to occur. This will mask a malfunction where one or both T tanks do not feed. With external tanks, trapped T tank fuel can be determined when the external tank(s) fuel feeding increases one or both wing quantities more than 200 pounds. When only one T tank does not feed, the wing with the higher fuel quantity is the side with the trapped fuel. A second indication of trapped T tank fuel is early second F tank feeding. If second F tank feeding begins at approximately 4900 pounds remaining, both T tanks have trapped fuel. If the second F tank feeding begins at approximately 4200 pounds remaining, one T tank has trapped fuel. In an aircraft without external tanks, early F tank feeding is the first indication of trapped T tank fuel.

WARNING

If trapped T tank fuel is not noticed or suspected until No. 3 tank quantities begin to decrease, there may not be adequate usable fuel to land the aircraft.

Trapped T tank fuel indicated by a premature depletion of No. 3 tank fuel cannot be corrected using the procedure for PREMATURE NO. 3 TANK DEPLETION. There is no action the pilot can take to correct this malfunction. Early detection through frequent fuel quantity and balance checks, and analysis of fuel sequencing events will alert the pilot to the malfunction.

Trapped Fuel in Transfer Tank(s) O.

Trapped T tank fuel can be corrected using the procedure for PREMATURE NO. 3 TANK DEPLETION, this section.

FLIGHT OPERATIONS WITH LOW FUEL QUANTITY

Care must be taken when conducting flight operations with fuel quantity-low warning lights illuminated or when total fuel indicated is less than 1000 pounds. Prolonged turns, decelerations, or negative g maneuvers should be avoided to preclude fuel flow interruption and subsequent engine flameout. The hopper tank will supply fuel for at least 30 seconds engine operation at 4000 pounds per hour flow with 650 pounds in each No. 3 tank during the above maneuver. However, at No. 3 tank quantities below 650 pounds, the 30 second operating time has not been verified. If a fuel quantity-low light illuminates or total fuel quantity indicated reaches 1000 pounds, proceed as follows:

1. Avoid prolonged turns, decelerations, or negative g maneuvers and maintain a nose-high attitude, if practical.
2. Land as soon as possible from a straight-in approach.

WARNING

To avoid uncovering the aft fuel intakes in No. 3 tanks, fly the airplane in a nose-high attitude. Avoid combinations of large thrust changes, speed brakes and landing gear extensions. The recommended glide speed of 250 KCAS (gear up and speed brakes closed) and normal traffic pattern attitudes provide safe conditions.

PREMATURE NO. 3 TANK DEPLETION

A malfunctioning vent/anti-G valve in the No. 3 fuel tank combined with failure of the fuselage tank to depressurize when empty will cause a cessation of fuel transfer to the No. 3 tank. If fuel ceases to transfer to the No. 3 tank from the remainder of that wing group, the following steps should be accomplished:

1. Fuselage tank emergency pressure switch—Check OFF.
2. Fuselage tank switch—OFF.
3. Land as soon as possible.
   The indication to the aircrew that this procedure has been effective is stabilization of the fuel level in the No. 3 tank at or slightly below the level existing when the action was taken.

CADC FAILURE WARNING LIGHT ILLUMINATED

Illumination of the CADC failure warning light indicates failure of either the Mach module, altitute module, or airspeed module within the CADC. The pilot cannot determine which module has failed; therefore, all AMI and AVVI indications must be considered unrealiable even though the "OFF" flag may not appear. Refer to the standby altimeter and standby airspeed indicators for altitude and airspeed information. In conventional instrument airplanes, the servoed altimeter (AAU-19/A) reset-standby lever should be positioned to STBY to prevent the possibility of erroneous altitude information being displayed.

WARNING

Variable ramp operation may also be affected if the Mach signal drives to 1.4 Mach or above. The variable ramps will extend causing a reduction in available thrust and, if in the landing configuration, thrust may not be adequate to maintain level flight. If this occurs, the vari-ramps should be retracted by placing the variable ramp switch to EMER OPEN. Refer to VARIABLE RAMP FAILURE.

NOTE

If the Mach signal begins driving up, indicating possible variable ramp extension, the process can be stopped by turning off the main AC generator if climatic conditions permit. This action removes power from the variable ramp controller and should be attempted if vari-ramp switch fails to retract the vari-ramps.

AC POWER FAILURE WARNING LIGHT ILLUMINATED

The ac power failure warning light illuminates when the main ac generator fails. To verify the warning indication, and to preclude engine flameout from lack of fuel boost pressure, use the following procedures:

NOTE

Main ac generator failure also results in loss of input power to the 200-amp TR and, therefore, power to the dc nonessential bus.

1. Fuel boost pressure-low warning lights—Check not illuminated.
   If fuel boost pressure-low warning lights illuminate, check ATG switch in AUTO position.
2. Throttle—83% rpm minimum.
3. Altitude—Establish 35,000 feet or below.

NOTE

- If operating above 35,000 feet at the time of ac power failure, descend to 35,000 feet or below within two minutes.
- Starting loading of the ATG may require power settings of up to full military power. If the ATG does not start immediately, increase rpm to military power and descend with this throttle setting to 35,000 feet. Below 35,000 feet, 83% rpm sustains starting and operating loads.

4. Generator switch—OFF, then ON.
5. Cabin temperature control knob—HOT.
6. Rain removal switch—ON (if subsonic).
7. If the warning light remains illuminated:
   a. Generator switch—OFF.

NOTE

Emergency ac generator power is available automatically to power the ac essential bus including flight instruments.

   b. Land as soon as practical.
8. Important system losses that are caused by loss of power to both the ac nonessential and dc nonessential buses:
   a. Automatic variable ramp control.
   b. Windshield and canopy anti-icing.
   c. Pitch and yaw dampers.
   d. Fuel in external wing tanks.
   e. If ATG is inoperative:
      (1) Fuel boost pumps.
      The fuel flow equalizer automatically goes into bypass with the loss of boost pumps.
      (2) Pitot heat (nose boom).
      (3) TACAN and ILS (integrated flight instrument display).
   f. If the emergency ac generator is inoperative:
      (1) Engine instruments except tachometer.
      (2) Main ADI and integrated instruments.
      (3) Fuel quantity indication.
      (4) Cockpit lighting.
      (5) ADF.
      (6) IFF.
      (7) Turn indicator.
      (8) TACAN and ILS (conventional instrument display).

NOTE

- Only the ac operated turn indicator on the ADI of the conventional instrumented airplanes is affected.
- Emergency ac generator failure also results in loss of input power to the 50-amp TR. When this occurs, dc power failure warning light illuminates and the dc essential and emergency buses are powered by the battery.

9. Land as soon as practical. Avoid high Mach numbers. Make a straight-in, nose-high approach.

WARNING

AC power fail light may be indicative of pending CSD failure.

NOTE

If at any time both fuel boost pressure-low warning lights illuminate steadily, use procedures for fuel boost pump failure. It is a normal condition if the fuel boost pressure-low lights illuminate momentarily during changeover from ac power to ATG power. If it is determined that the ATG is not operating, place the ATG switch to OFF to preclude unnecessary damage to the unit.

200 AMP TR FAILURE

A momentary flash of the dc power failure warning light and a loss of functions on the dc nonessential bus indicate 200-amp TR failure. The essential and emergency dc buses will be powered by the 50-amp TR. Important system losses caused by loss of dc nonessential bus power are:

a. MA-1 system (power dumps to off).

b. Fuel in external tanks.

c. Pitch and yaw dampers.

d. Seat and rudder pedal adjustment.

e. Taxi and landing lights.

f. Anticollision lights.

g. Automatic ice detector.

h. F tank emergency boost pump control.

i. Automatic vari-ramp control.

j. Automatic cg fuel transfer.

DC POWER FAILURE WARNING LIGHT ILLUMINATED

The dc power failure warning light illuminates when the battery is powering the dc essential and emergency buses. It indicates loss of both 200-amp TR and 50-amp TR output power. Important system losses caused by loss of dc nonessential bus power are the same as in 200-amp TR failure. Since the battery is powering the dc essential and emergency buses, dc electrical load should be reduced as much as practical through the following procedures:

1. Minimize the use of trim.

2. Minimize the use of UHF radio.

3. Land as soon as practical.

The battery will not be recharged with both TR units failed. All dc power will be lost should the battery be depleted, and all warning lights will be inoperative. With total dc power failure, the main ac generator will provide power to some flight and engine instruments; however, important system losses are essentially the same as complete electrical failure and should be treated as such.

NOTE

With subsequent total dc power failure, no emergency ac generator or ATG power will be available if the main ac generator fails. Refer to COMPLETE ELECTRICAL FAILURE.

AC AND DC POWER FAILURE WARNING LIGHTS ILLUMINATED

Illumination of both ac and dc power failure warning lights indicate a failure of the main ac generator and the dc essential and emergency buses being powered by the battery. This condition could be caused by: (1) failure of the main ac generator and the 50-amp TR or (2) failure of the main ac generator and failure of the emergency ac generator to power the 50-amp TR. In the first condition, the emergency ac generator powers the ac essential bus automatically, and in both conditions the ATG powers the ATG bus automatically. Important systems losses are the same as with ac power failure warning light illuminated; however, since the battery is supplying power to the essential bus, the electrical load should be reduced and use of trim should be minimized to conserve battery power.

NOTE

The battery will not be recharged with the main ac generator failed. Since emergency ac power sources require dc essential power for operation, all ac and dc power will be lost if battery is depleted. Refer to COMPLETE ELECTRICAL FAILURE.

If the master switch is turned to OFF, the dc emergency bus will be connected to the battery and the following will be available.

a. Emergency drag chute deploy.

b. Tailhook.

c. Canopy.

B d. Bailout warning.

WARNING

Flight through rain or heavy moisture with the landing gear extended can cause a short circuit in the ac generator control unit located in the right main wheel well. This can cause the ac generator to cycle on and off, thereby not allowing the emergency ac generator and the 50-amp TR to start.

COMPLETE ELECTRICAL FAILURE EXCEPT BATTERY

The following are either independent of electrical power or require battery power only and will continue to function in event of complete electrical failure except battery:

1. All airplanes:

   a. Armament salvo.

   b. Cabin pressure altitude gage.

   c. Canopy jettison.

   d. Drag chute.

   e. Emergency fuel transfer.

   f. Exhaust gas temperature gage.

   g. Landing gear and tailhook down warning lights.

   h. Manual engine anti-icing.

   i. Speed brakes.

   j. Standby magnetic compass.

   k. Surface trim

   l. Tachometer.

   m. Turn-and-slip indicator.

NOTE

Only dc powered turn and slip indicators will continue to function. The turn and slip indicator on the ADI of the conventional instrumented airplanes is ac powered and will not continue to function.

   n. Variable ramp emergency retraction.

   o. UHF radio.

   p. Standby attitude indicator.

2. Conventional instrument display only:

   a. Accelerometer.

   b. Airspeed indicator.

   c. Altimeter.

   d. Vertical velocity indicator.

3. Integrated flight instrument system only:

   a. Standby airspeed indicator.

   b. Standby altimeter.

COMPLETE ELECTRICAL FAILURE

Complete electrical failure will occur after loss of main ac generator, ATG, emergency ac generator, and depletion of the battery. If this occurs, the aircraft can be successfully landed under visual flight conditions. Plan approach and landing without use of speed brakes, drag chute, and tailhook as these will not be available. Land as soon as possible.

Important system losses:

a. Emergency drag chute.

b. Tailhook.

O c. Interphone and bailout warning.

d. Exhaust gas temperature gage.

e. Standby attitude indicator.

NOTE

The standby attitude indicator will provide useful attitude information for approximately nine minutes during gyro wind-down in spite of an OFF warning flag.

f. Normal landing gear extension.

It should be noted that several instruments are completely independent of the electrical power sources and will continue to function with a complete loss of electrical power. The instruments are:

1. Conventional instrument display:

   a. Airspeed phase of the airspeed-angle of attack indicator.

   b. Cabin pressure altitude gage.

c. Accelerometer.

d. Tachometer.

e. Vertical velocity indicator.

f. Altimeter.

g. Standby magnetic compass.

2. Integrated flight instrument system:

a. Tachometer.

b. Standby altimeter.

c. Standby airspeed indicator.

d. Standby magnetic compass.

e. Cabin altitude marker.

HYDRAULIC POWER SYSTEM FAILURE

NOTE

Make an entry on Form 781 if the ram air turbine has been operated under a cavitated condition. This condition would occur if all hydraulic fluid leaked out due to a leak in a primary hydraulic system line.

In the event of failure of one hydraulic system, the other system will remain in operation, but will produce only approximately half the power to the flight controls, since both hydraulic systems are almost identical in capabilities. Loss of both hydraulic systems will require displacement of the ram air turbine for flight control operation. With complete ac power failure (which may accompany failure of both hydraulic systems if the cause is a "frozen" engine), two of the instruments which will be rendered inoperative are the hydraulic pressure gages. The pressure gages in this instance may not necessarily return to a reading of zero pressure but may continue to indicate the pressure readings at the time of failure. After displacement of the ram air turbine, the only indication of hydraulic pressure will be the dc (battery) operated hydraulic pressure-low warning light and physical movement of the flight controls.

CAUTION

During flight, an above-normal increase in hydraulic pressure on either system (i.e., over 3100 psi), with no demand on the system, is an indication of possible hydraulic system component failure, and a landing should be accomplished as soon as practicable.

HYDRAULIC FAILURE WARNING LIGHT ILLUMINATED (FLASHING)

If the HYD FAIL (pressure-low) warning light flashes, it is an indication that one of the hydraulic systems has failed. To best utilize the remaining system, proceed as follows:

1. Airspeed—Below 350 KCAS.

CAUTION

Do not use the speed brakes, as this will reduce the pressure available for flight control.

2. Hydraulic pressure gages—Check.
   Check the hydraulic pressure gages to determine which system gives the low pressure indication, then proceed with applicable procedures.

NOTE

A failure of either hydraulic system in which all fluid is lost, will also cause a pneumatic system failure. As a result, only emergency high pressure air will be available.

Failure of Primary Hydraulic System

1. Avoid violent maneuvers, dives and unnecessary use of speed brakes.

2. Land as soon as practicable.

   a. Landing gear handle—DOWN.
      Extend the landing gear with the normal system.

WARNING

Landing gear extension should be made at a time when minimum use of flight controls is required. Speed brakes should not be used during gear extension since the secondary hydraulic system will be used for both landing gear extension and flight control operation. Maintain at least 80% engine rpm during landing gear extension to increase secondary hydraulic system capabilities.

b. RAT—Extend.
Extend the ram air turbine after entering the landing pattern and after extending the gear.

Failure of Secondary Hydraulic System

NOTE

If the secondary hydraulic system fails, the following will be inoperative: nose wheel steering, pitch damper, emergency ac generator, normal speed brake operation, normal variable ramp operation, normal landing gear operation and normal slipway door operation. With the secondary hydraulic system failed, control stick breakout forces will increase, and positive centering of the stick may not be possible. In some instances failure of the secondary system results in an increased sensitivity of the flight controls.

1. Flight mode selector switch—YAW.
   Place the flight mode selector switch to YAW to prevent "wandering" of the control surfaces.
2. Avoid violent maneuvers, dives, and use of speed brakes.
3. Land as soon as practicable.
4. Landing gear—Emergency extend.
5. Drag chute handle—Emergency deploy (on landing).

WARNING

- Do not extend the ram air turbine. Extension will serve only to increase the temperature of the hydraulic system. An increase of temperature could have an adverse effect on primary hydraulic system operation.
- If secondary hydraulic system failure has been caused by a known malfunction in the speed brake system, asymmetrical speed brake extension may occur if the drag chute is deployed. Therefore, a no-drag-chute landing should be planned if runway conditions, length and cable availability permit. If use of drag chute is necessary, nose wheel should be lowered to the runway prior to deploying the drag chute.
- If the pneumatic pressure-low warning illuminates, consideration should be given to prompt gear extension and landing.

HYDRAULIC FAILURE WARNING LIGHT ILLUMINATED (STEADY)

If the HYD FAIL (pressure-low) warning light illuminates steadily, it is an indication that both systems have failed. Proceed as follows:

1. **RAT—EXTEND.**

WARNING

- Minimum airspeed is 174 KCAS when the ram air turbine is the only source of hydraulic pressure. However, this will not assure control for other than wings level flight.
- If airspeed is above ram air turbine maximum extension speed and engine is "frozen," do not extend the speed brakes to slow the airplane. Speed brake extension will cause immediate depletion of remaining secondary hydraulic system pressure. Deceleration should be accomplished by moving the flight controls a minimum amount to establish a flight attitude that will provide deceleration.

NOTE

- Check that hydraulic pressure-low warning light starts to flash indicating that the ram air turbine is providing pressure through the primary system.
- In the event that hydraulic system failure is the result of a frozen engine, the hydraulic pressure gage will be in-

operative due to complete ac power failure and, therefore, will not indicate hydraulic pressure even though the emergency system is operating. In this event the pressure gage will not necessarily return to a reading of zero pressure. At this time, the dc (battery) operated hydraulic pressure-low warning light will be the only instrument for indication of hydraulic pressure.

2. If pressure is available for flight operation, land as soon as practicable.

NOTE

Plan landing to provide for a straight-in approach.

3. If flight control operation is not possible—Eject.

TRIM FAILURE

If any of the three trim actuators should fail to operate, the force required to perform normal maneuvers should be well within normal physical capabilities. Complete loss of dc power will cause the trim system to be inoperative.

DAMPER MODE FAILURE

Both damper systems become inoperative if the generator or 200-amp TR fails. Yaw damper is lost when primary hydraulic system pressure fails, and secondary hydraulic pressure failure will result in the loss of pitch damper. If any of these conditions occur, the hydraulic control valves permit normal pilot control without stability augmentation.

ARTIFICIAL FEEL SYSTEM INOPERATIVE

Failure of the artificial feel system may be caused by a leak in the pneumatic pressure line, a leak in the feel force cylinder, internal failure of the feel force regulator, or by electrical failure to either or both of the ram air (q) intakes, allowing them to become clogged by ice while operating in icing conditions. Failure of the artificial feel system may be recognized by either high or low stick and/or rudder forces, or pilot-induced oscillations. In the event of artificial feel system failure, proceed as follows:

1. Airspeed—Reduce to 230 KCAS.
2. Use minimum control stick movement.
3. Flight mode selector switch—DIR MAN.

WINDSHIELD HEATING/ANTI-ICING FAILURE

The laminated windshield is electrically heated to prevent fogging and icing. In the event of loss of electrical power to the laminated windshield, windshield defogging may be obtained by the following procedure:

1. If the windshield is heated and ac power failure is noted, immediately proceed as follows:
   a. Rain removal switch—ON (below supersonic speed).
      If the system has functioned normally, maintaining a heated windshield, and ac power failure is noted, the rain removal system should be turned on immediately. Activation of the rain removal system will provide an effective "heat block" for the heat energy stored in the left-hand windshield panel at the time of power failure and maintain the inside surface temperature of the left-hand panel.
2. If system power failure is not noted until condensation has formed, proceed as follows:
   a. Rain removal switch—ON (below supersonic speed).
      Activation of the rain removal system will initiate a heat addition process on the left-hand windshield outer surface.
   b. Cabin temperature control knob—HOT.
      Regulate cabin temperature to maximum tolerable. This action will start a heat addition process on the inside surface of the windshield.

NOTE

The desired heating on a windshield that has cooled, or was not preheated electrically, will require from two to four minutes when using the above procedure.

CRACKED WINDSHIELD

At high altitudes and low temperatures, uneven heat distribution, caused by possible malfunction of the electrical input to the defogging system, could cause a windshield panel to crack. A hairline crack, which leaves the panel transparent, indicates an outer layer failure only. However, if the panel becomes white or opaque, the inner layer, which is the stress-bearing part of the windshield, has probably failed. Inner layer failure may further be evidenced by feeling the glass, and by observing particles of shattered glass within the cockpit. In the event of a cracked windshield, proceed as follows:

1. Helmet visor(s)—Down. (FP-RP)
2. Cabin air selector switch—Ram.

WARNING

Cabin pressure must be dumped immediately in the event of an inner layer crack, but need not be dumped if only the outer layer is cracked.

3. Windshield anti-icing, antifog switch—OFF (on side corresponding to the cracked panel).

CAUTION

Subsequent cracking may short the anti-icing, antifog circuit if the windshield failure is due to excessive heat.

4. Airspeed—Reduced.
5. Descend and land as soon as practical.

CANOPY UNLOCK WARNING LIGHT ILLUMINATED/LOSS OF CANOPY

Illumination of the canopy unlocked warning light in flight indicates that the canopy latch hooks are not fully engaged, and loss of the canopy could ensue. If the light comes on in flight, observe the following:

1. If the canopy unlocked warning light illuminates in flight when the canopy latch handle is in an apparent full forward position, and the canopy latches are engaged, carefully push the handle (fully) to the LOCK position. Any slight movement of the latch mechanism in the aft direction would cause the warning light to illuminate.

WARNING

Under no circumstances should the canopy latch handle be moved aft. Windblast would jettison the canopy.

2. If warning light fails to go out, handle is not in an apparent locked position, or canopy latches are not engaged:
   a. Airspeed—Reduce to 230 KCAS.
   b. Cabin air selector switch—OFF.
   c. Land as soon as practical.

SHOULD LOSS OF CANOPY IN FLIGHT OCCUR:

3. Obtain a visual check (if possible), or reduce to approach speed to verify the integrity of the airframe, noting the minimum control speed if damage has been sustained.
4. Land as soon as practical using normal approach speeds or the safe control speed if higher.

ENGINE COMPARTMENT OVERPRESSURE WARNING LIGHT ILLUMINATED

Illumination of the engine compartment overpressure warning light while in flight indicates that the pressure limit in the engine accessory compartment has been reached. If the light illuminates, proceed as follows:

1. Airspeed—Reduce to below Mach 1.0 as soon as practical.

   Gradually reduce airspeed below Mach 1.0 within 2-1/2 minutes to prevent possible damage to the fuselage from excessive pressure, and to conserve high-pressure pneumatic system pressure. Continued subsonic operation with the light on presents no hazard.

NOTE

Once illuminated, the light will remain on for the duration of the flight.

PNEUMATIC PRESSURE-LOW WARNING LIGHT ILLUMINATED

When pressure in the two main pneumatic pressure storage flasks drops to approximately 1700 psi, the pneumatic pressure-low warning light will illuminate. To conserve remaining pressure, proceed as follows:

1. Do not recycle the armament system.
2. Use rudder control with caution.
3. Plan on no-drag-chute landing.
4. There is a possibility of loss of one or both brakes. Check system pressure prior to taxi.

EMERGENCY OPERATION OF PRESSURE-BREATHING OXYGEN SYSTEM

1. If symptoms of hypoxia develop, check oxygen hose connections and check pressure-breathing oxygen supply switch ON.
2. If the airplane's oxygen supply is depleted, or not supplying oxygen, actuate the emergency oxygen supply by pulling the emergency oxygen manual release (round green knob) on the personal equipment lead bundle. Turn pressure-breathing oxygen supply switch OFF and descend to a cockpit altitude below 10,000 feet within 10 minutes.

2A. If oxygen contamination is suspected, turn pressure-breathing oxygen supply switch OFF, actuate emergency oxygen manual release and descend to a cockpit altitude below 10,000 feet within ten minutes.

3. If wearing an MBU-3/P or MBU-5/P oxygen mask and cabin pressure is lost, an immediate descent to 25,000 feet or below is mandatory.

OXYGEN-LOW WARNING LIGHT ILLUMINATED

When the oxygen supply in the liquid oxygen system falls below 1.0 liter, the oxygen-low warning light illuminates. Should this occur, proceed as follows:

1. Descend to an altitude where oxygen is not required.
2. Actuate emergency bailout bottle, if necessary.

SEPARATION OF PERSONAL EQUIPMENT LEADS ASSEMBLY OR SHIP-TO-KIT DISCONNECT

If the personal equipment leads assembly or ship-to-kit disconnect separates from the survival kit, the aircrew will be separated from the aircraft oxygen system. If this occurs, 100% oxygen free-flows into the cockpit and complete communications failure results. If the personal equipment leads assembly separates, the oxygen supply to the pilot is cut off immediately and breathing with the oxygen mask on requires considerable effort. If the ship-to-kit disconnect separates, the emergency oxygen supply in the seat kit is automatically actuated and supplies oxygen to the pilot for 10 to 15 minutes. Activation of the emergency oxygen system results in a slight increase in oxygen pressure supplied to the pilot. As the emergency oxygen supply is depleted, breathing with the oxygen mask on becomes more difficult.

NOTE

Breathing with the oxygen mask on when disconnected from the aircraft oxygen system requires considerable effort since it is necessary to overcome the restrictor valve in the CRU-43 connector.

If complete communications failure is experienced and separation of the personal equipment leads assembly or ship-to-kit disconnect is suspected, attempt to reestablish communications by using the alternate communications lead and confirm the integrity of the oxygen system as follows:

1. Oxygen supply lever—OFF.
2. If breathing is normal with the lever on but impossible with it off, the system is functioning properly. Return lever to ON.
3. If breathing is difficult and is unaffected by the position of the supply lever, the personal equipment leads have separated.
4. If normal pressure breathing continues and is unaffected by the position of the supply lever, oxygen is being supplied from the emergency oxygen bottles. In this event, the ship-to-kit disconnect has separated.
5. If either the personal equipment leads assembly or the ship-to-kit disconnect separates, descend below 10,000 feet cabin altitude as soon as possible.

LOSS OF CABIN PRESSURE OR CABIN PRESSURE-LOW WARNING LIGHT ILLUMINATED

When the cabin pressure rises to approximately 44,000 feet, the cabin pressure-low warning light will illuminate and the emergency cabin pressure system will be energized. The warning light and the emergency pressure system will be deenergized as cabin pressure increases and cabin altitude drops to approximately 26,000 feet. When cabin pressure loss occurs or in the event the warning light illuminates during flight, proceed as follows:

1. Oxygen mask connections—Check. (FP-RP)
2. Refrigeration unit switch—ON.
3. Cabin air selector switch—PRESS.

NOTE

The cabin pressure-low warning light will illuminate if the cabin pressure altitude reaches approximately 44,000 feet or greater, and emergency pressurization will commence automatically.

4. If cabin altitude is higher than actual altitude, place the cabin air selector switch to OFF and reduce speed.
5. Turn MA-1 power switch to EMER and descend to 24,000 feet.
6. If cockpit is contaminated and depressurization is necessary, place cabin air selector switch to RAM.

EXCESSIVE COCKPIT TEMPERATURE

1. Cabin temperature control knob—Push in for manual operation and position as desired.
2. Deleted.
3. G suit—Check for excessive hot air flow.
4. If cockpit temperature cannot be decreased manually, move cabin air selector switch to OFF.

5. Canopy antifog switch(es)—OFF.
6. If cockpit temperature remains excessive, move cabin air selector switch to RAM.

NOTE

If, after accomplishing above steps, cockpit temperature remains excessive, consider jettisoning the canopy.

REFRIGERATION UNIT FAILURE

If refrigeration turbine fails (failure of the refrigeration turbine will be evidenced by a rapid increase in temperature and a decrease in pressure), use the following procedures to provide emergency cooling of the MA-1 system electronics equipment:

1. Refrigeration unit switch—OFF.
2. MA-1 power switch—EMER.

CAUTION

When the refrigeration unit switch is placed in the OFF position, the MA-1 power switch must be immediately placed in the EMER position.

3. Airspeed—250 KCAS.

CAUTION

To prevent overheating of the MA-1 system electronics equipment, airspeed should be reduced to 250 KCAS.

4. Descend to 25,000 feet MSL or below as soon as practical.
5. Land as soon as practical.
6. MA-1 power switch—OFF (after landing).

ELECTRONIC COOLING WARNING LIGHT ILLUMINATED

GROUND OPERATION

1. Cabin air selector switch—OFF.
2. RPM — Increase.

CAUTION

If the electronic cooling warning light cannot be extinguished through the above procedures, the MA-1 power switch must be placed in the OFF or EMER position to avoid damage to the electronic equipment. Return to line and determine cause of malfunction.

FLIGHT OPERATION

1. Throttle—Advance if possible.
2. Flight conditions—Change if possible.
3. Cabin temperature—Increase.
4. Cabin air selector switch—OFF or RAM.
5. MA-1 power switch—STBY.
6. If the above actions fail to extinguish the warning light within 10 minutes, follow procedures under REFRIGERATION UNIT FAILURE.

HOT AIR BLEED LINE/DUCT FAILURE

Problems detected in the air conditioning and pressurization system, electronic cooling, and electrical system (when persistent), or any combination of these problems, may be an indication of hot air bleed line/duct failure. Hot air bleed line/duct failure should be suspected any time multiple or sequential failures of unassociated aircraft systems occur. For example, flight control oscillations accompanied by pneumatic pressure failure, instrument failure, and erratic fuel gage indications would be a strong indicator of hot air bleed line/duct failure. When such a failure is suspected on the ground, the flight should be aborted and the engine should be shut down. When failure is suspected while airborne, hot air bleed line/duct failure should be treated as an emergency requiring minimum thrust and landing as soon as possible. In a malfunction caused by rupture of hot air bleed line, continued flight can be extremely hazardous.

WARNING

After landing, open the canopy, shut down the engine, and abandon the airplane. Do not turn off any electrical switches to preclude the possibility of explosion of fuel fumes.

ENGINE ANTI-ICING WARNING LIGHT ILLUMINATED

1. Surface and engine anti-icing switch—MAN ON.

CAUTION

- The engine inlet anti-icing system should not be used in MAN ON at supersonic speeds. During high-speed flight, particularly at low altitude, engine bleed air used for anti-icing may reach temperatures higher than 850 °F. The prolonged use of this high-temperature air for anti-icing the engine inlet guide vanes would adversely affect the engine number one bearing area.
- Avoid extended ground operation with the switch in MAN ON due to the possibility of damaging the inlet duct structure and the artificial feel air intake tubes.
- If the anti-icing warning light is illuminated in AUTO ON but extinguishes in MAN ON, the detector probe may be defective and all anti-icing systems may be activated. In this case, operate the system manually as flight conditions dictate.

NOTE

If the anti-icing warning light illuminates when the surface and engine anti-icing switch is in AUTO ON or MAN ON position, cycle the switch. After cycling the switch, if the light remains on with AUTO ON or MAN ON position selected, the engine anti-icing system has malfunctioned and the engine anti-icing shutoff valve may be inoperative.

ARMAMENT JETTISON PROCEDURE

The AIM-4F and AIM-4G missiles may be jettisoned (salvoed) in one operation. The salvo selection is provided to insure jettisoning of all armament in an emergency. The salvo operation is independent of MA-1 functions, using electrical power from the dc essential bus. The two aft bay missiles are jettisoned and then the two forward bay missiles. The missile motors function but the missile is unarmed. The maximum time required for the salvo cycle is about 4 seconds during which the armament trigger must be held pressed. If a missile misfires during SALVO, the cycle stops as it would for a normal four-missile pass. The salvo circuits also provide for complete operation to jettison all remaining armament if some of the load has been previously fired or misfired. Use the following procedure for armament jettison.

1. Armament selector switch—SALVO.
2. Arm-safe switch—ARM.
3. Armament trigger—Press to second detent.
   When the trigger is pressed, the missile bay doors open, the armament is jettisoned, and the doors close. The trigger must be held pressed through the cycle.
4. Misfire warning light—Monitor.
   The misfire and master warning lights flash briefly when the aft missiles are launched, and finally when the forward missiles are launched.
5. Armament trigger—Release.

MISFIRE OR DOOR OPEN WARNING LIGHT ILLUMINATED

Use the following procedure if the missile bay door open or misfire warning light remains illuminated:

1. Armament trigger—Release (if pressed).
2. Auto search button—Press to break lockon.
3. Missile displaced warning light—Check NOT illuminated.
   If this light is illuminated, follow the MISSILE DISPLACED procedure for applicable configuration.
4. Wait seventy-five seconds (if missiles are aboard).

WARNING

If emergency procedures are necessary for retraction, the missiles must not be retracted less than 75 seconds after full extension. A potential hazard of an "in bay" explosion, resulting in severe aircraft damage and pilot danger exists if AIM missiles are retracted into the missile bay with the electrical-hydraulic power supply still operating.

5. Arm-safe switch—SAFE.
6. Armament selector switch—VIS IDENT.
7. Missile bay doors close button—Press and hold until misfire and door-open warning lights extinguish.

MISSILE DISPLACED WARNING LIGHT ILLUMINATED

Illumination of the missile displaced warning light indicates that a missile is displaced (not properly seated on a launcher) or a launcher is not up and locked with the doors closed. This light may be accompanied by illumination of the misfire and door open warning lights. If the light illuminates during ground operation, the cause should be determined and the condition corrected prior to flight. Use the following procedures for inflight illumination of the warning light.

1. Launchers extended.
   a. If a clean aircraft configuration is not mandatory, proceed as follows:
      (1) Fuel consumption—Monitor for range considerations.
      (2) Land as soon as practical with the launchers extended.

CAUTION

Retraction of missiles with the missile displaced warning light illuminated can result in structural damage to the aircraft and missiles. Retraction under these conditions should be performed only when absolutely necessary for safe recovery of the aircraft.

   b. If a flight condition exists where a clean aircraft configuration is mandatory, use the following procedure to retract the launchers:
      (1) Auto search button—Press to break lockon.
      (2) Wait seventy-five seconds.
      (3) Arm-safe switch—SAFE.
      (4) Armament selector switch—VIS IDENT.
      (5) Missile bay doors close button—Press and hold until DOOR OPEN warning light extinguishes.
2. Doors closed.
   a. If the missile displaced warning light illuminates in flight and the doors are closed, the aircraft should be landed without further armament operation.

THROTTLE HANGUP/LINKAGE FAILURE

NOTE

- Throttle hangup may occur due to freezing of moisture in the throttle teleflex cable. This problem can be eliminated by descending to below the freezing level.
- Part of the throttle linkage is exposed near the cockpit floor in the lower left console. Prior to executing the following procedures, check the linkage to insure that it is intact and no foreign objects are restricting throttle movement.
- If there is no visible foreign object causing a throttle restriction it is possible that some loose item out of the pilot's view might be causing the stuck throttle. If fuel quantity and climatic conditions permit, zero or negative "G" maneuvers should be performed in an attempt to dislodge the foreign object.
- A failure of the normal engine fuel control may resemble a throttle linkage failure in the lack of engine response with throttle movement. If throttle linkage failure is suspected, confirmation should first be made as to the proper operation of the normal fuel control.

With throttle hangup or throttle linkage failure at high rpm where throttle control cannot be regained, the only method of stopping the engine is with the fuel shutoff switches or by fuel starvation. If suspected throttle hangup has occurred, proceed as follows:

1. Check for possible foreign object restriction.
2. Fuel control switch—EMERGENCY.

IF THROTTLE RESPONSE IS REGAINED:

3. Land as soon as practical.

IF THERE IS NO THROTTLE RESPONSE:

4. Fuel control switch—NORMAL.
5. Retain drop tanks and burn off excess fuel in the vicinity of base of intended landing.
6. Press to test fuel shutoff valve warning lights.
7. Slow aircraft to below maximum gear lowering speed by use of speed brakes and climbing.
8. Descend to traffic pattern altitude and fly a long straight-in final approach. Anticipate a higher than normal approach speed if rpm is above the required for normal approach speed.

NOTE

- Selection of emergency fuel may reduce thrust.
- S-turns on final approach may be required to reduce speed if the throttle cannot be retarded below 90% rpm.
- If required to land from the rear cockpit of Ⓑ aircraft it may be preferable to land from a modified overhead traffic pattern using approximately 1000 feet for pattern altitude. This will reduce the potential for disorientation on final approach due to S-turns. It will also allow the rear cockpit pilot to keep the runway in sight throughout the pattern.

9. At approximately 1 to 2 miles from the approach end of the runway, move boost pump switches to OFF and close the fuel shutoff switch on one side. Check fuel warning light on.
10. When landing is assured, close the remaining fuel shutoff switch. Check fuel warning light on.

NOTE

The fuel shutoff valves are normally open throughout a flight. When a malfunction occurs where the thrust setting cannot be changed (such as throttle hangup), the only controlled fuel shutoff is with the fuel shutoff switches. Ground tests have demonstrated the following lag times before thrust loss after closing the fuel shutoff valves:

Thrust Setting	Time from Fuel Shutoff to Thrust Loss
Full Military	4 seconds
90%rpm	6 seconds
80% rpm	10 seconds

11. Execute normal touchdown and landing. Anticipate landing long and be prepared to engage the cable.

NOTE

- Landing roll can be reduced by selecting afterburner immediately after touchdown. This dumps fuel into the afterburner lines and rapidly depletes fuel downstream from the fuel shutoff valves thus accelerating engine coastdown. The afterburner will not light if the fuel shutoff valves are closed.
- In the event of a confirmed throttle linkage failure with the ability to move the throttle into the afterburner range, selection of afterburner may provide additional thrust, if required, for a climb or in the event a go-around is necessary.

STRUCTURAL DAMAGE/CONTROLLABILITY CHECK

If structural damage occurs in flight, the pilot must decide whether to leave the aircraft at that point, proceed to an area that is more favorable for bailout, or to attempt a landing. If the aircraft remains controllable, the pilot must attempt to ascertain what damage has occurred and to what degree it will affect continued flight or attempted landing. Obvious indications to the pilot will be control forces (response) necessary to continue flight and engine or systems instruments in the cockpit. If another aircraft is available, that pilot should position himself to safely observe and report the damage that has occurred. If the pilot elects to attempt a landing, he should check for aircraft controllability by simulating a landing approach. If time, fuel and weather permit, the pilot should position the airplane near the field of intended landing at a minimum of 15,000 feet. At this point he should:

1. Obtain a visual inspection from another aircraft if practical.
2. Simulate a landing approach with gear down, speed brakes retracted (switch neutral) at recommended approach speed for fuel aboard.

3. If aircraft is not controllable at approach speed, eject.

4. If aircraft is controllable at approach speed, plan for a straight-in approach without speed brakes. Once the gear is down on the simulated approach, leave it down.

5. Maintain recommended approach speed until landing is assured.

6. Runway conditions permitting, lower nose wheel to the runway prior to deploying drag chute.

SPEED BRAKE STRUCTURAL FAILURE

If an inflight loss of one or both speed brakes occurs, the speed brake switch must be returned to the neutral position to prevent failure of the secondary hydraulic system due to fluid loss. Loss of both speed brakes is evidenced by a slight nose down pitch change and loss of deceleration force as though the speed brakes were closed. Loss of a single speed brake may induce a severe yaw and roll in the direction of the remaining speed brake. Flight tests indicate that at an airspeed of 150 to 200 KCAS, 90% of full rudder is required to maintain zero sideslip with a single speed brake extended. However, no flight tests have been conducted at speeds above 200 KCAS. Operational experience indicates that at speeds above 200 KCAS, the airplane is uncontrollable until the remaining speed brake is closed.

If an inflight loss, or suspected loss, of one speed brake occurs, as evidenced by a severe yaw and rapid roll, immediately close the remaining speed brake and return the switch to the neutral position. Adequate rudder is available to counter the yaw and roll tendency at airspeeds below 200 KCAS, however, above this speed airplane control may not be retained until the remaining speed brake is closed.

LANDING

LANDING GEAR WARNING LIGHT REMAINS ILLUMINATED ON LANDING GEAR EXTENSION

1. Obtain a visual inspection and then recycle the landing gear handle.

NOTE

If visual inspection is not possible or indicates improper configuration, do not recycle.

2. After recycling attempts, if the landing gear warning light does not go out, the landing gear green indicator lights do not illuminate, or the audio warning signal continues with the landing gear handle in the DOWN position, use the procedure for LANDING GEAR EMERGENCY EXTENSION.

NOTE

On night missions, in addition to pressing to test the green indicator lights, move the warning lights dimmer switch to the BRT position. If safe indication is obtained on BRT, a resistor in the dimming circuit is defective.

LANDING GEAR EMERGENCY EXTENSION

1. Speed—Below 250 KCAS.
2. Landing gear emergency extension handle—Press down, then pull.

WARNING

Insure that the landing gear emergency extension handle is fully extended when actuated. If the handle binds before being fully extended, attempt jiggling the handle in a clockwise, counterclockwise rotating motion while maintaining the rearward pull. Recycling the handle after it has once been fully extended will induce air into the secondary hydraulic system and may fail the system, cause flight control oscillations and deplete the pneumatic system.

NOTE

- Time required for emergency extension of the landing gear is approximately 5 seconds.
- Nosewheel steering is inoperative when the landing gear has been extended with the emergency system.

3. Landing gear handle—DOWN.

NOTE

Emergency landing gear extension can be accomplished with the landing gear handle in either the up or the down position; however, if the handle is in the up position, the red warning light will illuminate and the audio warning will sound even though the landing gear is extended.

4. Landing gear—Check down and locked.

NOTE

- If the emergency gear lowering procedure does not result in a safe indication, yaw the aircraft with alternate rudder applications and apply g to attempt to lock the gear down.
- Should use of the emergency extension system fail to provide a safe indication because of a hung landing gear door, the gear door may be removed by airloads allowing the landing gear to fall to the down and locked position. It should first be verified visually by a chase airplane or from the ground that a main landing gear door is partially opened, preventing landing gear extension. If the door is partially opened, accelerate to above 310 KCAS at which time the hung door should depart the airplane and a down and locked indication should appear on the landing gear position indicator. This procedure should be used only as a last resort prior to landing with one or both main landing gears retracted. Substantial damage will occur to the door actuating system and loss of secondary hydraulic system is probable.
- If a safe indication cannot be obtained on the main landing gear, however, if a visual inspection confirms the gear is fully down, then an approach end cable engagement should be considered.

CAUTION

Bouncing the airplane on the runway in an attempt to jar loose a hung landing gear is not recommended. This procedure has had little success in the past and exposes the pilot and airplane to hazards more critical than those associated with the prescribed emergency procedures.

5. Landing or taxi lights—ON.
   Place the landing and taxi light switch to LANDING LIGHTS if a main gear is unsafe, or to TAXI LIGHTS if the nose gear indicates unsafe. The light on each respective landing gear will illuminate if the gear is down and locked. Have mobile or the tower check to determine if the corresponding lights have illuminated.
6. If external tanks contain required fuel, place external tank emergency switch ON.

NOTE

- If difficulty was experienced in extending the landing gear, even though the gear indicates down and locked, stop on the runway and have safety pins installed. It is possible that other malfunctions may exist.
- Record emergency gear extension on Form 781.

LANDING WITH TAILHOOK EXTENDED

If the tailhook is inadvertently extended in flight, it will not introduce any problems while airborne. A safe touchdown can be made with the hook extended.

WARNING

If the tailhook is extended in flight and there is a barrier on the approach end of the runway, the barrier should be removed before an approach is performed or the aircraft touchdown point should be adjusted to avoid inadvertent engagement with the barrier cable. When extended, the tailhook may drag for 1000 feet before aircraft touchdown during a normal landing. When landing with the tailhook extended, and an approach end engagement is not desired, fly a high final approach and plan to touch down 1500 feet beyond the barrier cable.

FLAT TIRE ON LANDING

If a main landing gear tire is blown prior to landing, an approach end cable engagement is the recommended landing procedure.

WARNING

- Do not hold the brake on the blown tire prior to cable engagement. This may cause damage to the underside of the wing, but it will insure that the cable will not be severed by the flat tire rim, thus increasing the success of cable engagement.
- If a known bare wheel exists and a cable engagement is not planned, lock that wheel prior to touchdown and keep that wheel locked throughout landing roll to prevent wheel fragments from penetrating wing tanks or possible gear collapse due to heavy vibration.

If a tire is blown prior to landing or blows out on landing: move the throttle to idle, deploy the drag chute and move the idle thrust switch to the ON position. If the failed tire is on the main landing gear and an approach end cable engagement is not possible/successful, the nose should be lowered immediately to the runway, nose wheel steering engaged, and the control stick moved away from the blown tire to relieve as much weight as possible from the wheel. Keep the nose wheel steering button depressed to maintain positive engagement. Differential braking and nose wheel steering should be used to maintain directional control. As vibration increases, the brake on the wheel with the blown tire should be held and locked. The good tire should not be deliberately blown as braking efficiency is reduced and the hazard of particles being thrown into the wings is increased. If the tire failure is on the nose gear, hold full up elevator to relieve as much weight as possible from the nose wheel. If nose wheel steering becomes uncontrollable, it should be disengaged.

NOTE

If nose wheel steering is not available, or has been intentionally disengaged, and the airplane is above normal taxi speed, shut the engine down and follow ABORT procedure. Unless the situation dictates, do not stopcock the engine at speeds less than normal taxi speed, but maintain idle rpm until fire equipment arrives. Stopcocking the engine at slow airspeeds allows fuel to vent in the vicinity of the wheel brake area, creating a fire hazard.

PARTIAL GEAR CONDITIONS

Consider the following recommendations when a partial gear condition exists (the pilot should consider all factors of environment, fuel remaining, weather, etc. in his decision to eject or land the aircraft in a partial gear condition):

Gear Condition	Recommendation
1. Both Main—UP Nose—UP	— Belly landing (conditions permitting).
2. Both main—UP Nose—DOWN	— Belly landing (conditions permitting).
3. Both main—DOWN Nose—UP	— Normal landing using NOSE GEAR UP LANDING procedures.
4. One main—DOWN Nose—UP	— Attempt to retract gear, then use BELLY LANDING procedure. — If unable to retract gear, consideration should be made for a controlled ejection. — If unable to eject, follow APPROACH END CABLE ENGAGEMENT procedure.
5. One main—DOWN Nose—DOWN	— Attempt to retract gear, then use BELLY LANDING procedure. — If unable to retract gear, consideration should be made for a controlled ejection. — If unable to eject, follow APPROACH END CABLE ENGAGEMENT procedure.

WARNING: If cable engagement is missed, maintain wings level and attempt a go-around.

RUNWAY APPROACH END CABLE ENGAGEMENT (BAK-9, BAK-12)

Engagement of the BAK-9 or BAK-12 type arresting gear at the approach end of the runway is recommended when a condition occurs which is likely to cause loss of directional control after touchdown or when extended runout can cause progressive failure, such as a blown main gear tire.

CAUTION

Approach end cable engagements are not recommended if the only problem is failure of the nose gear to extend. Emergency landings utilizing a normal approach and landing roll, have experienced no control difficulty and only minor damage.

Engagement of the cable at the approach end of the runway will provide the following:

a. Additional directional stability.

b. A reduction in time that the pilot and airplane are exposed to possible injury or damage.

c. Limit airplane rollout or uncontrolled skid to 1500 feet or less.

d. A specific location where emergency vehicles can plan to meet the airplane.

Refer to figure 5-4 for maximum cable engagement ground speed. The decision to attempt an approach end arrestment must be dictated by local conditions. Where the arresting cable is installed at the extreme end of the runway or in the overrun, the ability of the overrun area to accommodate touchdown loads should be considered. Touchdown on poorly paved overrun may prevent an arrestment through loss of directional control, hook skip, or damage to the airplane. At least 750 feet of rollout are required from an on-speed touchdown to lower the nose wheel to the runway. Although desirable, lowering the nose prior to engaging the cable is not mandatory. If one main gear is up or unsafe, the nose wheel should not be lowered to the runway. The wing may contact the runway and sever the cable prior to tailhook engagement. In all cases, when a condition occurs which is likely to cause loss of directional control after touchdown, an approach end arrestment is recommended whether or not the nose wheel can be lowered to the runway prior to engagement. There have been several inadvertent approach end arrestments in the F-106 where the aircraft was still in the landing attitude when the tailhook engaged the cable. There have been no injuries as a result of these engagements. In most instances, damage has been limited to a nose strut failure. This damage is minimal when compared to the risks involved with an uncontrollable aircraft at landing speeds. If it is decided that an approach end cable arrestment is to be made, proceed as follows:

WARNING

Do not attempt to engage the MA-1/1A type barrier on the approach end as injury and damage will result. If time allows, the MA-1/1A should be removed before an approach end engagement of either the BAK-12 or BAK-9 cable is attempted. If time does not allow for removal of the MA-1/1A, the tailhook must be deployed after passing the MA-1/1A barrier cable(s).

1. Expend excess fuel to lighten airplane and minimize fire hazard. Retain empty drop tanks.

NOTE

Alert ground personnel and request BAK-9 or BAK-12 arresting gear be installed on approach end of runway.

NOTE

Based on engaging the cable at recommended touchdown speed, maximum fuel on board should be:

	CONFIGURATION	BAK-9	BAK-12
A	Unarmed	11,600	9,500
A	Missiles (4)	11,000	8,900
A	M61A1 + Ammo	10,300	8,300
A	Missiles (4) + M61A1 + Ammo	9,700	7,700
B	Unarmed	9,000	7,200
B	Missiles (4)	8,400	6,600

2. Tailhook down button—Depress.

CAUTION

Do not deploy the tailhook in flight where obstructions such as power lines, fences, approach lights, etc., could be engaged by the arresting hook.

NOTE

- Plan touchdown point according to type of emergency. A normal, smooth landing flare and touchdown is of primary importance. Therefore, do not "force on" or "hold off" airplane to achieve planned touchdown point.
- If conditions permit, touchdown point should be sufficiently short of the arresting cable to permit lowering of nose gear to runway before arrestment.

NOTE

Plan touchdown and cable engagement to be as near the runway centerline as possible.

WARNING

Premature touchdown and lowering of the nose with one main gear up will cause the wing to drop, resulting in loss of directional control. Maintain sufficient airpseed to engage cable with wings level, if possible.

3. Shoulder harness inertia reel handle—MANUAL LOCK. (FP-RP)
4. Drag chute—Deploy.
5. Nose wheel steering—Engage.
6. Avoid using brakes just prior to engagement.

CAUTION

Do not attempt to lock brakes on wheel with flat tire until after crossing arresting cable. The wheel should be rolling when passing over the cable to avoid snagging or cutting the cable.

7. Throttle—IDLE or OFF.

CAUTION

When landing with a flat main gear tire, keep engine running until fire equipment arrives. Stopcocking the engine allows fuel to vent overboard near the wheel brakes, thus creating a fire hazard.

NOTE

Throttle advancement may occur during rapid deceleration if the pilot's hand is on the throttle.

8. Fuel shutoff switches—CLOSE (if necessary).
9. Master electrical power switch—OFF (if required).

CAUTION

Master electrical power switch must be ON if nose wheel steering is required.

NOSE GEAR UP LANDING

The only partial gear configuration for which landing is recommended is nose gear up, both main gears down.

1. External wing tanks release button—Depress (if required).
   Depress the external tanks release button to jettison the external tanks if tanks are installed and contain fuel. If external tanks are empty, they should be retained to cushion the impact unless landing is to be made on an unprepared surface.
2. Plan normal approach and landing with speed brakes out.
3. Shoulder harness inertial reel handle—MANUAL LOCK. (FR-RP)
4. Radar boresight switch—BORS, rotate antenna to full up position.
5. After touchdown:
   a. Drag chute handle—Pull (emergency deploy).
   b. Hold nose gear off ground, but fly it down before positive control is lost.
   c. Throttle—OFF prior to lowering nose.
   d. Fuel shutoff switches—CLOSE.
   e. Master electrical power switch—OFF.
   f. Canopy—Retain.

WARNING

Do not jettison or open the canopy prior to passing all runway barriers as the arresting cable may slide up the nose and into the cockpit.

   g. Braking—As required.

BELLY LANDING

If forced to make a gear-up landing, proceed as follows:

CAUTION

If conditions permit, salvo the armament.

1. Tanks—Jettison (if required).
   Jettison external tanks if tanks are installed and contain fuel. If external tanks are empty, they should be retained to cushion the impact unless landing is to be made on an unprepared surface.
2. Make normal approach.
3. Speed brakes—Open.
4. Should harness inertia reel handle—LOCKED. (FP-RP)
5. Immediately before touchdown:
   a. Throttle—OFF.
   b. Fuel shutoff switches—CLOSE.
   c. Canopy—Retain.

WARNING

If the canopy is to be jettisoned, make sure it is jettisoned before the airplane comes to a complete stop. Otherwise, sparks from the canopy remover may cause a fire if fuel is spilled in the vicinity of the airplane.

6. Normal landing attitude for touchdown.
7. Drag chute handle—Pull (emergency deploy).
8. Master electrical power switch—OFF.

EJECTION VS FLAMEOUT LANDING

Normally, ejection is the best course of action in the event of complete engine flameout (windmilling or frozen), or if positive control of the airplane cannot be maintained. Because of the many variables encountered, the final decision to attempt a flameout landing or to eject must remain with the pilot. It is impossible to establish a predetermined set of rules and instructions which would provide a ready-made decision applicable to all emergencies of this nature. The basic conditions listed below, combined with an analysis of the condition of the airplane, type emergency and pilot proficiency, are of prime importance in determining whether to attempt a flameout landing, or to eject. These variables make quick and accurate decision difficult.

NOTE

No attempt should be made to land a flamed-out airplane at any field where approaches are over heavily populated areas. If possible, prior to ejection, an attempt should be made to turn the airplane toward an area where injury to persons or damage to property on the ground or water is least likely to occur.

Before a decision is made to attempt a flameout landing, the following basic conditions should exist:

a. Flameout landings should be attempted only on a prepared or designated suitable surface.

b. Approaches to the runway should be clear.

c. 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 flameout landing pattern.

NOTE

Night flameout landings, or flameout landings under poor lighting conditions such as at dusk or dawn should not be contemplated regardless of weather or field lighting.

d. Flameout landings should be attempted only when either a satisfactory high key or low key position can be achieved.

e. If at any time during the flameout approach, conditions do not appear ideal for successful completion of the landing, ejection should be accomplished. Eject not later than the low key altitude.

AIRSTART ATTEMPTS DURING FLAMEOUT LANDING PATTERN

It is suspected that a contributing factor in some recent unsuccessful flameout landings may have been that the pilot did not devote his full attention to the maintenance of the required flameout pattern once high key was reached. The distracting influence in these instances was airstart attempts. The solution to this problem is not simply to prohibit airstart attempts once high key is reached. Past experience has shown that flameout landings are dangerous and should be attempted only under ideal conditions. Accordingly, it would be dangerously misleading to create the impression that airstarts should be abondoned at any specific time and all concentration be directed towards a flameout landing. If several airstarts have already been attempted or if the nature of the flameout indicates that any further airstart attempts will be futile, then obviously no further attempts should be made even long before the high key point is reached. But if flameout has occurred near high key point, the pilot can attempt an airstart below high key provided he is not dangerously distracted. Regaining power must be afforded a high priority since, as already pointed out in previous instructions, flameout landings should be avoided to the extent that ejection is normally considered the best course of action. If it is decided to attempt a forced landing, the following considerations should be observed:

a. In the event of a flameout, attempt to complete all airstart efforts before high key is reached so that full attention may be devoted to accomplishing a successful flameout landing.

b. If the circumstances of flameout have precluded conclusive airstart attempts prior to high key, further airstarts may be attempted, but primary attention should be devoted to proper execution of the flameout landing.

c. Do not attempt airstarts after low key is reached.

NOTE

This does not preclude airstart attempts when flameout occurs below low key.

d. These instructions in no way alter previously established requirements for ejection versus forced landing. (Refer to EJECT VS. FLAMEOUT LANDING.)

FLAMEOUT LANDING (ALL GROSS WEIGHTS)

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 and damage to the airplane. The inherent nose-high landing attitude of this airplane will result in severe "slap" to the ground if the tail section is permitted to take the initial shock of the wheels-up landing. Therefore, to reduce vertebral injuries, all landings should be made with the gear extended.

WARNING

- External tanks should be jettisoned prior to high key/gear extension if they contain fuel.
- If terrain is unknown or unsuitable for forced landing, eject.
- The canopy should be retained if a crash landing is to be made.
- All landings should be made with landing gear extended, even in the event of a damaged or missing tire or wheel, or when only partial gear extension is possible.

WARNING

During crash landings or ditching, the helmet visor should be placed in position over the face as the visor affords protection to the eyes and exposed areas.

See figure 3-6 for recommended procedures and techniques for a flameout landing on suitable terrain.

SIMULATED FLAMEOUT LANDING

See figure 3-6 for simulated flameout landing configuration.

EJECTION

The egress system provides safe ejection capability at all points in a normal or flameout landing pattern. It is essential that proper airspeed be maintained to provide the capability to "zoom" the airplane prior to an ejection in the landing pattern. Figure 3-3 shows ejection parameters during a flameout landing. Refer to EJECTION (INFLIGHT) for ejection procedures.

WARNING

- Do not delay decision to eject if airplane becomes uncontrollable at any point in the landing pattern.
- For B airplanes, the forward seat is ejected one second later than the aft seat. This fact must be considered when planning a flameout landing.

DITCHING

In all cases where the capability of successfully ditching the airplane is available to the pilot, i.e., controllable airplane, the capability also exists for a successful ejection regardless of altitude. Therefore, eject rather than ditch the airplane.

DRAG CHUTE FAILURE

Landing distances for a dry runway without a drag chute as shown in the Performance Data can be obtained by using the minimum run landing techniques described in Section II. For a dry or

flameout landing
(typical)

WINDMILLING OR FROZEN ENGINE—ALL GROSS WEIGHTS

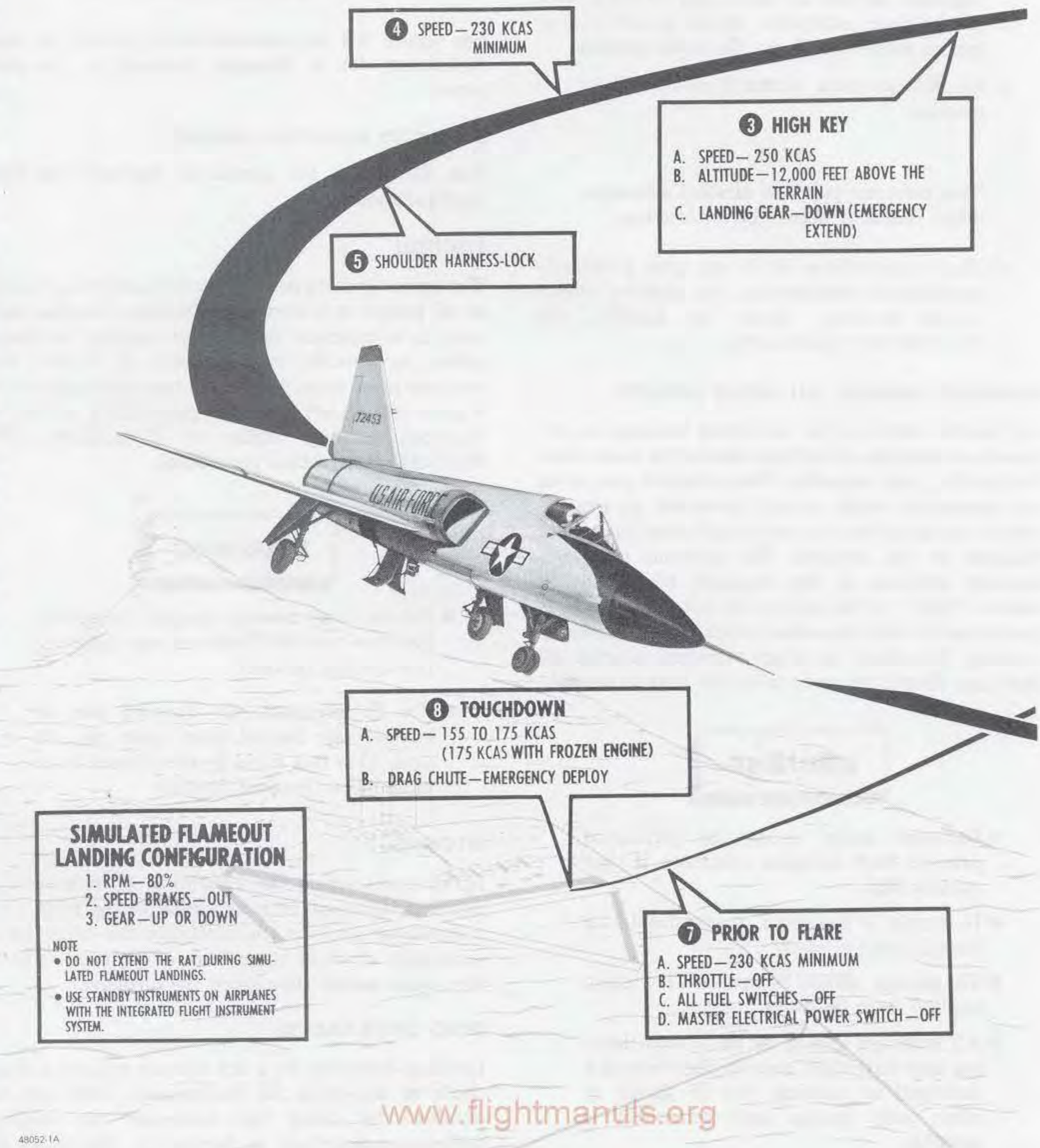
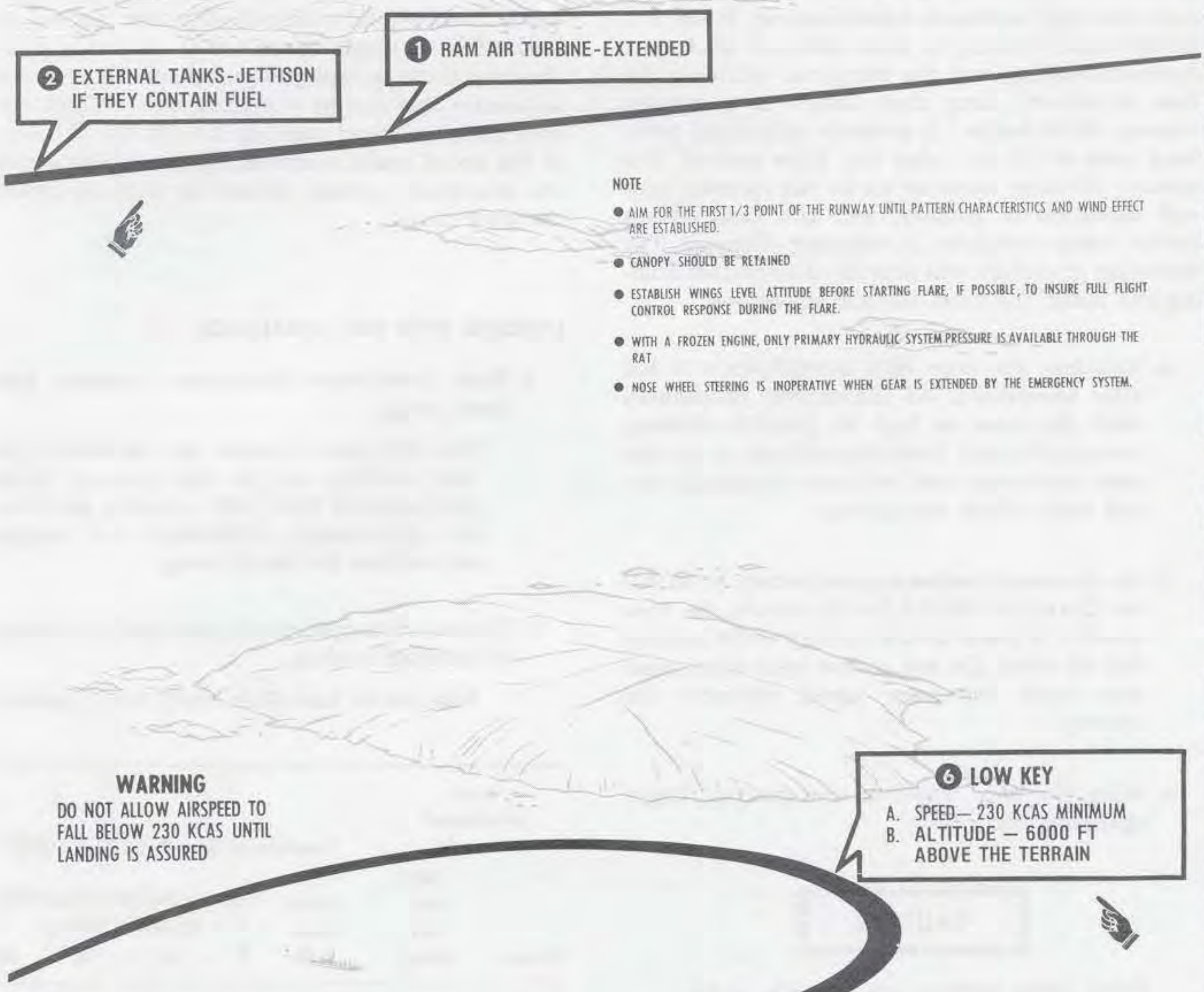


Figure 3-6 (Sheet 1 of 2)



NOTE

- AIM FOR THE FIRST 1/3 POINT OF THE RUNWAY UNTIL PATTERN CHARACTERISTICS AND WIND EFFECT ARE ESTABLISHED.
- CANOPY SHOULD BE RETAINED
- ESTABLISH WINGS LEVEL ATTITUDE BEFORE STARTING FLARE, IF POSSIBLE, TO INSURE FULL FLIGHT CONTROL RESPONSE DURING THE FLARE.
- WITH A FROZEN ENGINE, ONLY PRIMARY HYDRAULIC SYSTEM PRESSURE IS AVAILABLE THROUGH THE RAT
- NOSE WHEEL STEERING IS INOPERATIVE WHEN GEAR IS EXTENDED BY THE EMERGENCY SYSTEM.

WARNING

- ALL LANDINGS SHOULD BE MADE WITH LANDING GEAR EXTENDED, EVEN IN THE EVENT OF A DAMAGED OR MISSING TIRE OR WHEEL, OR WHEN ONLY PARTIAL GEAR EXTENSION IS POSSIBLE.
- IF TERRAIN IS UNKNOWN OR CONDITIONS ARE UNSUITABLE FOR FORCED LANDING, EJECT. (SEE EJECTION VS FORCED LANDING THIS SECTION.)
- ON AIRPLANES WITH THE INTEGRATED FLIGHT INSTRUMENT SYSTEM, THE STANDBY INSTRUMENTS SHOULD BE USED DURING ALL SIMULATED FLAME-OUT APPROACHES TO ACCUSTOM PILOTS WITH THEIR USE PRIOR TO ACTUAL EMERGENCIES.
- UNDER ACTUAL FLAMEOUT CONDITIONS CAUSED BY ENGINE SEIZURE OR ACCESSORY DRIVE FAILURE, SINK RATES MAY EXCEED THOSE NORMALLY EXPERIENCED DURING SFO PRACTICE. CAUTION SHOULD BE USED NOT TO DEPLETE AIRSPEED BELOW 174 KCAS PRIOR TO TOUCHDOWN. (RAT IS ONLY SOURCE OF HYDRAULIC PRESSURE FOR FLIGHT CONTROLS.)
- WHILE PRACTICE FLAMEOUT APPROACHES IMPROVE PROFICIENCY, SUCCESSFUL COMPLETION OF SFO's WILL NOT ASSURE ACTUAL FLAMEOUT LANDING SUCCESS. DURING AN ACTUAL FLAMEOUT, IF CONDITIONS AT ANY TIME DO NOT APPEAR IDEAL—EJECT. TURN AIRCRAFT AWAY FROM POPULATED AREAS. REFER TO EJECTION VS FLAMEOUT LANDING, THIS SECTION.

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Figure 3-6 (Sheet 2 of 2)

wet runway (RCR 12 or above), maintain the nose high touchdown attitude utilizing maximum aerodynamic braking until 115 KCAS. Then lower the nose and apply optimum wheel braking. Below 115 KCAS wheel braking is more effective than aerodynamic braking and the danger of skidding the tires is reduced. Drag chute failure on a slippery runway (RCR below 12) presents additional problems over which the pilot has little control. The amount of water, snow or ice on the runway, type and condition of runway, and tire tread depth induce many variables in stopping distance. The following procedure will provide the shortest landing roll under the most adverse conditions.

a. Maintain the nose high touchdown attitude after touchdown. As the aircraft decelerates raise the nose as high as possible without scraping the tail. Hold this attitude as the aircraft decelerates and maintain directional control with rudder and aileron.

b. As the speed reaches approximately 80 KCAS for Ⓐ and 100 KCAS for Ⓑ aircraft, the nose wheel will lower to the runway while holding full aft stick. Do not release back stick pressure until the nose wheel contacts the runway.

c. With the nose wheel on the runway, begin optimum braking.

CAUTION

Drag chute failure may require cable engagement. Monitor deceleration carefully and, if not sure of stopping on available runway, plan for cable engagement. Refer to TAKEOFF for overrun cable engagement procedures.

LANDING WITH A SPEED BRAKE FAILURE

In the event of a speed brake malfunction or suspected speed brake structural failure, a no-speed-brake, no-drag-chute landing should be planned. Past experience has shown that with a speed brake failure, the drag chute probably will not be available. Runway conditions and length, plus availability of a cable should be considered. If use of the drag chute is required, the nose wheel should be lowered to the runway prior to attempting deployment. Pilots should anticipate the yaw that will be induced by a single speed brake extension when the drag chute is deployed and should be prepared to counter this yaw by a combination of flight controls and nose wheel steering, if available. If failure of the speed brake electrical system is suspected, the emergency system should be used to deploy the drag chute.

LANDING WITH FUEL IMBALANCE

1. Fuel imbalance—Determine amount and heavy wing.

   The difference between the left and right wing readings on the fuel quantity gage plus external fuel (2327 pounds) provides the approximate differential fuel weight and verifies the heavy wing.

2. Crosswind component—Determine for runway of intended landing.

   Attempt to land with heavy wing upwind.

Fuel Imbalance* (Pounds)		Touchdown Speed (KCAS)** Ⓐ Ⓑ				
	360 Gal. Ext	Cross-wind	Crosswind (Kt) from Side of Lighter Wing			
Clean	Tanks	0 Kt	5	10	15	20
2500	—	150	150	150	152	164
3000	—	150	150	150	162	172
3500	—	150	150	160	170	180
—	2500	170	170	170	170	174
—	3000	170	170	170	175	184
—	3500	170	170	175	185	192
—	4000	170	170	180	190	198
—	4500	170	180	190	197	204
—	5000	180	186	195	203	210
—	5500	185	193	200	209	216

*For a fuel imbalance less than the amount shown, use the touchdown speeds recommended for the total fuel on board.
**Add 20 Kt for prior to flare and 30 Kt for final approach.

Use the zero wind figure if the crosswind component is from the side of the heavy wing. If the crosswind is from the side of the lighter wing, the touchdown speed may be unsuitable for the landing conditions or runway length. Consideration then should be given to jettisoning external tanks to reduce the fuel imbalance or to landing from a direction that will place the crosswind from the side of the heavy wing.

3. Compute minimum touchdown, prior to flare, and final approach speeds.

   Select minimum touchdown speed from the table and add 20 knots for prior to flare speed and 30 knots for final approach speed.

WARNING

Landing should be accomplished from a straight-in approach if a fuel imbalance requires a higher than normal final approach speed. Severe directional control problems may be encountered during final turn from an overhead pattern if a major fuel imbalance exists.

RUNWAY DEPARTURE END CABLE ENGAGEMENT

Refer to RUNWAY OVERRUN CABLE ENGAGEMENT procedures in the TAKEOFF section.

auxiliary equipment

Section IV

48057

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AIR-CONDITIONING AND PRESSURIZATION SYSTEM

The air-conditioning and pressurization system uses hot bleed air from the engine high-pressure compressor. The hot air is first cooled in a heat exchanger and then refrigerated in a refrigeration turbine. To control cockpit temperature, hot air bypassed around the heat exchanger and the refrigeration turbine is mixed with cold air from the refrigeration turbine and discharged into the cockpit through outlets located under the canopy sills behind the ejection seat, on the floor outboard of the rudder pedals, and through diffusers (one on each side of the instrument panel). Normally, air is discharged into the cabin through the vertical outlets located behind the ejection seat. The horizontal outlets under the canopy sill are designed for use when flight conditions make the cockpit extremely hot and better circulation of air around the body is desired. A modulating temperature control valve, controlled either by a thermostat which measures cockpit air temperature or by a thermostat which measures cockpit inlet duct temperature, mixes the proper amounts of hot and cold air to maintain the selected inlet duct or cockpit air temperature. Cockpit pressurization (figure 4-2) is provided by regulating the rate of discharge of the conditioned air from the cockpit. An airflow control valve maintains airflow into the cockpit at a constant rate, and a pressure regulator valve controls cockpit air discharge to maintain an unpressurized cockpit up to an altitude of 12,500 feet, a cockpit altitude of 12,500 feet up to 31,000 feet, and a cockpit pressure five psi above ambient at altitudes above 31,000 feet. An emergency cabin pressurization system uses high-pressure pneumatic supply system air for cabin pressurization and includes a cabin pressure-low warning light. If the cabin air selector switch is in PRESS or OFF position when the cabin pressure altitude rises

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All data on page 4-3, including figure 4-1, sheet 2, deleted.

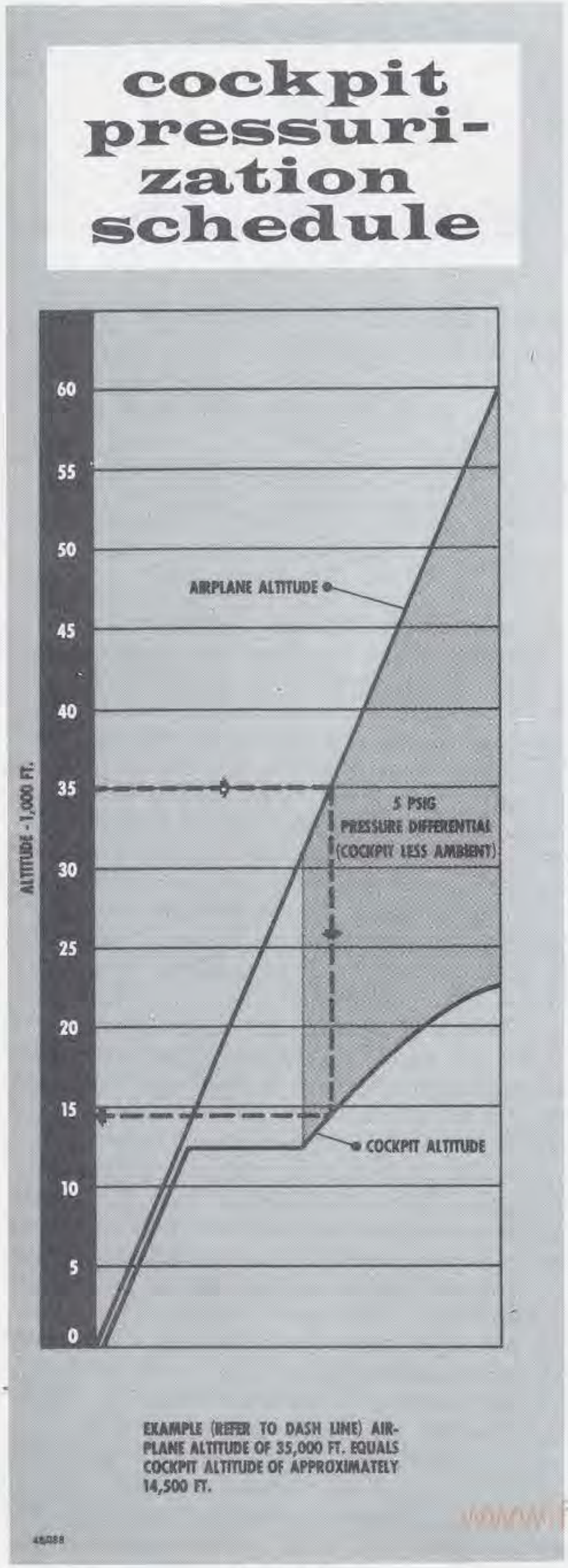

Figure 4-2

above approximately 44,000 feet, a pressure switch in the cockpit illuminates the cabin pressure-low warning light and electrically (dc essential bus power) opens a valve which admits air from the pneumatic supply system to the canopy seal and to the cabin for cabin pressurization. The pressure switch cuts off electric power, extinguishing the cabin pressure-low warning light and closing the valve to shut off pneumatic system pressure when cabin pressure altitude is decreased to approximately 26,000 feet. Pneumatic supply system air for emergency cabin pressurization is taken from the two main air supply bottles. If desired, the cockpit can be ventilated by ram air; however, pressurization and temperature control are not operative when ram air ventilation is used. Partially conditioned air which has been cooled in the air-conditioning system heat exchanger is always available for use in the following systems: fuel transfer, fuel tank pressurization, canopy seal, variable ramp seal, and anti-g suit pressurization. A connector located under the left wing is provided to permit using an auxiliary source of refrigerated air for ground cooling of the electronic compartment, missile bay, and cockpit.

ELECTRONIC COMPARTMENT COOLING AND PRESSURIZATION

Electronic compartment cooling and pressurization is provided through the airflow control valve which routes conditioned air in excess of that required for cockpit pressurization into the electronic and IFF compartments. When cockpit pressurization is shut off, a diverter valve routes the conditioned air to the electronics and IFF compartments. To prevent overcooling of the electronics compartments, engine bleed air is by-passed around the heat exchanger. This increases the temperature of the refrigeration unit intake air and, in turn, the temperature of the refrigeration unit discharge air. If the refrigeration unit switch is placed in the OFF position, the electronics ram air shutoff valve opens to supply ram air to the forward and aft electronics compartments for emergency electronics cooling. On Ⓑ airplanes when the refrigeration unit switch is placed in the OFF position, a second ram air shutoff valve opens to supply additional ram air for cooling of the upper aft electronics compartment equipment. When the MA-1 power switch is placed in the EMER position, cooling air will be routed directly to the electronic communications installation area, located in the aft electronic compartment. Pressurization of the electronics compartments is maintained by a fixed restrictor through which electronics compartment cooling air is discharged into the fuselage from where it flows into the missile bay and into the hydraulic compartment where it is dumped overboard. With the nose wheel well door open, air from the forward electronics compartment dumps overboard through the nose wheel well. A check valve prevents the flow of air from the aft electronics compartment into the nose wheel well so that with the nose wheel well door open, aft electronics compartment air flows through the fixed restrictor valve as it does during flight. For electronic compartment ground cooling, an auxiliary source of refrigerated air may be utilized through a connector located under the left wing.

CAUTION

For electronic equipment ground cooling limitations, refer to COOLING LIMITATIONS (GROUND OPERATIONS), Section V.

REFRIGERATION UNIT SWITCH

The refrigeration unit switch (figure 4-3) is located on the right console. On B airplanes the refrigeration unit switch is located in the forward cockpit only. The switch is placarded "Refr Unit," and has two positions, ON and OFF. With the switch in the ON position, the refrigeration unit shutoff valve is open to route engine high-pressure compressor bleed air through the refrigeration turbine and the electronics ram air shutoff valve is closed. The air-conditioning and pressurization system is under control of the cabin air selector switch. With the refrigeration unit switch in the OFF position, the electronics ram air shutoff valve is open and the refrigeration unit shutoff valve, the cabin temperature control valve and the hot-air regulator are closed. On B airplanes when the refrigeration unit switch is placed in the OFF position, a second ram air shutoff valve opens to supply additional ram air for cooling of the upper aft electronics compartment equipment. Engine high-pressure compressor bleed air cannot flow into the refrigeration turbine nor through the refrigeration unit bypass; therefore, the cockpit, electronics compartments, and IFF compartments cannot be pressurized and temperature control is not possible.

NOTE

- The refrigeration unit switch contains a locking feature which prevents the switch from being inadvertently moved to the OFF position. It is necessary to pull out on the switch before it can be moved to OFF.
- With the refrigeration unit switch in the OFF position, cockpit and electronic compartment pressurization and temperature control is not possible; however, ram air is supplied to the electronics compartment for emergency electronics cooling, and air which has been partially cooled in the heat exchanger is still available for the following functions: fuel transfer, fuel tank pressurization, canopy seal, variable ramp seal, and anti-g suit pressurization. On B airplanes a second ram air shutoff valve opens to supply additional ram air for cooling of the upper aft electronics compartment equipment.
- For ground cooling, with the ground cart, the refrigeration unit switch must be in ON position. This will close the emergency electronic cooling valve, and allow normal cooling.

CAUTION

- If the refrigeration unit switch is placed in the OFF position, the MA-1 power switch must be immediately placed in EMER position. To prevent overheating of the MA-1 system electronics equipment, airspeed should be reduced to 250 KCAS.
- If the refrigeration unit switch is placed in the OFF position and cabin altitude is above approximately 44,000 feet, the emergency cabin pressurization system will be actuated if the cabin air selector switch is not in the RAM position. Continued operation with the emergency pressurization system actuated will deplete the pneumatic power supply for the following: Constant-speed drive air-oil cooler shutoff valve, rudder feel system, armament system, emergency cg fuel transfer, normal hydraulic reservoir pressurization, and IR seeker head extension and retraction.

The refrigeration unit switch receives power from the dc essential bus.

CABIN AIR SELECTOR SWITCH

The cabin air selector switch (figure 4-3) is located on the right console. On B airplanes the cabin air selector switch is located in the forward cockpit only. The switch is placarded "Cabin Air" and has three positions, RAM, OFF, and PRESS. With the switch in the OFF position, the diverter valve is open to the electronics compartment while the ram air shutoff valves, the cabin safety vent valve, the cabin temperature control valve and the hot-air pressure regulator are closed. If the refrigeration unit switch is in the ON position, refrigerated air is supplied to the electronics and IFF compartments. Moving the cabin air selector switch to the PRESS position opens the diverter valve to the cabin, activates the hot-air pressure regulator, and permits automatic temperature control as selected by the cabin temperature control knob. Placing the cabin air selector switch in the RAM position opens the diverter valve to the electronics and IFF compartments, closes the hot-air pressure regulator, opens the cabin safety vent valve, and opens the ram air shutoff valve to route ram air to the cockpit. Whenever the cabin air selector switch is in the OFF and PRESS position and cabin altitude is above approximately 44,000 feet, the emergency cabin pressurization system will be actuated. The cabin air selector switch receives power from the dc essential bus.

CABIN TEMPERATURE CONTROL KNOB

The cabin temperature control knob (figure 4-3), located on the right-hand console, provides for automatic control of the cockpit temperature or for manual control of the system in the event of malfunction of the automatic control. On B airplanes the cabin temperature control knob is located in the forward cockpit only. The knob can be positioned through an AUTOMATIC HEAT range having a COLD position at one extreme and a HOT position at the other. With the knob set within this range, temperature is automatically controlled by modulating the temperature control valve to mix hot bleed air with refrigerated air in the proportions required to maintain the selected cabin temperature. To override the automatic system, the knob is depressed and is moved past either the HOT or COLD extreme of the automatic range into a neutral zone opposite the AUTOMATIC HEAT band. When the knob is in the neutral zone, automatic temperature control is not provided and the temperature control valve is no longer modulated but remains as it was when the knob was moved into the neutral zone. After the knob is in the neutral zone, temperature may be increased or decreased by turning the knob toward the dot below either the HOT or COLD position until the stop is felt. Temperature will then be increased (HOT position) or decreased (COLD position) as long as the knob is held at the dot. When the knob is released, it will return to the neutral zone.

CAUTION

> It is possible to force the knob beyond the stop. If this is done, the knob will not return to the neutral position when released, and erratic operation of the temperature control valve will result.

To return to automatic control, the knob is depressed and moved past either the HOT or COLD position and into the AUTOMATIC HEAT range. Power is supplied from the dc essential bus and the ac essential bus.

CABIN-AIR SELECTOR HANDLE

The cabin-air selector handle (figures FO-1 and FO-2) is located at the rear of the cockpit to the left of the seat. The handle mechanically operates a butterfly valve which directs discharge air either to the horizontal canopy sill outlets, to the vertical outlets behind the seat, or to both outlets simultaneously. Some airplanes have placards adjacent to the handle which read "Vertical Piccolo-Handle Down" and "Horizontal Piccolo-Handle Up." Other airplanes have placards reading "Vertical Piccolo-Handle Up" and Horizontal Piccolo-Handle Down." The handle may be positioned at an intermediate point to simultaneously direct air to the canopy sill outlets and the outlets behind the seat. The flow of conditioned air through the diffusers, and through the discharge tubes near the rudder pedals, is not affected by the cabin air selector handle. Normal cabin air inflow should be through the vertical outlets behind the seat, which are designed for low velocity inflow. The horizontal canopy sill outlets direct the flow at higher velocity around the pilot's body for increased circulation at high temperature conditions.

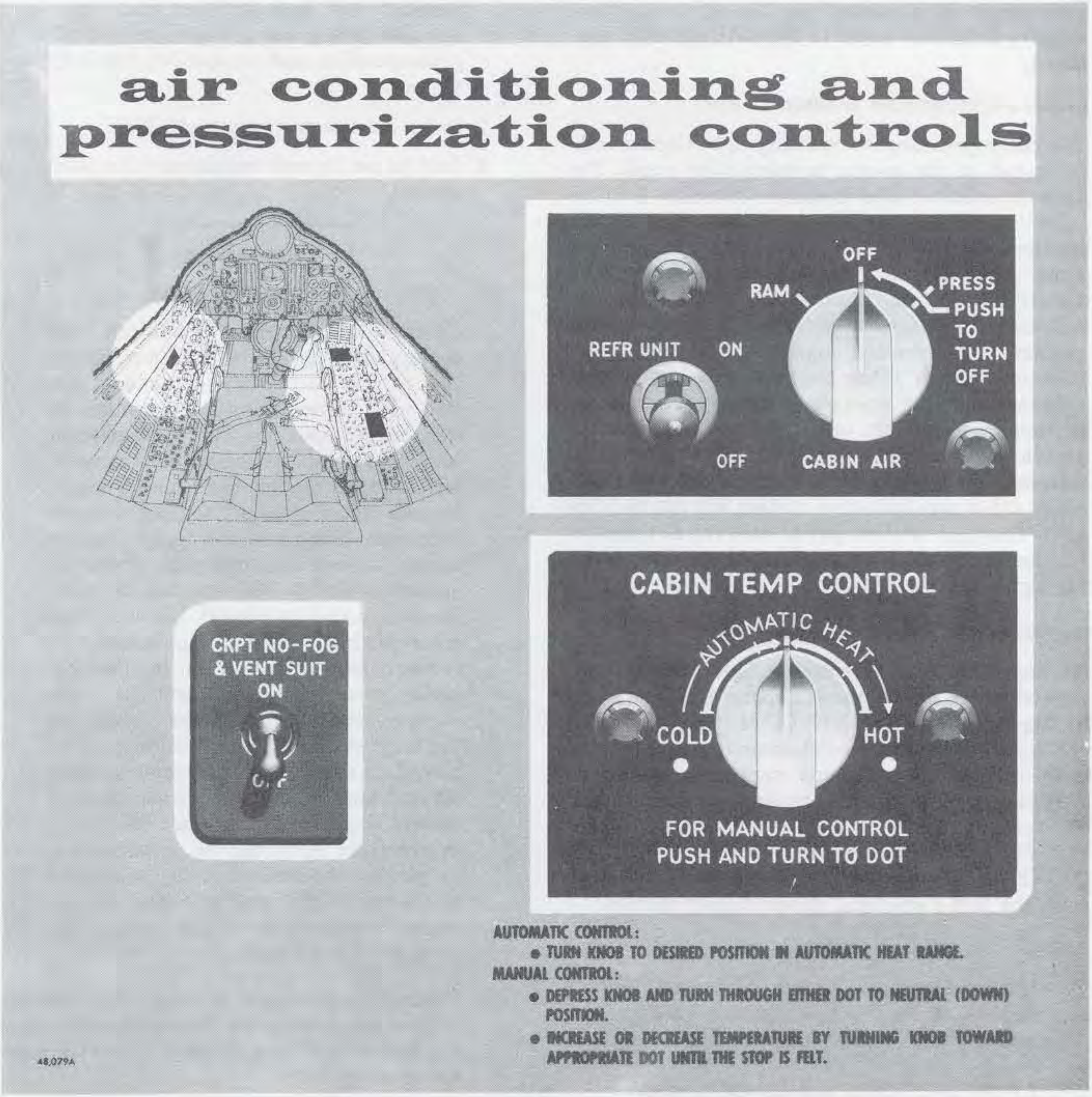

Figure 4-3

CABIN-AIR DIFFUSER HEADS

On airplanes with the conventional instrument display the cabin-air diffuser heads in the air-conditioning outlets (figures FO-1 and FO-2) are located on either side of the instrument panel. The heads can be adjusted manually to direct cooling air directly on the pilot, or can be completely shut off.

CABIN PRESSURE ALTITUDE GAGE

On airplanes with the conventional instrument display the cabin (cockpit) pressure altitude gage (figures FO-1 and FO-2) is located on the instrument panel. The gage indicates cockpit pressure altitude in feet above sea level. On airplanes with the integrated instrument system, cabin pressure altitude information is presented on the altitude-vertical velocity indicator. Refer to INSTRUMENTS, Section I.

CABIN PRESSURE-LOW WARNING LIGHT

The cabin pressure-low warning light (figure 1-36) is located on the master warning light panel. The light illuminates and displays "CABIN PRESS LOW" when cabin pressure altitude rises to approximately 44,000 feet. The light extinguishes when cabin pressure altitude drops to approximately 26,000 feet. Illumination of the light also indicates that the emergency cabin pressurization system is in operation supplying pneumatic pressure to the cabin. When the light is extinguished it indicates that the emergency cabin pressurization system has been shut off. If the cabin air selector switch has been placed in the RAM position, the warning lights will not illuminate and the emergency cabin pressurization system will not be actuated. The light receives power from the dc essential bus and is tested by depressing the master warning lights test button.

ELECTRONIC COOLING WARNING LIGHT

An electronic cooling warning light (figure 1-36) located on the master warning panel will illuminate to display "ELECTRONIC COOLING" when the cooling air directed to the electronic compartments is insufficient for sustained equipment operation. A heat sensor within the cooling air duct to the electronic compartments actuates the light. Refer to OPERATION OF ELECTRONIC COOLING SYSTEM, this section. The light receives power from the MA-1 electrical power supply system.

NOTE

When the MA-1 switch is placed in EMER or OFF the electronic cooling warning light will be inoperative.

OPERATION OF COCKPIT AIR-CONDITIONING AND PRESSURIZATION SYSTEM

1. Refrigeration unit switch—ON.

NOTE

With the refrigeration unit switch in the OFF position, air-conditioning and pressurization is inoperative with the exception of electronics cooling by ram air, and emergency cabin pressurization; however, air which has been cooled in the heat exchanger is available for fuel transfer, fuel tank pressurization, canopy seal, anti-g suit pressurization, CSD pressurization, and canopy anti-fog in Ⓞ aircraft.

2. Cabin air selector switch—PRESS.
3. Cockpit no-fog and ventilated suit switch—As desired.

WARNING

During high humidity conditions, the cooling effect produced by the refrigeration turbine of the air-conditioning system can create heavy condensation in the cockpit inlet air. This condensation forms a very dense fog within the cockpit. Under extreme conditions cockpit fog can reduce visibility to a point where it is impossible to see the cockpit instruments, as well as completely obscuring outside visibility. Cockpit fog is most likely to occur on takeoff, but may also occur during landing or go-around. To prevent fog formation in the cockpit under most climatic conditions (dew point of less than 80°F), the cockpit no-fog and ventilated suit switch should be placed on the ON position prior to takeoff and landing. Effective prevention of cockpit fog with ambient air dew point in excess of 80°F can be accomplished by placing the cockpit no-fog ventilated suit switch OFF and selecting a high cockpit temperature with the cabin temperature control knob.

4. Cabin temperature control—As desired. Adjust temperature as desired by positioning the temperature control knob within the automatic range.

NOTE

The cabin temperature control knob is bypassed and cannot be used to select cockpit temperature when the cockpit no-fog and ventilated suit switch is in the ON position. However, selecting MAN on the temperature control knob will override the cockpit no-fog and vent suit switch.

5. Cabin air selector handle—Adjust for vertical outlet.

6. Cabin air diffuser heads—As desired.

OPERATION OF ELECTRONIC COOLING SYSTEM

An electronic cooling warning light is located on the master warning light panel. The warning light system measures both cooling air temperature and airflow to the forward electronics compartment. It is possible for the light to illuminate under the following conditions:

GROUND OPERATION

a. Taxiing at idle rpm on warm days.

FLIGHT OPERATION

a. Reduction of engine power.

b. During letdown and approach.

c. Leveling out after a high-thrust climb.

d. Zoom maneuvers at high altitude.

e. Subsonic flight above 49,500 feet.

As with all electronic equipment, excessive heating is detrimental. If the electronic cooling warning light illuminates, refer to ELECTRICAL COOLING WARNING LIGHT ILLUMINATED, Section III.

ANTIFOG SYSTEMS

Electrical current and hot engine bleed air are used for defogging various parts of the airplane.

CANOPY HOT AIR ANTIFOG SYSTEM (A)

The canopy hot air antifog system uses a mixture of partially conditioned engine bleed air from the heat exchanger and cockpit air to defog the canopy panels. The hot air is distributed along the canopy panels by ducts attached to the canopy frame. The system is powered by the dc essential bus and is controlled by the canopy anti-fog switch.

CANOPY ANTIFOG SWITCH (A)

The canopy antifog switch (figure 4-4) is located on the right console. The switch is placarded "Canopy Antifog" and has positions ON and OFF. When the switch is placed to ON, an electrically operated valve opens and air from the heat exchanger enters the defog ducting to the pressure regulator and defog jet pump. The jet pump, creating a low-pressure area, draws air from the cockpit (behind the ejection seat) into the defog ducting. This mixture of air flows up into the manifold duct and forward along each side of the canopy sill where it is

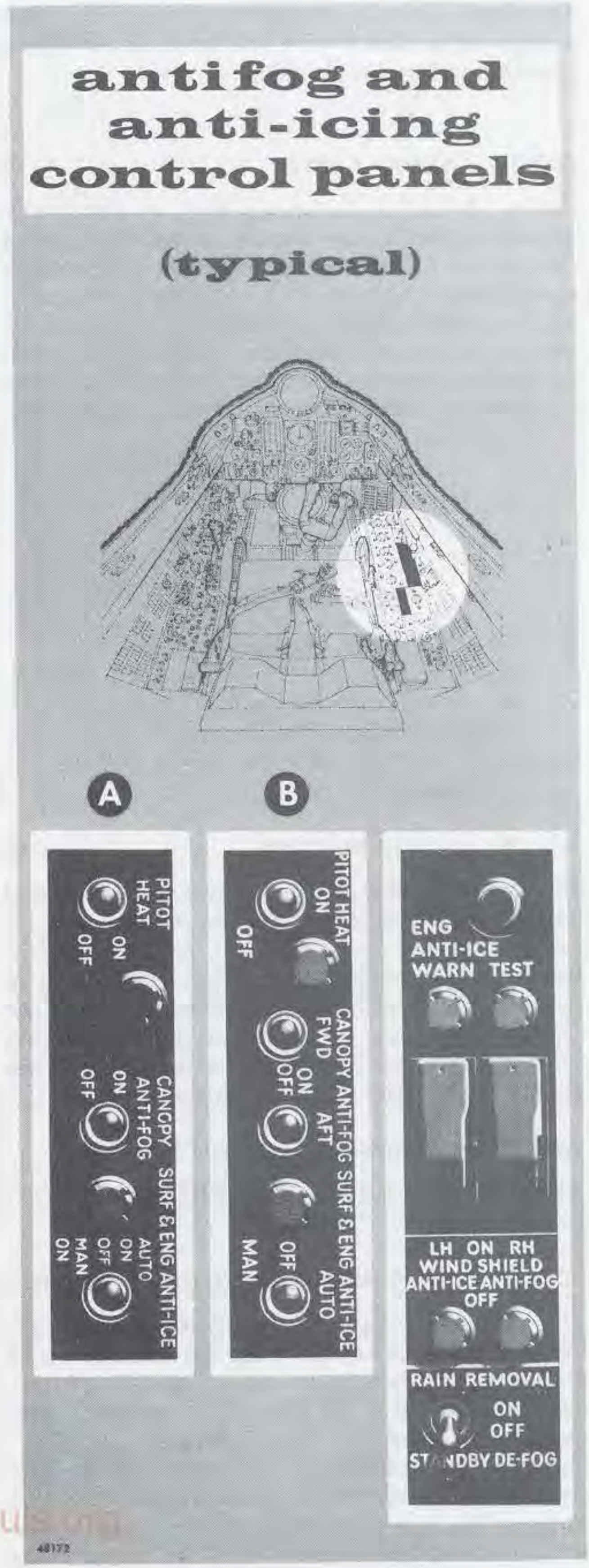

Figure 4-4

discharged through corrugated outlets onto each canopy panel. There is no provision for regulating the temperature by the pilot.

CANOPY ANTIFOG SYSTEM

Canopy defogging is accomplished by electrically heating a conductive coating embedded in each side panel. The system is identical to the windshield anti-ice system. Panel heating is controlled by the canopy antifog switches and temperature sensing elements which are embedded in each panel. The elements automatically control the electrical power supply, thus preventing overheating of the panels.

WARNING

Moisture within the canopy panels may cause arcing. If this occurs turn the canopy antifog switches OFF to prevent possible vertigo. If distortion of canopy panel is noted, turn the canopy antifog switches OFF.

CANOPY ANTIFOG SWITCHES

The canopy antifog switches (figure 4-4) are located on the forward right console. The switches are placarded "Canopy Anti-Fog—Fwd, Aft" and control the respective canopy panels. Each switch has two positions, ON and OFF. With either switch in the ON position, power is supplied to the selected (forward or aft) canopy antifog system. The switches receive power from the ac nonessential bus.

WINDSHIELD ANTI-ICING, ANTIFOG SWITCHES

Refer to ANTI-ICING AND RAIN REMOVAL SYSTEMS.

COCKPIT NO-FOG AND VENTILATED SUIT SWITCH

The cockpit no-fog and ventilated suit switch (figure 4-3) is located above the left console. On airplanes the cockpit no-fog and ventilated suit switch is located in the forward cockpit only. The switch is placarded "Ckpt No-Fog & Vent Suit" and has ON and OFF positions. Selecting the OFF position places cockpit temperature under control of the cabin temperature control knob. Placing the switch in the ON position transfers temperature control to the duct thermostats which maintain a constant discharge temperature of 80°F to prevent cockpit fog which could occur during landing and takeoff when humidity is high. The system is effective in the prevention of cockpit fog under most climatic conditions (dew point of less than 80°F). Under extreme climatic conditions of dew point in excess of 80°F effective prevention of cockpit fog can be accomplished by placing the cockpit no-fog ventilated suit switch OFF and selecting a high cockpit temperature with the temperature control knob. The cockpit no-fog and ventilated suit switch controls power from the ac essential bus.

NOTE

Selecting MAN on the temperature control knob will override the cockpit no-fog and vent suit switch.

MASK DEFOG RHEOSTAT

The mask defog rheostat (figures FO-1 and FO-2) located on the left console, is placarded "Mask De-Fog." This function has been disabled. The knob should be fully counterclockwise.

OPERATION OF ANTIFOG SYSTEMS

1. Canopy antifog switch(es)—ON.
2. Windshield anti-icing, antifog switches—ON.
3. Cockpit no-fog and ventilated suit switch—As desired.

NOTE

If excessive fog occurs during takeoff, landing, or go-around, and if the normal antifog systems do not remove the fog, place the cabin air selector switch in the RAM position.

ANTI-ICING AND RAIN REMOVAL SYSTEMS

Hot engine bleed air and electrical currents are used to anti-ice different parts of the airplane (figure 4-5). The engine and engine inlet duct lips, anti-icing systems and the windshield rain-removal system use unconditioned (hot) engine bleed air. Electrical current is used to anti-ice the windshield,

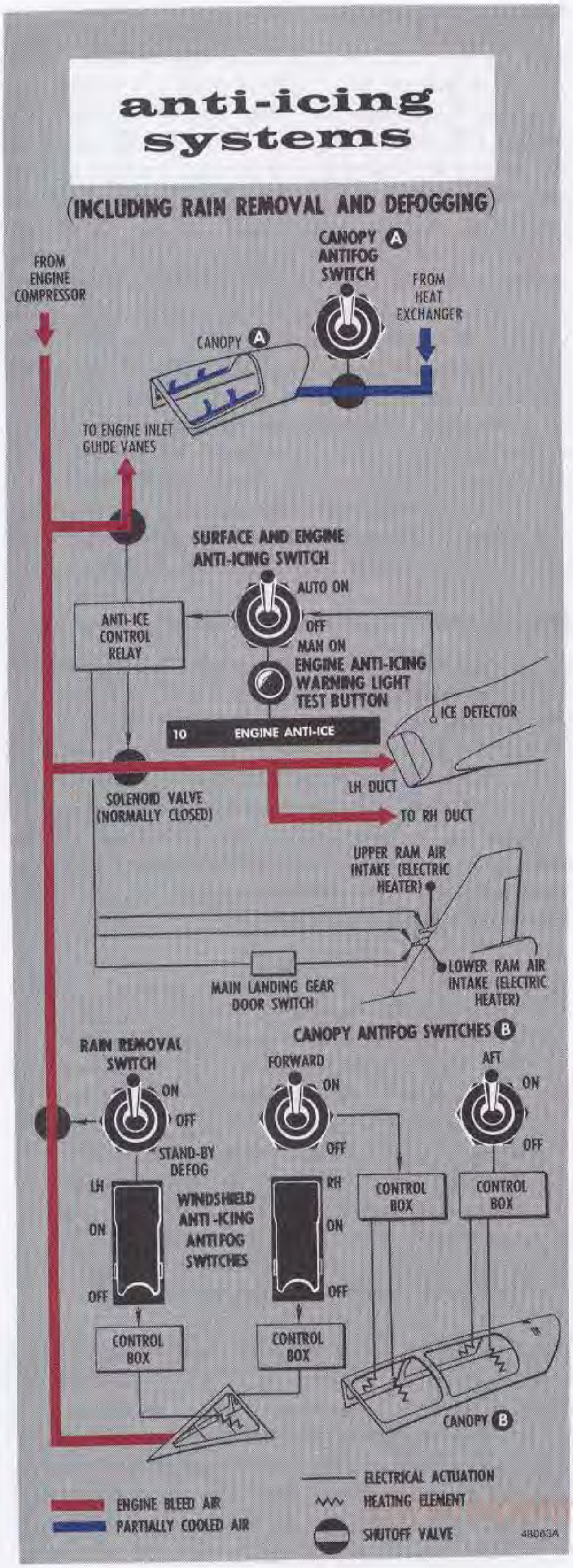

Figure 4-5

the two artifical feel system intakes on the leading edge of the vertical stabilizer, the pitot-static tube on the nose boom, and the two variable ramp pitot-static tubes in the engine air inlet ducts. Wing and vertical stabilizer anti-icing is not provided.

SURFACE AND ENGINE ANTI-ICING SYSTEM

The surface and engine anti-icing system is an automatic anti-icing detection and control system which controls three individual anti-icing systems: the engine, the engine air intake ducts, and the artificial feel system air intake anti-icing systems. An ice detector probe is mounted in the engine intake duct to sense icing conditions. If the automatic anti-icing system is armed, when the ice detector probe detects icing it automatically turns on the automatic anti-icing system and the probe immediately starts to de-ice. The probe normally de-ices in less than 17 seconds; however, a time delay relay holds the automatic anti-icing system on for one minute after the probe is de-iced. Though the probe may make several "ice—de-ice" cycles at intervals of less than one minute, the anti-icing system will remain on until there is no further indication of ice for a period of one minute after the probe is de-iced. The system will then automatically shut down until the next time the ice detector probe senses ice. If the probe becomes clogged, the probe heater fails, or for any reason the probe does not de-ice within 15 or 20 seconds, the pilot is informed through an indicator light on the master warning panel. The system may then be manually operated. Depressing the engine ignition button heats the ice detector probe to remove any ice which may have accumulated either in flight or on the ground.

ENGINE ANTI-ICING

The engine inlet guide vanes at the face of the compressor and the engine nose fairing are anti-iced by engine bleed air. The air flows through the hollow guide vanes into the engine nose fairing and is exhausted at the aft edge of the fairing. This system is a component part of the engine and is controlled through the surface and engine anti-icing switch.

CAUTION

Avoid using manual anti-ice unless operating subsonic in known icing conditions. Use results in slightly reduced EPR, and causes unnecessary wear to number one engine bearing and bullet nose.

NOTE

Operation below approximately 85% rpm may not supply sufficient heat to keep the engine inlet clear of ice under severe conditions. At the relatively high thrust settings used during climb or cruise, ample heat will be provided to assure protection. However, during descent at high airspeeds and low thrust settings, the heat supplied may be inadequate if the ice formation is severe. Under such circumstances, increased thrust should be applied to provide more heat.

INTAKE DUCT ANTI-ICING

The engine intake ducts are supplied with hot engine bleed air. The pressure regulated bleed air flows through the spanwise channels of the duct leading edge and is exhausted partly into the fuselage boundary layer flow area, and partly along the outside surface of the inlet lip. The system is controlled through the surface and engine anti-icing switch.

RAM AIR "q" PRESSURE INTAKE ANTI-ICING

The ram air pressure intakes on the vertical stabilizer are electrically anti-iced by power from the dc nonessential bus. Electrical power to heaters in the "q" probes is controlled through the surface and engine anti-icing switch. Output of the lower intake anti-icing heater is reduced when the main landing gear doors are open.

WINDSHIELD ANTI-ICING AND DEFOGGING

Anti-icing and defogging of two windshield panels is accomplished by electrically heating a conductive coating embedded in the panels. For each panel, a relay and a temperature sensing element embedded in the panel automatically control power to the panels to maintain the proper glass temperature. Left-hand windshield anti-icing is shut off and cannot be actuated whenever the rain removal system is in operation.

NOTE

Allow approximately two minutes between activation of the switch and actual defogging or anti-icing. Because of this time lag, the switches should be activated prior to takeoff if icing conditions are anticipated.

SURFACE AND ENGINE ANTI-ICING SWITCH

The surface and engine anti-icing switch (figure 4-4), located on the right console, is placarded "Surf & Eng Anti-Ice" and has three positions, AUTO ON, MAN ON, and OFF. On **B** airplanes the switch is located in the forward cockpit only, is placarded "Sur & Eng Anti-Ice," and has three positions, AUTO, OFF, and MAN. When the switch is in AUTO ON position and the anti-icing system warning light is extinguished, the system is armed and anti-icing of the engine inlet guide vanes, intake duct leading edges, and ram air pressure intakes on the vertical stabilizer is controlled by the automatic anti-icing system. When the switch is in the MAN ON position, the automatic features of the anti-icing system are bypassed and all of the anti-icing systems which are normally controlled by the automatic anti-icing system are activated regardless of icing conditions. The anti-icing switch receives power from the dc essential bus.

ENGINE ANTI-ICING WARNING LIGHT

A light on the warning light panel (figure 1-36) will illuminate to display "ENGINE ANTI-ICE" when the surface and engine anti-icing switch is in the OFF position, or when the switch is in AUTO ON and airflow through the engine intake duct is too low to actuate the ice detector probe or the ice detector probe heater is on for more than approximately 25 seconds. Illumination of the engine anti-icing warning light indicates that the automatic anti-icing system is inoperative.

NOTE

On airplanes equipped with the engine anti-icing warning test button, illumination of the warning light may indicate a malfunction in the automatic icing detector or a malfunction of the anti-icing shutoff valve. If the warning light extinguishes after placing the surface and engine anti-icing switch in MAN ON, the malfunction is in the icing detector circuits. If the light does not extinguish, the malfunction is in the valve.

The light illuminates when the surface and engine anti-icing switch is in the AUTO ON or MAN ON position and the engine anti-icing shutoff valve is in an intermediate position between open and closed. The light is part of the master warning system and receives power from the dc essential bus.

ENGINE ANTI-ICING WARNING LIGHT TEST BUTTON

An engine anti-icing warning light test button (figure 4-4) is located on the right console and is placarded "Eng Anti-ice Warn Test." Depressing the button for approximately three seconds will illuminate the engine anti-icing warning light if the surface and engine anti-icing switch is in either the AUTO ON or the MAN ON position.

NOTE

Depressing the engine anti-icing warning light test button will provide an operational check of the three- to five-second time delay relay only. With the button depressed for approximately three seconds, the engine anti-icing warning light will illuminate if the relay is operating properly.

WINDSHIELD ANTI-ICING, ANTIFOG SWITCHES

Two switches placarded "Windshield Anti-Ice, Anti-Fog, LH" and "RH" (figure 4-4) are located on the right console and have ON and OFF positions. On **B** airplanes the windshield anti-icing, antifog switches are located in the forward cockpit only. On some airplanes the switches are guarded. Fog as well as ice can be cleared from the entire surface of the windshield panels when the appropriate switch is placed on the ON position. The windshield heating elements and the control relays receive power from the ac nonessential bus.

NOTE

- If both the left-hand windshield anti-icing, antifog switch and the rain removal switch are in the ON position, the rain removal switch will take precedence and power will be temporarily disrupted to the left-hand windshield anti-icing, antifog circuit. The right-hand windshield anti-icing, antifog circuit is not shut off. This feature is provided to prevent structural failure resulting from overheating of the left-hand windshield panel.
- Allow approximately two minutes between activation of the switches and actual defogging or anti-icing. Because of this time lag, the switches should be activated prior to takeoff.

RAIN REMOVAL SYSTEM

Engine bleed air is used to remove rain and snow from forward sections of the left windshield panel. This system also aids in the prevention of ice or fog formation of this portion of the windshield. Nozzles below and forward of the windshield eject the hot air at high velocity from the rain clearing air duct. Flow of air to the nozzles is controlled by a two-position solenoid operated valve. When the rain removal system is in operation, the electrical power for left-hand windshield anti-icing is shut off.

Rain Removal Switch

The rain removal switch (figure 4-4) is placarded "Rain Removal" and has ON, OFF, and STANDBY DE-FOG positions. The switch is located on the right console. On **B** airplanes the rain removal switch is located in the forward cockpit only. With the switch in the ON position, the rain removal valve is open and a disconnect relay cuts power to the left-hand windshield electric anti-icing system. With the switch in the OFF position, the rain removal valve is closed and power can be supplied to the left-hand windshield electric anti-icing system, if the left-hand windshield anti-icing, antifog switch is in the ON position. If the rain removal switch is placed at STANDBY DE-FOG, the rain removal system will be armed for operation if ac nonessential power is lost.

CAUTION

To prevent inadvertent operation at supersonic speeds, the STANDBY DE-FOG position is not utilized. Refer to OTHER OPERATING LIMITATIONS, Section V, for limitations on the rain removal system.

The switch receives power from the dc essential bus.

NOTE

The rain removal system does not clear the entire left-hand windshield when used for anti-icing. The system should be used for anti-icing only if regular electrical anti-icing system fails.

CAUTION

Before making engine runups using ground electrical power, the rain removal switch must be placed in the OFF position to prevent damage to the windshield.

PITOT HEAT SWITCH

The pitot heat switch (figure 4-4), located on the right console, is placarded "Pitot Ht" and has ON and OFF positions. On Ⓑ airplanes the pitot heat switch is located in the forward cockpit only. When in the ON position, the switch supplies dc essential bus power to the pitot heater control relay. The relay in turn supplies ac essential or ATG power to the nose boom heater and ac nonessential power to the engine variable ramp pitot heaters. The pitot heat switch also controls power to the angle of attack transducer and beta vane heater circuits.

OPERATION OF ANTI-ICING SYSTEMS

To place the anti-icing systems in operation:

1. Surface and engine anti-icing switch—AUTO ON.
2. Windshield anti-icing, antifog switches—ON.
3. Pitot heat switch—ON.
4. Rain removal switch—As desired.

communications and associated electronic equipment

TYPE	FUNCTION	PRIMARY OPERATOR	RANGE	LOCATION OF CONTROLS
INTERPHONE EQUIPMENT	CONNECTS AUDIO OF RADIO AND NAVIGATION SYSTEMS AND PILOT'S HEADSET. ALSO PROVIDES COMMUNICATION BETWEEN PILOT AND GROUND CREW WHEN PLANE IS ON THE GROUND. PROVIDES COMMUNICATION BETWEEN PILOTS ON Ⓑ AIRPLANES.	PILOT (S) AND GROUND CREW	COCKPIT TO GROUND CREW AND BETWEEN PILOTS ON Ⓑ AIRPLANES.	GROUND CREW CONNECTION AND AMPLIFIER IN THE NOSE WHEEL WELL. ON Ⓑ AIRPLANES PILOTS' CONTROLS ON FWD AND AFT LEFT CONSOLES.
UHF RECEIVER TRANSMITTER	COMMUNICATIONS FROM AIRPLANE TO AIRPLANE AND FROM AIRPLANE TO GROUND BY UHF COMMUNICATIONS RADIO.	PILOT	LINE OF SIGHT.	LEFT-HAND CONSOLE.
AUTOMATIC DIRECTION-FINDING EQUIPMENT (UHF)	INDICATION OF RADIO STATION BEARING, OR AIRPLANE TO AIRPLANE BEARING.	PILOT	LINE OF SIGHT.	LEFT-HAND CONSOLE. INDICATOR ON INSTRUMENT PANEL.
TACAN	USED IN CONNECTION WITH TACAN SURFACE BEACON TO PROVIDE AIRPLANE GEOGRAPHICAL LOCATION.	PILOT	LINE OF SIGHT 300 MILES	RIGHT-HAND CONSOLE. INDICATOR ON HORIZONTAL SITUATION INDICATOR.
ILS RECEIVER	RECEIVES ILS LOCALIZER AND GLIDE SLOPE TRANSMISSION.	PILOT	LOCALIZER APPROXIMATELY 45 MILES; GLIDE SLOPE APPROXIMATELY 25 MILES.	LEFT-HAND CONSOLE. INDICATOR ON INSTRUMENT PANEL.
IFF/SIF (GROUND TO AIR)	AUTOMATIC RADAR IDENTIFICATION RETURNED IF CHALLENGED BY SURFACE EQUIPMENT. CAN TRANSMIT EMERGENCY IDENTIFICATION SIGNAL.	PILOT	LINE OF SIGHT.	LEFT-HAND CONSOLE.
DATA LINK	GCI DATA RECEIVER.	PILOT	200 MILES LINE OF SIGHT.	RIGHT-HAND CONSOLE.

Figure 4-6

Figure 4-7

COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT

See figure 4-6 for a summary of communications and associated electronic equipment. Figure 4-7 shows antenna locations.

INTERPHONE SYSTEM (A)

An interphone system is installed to permit communications between the pilot and ground crew through the nose wheel well connection. The microphone is hot and operates on airplane dc essential power. Volume is controlled by the volume control knob on the UHF command radio panel.

INTERPHONE SYSTEM (B)

The interphone system provides audio communication between the pilots. When the airplane is on the ground with the ground interphone equipment connected, the system also allows communication between persons in the cockpit and outside the airplane. The interphone functions as a "hot mike" (the microphone buttons need not be depressed to communicate on interphone). The pilot's microphones and headsets are part of the interphone system. Volume controls, located on the forward and aft left consoles, allow the pilots to select a comfortable volume level for listening. A receptacle on the nose wheel well switch panel provides for connection to the interphone system by the ground crew. The interphone system operates on airplane dc essential power.

Intercom Volume Control Knob

The intercom volume control knob (figure FO-2), located on the forward and aft left consoles, is normally set at a comfortable volume level for listening, but can be used to reduce volume below hearing level if so desired.

Operation of the Interphone System

1. Master electrical power switch—ON or external power connected.
2. Adjust volume control to desired listening level.

NOTE

The interphone system functions as a "hot mike," and the microphone buttons need not be depressed to communicate on interphone. Depressing a microphone button cuts out interphone communications and actuates the UHF command radio transmitter. When either cockpit microphone button is depressed, either pilot can transmit on UHF communications. When either pilot is transmitting on UHF, the other pilot hears the transmission through the UHF circuits and not through normal interphone circuits.

UHF COMMAND RADIO — AN/ARC-164

The command radio, AN/ARC-164, consists of a receiver-transmitter, a control panel, a remote indicator, and an automatic direction finding (ADF) unit. The UHF antenna is located on the bottom of the fuselage forward of the missile bay door. The control panel (figure 4-8) is located on the left console and permits selection of 20 preset channels, manual selection of any frequency in the operating range, or selection of a preset guard frequency.

The remote indicator displays the preset channel, the manual frequency, or the guard frequency. The command radio is powered by the dc essential bus.

Function Control Switch

The function control switch (figure 4-8) is a four-position rotary switch that controls the following functions: The OFF position removes power from the set; the MAIN position enables the transmitter and receiver to operate on the same selected main frequency; and the BOTH position allows transmission and reception on the MAIN selected channels and simultaneous reception on the GUARD channels. The ADF position is inoperative in this installation.

Tone Button

A springloaded button placarded "Tone" is located on the UHF control panel (figure 4-8). Depressing the button interrupts reception and provides a continuous tone transmission on the selected frequency. The tone transmission aids ground stations in obtaining a direction finding bearing.

Volume Control Knob

The volume control knob on the UHF control panel (figure 4-8) is placarded "Vol." It controls all audio volume except the landing gear warning tone and the altitude warning tone.

Squelch Control Switch

The squelch control switch (figure 4-8) is a two-position switch for control of the receiver squelch. ON allows squelch circuits to operate normally in main and guard receivers. OFF disables squelch in the main receiver allowing receiver noise in the absence of a signal and may increase reception range. The normal position of the switch is ON to avoid uncomfortable noise in the audio system.

Mode Control Switch

The mode control switch (figure 4-8) is a three-position rotary switch used to select the desired operating mode. The manual position of the switch permits any desired frequency within the operating range of the set to be manually selected by the manual frequency selector knobs. The GUARD position selects the fixed guard frequency for the main receiver and transmitter. The PRESET position is used to allow selection of any of 20 preset frequencies. When the mode control switch is at PRESET, movement of the channel selector knob changes the frequency of the desired preset channel. A numerical indication of the preset selected channel appears in the channel indicator window.

A record of the frequencies that have been preset and assigned to the 20 channels can be noted on the preset channel frequency card.

Preset Channel Selector Knob

The preset channel selector knob (figure 4-8) is a 20-position rotary control linked to a memory drum on which 20 preset frequencies can be stored. The corresponding numerical indication of the preset frequency selected will appear in the channel indicator window.

Preset Channel Indicator Window

The preset channel indicator window (figure 4-8) displays the corresponding numerical indication of the preset channel selected by the preset channel selector knob.

Frequency Indicator Windows

The frequency indicator windows (figure 4-8) display the frequency selected by the manual frequency selector knobs.

Manual Frequency Selector Knobs

Five manual frequency selector knobs (figure 4-8) are used to select frequencies within the operating range of the set. The digits of the selected frequency are displayed in the frequency indicator windows.

Preset Channel Frequency Card

The preset channel frequency card (figure 4-8) serves as a hinged cover for the memory PRESET switch and records the preset channel frequencies.

Memory Preset Button

The memory preset button (figure 4-8) is used to set 20 preselected frequencies on the transceiver's memory drum.

Presetting Frequency Channels

New frequencies are preset by selecting PRESET on the mode control switch, placing the channel selector knob on the desired channel, setting the desired frequency with the manual frequency selector knobs, and depressing the preset button.

UHF Remote Indicator

The UHF remote indicator (figures FO-1 and FO-2) is located on the instrument panel and is labeled

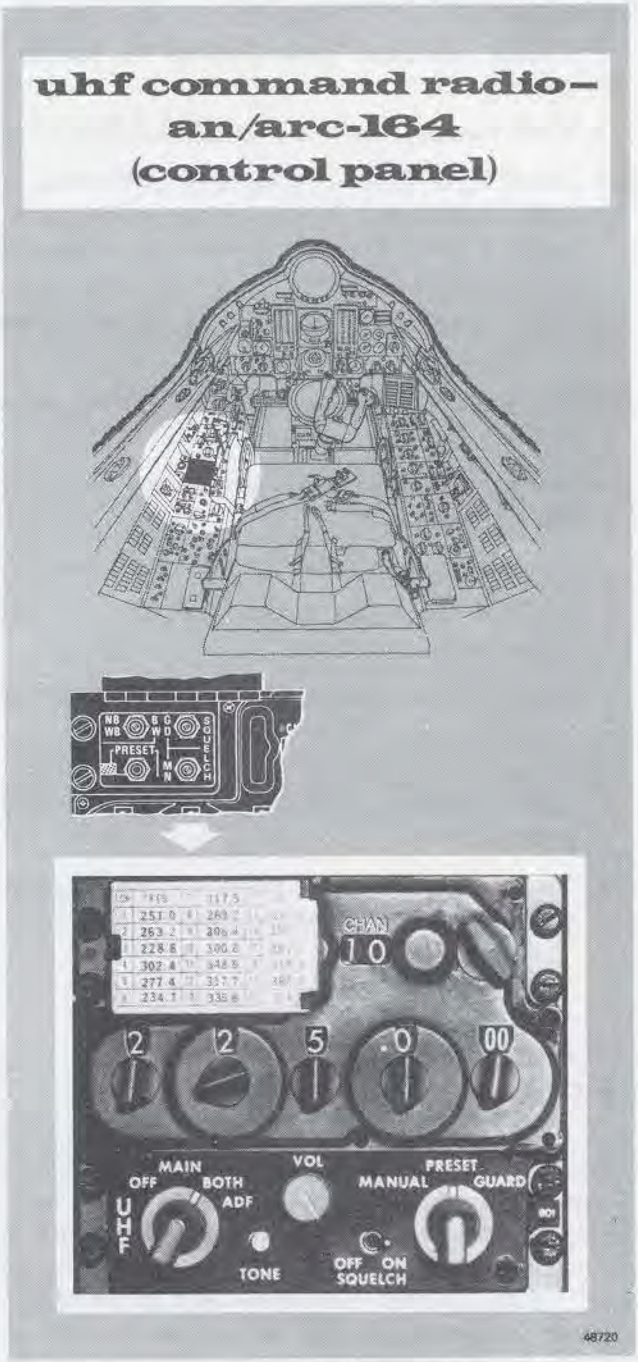

Figure 4-8

UHF. With the mode selector switch in PRESET, the selected preset channel appears in the remote indicator. When the mode switch is in MAN position, the five-digit manually selected frequency is displayed. Guard frequency is displayed when the mode switch is in GUARD position. On Ⓑ airplanes, the UHF remote indicator functions only in the cockpit having control of the radio.

Operation of UHF Command Radio — AN/ARC-164

1. Master electrical power switch or external power—ON.
2. UHF function control switch—BOTH/MAIN.
3. Check UHF-TACAN control transfer monitor light illuminated. If light is not illuminated, depress UHF-TACAN transfer button and recheck light illuminated.
4. Select PRESET with the UHF mode control switch.
5. Select desired channel with the UHF channel selector knob.
6. Adjust the UHF volume control knob for desired audio level.
7. To operate on a manually selected frequency:
   a. Place the mode control switch to MAN position.
   b. Select the desired operating frequency using the manual frequency selector knobs.
8. To transmit and receive on guard frequency, place the mode control switch to GUARD position.
9. To turn off the UHF command radio, place the UHF function control switch to OFF.

UHF and TACAN Control Transfer Buttons and Control Monitor Lights

The UHF and TACAN control transfer buttons (figure 4-9), one on the forward and one on the aft transfer control panels, are placarded "UHF Comm TACAN." The buttons are used to shift control of the command radio and the TACAN to the forward or aft control panels. A monitor light in the switch housing illuminates in the cockpit having control. Control is transferred by depressing the button. For example: if control is at the forward panels, as indicated by illumination of the forward monitor light, depressing the aft UHF control transfer button will shift control to the aft control panels and illuminate the aft control monitor light. The control transfer buttons and control monitor lights receive power from MA-1 electrical power supply system. When the MA-1 power switch is placed in EMER position, control is automatically transferred to the forward control panels.

AUTOMATIC DIRECTION FINDER

The automatic direction finder provides an indication of the bearing of transmitting stations picked up on the UHF command radio. A bearing of GCI transmitting stations can also be received through the data link receiver. The station bearing is indicated by the HSI bearing pointer (airplanes with the integrated flight instrument system) and the TSD command heading pointer (airplanes with the conventional instrument display). The automatic direction finder is on and in standby at any time the command radio is on. On airplanes with the conventional instrument display, controls for the ADF are located on the tactical situation display indicator. On airplanes with the integrated flight instrument system, the controls are incorporated as part of the bearing selector switch. The antenna is located under the fuselage just forward of the nose wheel well. Power is supplied from the ac and dc essential buses; however, the ADF will not be powered if the MA-1 power switch is in OFF position.

Operation of Automatic Direction Finder

NOTE

For frequency selection details, refer to OPERATION OF UHF COMMAND RADIO, this Section.

1. TSD mode selector switch—ADF-CMD (some airplanes).
   Bearing selector switch—UHF-ADF or DL-ADF (other airplanes).
2. Select direct command radio frequency.
   Station bearing will be indicated by one of the following methods:
   a. By the grid pointer on the TSD. An arrow on the diametral line of the TSD indicates the bearing on the compass on airplanes with the conventional instrument display.
   b. By the bearing selector pointer on the HSI on airplanes with the integrated flight instrument system.
3. The command ADF feature is turned off by changing to any position other than an ADF selection on the TSD mode selector switch or the bearing selector switch (as applicable).

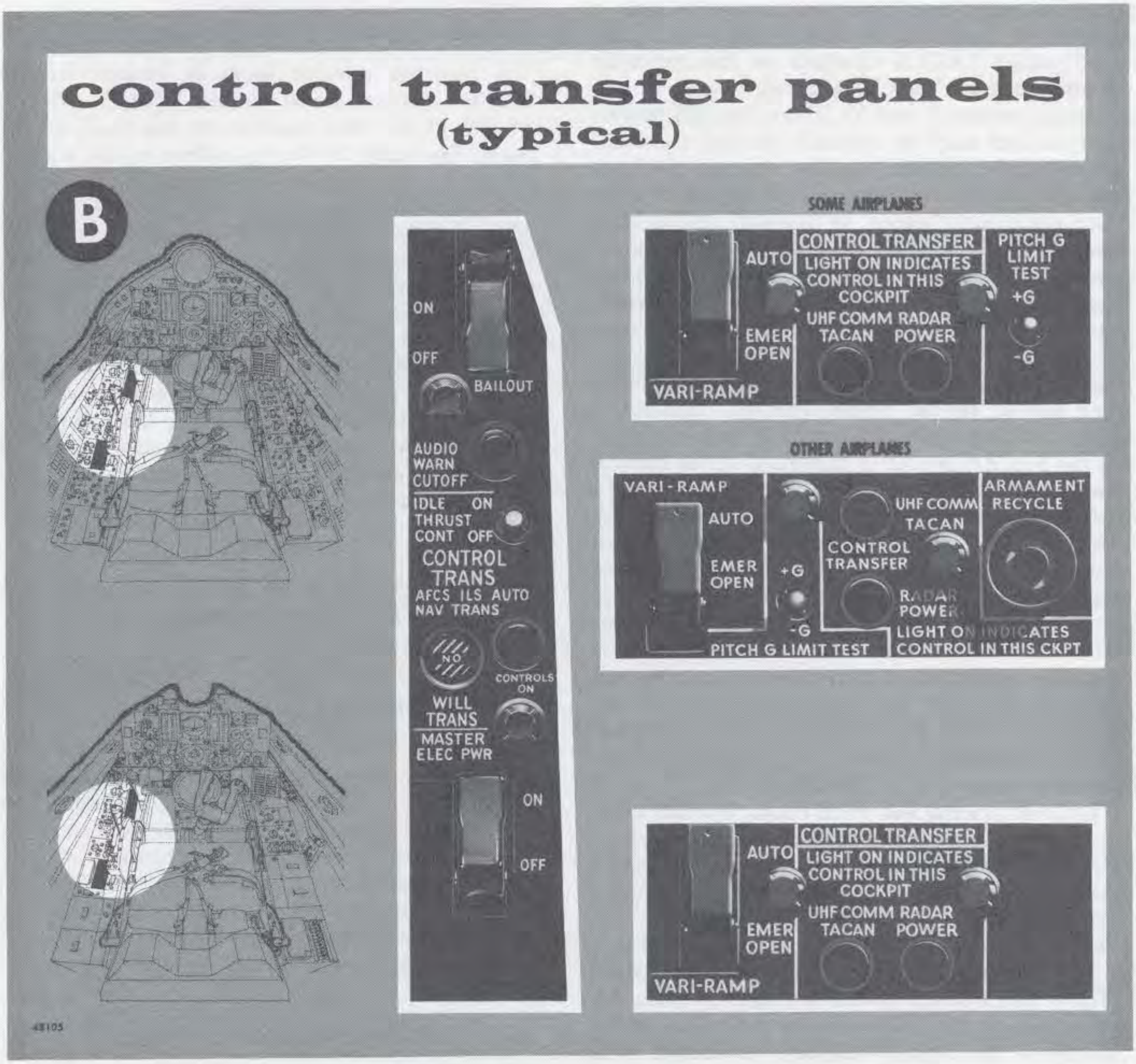

Figure 4-9

NOTE

- Bearings of the TSD grid pointer are repeated by the HSI bearing pointer.
- UHF audibility will be degraded when using ADF position.
- On B airplanes, ADF function is inoperative unless control of both UHF and AFCS is in the same cockpit.

TACAN

The TACAN (Tactical Air Navigation) equipment operates in conjunction with a surface navigation beacon or with the TACAN equipment in a similarly equipped airplane. The system enables the airplane to receive continuous indications of range and bearing from a fixed TACAN beacon or line-of-sight distance only to a cooperating airplane with a maximum range of 300 nautical miles. TACAN equipment consists of a receiver-transmitter unit, a control unit, and a signal data converter. Any one of 23 preset TACAN channels or 126 manually selected channels may be selected in each of two operating modes (X and Y). Three TACAN operating functions may be selected: receive, transmit/receive, and air-to-air. In the receive function, TACAN provides continuous bearing information to a fixed ground beacon. In transmit/receive function, both bearing and distance to the selected ground beacon are provided. In air-to-air function, TACAN receives range information from a cooperating airplane and serves as a transponder to a maximum of five cooperating airplanes. In the air-to-ground functions (receive and transmit/receive) when one of the 23 preset TACAN channels is selected, a map of the geographical area surrounding the TACAN beacon is presented on the tactical situation display (TSD). The displays of the 23 TACAN areas are preset and controlled by the MA-1 computer. For each preset channel there is a choice of either a 50-, 200-, or 400-mile radius scale map of the specific area. The scale presented is governed by the position of the radius miles selector switch on the TSD. When a TACAN station is selected, the digital computer receives bearing and range signals from the station and converts the signals into MA-1 grid coordinates of the interceptor. An interceptor projected on, and moving relative to the map display, provides a direct readout of TACAN bearing and slant range. Manual selection is used to select one of the 126 TACAN channels regardless of location. Operation on a manual channel does not present a map of the transmitter area on the TSD. Instead, manual selection provides a choice of any one of three indexes and test maps (see MAP SELECTION and RADIUS MILES SELECTOR SWITCH, this Section). An annunciator on the TSD presents indications of the validity of the TACAN display. Associated with each TACAN station is a convergence angle that is used to position the interceptor bug on the TSD. For preset TACANs, the convergence angle is programmed into the MA-1 computer via the auxiliary data tapes. Since this information is not available for manual TACANs, the computer sets the convergence angle to that of the last preset that was selected for more than 10 seconds when manual TACAN is selected. Power is supplied from the ac essential and ac nonessential buses, or from the ATG bus after generator failure. TACAN will not be powered if the MA-1 power switch is in OFF.

TACAN Function Selector Knob and Indicator Window

The function selector knob is located on the TACAN control panel (figure 4-10). It is the smaller of the two controls on the right of the panel. The knob has four positions which are displayed in the indicator window below the knob. The positions in clockwise order are OFF, REC, T/R, and A/A. In the OFF position, power is removed from the set. In REC (receive), TACAN receives bearing data from a ground beacon. In T/R (transmit/receive), distance and bearing data are available from a ground beacon. In A/A (air-to-air), TACAN supplies line-of-sight distance to a cooperating airplane. To cooperate with another airplane in the air-to-air function, both airplanes must have A/A selected and the channels selected must be 63 channels apart. Cooperating airplanes must operate in the same mode (X or Y).

NOTE

> The IFF may cause interference/unlock during TACAN A/A mode on channels 3, 6, 66, and 69.

Preset TACAN Channel Selector Knob

The preset channel selector knob, placarded "Preset," is located on the TACAN control panel (figure 4-10). It is the larger of the two knobs on the right of the panel. The knob is used to select one of the 23 preset TACAN channels. A 24th position, labeled M, is used when manual channel selection is desired. As the preset channel selector knob is rotated, the switch position is displayed in a window on the left side of the knob.

Manual TACAN Channel Selector Controls

The manual channel selector controls, placarded "Man," consist of two concentric knobs on the left of the TACAN control panel (figure 4-10). The knobs are used to select one of the 126 manual TACAN channels available. The selected channel is displayed in a window on the left side of the controls. The larger (outer) knob controls positions 1 through 12 with a blank for zero. These selections are displayed as the first or first and second digits in the indicator window. The smaller knob controls positions 0 through 9 which appear as the last digit in the window.

TACAN Volume Control Knob

The volume control knob (figure 4-10) is placarded "Vol." It is used to control the audio level of the TACAN station identification signal.

TACAN Mode Selector Switch

The mode selector switch, placarded "Mode," is located on the TACAN control panel (figure 4-10)

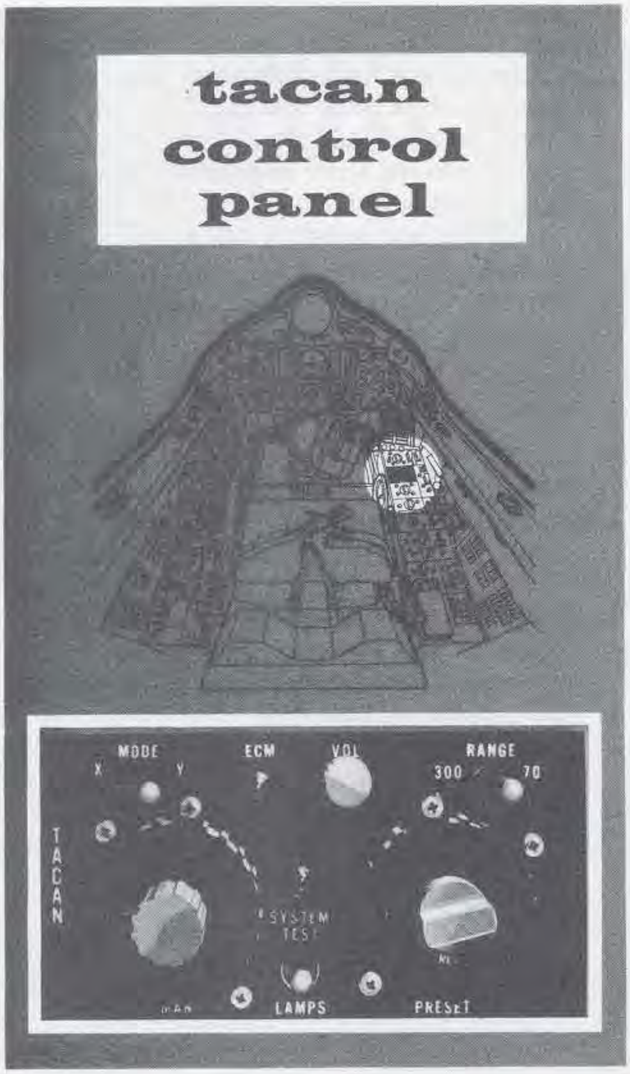

Figure 4-10

and has positions X and Y. In the X position, the 23 preset or 126 manual channels of the X-mode may be selected. In the Y position, 23 preset or 126 manual channels in the Y-mode may be selected. The switch is effective when using manual TACAN channel selection and in the air-to-air function. (When operating on preset channels, the TACAN equipment automatically selects the X or Y mode.)

NOTE

> Y mode is not operational for ground stations.

TACAN Range Selector Switch

The range selector switch is located on the TACAN control panel (figure 4-10) and is placarded "Range." It has positions 300 and 70. In the 300 position, the TACAN operates over the full 300-mile range. Placing the switch in the 70 position prevents the processing of range information from stations beyond the 70 miles range.

NOTE

> Selecting the 70 position when TACAN distance is greater than 70 nautical miles will not cause the range window on the HSI to shutter. Displayed range will normally be erroneous.

TACAN System Test Switch

The system test switch on the TACAN control panel (figure 4-10) has placarded positions of SYSTEM TEST and LAMPS and is spring-loaded to the center (off) position. The switch provides a go, no-go test of the TACAN. Holding the switch in the SYSTEM TEST position activates self-test circuits in the receiver transmitter causing the following self-test sequence: system test indicator light illuminates and an audible tone is heard; system test light goes out and audible tone ceases; bearing pointer drives to 069°; range indicator drives to zero.

NOTE

> If TACAN is in the A/A mode when the switch is placed in SYSTEM TEST, the system test indicator lamp will flash erratically unless there is another aircraft cooperating in A-A mode.

Holding the switch in LAMPS position causes the ECM indicator light and the system test indicator light to illuminate as a check of lamp operation.

TACAN System Test Indicator Light

The system test indicator light on the TACAN control panel (figure 4-10) is located immediately above the system test switch. The amber light illuminates and remains illuminated if a no-go condition exists when the system test switch is held in the SYSTEM TEST position. The amber light also illuminates when TACAN is turned on and goes out when warmup of the set is completed. Light operation is checked by holding the TACAN system test switch in the LAMPS position.

TACAN ECM Indicator Light

The ECM indicator light on the TACAN control panel (figure 4-10) is placarded "ECM." The amber light illuminates when a TACAN jamming signal is detected by the decoder in the receiver-transmitter. Light operation is checked by holding the TACAN system test switch in the LAMPS position.

Figure 4-11 deleted.

TACAN Bearing/ADF Select Switch

On airplanes with the conventional instrument display, a two-position switch, installed above the right console, determines whether the HSI bearing is controlled by TACAN bearing or ADF bearing (CMD or DL). When the switch is set to TACAN BEARING, the HSI bearing pointer indicates bearing to a selected TACAN station regardless of the position of the TSD mode switch. When the switch is set to ADF and the TSD mode selector switch is set to ADF-CMD, the HSI bearing pointer indicates bearing to the UHF radio transmitter to which the command radio is tuned. With the switch in ADF and the TSD mode selector switch in ADF-DL, the bearing pointer indicates bearing to the UHF transmitter to which the data link equipment is tuned. If ADF is selected and the TSD mode switch is not at ADF-CMD or ADF-DL, the bearing pointer indication may be erroneous.

TACAN Annunciator

The TACAN annunciator (figure 4-14) is located on the TSD. The TACAN annunciator indicates the condition of the interceptor information on the TSD. Five displays are possible on the annunciator:

a. "OK"—Valid TACAN information is being received. This consists of range and bearing information used to position the interceptor symbol on the TSD (indirectly by the digital computer), to compute wind, and to make dead reckoning computations.

b. "VR"—Valid range is being received and displayed (HSI). If valid DR position is available, the digital computer will DR the course deviation indicator. If computer DR becomes invalid, the CDI will center in line with the course pointer. TSD interceptor symbol position is being dead reckoned by the computer.

c. "BV"—Valid bearing is being received and displayed (HSI). If valid DR position is available, the digital computer will DR range and the range counter on the HSI will be unmasked. If computer DR becomes invalid, the range counter will be masked. TSD interceptor symbol position is being dead reckoned by the computer.

NOTE

With the display of VR (or BV) the display of bearing (or range) may be dead reckoned from previously received TACAN (OK has been displayed during flight) or from initial position (OK has not been displayed during flight). If it is desirable to determine which is the case, TACAN reception of a valid signal may be interrupted and the display of DR or OFF checked.

d. "DR"—Range and bearing are not being received and interceptor position and HSI range and bearing are being dead reckoned by the digital computer from the last valid TACAN data, using the last wind computation.

e. "OFF"—Reliable TACAN information has never been received.

Valid TACAN must be received to obtain a valid annunciator indication; both range and bearing to display OK; valid range only to display VR and bearing valid only to display BV. Prior to TACAN reception, the TACAN annunciator indicates OFF. However, interceptor position is being dead reckoned by the computer from initial position. If BV is the first indication of TACAN reception, valid bearing is available on the HSI and range (HSI) and interceptor position (TSD) are being dead reckoned from initial position by the computer. The converse is true if VR is the first indication. If this first reception of range or bearing is subsequently lost prior to an OK indication, OFF will again be displayed. When both range and bearing are received simultaneously, OK is indicated. If TACAN is lost after an OK indication DR will be displayed until range or bearing or both are received. Once an OK is obtained, OFF will not be displayed again until the flight is terminated (Mach less than 0.25 and ILS selected). When BV or VR is displayed, the use of the valid information on the HSI should be considered when utilizing the dead reckoned position of the interceptor on the TSD, since the computer will DR from initial position or from last valid TACAN position without consideration of the amount of time received or time since last received.

Operation of TACAN Equipment

1. MA-1 power switch—WARM, RADAR STBY, or ON; power annunciator displaying "OK."
2. TACAN function selector knob—As required.

NOTE

When A/A is selected, the bearing pointer is meaningless and the TACAN annunciator initially displays VR. For eight seconds after A/A selection, it is possible that range information from the last selected TACAN ground site is still being presented. After eight seconds, if valid air-to-air range is not available, the TACAN annunciator displays DR. If valid air-to-air range is available, the VR annunciator display will be retained.

3. TACAN mode selector switch—X or Y as required.
4. TACAN range selector switch—300 or 70 as desired.
5. Preset TACAN channel selector knob—Set to desired channel or M (depending on whether preset or manual selection is desired).
6. Manual TACAN channel selector knobs—Set to desired channel (if manual selection is desired and the preset channel selector knob is in the M position).
7. TACAN volume control knob—Adjust to desired level and identify station.

NOTE

TACAN may lock onto the wrong station. Station identification should be accomplished when making a channel selection.

8. TACAN ECM indicator light—Out.
9. Lamp and system test (if desired):
   a. TACAN system test switch—LAMPS; check ECM indicator and system test indicator lights illuminated.
   b. Select channel that is beyond receiver range.
   c. TACAN system test switch—SYSTEM TEST.
   d. System test light on; audible tone in earphones.
   e. System test light out; audible tone off.
   f. Bearing pointer to 069°.
   g. Range indicator to zero.
   h. TACAN annunciator—OK.
   i. TACAN system test switch—Release.

NOTE

System test in air-to-air function provides a test of range reception only.

10. TSD scale selector switch—Set as desired.
11. TSD light intensity rheostat and red filter switch—Set as desired.
12. TACAN annunciator—Check to determine availability of TACAN signals.
13. Bearing selector switch—TAC (airplanes with integrated flight instrument system).
14. Deleted.
15. TACAN bearing/ADF select switch—TACAN BEARING (if installed).

ILS (INSTRUMENT LANDING AND APPROACH SYSTEM)

The ILS equipment consists of a glide-slope-marker beacon receiver, a localizer receiver, channel selector, and a volume control. The proper glide-slope and localizer frequency are selected when the ILS channel selector switch is set at the preset ILS channel. The airplane can be manually flown on an ILS approach, or the automatic flight control system can be selected which will automatically fly the airplane down the approach path in response to ILS signals. The ILS equipment is operable at all times in normal flight, but does not supply steering signals to the automatic flight control system unless the flight mode selector switch is in the AUTO position and the automatic mode selector switch is in the ILS position. The ILS equipment receives power from the dc essential and ac nonessential buses, or from the ATG bus after generator failure. The ILS will not be powered if the MA-1 power switch is OFF.

NOTE

- With the ILS volume control knob turned up, headset noise may be mistaken for faulty UHF reception.
- On airplanes with conventional instruments, indications displayed on the ADI give both localizer and glide-slope information during an instrument landing approach.

ILS Channel Selector Switch

An ILS channel selector switch (figure 4-12) is located on the left console. The switch is placarded "Channel Selector" and has 20 positions. Each position represents a preset ILS channel.

ILS Volume Control Knob

A volume control knob is located adjacent to the ILS channel selector switch. The knob varies the level of the localizer audio signals delivered to the headset.

Operation of ILS Equipment

1. Deleted.

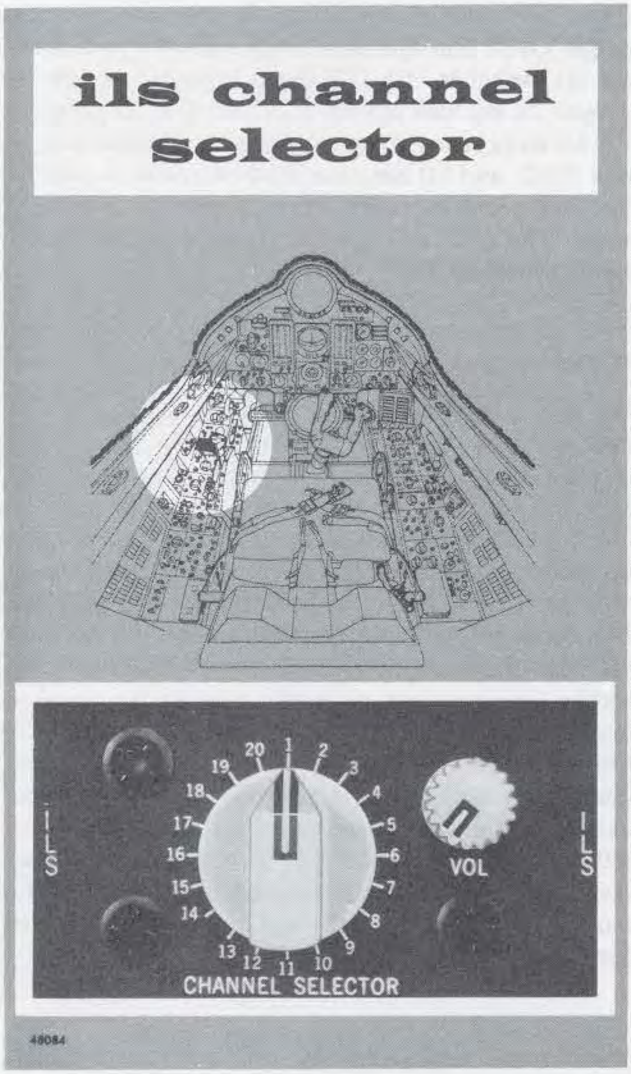

Figure 4-12

2. Conventional instrument display:

   a. MA-1 power switch—WARM, RADAR STBY, ON, or RADIO SILENCE.

   b. ILS channel selector switch—Set to desired channel.

   c. ILS volume control knob—Adjust.

NOTE

When ILS is selected and valid signals occur, bars will appear on the ADI and the CDI on the HSI indicating localizer information.

d. "LOC" and "GS" warning flags are not visible.

NOTE

- Appearance of the LOC (localizer) or GS (glide-slope) warning flags in the ADI indicates that localizer or glide-slope information is invalid.
- Disappearance of the LOC and GS warning flags in the ADI indicates only that the localizer and glide-slope receivers are receiving a valid signal. In order for valid ILS localizer information to be displayed in the cockpit, continue with the following procedure.

e. Display automatic mode selector switch—ILS.

f. Course arrow—Set to published localizer course.
Set the course arrow on the HSI to published localizer course using the CRS control on the HSI.

g. LOC warning flag—Not visible.

3. Integrated flight instrument system:
For operation of ILS equipment on airplanes with the integrated flight instrument system, refer to INTEGRATED FLIGHT INSTRUMENT SYSTEM, Section VII.

IFF SYSTEM (AN/APX-72)

The IFF system is used to automatically identify the aircraft in which it is installed whenever it is properly challenged by suitably equipped air or surface forces. The set has provisions for identifying the aircraft in which it is installed as a specific friendly aircraft within a group of other aircraft. The set has a provision for special signal transmission in an emergency or whenever desired. The set receives challenges and transmits replies to the source of the challenges which are displayed on the radar indicators of the challengers. It also is capable of transmitting aircraft pressure altitude information. The range of the set is line-of-sight. All operating controls are on the left hand console. An ejection relay is actuated when the canopy is jettisoned with the nose landing gear in the up position. If the IFF master control knob is in any position except OFF; the ejection relay causes the following: (1) switches the IFF from standby or low to normal; (2) enables modes 1, 2, and 3/A; (3) sets the IFF to emergency mode of reply and mode 3/A to code 7700; and (4) zeroizes mode 4 codes A and B. The unit receives power from ac and dc essential buses. The IFF will not be powered if the MA-1 power switch is OFF.

IFF Master control Knob

The IFF master control knob (figure 4-13) is a five-position, rotary switch. The knob is labeled MASTER and it controls the following functions: the OFF position removes power from the set; the STBY position applies power but does not enable the receiver; the LOW position, selected only upon order of a controlling agency, enables the receiver with reduced sensitivity so that only strong local interrogations are answered; the NORM position enables the receiver with full sensitivity so that reply may be made at maximum range. The EMER position is selected by pulling out on the knob before rotating. When actuated, this mode automatically squawks an emergency reply to interrogation of Mode 1, 2, and 3/A. To disable emergency mode, rotate the knob out of EMER position. The knob must be pulled out and rotated to OFF to remove power from the set.

Mode Enable/Test Switches

Mode 1, 2, 3/A and C have three-position toggle switches (figure 4-13) with an OUT, a center ON, and a spring-loaded TEST position. Placing one of these switches in the ON position will activate the mode associated with the switch. Proper operation of a mode is indicated when the test lamp illuminates while the mode enable/test switch is held in the TEST position. Mode C (altitude reporting) enables the IFF to report the aircraft pressure altitude to the interrogating agency by the use of a specified 11-bit code through the aircraft air data computer.

Mode 1 Code Select Wheels

The Mode 1 code select wheels (figure 4-13) are used to set the desired two-digit mode 1 reply code. The wheels are labeled MODE 1.

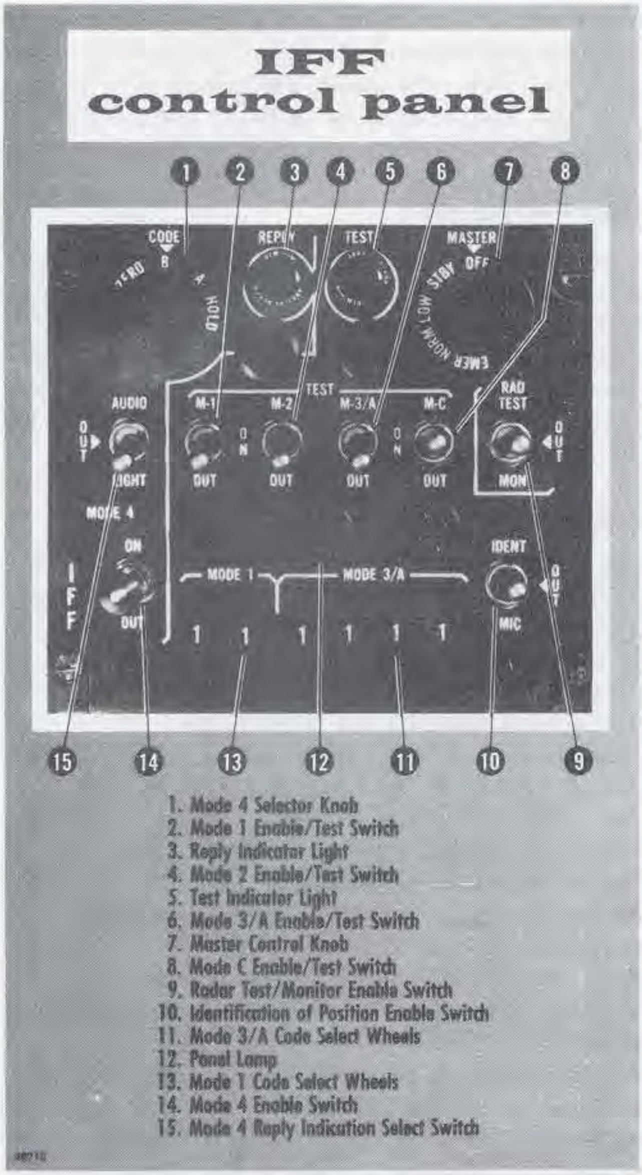

Figure 4-13

Mode 3/A Code Select Wheels

The Mode 3/A code select wheels (figure 4-13) are used to set the desired four-digit mode 3/A reply code. The wheels are labeled MODE 3/A.

Identification of Position Enable Switch

The switch labeled IDENT-OUT-MIC (figure 4-13) is a three-position toggle switch. OUT position disables the ident feature. At the request of the controlling agency, this switch is momentarily pressed to the IDENT position. The switch spring returns to the OUT position, but the set will initiate a special identification reply for 15 to 30 seconds on the mode and codes selected.

With the switch in the MIC position, the set will initiate the special identification on the mode and codes selected each time the UHF transmitter button is depressed. Codes C and 4 are not affected by this switch.

NOTE

> In the event the IP/MIC switch is in the MIC position and the UHF transmitter is keyed, the IFF transmitter may continue sending after the key is released. Should this occur, the IP/MIC switch should be manually moved to the OUT position to cease transmission.

Radar Test/Monitor Enable Switch

The switch labeled RAD TEST-OUT-MON (figure 4-13) is a three-position toggle switch. The OUT position disables all functions of this switch. The MON position causes the test indicator light to illuminate when a reply is made to an interrogation of any selected mode. The RAD TEST position is used for ground test operation and requires additional equipment.

Test Indicator Light

The test indicator light (figure 4-13) is labeled TEST and illuminates to indicate proper operation of the IFF modes when a mode enable switch is held at TEST. This light also illuminates when the radar test/monitor switch is at MON, the master switch is at NORM and the set is replying to an interrogation of any selected mode. It is a green press-to-test type light that may be dimmed for night operation.

Mode 4

Mode 4 is a military secure mode. Controls and indicators for mode 4 are located on the left side and top of the IFF control unit (figure 4-13) outlined by a white line. Mode 4 interrogation is received by a special transponder-computer which encodes and triggers a proper identification response signal. The master rotary switch controls transponder action in all modes. When the mode 4 enable switch is selected ON, mode 4 will operate normally in either NORM or EMERG position of the master control knob and at a reduced receiver sensitivity in LOW. Mode 4 is inoperative in either STBY or OFF position of the master control knob. To operate mode 4, the mode 4 enable switch must be in the ON position, special codes must be inserted into the system, and code A or B selected. Should mode 4 fail to reply to a valid interrogation, the IFF caution light will illuminate.

IFF Caution Indicator Light

The amber colored IFF caution light is located on the forward right console adjacent to the oil pressure gauge. It illuminates whenever (1) the IFF has failed to reply to a valid Mode 4 interrogation, (2) the Mode 4 code is zeroized, or (3) the automatic self-test function of the Mark XII computer detects a computer malfunction. Should the IFF caution light illuminate then remain illuminated, avoid operation in a known Mode 4 interrogating environment or if already in one, take appropriate corrective or emergency action as operationally directed for an inoperative Mode 4 condition.

Mode 4 Invalid

Incorrect positioning of the IFF controls can result in Mode 4 being reported invalid by the interrogation site. These conditions will not cause the caution light to illuminate. Should Mode 4 be reported invalid, attempt to correct by confirming the following:

1. IFF master control—NORM.
2. Mode 4 enable switch—ON.
3. Mode 4 reply indication select—AUDIO.
4. Mode 4 code selector—Proper A or B code position for current code time period.

Mode 4 Enable Switch

The mode 4 enable switch (figure 4-13) is provided for control of mode 4 operation. It is labeled ON and OUT. It is a positive action switch which must be pulled out to be placed ON or OUT.

Mode 4 Reply Indication Select Switch

The mode 4 reply indication select switch (figure 4-13) is a three-position toggle switch with LIGHT, OUT (center), and AUDIO positions. When the switch is placed in the LIGHT position, only the reply light (figure 4-13) of mode 4 reply is enabled. The AUDIO position enables both the reply light and aural indication. The aural indication in the pilot's headset is not adjustable by the pilot. With the switch in AUDIO position, an aural signal indicates mode 4 interrogations are being received and illumination of the mode 4 reply light indicates replies are transmitted. In the OUT position, both light and audio indications are inoperative. This switch must be in either the AUDIO or LIGHT position when operating mode 4.

Reply Indicator Light

A green mode 4 reply indicator light (figure 4-13) is provided to indicate mode 4 replies are being transmitted when the mode 4 reply indication select switch is either in the AUDIO or LIGHT position. In order to press to test the mode 4 reply indicator light the AUDIO-OUT-LIGHT switch must be in the AUDIO or LIGHT position.

Mode 4 Code Selector Knob

The mode 4 code selector is a four-position (HOLD, A, B, and ZERO) rotary knob (figure 4-13). A and B codes are preset daily as operationally directed by the single insertion of a code changer key. A is the present code and B is the next succeeding code thereby enabling the set to properly reply to any valid mode 4 interrogation during a given time period. The ZERO position zeroizes the code setting. Both codes are normally zeroized when the master switch is turned to OFF after the aircraft has landed. If the second flight is anticipated during the proper time periods, the code setting may be retained by selecting the HOLD position of the knob. The HOLD position is spring-loaded to return to the A position. To hold codes, the knob must be held momentarily (2 to 3 seconds) to the HOLD position before power is removed from the transponder. Allow transponder power to remain on for at least 15 seconds after the knob is released, and then turn off as desired. The code setting is now mechanically latched and will be retained when aircraft power is turned off.

NOTE

- To hold the code setting, the aircraft landing gear must be down and locked. The hold feature will remain in effect until the aircraft landing gear is retracted.
- If power is removed from the transponder less than 15 seconds after selecting HOLD, either by turning the transponder off or by turning off aircraft electrical power, the code setting will zeroize when transponder power is lost.

Both A and B codes may be zeroized any time the aircraft has electrical power on and the IFF master control knob is in any position except OFF by placing the code selector knob to the ZERO position. The code selector must be pulled out before it can be turned to the ZERO position. Any time (in flight or on the ground) the IFF master control knob is placed in the OFF position, the A and B codes are zeroized unless the HOLD function has been properly actuated. Use Code A or Code B as operationally directed.

IFF Normal Operation

1. MA-1 power switch—RADAR STBY, WARM, EMER, or ON and power annunciator displaying "OK."
2. Master control knob—STBY (warm up for 2 minutes).
3. Mode enable/test switch—ON (desired modes).
4. Mode code control wheels—Code set as desired.
5. Radar test/monitor enable switch—As desired.
6. Master control knob—NORM (before takeoff).
7. Mode enable/test switch—Hold desired mode switch to TEST until test light illuminates. If light does not come on, the selected mode is inoperative. (There is no test for mode 4.)

Mode 4 Operation

1. IFF master control knob—LOW, NORM, or EMERG.
2. Mode 4 enable switch—ON.
3. Mode 4 reply/indication select switch—Audio or light.

NOTE

Audio is recommended so the pilot can be alerted to Mode 4 interrogations in addition to system reply.

4. Mode 4 code control knob—A or B (as required for time period).

IFF Emergency Operation

For emergency operation, pull upward on the master control knob and rotate to EMER position. Modes 1, 2, and 3/A are enabled automatically. Modes 1 and 2 will reply to interrogations with the reply code selected by their respective code switches. Mode 3/A reply code will be 7700 regardless of the position of the mode 3/A code switches.

TACTICAL SITUATION DISPLAY (TSD)

The TSD (figure 4-14) is a map display instrument which presents tactical and navigation data pictorially during the various mission phases. On airplanes with the conventional instrument display an automatic direction finder switch position has been incorporated. The face of the indicator displays a map centered on the selected TACAN station. A delta-wing symbol representing the interceptor, and an X-bisected-by-an-arrow symbol representing an enemy target or a homing point, move over the map. A grid of three parallel lines engraved on the screen indicates command heading and a cursor at the edge of the display indicates interceptor heading. Functions of controls and indicators on the TSD are discussed in the following paragraphs.

Map Selection

When the preset selector switch on the TACAN control panel is set to the desired TACAN station, a map of the area surrounding that station appears on the TSD. The selected map is the stationary reference, and it appears with magnetic north at the top. The aircraft and target symbols move in relation to the map. The TSD stores film maps for each of the 23 preset TACAN stations. The scale and the information on the film maps is similar to that on the standard foldout flight charts. In the case when channel 23 preset TACAN 400-mile radius scale map is selected, the IRAM program inputs an offset distance in X and Y to position the interceptor bug relative to the center tower of the ACMI ring (scaled for 50-mile radius). The HSI range and bearing will show range and bearing from Tyndall TACAN. For additional information on the maps presented in conjunction with preset TACAN selection, refer to RADIUS MILE SELECTOR SWITCH, this Section. When a TACAN station is selected by the manual method, area maps of the stations selected are not available. Rather, a choice of three maps (depending on the position of the radius mile selector switch) is available as follows:

a. The 50-mile map contains a homing index and a calibrated test map.

b. The 200-mile map is a graphic index showing geographical locations of the available preset TACAN stations.

c. The 400-mile map is a calibrated test map which includes a tabular index listing the available preset TACAN stations and map charts available for each station.

tactical situation display (typical)

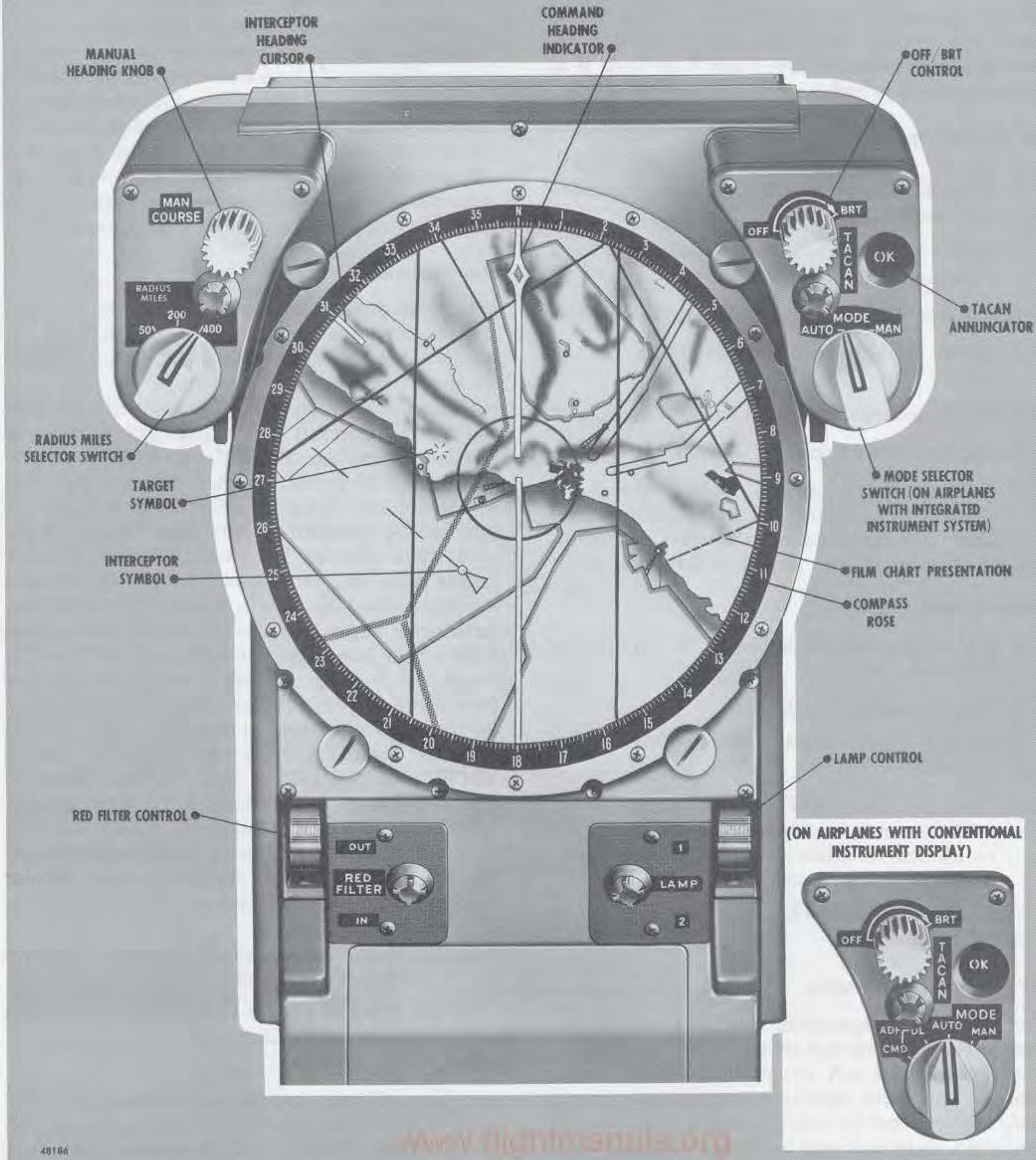

Figure 4-14

Interceptor Symbol

The delta-wing interceptor symbol, projected on the screen, is about one inch long and has a dashed range line extending forward to indicate the no-wind flight path. After takeoff, when the interceptor exceeds 0.25 Mach and before initial reception of TACAN, the interceptor symbol is positioned by the digital computer, based on the computer's dead reckoning from initial position. When reliable information is being received from a TACAN station, the interceptor symbol is positioned directly from the TACAN equipment and serves as a direct readout of TACAN bearing and slant range. Whenever TACAN is lost and the computer is dead reckoning interceptor position, the symbol is positioned by direct inputs from the computer. Correction for altitude is made, assuming that the TACAN station is at sea level. The heading of the symbol always shows actual interceptor heading and always agrees with the heading cursor. Dead reckoning moves the interceptor symbol along its ground course on the TSD map. The dashed line along the longitudinal axis of the interceptor symbol may be used for approximate range determination. The first line segment from the interceptor is one-half inch long as is the first space between segments. All succeeding line segments and the succeeding spaces between them are one inch in length. On all of the map scales, one inch equals 1/8 of the total range of the chart. For example, on the 50-mile radius scale, one inch represents 1/8 of 100 miles or 12.5 miles. On the 200-mile radius scale, the first line segment (one-half inch long) from the interceptor represents 25 miles, since one inch represents 1/8 of 400 miles or 50 miles.

Target Symbol

The position and heading of the target are represented by a symbol in the form of a X bisected by an arrow. In the AUTO NAV mode, the target symbol indicates the position and assigned heading of the homing point selected by the homing point selector (figure 4-15). If the homing point is not located on the map selected, the display can be seen by turning to a map which does contain the homing point location. In data link modes, the symbol indicates target position and heading from MCC messages of target position and velocity. Target position is dead-reckoning when MCC messages cease. The target heading displayed is the estimated air-mass heading of the target, assuming that the wind value of the target is the same as that at the interceptor. In data link modes, the appearance of the target symbol is the best indication that valid MCC messages have been received. During all attack modes with at least one radar lock-on, the symbol will represent the radar target. In an attack mode without a lock-on, the symbol will not be displayed. If the desired heading to the homing point is greater than 90° from present interceptor heading, the heading of the target symbol will show a maximum of 90° off present interceptor heading. As the interceptor turns toward the homing point, the target symbol will turn with the interceptor, remaining 90° off interceptor heading, until the difference between interceptor heading and desired heading-to-homing-point becomes less than 90°. At this time the heading of the symbol will stabilize on the computed desired heading-to-homing-point for the remainder of the interceptor's turn.

Figure 4-15

Interceptor Heading Cursor

The interceptor heading cursor at the edge of the fixed compass rose indicates the magnetic heading of the interceptor, and may be used as a quick-reference check to determine angular difference between present interceptor heading and the command (data link) or desired (AUTO NAV) heading, as indicated by the command heading indicator (three parallel lines on TSD face).

Command Heading Indicator

The three parallel lines engraved on the TSD screen indicate command heading from data link inputs, or desired heading-to-homing-point during AUTO NAV mode. The action of these lines during AUTO NAV is the same as that of the target symbol heading when the desired heading-to-homing-point is initially greater than 90° off present interceptor heading. The mode selector switch on the right TSD control panel controls the operation of the command heading indicator. DL command headings are referenced to AHRG before being displayed on the TSD. Any compass errors will be reflected in the position of the command heading indicator on the TSD.

Radius Miles Selector Switch

The radius miles selector switch (figure 4-14) is located on the tactical situation display. The switch is placarded "Radius Miles" and has 50-mile, 200-mile, and 400-mile positions. The switch is used to select the desired scale of the display map. A discussion of the three maps available in conjunction with manual TACAN selection is included under MAP SELECTION, this Section. When TACAN selection is by the preset method, three maps (50-, 200-, and 400-mile scales) are available for each station and contain the following information:

a. The 50-mile scale is a terminal map which includes such information as the length and direction of runways, dangerous and prohibited areas, emergency safe altitude, approach lights, approach markers, ILS and tower communication channels, published letdown plates, computer grid correction angles, and related data.

b. The 200-mile scale includes information concerning holding points, recovery and departure procedures, and related data.

c. The 400-mile scale is a general tactical and cross-country navigation map which shows locations of air bases, navigational aids, and other pertinent data. In the case when channel 23 preset TACAN is selected, the radius of the 400-mile map becomes 50 miles.

Power is supplied from the MA-1 electrical power supply system.

NOTE

> In the data link mode of operation the target and interceptor bugs must both be on the TSD for an accurate range display on the HSI.

TSD Manual Heading Knob

The TSD manual heading knob (figure 4-14) is located on the TSD. The knob is placarded "Man. Course" and operates only when the TSD mode selector switch is in the MAN position. Manually turning the knob rotates the grid lines on the display screen. The TSD manual heading knob receives power from the MA-1 electrical power supply.

TSD Mode Selector Switch (Airplanes With Conventional Instrument Display)

The TSD mode selector switch (figure 4-14) is located in the upper right corner on the TSD. The switch is placarded "Mode" and has four positions: ADF CMD, ADF DL, AUTO and MAN. With the switch in the ADF CMD position, the grid lines are positioned to indicate command heading to the

UHF radio transmitter to which the command radio is tuned. With the switch in the ADF DL position, the grid lines are positioned to indicate command heading to the GCI transmitter to which the data link equipment is tuned. When the switch is in AUTO position the command heading displayed is determined by selection of a TACAN station (or associated homing point), a data link transmitter, or ADF (data link on UHF) fix. When flying an ILS with the AUTO position selected, the grid lines and command heading pointer are slaved to airplane heading. When the switch is in MAN position, the grid is manually positioned by turning the TSD manual heading knob. The TSD mode selector switch receives power from the MA-1 electrical power supply system.

TSD Mode Selector Switch (Airplanes With Integrated Flight Instrument System)

The TSD mode selector switch (Figure 4-14) is located in the upper right corner on the TSD. The switch is placarded "Mode" and has positions AUTO and MAN. When the switch is in the MAN position, the grid and command heading pointer are manually positioned by turning the TSD manual heading knob. When the switch is in the AUTO position, the command heading pointer presents command heading derived from data link or the digital computer. The TSD mode selector switch receives power from the MA-1 electrical power supply system.

Light Intensity Rheostat and Off Switch

The light intensity rheostat (figure 4-14) is located on the TSD, has positions OFF and BRT, and controls the intensity of the display screen lighting accordingly. The switch normally controls power from the MA-1 electrical power supply system; however, when the MA-1 power switch is in EMER position, power supply to the switch is from the airplane ac essential bus.

CAUTION

Place OFF/BRT control to first detent for a minimum of 30 seconds to prevent TSD lamp burnout.

NOTE

On airplanes with the conventional instrument display, the loss of MA-1 electrical power to the light intensity rheostat causes automatic switching to the airplane nonessential bus when the MA-1 switch is in any position other than OFF.

Red Filter Switch

The red filter switch (figure 4-14) is located on the TSD. The switch is placarded "Red Filter" and has two positions, OUT and IN, which manually control the red filter.

Lamp Selection Switch

The lamp selection switch (figure 4-14) manually controls the selection of either of the two lamps available for projecting the map on the TSD screen. The switch is placarded "Lamp" and has positions 1 and 2 which select map projecting lamp one or two as indicated. The switch is located on the TSD.

LIGHTING EQUIPMENT

EXTERIOR LIGHTING

Exterior lighting consists of two anticollision (beacon) lights on the fuselage, one navigation light near each wing tip, a navigation light near the top of the vertical stabilizer, one landing light on each main landing gear fairing door, a taxi light on the nose landing gear fairing door, and two air refueling slipway lights. The formation and anticollision lights are controlled by a switch in the cockpit (figure 4-16) which allows selection of either formation or navigation lighting display, and a dimming switch to control the brightness of the lights if the formation condition is selected. The landing and taxi lights are controlled by a single selector switch. The air refueling slipway lights are controlled by the air refuel switch. The anticollision lights have dual functions. When the formation-navigation lights switch is in NAV ON, the lights rotate, producing a flashing effect. When the switch is in FORM ON, the lights remain on but do not rotate. The lights appear white from directly above or below, and red from all sides. The lights are manually operated by the formation-navigation lights switch. The lights on the wing tips and vertical stabilizer are illuminated regardless of whether formation or navigation lighting is selected, but can be dimmed by the dimmer switch only if the formation lighting display is selected. The light on the vertical stabilizer is a white light. The light near the left wing tip is red when viewed from forward of the airplane and white when viewed from behind. The light near the right wing tip is green when viewed from forward and white when viewed from behind.

FORMATION-NAVIGATION LIGHTS SWITCH

The formation-navigation lights switch (figure 4-16), located on the right console, has FORM ON, center (OFF), and NAV ON positions. On Ⓑ airplanes the formation-navigation lights switch is located in the forward cockpit only. When the switch is in the FORM ON position, the wing, tail, and anticollision lights will operate but the anticollision lights will not rotate. The lights can all be dimmed in the FORM ON position by use of the dimming switch on the lighting control panel. With the switch in the center (OFF) position, the wing, tail, and anticollision lights are inoperative. When the formation-navigation lights switch is in NAV ON position the anticollision lights rotate and the wing and tail lights are illuminated. In FORM ON position the formation-navigation light switch receives power from the ac essential bus. In NAV ON position, in addition to ac power, the switch receives dc nonessential bus power for the anticollision light circuit.

NOTE

> During flight through actual instrument conditions, the rotating anticollision light should be turned off by moving the formation-navigation light switch to FORM ON. With the light on during instrument conditions, vertigo could be experienced as a result of the rotating reflections of the light against the clouds. In addition, the light would be ineffective as an anticollision light during instrument conditions since it could not be seen by pilots of other airplanes.

FORMATION-NAVIGATION LIGHTS DIMMER SWITCH

A formation-navigation lights dimmer switch (figure 4-16) placarded "Form-Lts" with positions DIM and BRT is located on the right console. On Ⓑ airplanes the formation-navigation lights dimmer switch is located in the forward cockpit only. The switch will dim the formation lights only if the formation-navigation lights switch is in FORM ON position.

LANDING AND TAXI LIGHT SWITCH

The landing and taxi light switch (figures FO-1 and FO-2) is located on the cockpit left sidewall. On Ⓑ airplanes the landing and taxi light switch is located in the forward cockpit only. The switch has three positions, LANDING LIGHTS—OFF—TAXI LIGHTS, which allows selection of either landing or taxi lights. A switch on each main landing gear prevents the landing light from operating unless the main landing gear is down and locked. A switch on the nose landing gear prevents the taxi light from operating unless the nose landing gear is down and locked. The landing light and taxi light circuits receive power from the dc nonessential bus.

INTERIOR LIGHTING

Interior lighting equipment includes the edge-lighting from the instrument panels, switch panels and console panels, the thunderstorm lights, cockpit floodlights, the standby compass light, and a map reading light. Edge-lighting of the instrument panel, switch panels, and console panels is accomplished by small lights set into panels. The plastic panel facing has an opaque outer layer and a translucent inner layer. Light from the bulbs in the panels is conducted by the translucent inner layer to the edges of the instruments and the edges of holes through which switches and controls protrude, thereby illuminating instruments and outlining switches and controls. Wherever lettering is cut in the opaque surface material, to identify or mark the positions of a switch or control, light shines through from the translucent layer and illuminates the lettering. Red floodlights are directed at the right and left sides of the instrument panels and the tops of the consoles. White thunderstorm lights provide brilliant illumination of the cockpit to counteract the blinding effects of lightning on the pilot's vision. On airplanes with the integrated instrument system, augmentation lights illuminate the instrument panels to prevent reflection on the glass covering the instruments. Intensity of lighting in ac circuits (which include all of the cockpit lighting except the thunderstorm lights) is controlled by transformers, known as "powerstats." The powerstat control knobs on the lighting control panel have the appearance of rheostat controls. The lighting control panel is located on the right-hand console.

INSTRUMENT PANEL LIGHTS POWERSTAT

The instrument panel lights powerstat (figure 4-16) is located on the lighting control panel and is placarded "Inst Panel." Turning the pointer clockwise from OFF to BRT increases the intensity of the instrument panel lights, and with the pointer at BRT

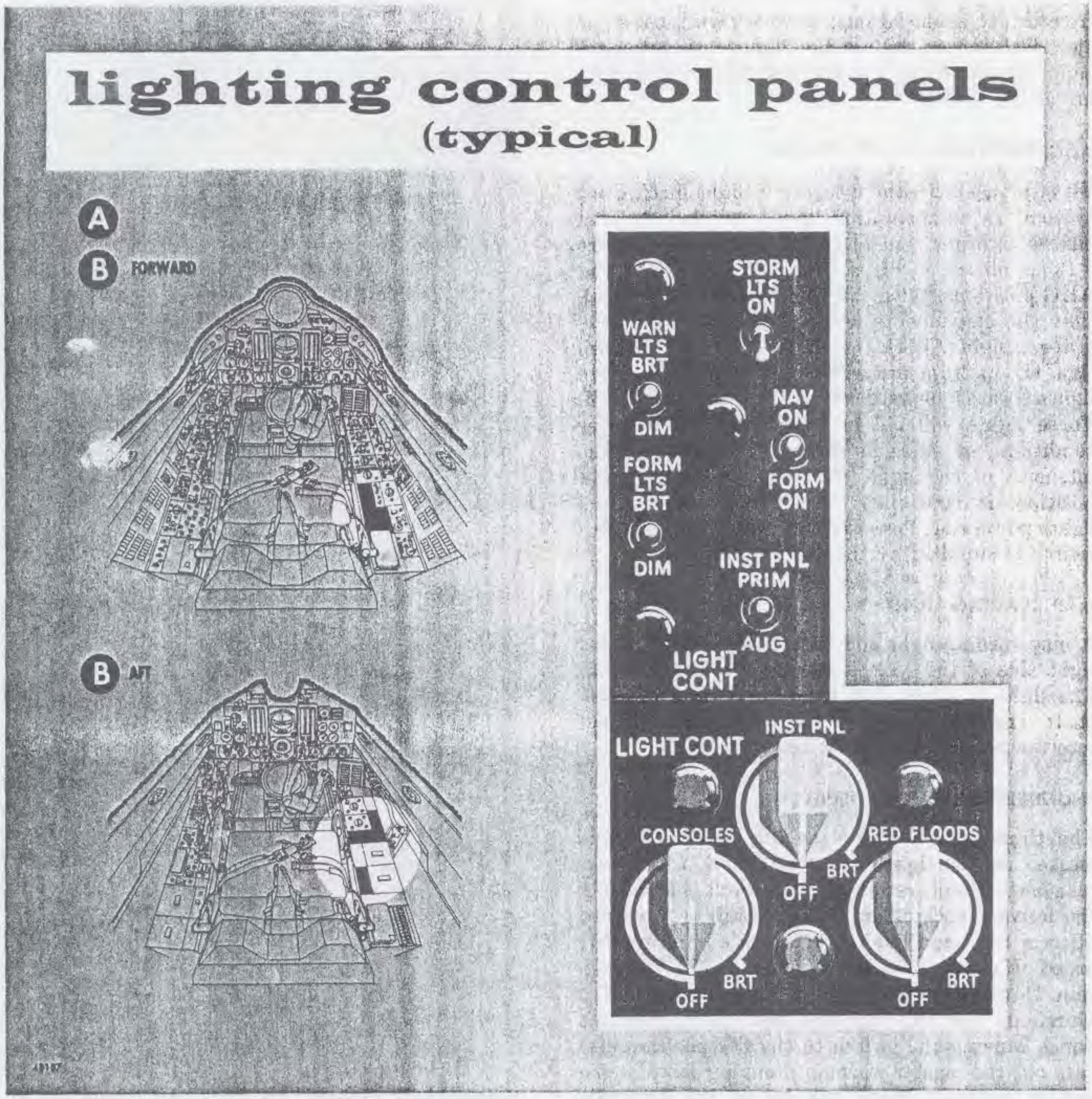

Figure 4-16

the instrument panel lights will be at full brilliance. Power is supplied from the ac essential bus.

CONSOLE LIGHTS POWERSTAT

The console lights powerstat (figure 4-16) is located on the lighting control panel and is placarded "Consoles." Turning the pointer clockwise from OFF to BRT increases the intensity of the lights on both consoles and the check list. Power is supplied from the ac essential bus.

COCKPIT FLOODLIGHTS POWERSTAT

The cockpit floodlights powerstat (figure 4-16) is located on the lighting control panel and is placarded "Red Floods." Turning the pointer clockwise from OFF to BRT increases the intensity of the red floodlights. Power is normally supplied from the ac essential bus; however, with loss of ac electrical power, the red floodlights are automatically transferred to the dc essential bus and operate at full brilliance.

AUGMENTATION LIGHTS SWITCH

On airplanes with the integrated flight instrument system, an augmentation lights switch is located on the lighting control panel. The switch (figure 4-16) is placarded "Inst Pnl" and has PRIM and AUG positions. With the switch in the PRIM position, the instruments will be illuminated by integral red lights. With the switch in the AUG position, the instruments will be illuminated by white lights located forward along the cockpit sidewall. These lights will aid in visual adaptation under conditions of extreme glare and reflection. The intensity of the light, with the switch in either position, is controlled by the instrument panel lights powerstat. Power to the augmentation lights switch is supplied by the ac essential bus.

MAP READING LIGHT

A map reading light and switch are located on the right side of the cockpit (figures FO-1 and FO-2). The light is white and is attached to a flexible shaft. The switch has ON and OFF positions, and receives power from the dc essential bus.

THUNDERSTORM LIGHTS SWITCH

The thunderstorm lights switch (figure 4-16) is located on the lighting control panel. On Ⓑ airplanes the thunderstorm lights switch is located in the forward cockpit only. The switch is placarded "Storm Lts" and has an ON position and unplacarded off position. With the switch in the ON position, 15 white thunderstorm lights are energized to illuminate the two consoles and the instrument panel. Moving the switch to the ON position also cuts out the master warning dimming relay so the master warning lights will be at full brilliance when the thunderstorm lights are on. The thunderstorm light switch receives power from the dc nonessential bus.

OXYGEN SYSTEM

The airplane is equipped with a liquid oxygen system (figure 4-17). The major components of the liquid oxygen system are a storage and converter unit, an oxygen regulator, an external filler valve,

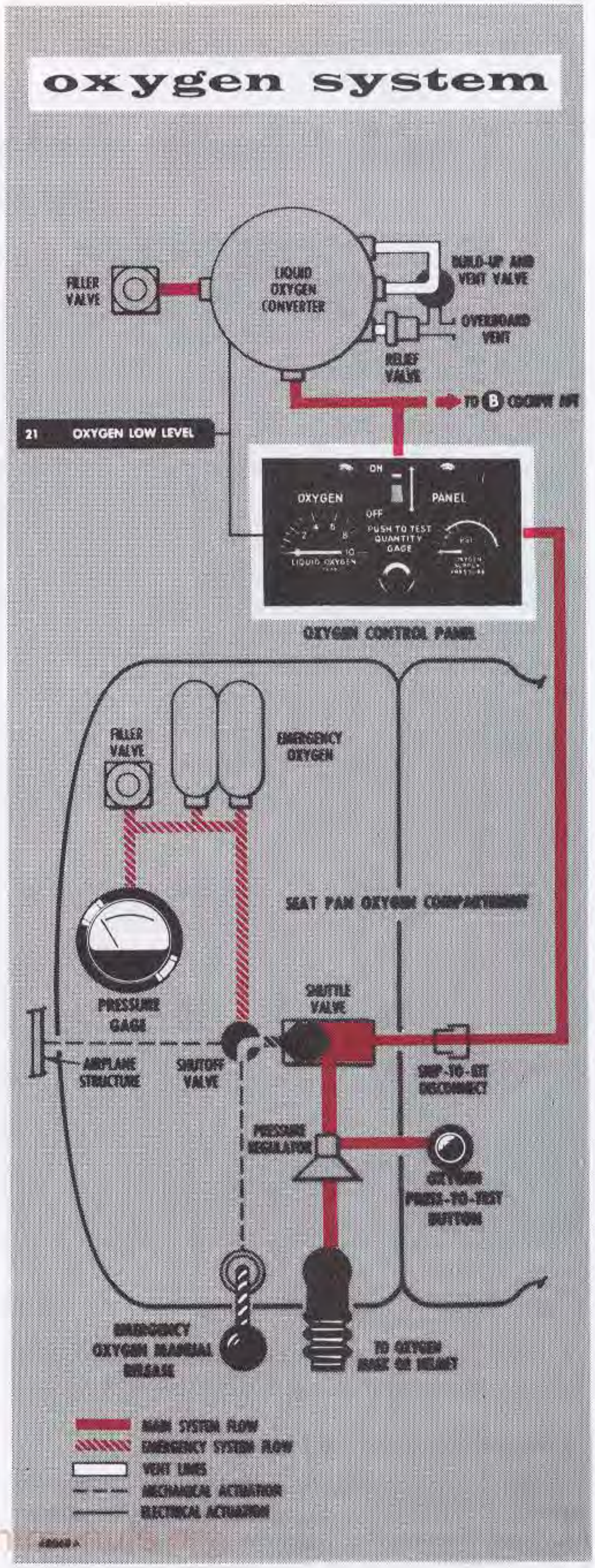

Figure 4-17

and a pressure gage and content gage located on the left console. The storage and converter unit is a ten-liter insulated storage container. This unit converts the liquid oxygen to gaseous oxygen and then supplies it to the oxygen regulator. The oxygen regulator, which is located in the survival kit, is a pressure-breathing regulator that delivers 100% oxygen at all times. The liquid oxygen content gage is a capacitance-type and indicates the supply of liquid oxygen in the storage container. Oxygen duration at various altitudes is shown in figure 4-18. At sea level and with average temperature, a full supply of liquid oxygen dissipates through a relief valve in about five days. The liquid oxygen system is serviced through a single-point filler valve located within an access door on the left side of the fuselage below the cockpit.

OXYGEN REGULATOR

A pressure-breathing oxygen regulator is mounted in the aft portion of the survival kit in the ejection seat. Gaseous oxygen is supplied from the oxygen converter at approximately 70 psi during normal operation. During emergency operation, oxygen is supplied from the emergency oxygen supply. Emergency oxygen pressure is approximately 1800 psi when fully charged; therefore it is necessary to reduce this pressure by means of a restrictor prior to delivery to the oxygen regulator. The regulator regulates and delivers 100% oxygen to the oxygen mask. Using the airplane oxygen supply, the regulator supplies oxygen under increasing pressure as altitude increases. The regulator will not function as a diluter (will not mix air with oxygen) and therefore delivers 100% oxygen at all times. The pressure-breathing oxygen system is controlled by a pressure-breathing oxygen supply switch (figure 4-17) located on the left console.

OXYGEN CONTROL PANEL

The liquid oxygen control panel (figure 4-17) is located on the left console. The panel contains a pressure-breathing oxygen supply switch, an oxygen quantity gage, an oxygen pressure gage, and an oxygen quantity gage test button. The pressure-breathing oxygen supply switch has ON-OFF positions and controls the flow of oxygen from the airplane supply to the pressure oxygen regulator.

WARNING

Uncontrolled flow of oxygen through open oxygen masks during ground operation will result in a rapid depletion of oxygen. During uncontrolled flow, frost will appear and may freeze the switch because the system is unable to convert at a rapid pace. This may cause liquid to enter the cockpit. The uncontrolled flow of oxygen occurs most frequently during engine start and taxi operations when the pressure-breathing oxygen supply switch is ON and the oxygen mask is not in place.

PRESSURE-BREATHING OXYGEN SUPPLY SWITCH

The pressure-breathing oxygen supply switch (figure 4-17) is located on the oxygen control panel. The switch controls the flow of oxygen to the regulator for the pressure-breathing oxygen system. The switch has two positions, ON and OFF; moving the switch forward to the ON position permits oxygen to flow from the airplane supply to the oxygen regulator in the survival kit. With the switch in the OFF position, no oxygen will flow to the oxygen regulator.

WARNING

Uncontrolled flow of oxygen through open oxygen masks during ground operation will result in a rapid depletion of oxygen. This uncontrolled flow of oxygen occurs most frequently during engine start and taxi operations when the switch is ON and the oxygen mask is not in place.

oxygen duration-hours

USING PRESSURE BREATHING OXYGEN MASK (TYPE MBU-3/P OR MBU-5/P)

CABIN ALTITUDE — FEET	10	9	8	7	6	5	4	3	2	1	
35,000 AND ABOVE	62.8	56.6	50.4	44.0	37.8	31.4	25.2	18.8	12.6	6.2	BELOW 1 LITER DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
30,000	45.4	40.8	36.2	31.6	27.2	22.6	18.0	13.6	9.0	4.6	
25,000	35.0	31.4	28.0	24.4	21.0	17.6	14.0	10.4	7.0	3.6	
20,000	26.6	24.0	21.4	18.6	16.0	13.4	10.6	8.0	5.4	2.6	
15,000	21.4	19.2	17.2	15.0	12.8	10.6	8.6	6.2	4.4	2.2	
10,000	17.2	15.4	13.8	12.0	10.4	8.6	6.8	5.2	3.4	1.8	
5,000	13.6	12.6	10.8	9.8	8.2	7.0	5.4	4.2	2.8	1.4	
SL	11.0	10.0	8.8	7.6	6.6	5.6	4.4	3.4	2.2	1.0	

QUANTITY GAGE—LITERS

NOTE

FIGURES SHOWN ARE FOR USE WITH A ONE-MAN CREW.
FOR USE WITH A TWO-MAN CREW, HALVE THE ABOVE FIGURES.

48069

Figure 4-18

NOTE

On some airplanes, the oxygen supply switch is a small toggle switch instead of the large plastic lever. The small switch could be more difficult to locate during an emergency egress.

OXYGEN QUANTITY GAGE

An oxygen quantity gage (figure 4-17) is included on the oxygen control panel installed on the left console. The gage is a capacitance type that indicates the contents of the oxygen converter through a sensing element submerged in the liquid oxygen. The gage is calibrated in liters from 0 to 10. Gage operation can be checked by the oxygen quantity gage test button; if the button is held depressed, the gage pointer should move toward zero, and when the button is released, the pointer should return to its original position. Failure of the pointer to move indicates a faulty system. The indicating system receives power from the ac essential bus.

NOTE Ⓐ

The oxygen quantity gage should read between eight and nine liters when the system is fully charged. It is impossible to charge the liquid oxygen converter to the full ten liters.

OXYGEN PRESSURE GAGE

An oxygen pressure gage is installed on the oxygen control panel. The gage shows gaseous oxygen pressure from 0 to 500 psi. When oxygen is being used from the system, the gage will normally indicate from 70 to 80 psi. However, under static conditions and on a hot day the gage may indicate as high as 110 psi. Gage operation requires no electrical power.

OXYGEN-LOW WARNING LIGHT

An oxygen-low warning light (figure 1-36) on the master warning light panel illuminates and displays "OXYGEN LOW LEVEL" when the oxygen supply in the liquid oxygen system falls below one liter. The light is actuated by the liquid oxygen content gage shaft pointer and receives power from the dc essential bus. The light is tested with the lights in the master warning system.

OXYGEN QUANTITY GAGE TEST BUTTON

An oxygen quantity gage test button (figure 4-17) is part of the oxygen control panel located on the left console. When the button is depressed, the oxygen quantity gage pointer will move toward zero, and when the button is released the pointer should return to its original position. Failure of the pointer to move indicates a faulty system. The indicator receives power from the ac essential bus.

OXYGEN PRESS-TO-TEST BUTTON

An oxygen press-to-test button is located on the forward edge of some survival kits. Depressing the button will provide positive pressure to the oxygen mask to determine that the oxygen system is operating properly prior to takeoff. The button is the only method of checking for proper operation of the pressure-breathing oxygen system (other than a decrease of liquid content and positive flow of oxygen through the system), as there is no blinker or flow indicator installed on this system. A several second delay may occur before pressure buildup.

OXYGEN MASK ADAPTER

When a flight is made with a MBU-3/P or MBU-5/P oxygen mask, an adapter is provided to enable the mask to be connected with the survival kit. The adapter is in two sections, one for the electrical connections and one for the oxygen connection. The adapter for the oxygen lead also provides a pressure restrictor to reduce the oxygen pressure from the regulator to the oxygen mask.

WARNING

If cabin pressure is lost while wearing an MBU-3/P or MBU-5/P oxygen mask, an immediate descent to 25,000 feet or below is mandatory.

PRESSURE-BREATHING OXYGEN SYSTEM PREFLIGHT CHECK (MBU-3/P OR MBU-5/P OXYGEN MASK)

Before takeoff, the oxygen system should be connected and tested as follows:

1. Check emergency oxygen bottle gage for 1800 psi minimum at 70°F.
2. Connect the oxygen mask adapter to end of oxygen hose in personal equipment lead bundle.
3. Attach oxygen mask and adjust for normal breathing. A slight positive pressure is supplied at all times, but should not cause resistance to breathing.
4. Check bailout bottle hose connected to mask connector (if required).
5. Check oxygen pressure gage at 70 to 110 psi.
6. Check oxygen quantity gage at 3 liters minimum, per crew member.
7. Oxygen-low warning light—Out.
8. Oxygen quantity gage test button—TEST. Depress and hold the oxygen quantity gage test button until the oxygen-low warning light illuminates at 1 liter.
9. Check pressure-breathing oxygen supply switch—ON.
10. If a MBU-3/P or MBU-5/P mask is worn, breathe normally into the mask. As a slight positive pressure is supplied at all times there should be no resistance to breathing.
11. Depress the oxygen press-to-test button (some airplanes). A definite positive pressure should result within the mask. Hold breath to determine whether there is leakage around the mask or faceplate. Release the oxygen press-to-test button. Check for normal breathing.

OPERATION OF PRESSURE-BREATHING OXYGEN SYSTEM

NOTE

Perform oxygen system preflight check as outlined above prior to each flight. After completion of preflight check, oxygen system is ready for normal usage.

1. Check pressure-breathing oxygen supply switch in the ON position.
2. After landing, when oxygen is no longer desired, place the pressure-breathing oxygen supply switch OFF immediately prior to removing oxygen mask.

NOTE

To prevent depletion of the oxygen supply, the pressure-breathing oxygen supply switch should not be left ON unless oxygen is being used by the pilot.

All data on pages 4-41, 4-42, and 4-43, including figures 4-19 and 4-20, deleted.

COMPASS SYSTEM

The magnetic compass system may be used as a directional gyro corrected for apparent drift due to the earth's rotation, or as a directional, gyro-stabilized magnetic compass. The magnetic compass system consists of a directional gyro assembly, electronic control amplifier, stable coordinate converter, compass system controller (CSC) (figure 4-21), compass card on the HSI, and interceptor heading cursor on the TSD. On Ⓑ airplanes, the CSC is located in the forward cockpit only. The two modes of operation, magnetic slaved mode and directional gyro, provide accurate directional reference for all latitudes. The directional gyro mode is the most reliable at latitudes near the magnetic poles since the magnetic slaved mode is subject to severe magnetic distortion near the poles. When in the magnetic slaved mode, the system is basically a gyro-stabilizer compass slaved to the magnetic azimuth detector transmitter. This mode provides magnetic heading without northerly turning error or oscillations. Directional gyro mode may be used at all latitudes, but it is most useful when navigating in the polar regions. When in directional gyro mode, the system is free of magnetic influence and operates as a directional gyro indicating an arbitrary gyro heading (corrected for apparent gyro drift due to the earth's rotation) as selected by the pilot. At different latitudes, apparent gyro drift varies, with the smallest amount of drift being at the equator and the greatest amount in the polar regions. In directional gyro mode, with proper latitude selection made, the gyro will precess the correct amount required to overcome gyro drift at the selected latitude. The system is powered by the ac essential bus.

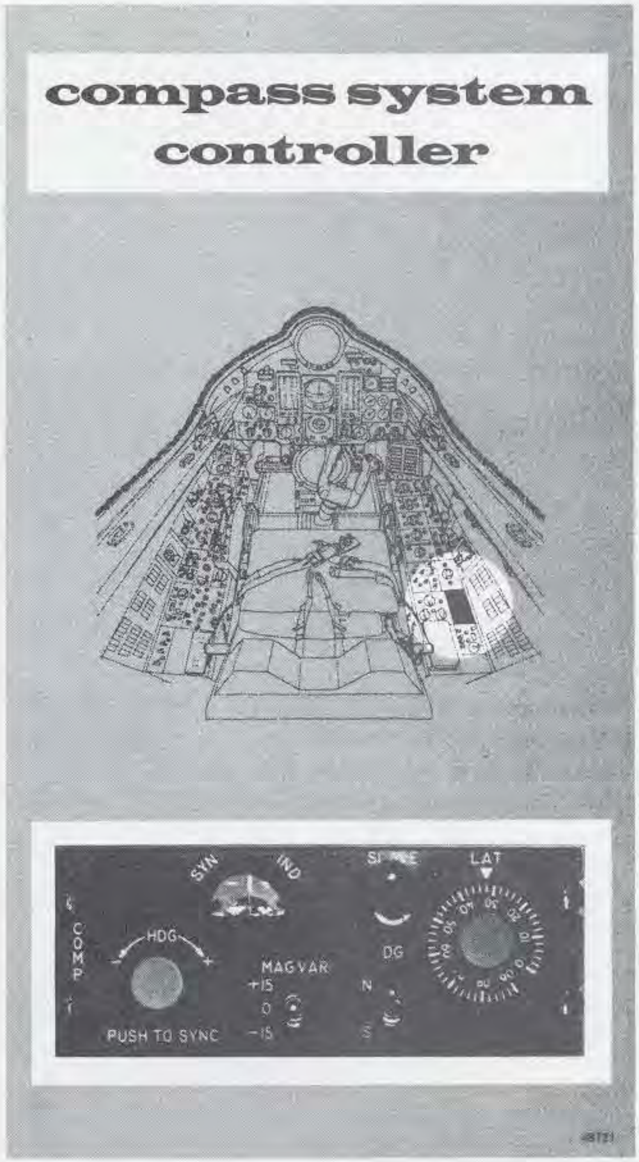

Figure 4-21

FUNCTION SELECTOR SWITCH

The function selector switch (figure 4-21), located on the CSC, has positions DG and SLAVE. DG selects the directional gyro mode; SLAVE selects the magnetic slaved mode.

SYNCHRONIZER KNOB AND SYNCHRONIZER INDICATOR

The HDG—PUSH TO SYNC knob (figure 4-21), located on the CSC, provides a means of synchronizing the rotating compass card of the horizontal situation indicator to the correct magnetic heading when the system is in the SLAVE mode. When in the DG mode, the knob is used to position the compass card to the desired gyro heading. Pushing and turning the knob in the DG mode provides a continuously increasing drive signal that is proportional to the knob position, left (−), or right (+). Pushing the knob while in either mode will result in manual fast erection (MFE) of the vertical gyro; also the automatic flight control system (AFCS) will automatically drop out of AUTO or ASSIST.

The SYNC IND needle provides an indication of magnetic alignment within ±0.25°. When the needle is off center, the sync knob can be depressed to center the needle. Centering the needle synchronizes the rotating compass card to the correct magnetic heading.

MAGNETIC VARIATION SWITCH

The MAG VAR switch (figure 4-21) provides the capability of applying a predetermined magnetic variation of ±15°. If local magnetic variation is East 8° or greater, place the switch to "−15." If local magnetic variation is West 8° or greater, place the switch to "+15." If local magnetic variation is between East 8° and West 8°, place the switch to "0."

HEMISPHERE SELECTOR

The hemisphere selector switch (figure 4-21) on the CSC is used to select the hemisphere (N or S) in which the airplane is operating.

LATITUDE SELECTOR KNOB

The latitude selector knob (figure 4-21) on the CSC is used to position a rotating dial that is graduated in degrees of latitude. The dial is numbered from 0 to 90 in 10° increments and has a mark at each 2 degrees. The latitude selector is used to select the latitude at which the airplane is operating. The vertical gyro will be corrected for apparent drift in DG and SLAVE modes.

NOTE

The proper corrections will not be made if the hemisphere selector switch is not correctly positioned.

OPERATION OF THE COMPASS SYSTEM

Magnetic Slaved Mode

1. Function select switch—SLAVE.
   Allow approximately 85 seconds warmup time after power is applied. When power is initially applied, or when switching from DG, a fast slewing action is applied for the first 20 seconds to synchronize the compass card with the flux valve (remote compass) transmitter. After the initial fast slave cycle, the system returns to the normal slewing cycle of 1 or 2 degrees per minute.
2. Select the desired hemisphere with the hemisphere selector switch.
3. Select the latitude at which the airplane will be operating with the latitude selector knob.
4. MAG VAR switch—Set
5. Before takeoff, check the synchronizer indicator to see if the system is synchronized. Use the PUSH-TO-SYNC knob to center the indicator needle.

Directional Gyro Mode

1. Allow approximately 85 seconds warmup time after power is applied.
2. Select the desired hemisphere with the hemisphere selector switch.

3. Select the latitude at which the airplane will be operating with the latitude selector knob.
4. After the desired heading is established in the SLAVE mode, move the function selector switch to DG. The system is now independent of the magnetic compass equipment and latitude correction for apparent gyro drift is being furnished to the compass card.

NOTE

As the airplane changes latitude in flight, the latitude selector knob should be rotated to the new latitude after each 2 degrees of latitude change.

AUTOMATIC FLIGHT CONTROL SYSTEM

NOTE

Refer to OTHER OPERATING LIMITATIONS, Section V, for limitations concerning AFCS operation.

The automatic flight control system provides pitch and yaw stability augmentation, automatic turn coordination, pilot assist (automatic pitch or altitude hold and heading or bank hold), and automatic steering for attack, navigation, or instrument landing approach. The system has five modes of operation: direct manual, yaw damper, pitch damper, assist, and automatic. In direct manual mode, no automatic flight control features are available. Automatic flight control modes are engaged, by using the flight mode selector switch, in steps as follows: first, yaw damper mode (yaw damping and turn coordination only); next, pitch damper mode is added and yaw damper mode remains engaged; then, because the damper system must be engaged before assist or automatic modes can operate, the assist mode can be engaged, and finally, the system can be placed in automatic mode. When the system is disengaged these steps are reversed. In yaw damper mode the automatic flight control system provides yaw damping and turn coordination. In the pitch damper mode the system provides pitch damping in addition to yaw damping and turn coordination. In the assist mode, electrical signals from the MA-1 aircraft and weapon control system are used to maintain airplane pitch attitude or altitude and to hold either heading or bank angle. In the automatic mode, electrical signals from the MA-1 system are used to steer the airplane on the desired attack, navigation, or instrument approach and landing course. To prevent application of excessive loads, a pitch g limiting system is provided to automatically return the system to the yaw damper mode if a malfunction occurs while the system is in the assist or automatic mode.

NOTE

- When in ASSIST or AUTO mode, the automatic pilot function of AFCS can be overridden by control stick movement. However, if rapid, abrupt control stick movements are made to counteract any undesired airplane attitude, the flight mode selector switch may step down to PITCH DAMPER.
- The ASSIST and AUTO modes are automatically disengaged during the seat ejection cycle. The stick will return to the neutral position, thus eliminating interference with the pilot and seat.

PITCH G LIMITER

The pitch g limiter prevents the automatic flight control system from subjecting the airplane to excessive pitch g forces when the system is in assist or automatic modes. The limiter is mechanized so that the system reverts to yaw damper mode when the limiter trips and the yaw damper is left engaged to provide adequate damping. The pitch g test switch may be used for an inflight check. Power is supplied to the pitch g limiter from the ac and dc nonessential buses.

Pitch G Limit Test Switch

A pitch g limit test switch (figures FO-1 and FO-2), located on the left console, is placarded "Pitch G Limit Test" and has positions +G, −G, and a spring-loaded center position. On B airplanes the pitch g limit test switch is located in the forward cockpit only. When the automatic flight control system is engaged, placing the switch to either the +G or −G position will actuate the g limiter, thus disengaging holding solenoids to return the system to the yaw mode. When the switch is held in the +G position, a force is simulated to actuate the limit system. In the −G position, a simulated force actuates the limit system. The pitch g limit test switch is operated by the dc nonessential bus.

DAMPER MODES

In the damper modes, yaw mode and pitch mode, the damper system provides stability by damping out short period oscillations of the airplane. The damper system is hydraulically actuated and electrically controlled. Electrical signals from rate gyros, which sense the direction and velocity of airplane oscillations in yaw, pitch, and roll, operate hydraulic control valves which in turn regulate primary and secondary hydraulic system flow to the surface actuator valves. The surface actuator valves then move the control surfaces to stop the pitch or yaw oscillation of the airplane. When the oscillations have been stopped, the control surfaces return to their original position. These damping movements of the controls are superimposed on the pilot's control action and are not felt at the control stick. In the yaw damper mode, the system damps yaw oscillations and in addition actuates a turn coordinator which automatically maintains the airplane in coordinated flight. Aileron motion of the elevons and airplane roll rate are electrically measured and then modified as a function of altitude and airspeed by the air data computer. The sum of yaw rate, roll rate and aileron position is used to electrically control the hydraulic control valve which in turn controls the rudder surface actuator. The actuator then moves the rudder surface to maintain coordinated flight. In the pitch damper mode, the system continues to provide yaw damping and automatic turn coordination and also damps the pitch oscillations. The damper system receives power from the airplane ac and dc nonessential buses.

ASSIST MODE

The assist mode relieves the pilot of routine steering tasks by performing conventional autopilot functions such as: (1) pitch attitude or altitude hold and (2) heading or bank attitude hold. Primary inputs to AFCS in this mode are from the AHRG. When the flight mode selector switch is in the ASSIST position and if the airplane's wings are within 5° of level flight with the heading hold engaged at the time of momentary interrupt trigger release, signals from the MA-1 system maintain the heading. When the flight mode selector switch is in the ASSIST position and if the bank angle is between 6° and 60°, or heading hold is not engaged, when the momentary interrupt trigger is released, the bank angle will be maintained. Large changes of pitch attitude, bank attitude, or heading may be made by using the momentary interrupt trigger. Small changes of pitch attitude, and bank attitude (if prevailing bank angle exceeds 5°) may be made by using the elevon trim button to "beep" in signals to the AFCS. When beep trimming in bank attitude, if the trim button is released when the wings are within 5° of level flight and the heading hold switch is ON, the airplane will return to level flight (heading hold). If the trim button is released when the bank angle exceeds 5° or if the heading hold switch is OFF, the prevailing bank angle at the time of release will be maintained. When the trim button is used, the pitch and roll references will change at a programmed rate as long as the button is depressed and saturation is not reached. When engaging assist mode, if the system does not function properly, monitor circuits prevent engaging and return the system to pitch damper mode.

AUTOMATIC MODES

Data Link Modes

In data link modes, the computer supplies command signals to the automatic flight control system and to the cockpit indicators to provide automatic steering of the airplane in response to data link signals. Altitude hold may be selected to override data link altitude commands. Data link signals can be used to provide either maximum range performance or minimum time performance of the airplane.

WARNING

The altitude flown by the automatic modes is determined from an assumed barometric pressure of 29.92 and, at low altitudes where the local barometric setting is other than 29.92, will be above or below the data link command altitude. Exercise caution at low altitudes when extreme pressure deviations from 29.92 exist. Automatic mode altitudes may not provide terrain clearance or target altitude separation under these conditions.

Approach Mode (Automatic ILS)

In this mode, the airplane is automatically flown throughout an ILS approach. Throttle control, landing gear actuation, and flareout and landing are accomplished manually. Throughout the approach, the HSI and ADI should be monitored for proper operation of the system. The automatic approach consists of two phases: constant altitude and glide-slope. The constant altitude phase extends from automatic ILS engagement to glide-slope entry. The glide-slope phase begins with glide-slope entry and extends to termination of the automatic approach. Selecting the proper localizer frequency prior to initial automatic ILS engagement insures that localizer course deviation (as determined from the localizer beam signal) and the heading error signal (difference between the airplane compass heading and the selected runway heading) combine to provide horizontal steering signals for localizer beam entry, bracketing, and flying the center of the localizer beam. Engagement may be made within the localizer engage area, which is a circle of four miles radius centered 15 miles from the runway, with the following airplane heading limits:

a. If the approach is made from the right of the runway, the engage heading should be between 60° to the right and 120° to the left of the runway heading.

b. If the approach is made from the left of the runway, the engage heading should be between 60° to left and 120° to right of the runway heading.

Altitude at engagement should be 1500 feet above runway altitude as automatic ILS steering sensitivity during glide-slope descent is reduced as a function of sensed barometric pressure. Glide-slope entry is indicated by airplane pitch change in response to the glide-slope signal. Thereafter, glide-slope deviation signals are used for vertical steering in place of pressure altitude signals which served to maintain altitude during the constant altitude phase. At minimum approach altitude the emergency direct manual button should be depressed and the landing completed manually.

CAUTION

- Flare and landing must be accomplished visually as the landing gear will not withstand the impact at 170 KCAS along the 3° glide slope.
- In automatic ILS modes, the flight mode selector switch will engage and remain engaged without a valid ILS signal. The localizer and glide-slope flags will be displayed and the airplane will turn to the heading set in the course readout window of the HSI.

If there are interruptions after glide-slope interception, the flight mode selector switch will drop to ASSIST, and prevailing attitude will be maintained. If the signals are restored, automatic ILS may be re-engaged but this should be done on a repenetration for optimum performance.

CAUTION

Automatic ILS should never be engaged at speeds above 300 KCAS or above 10,000 feet altitude.

Automatic Navigation Mode

In the automatic navigation mode, steering signals are supplied to the automatic flight control system to automatically fly the airplane to the selected homing point. Altitude hold may be selected to maintain any desired altitude enroute to the homing point. The throttle must be manually controlled. If the automatic navigation mode becomes invalid (navigation display on scope disappears) the flight mode selector switch will revert to ASSIST. The flight mode selector switch also will revert to assist when reaching the homing point.

FLIGHT MODE SELECTOR SWITCH

A flight mode selector switch is located on the flight modes panel (figure 4-22). The five-position rotary switch is spring-loaded to the DIR MAN position. A holding solenoid retains the switch in the selected mode. In the other mode positions, YAW, PITCH, ASSIST, and AUTO, power from the selected mode circuit actuates the holding solenoid and holds the switch in the selected position. If power for the selected mode is lost, the holding solenoid will be deenergized and the switch will rotate toward the DIR MAN position until it reaches a position at which the mode engage circuits are operative and will supply power to energize the holding solenoid. At this point the solenoid will be energized, and the switch will be held in the operative position. For example: if the switch is in AUTO, and power from the automatic mode is lost, the switch will rotate first to the ASSIST position. If power is available for the assist mode, the switch will stop at ASSIST. If power is not available, the switch will move to the PITCH position. If power is available for pitch mode operation, the switch will stop at PITCH. If power is not available for pitch mode operation, the switch will rotate to YAW, and if power is not available for yaw mode operation, the switch will go to DIR MAN position. With the switch in DIR MAN position, no automatic flight control system functions are available and airplane control is direct from the stick through the hydraulic actuators to the control surfaces. When the switch is in the YAW position, the airplane flight control system operates in yaw damper mode. The airplane flight control system operates in pitch and yaw damper mode when the switch is placed in the PITCH position. Moving the switch to ASSIST position puts the airplane flight control system in assist mode. When the switch is in AUTO position, the system operates in the automatic mode selected on the automatic modes switch. When AUTO NAV is selected and a climb is commanded with the interceptor within 0.07 Mach of the MA-1 climb schedule, the aircraft will be in Mach hold. When within 500 feet or 15 seconds of the command altitude, altitude hold is entered. With AUTO NAV selected, if a descent is commanded and the aircraft Mach is equal to or less than descent Mach plus .07, the aircraft will enter Mach hold and the descent attitude. Rate of descent should be adjusted with throttle and speed brakes. Normal AUTO NAV cruise Mach (310 KCAS) will meet these conditions. If ALT HOLD is engaged, it will disengage at this time. If MAX RNG or MIN TIME is selected and a descent is commanded, the aircraft will enter descent attitude regardless of aircraft Mach. If ALT HOLD is engaged, it will disengage at this time and the aircraft will enter descent attitude. If the automatic flight control system is disengaged by the pitch g limiter, the switch will rotate to the YAW position. The switch receives power from the dc nonessential bus.

ALTITUDE HOLD SWITCH

An altitude hold switch (figure 4-22) is located on the flight modes panel and has ALT HOLD and OFF positions. When the flight mode selector switch is in the ASSIST or AUTO position and the altitude hold switch is in the ALT HOLD position, the AFCS will maintain the existing airplane altitude. If the airplane enters the transonic speed range (Mach 0.96 to 1.05) after altitude hold has

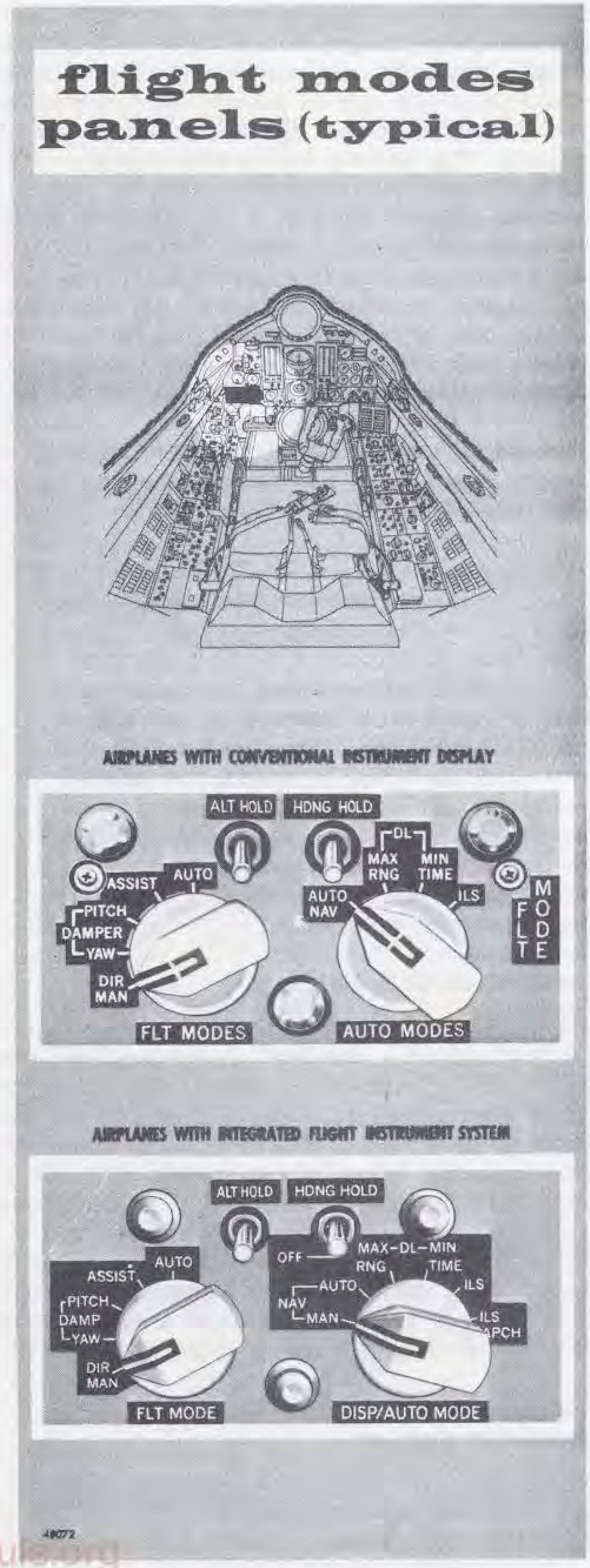

Figure 4-22

altitude hold has been selected, the flight mode automatically changes from altitude hold to pilot assist. When the airplane leaves the transonic speed range the system automatically re-engages and maintains altitude hold at the re-engagement altitude. The altitude hold switch will revert to OFF whenever the airplane is trimmed in pitch attitude (ASSIST ONLY) or any time the flight mode selector switch is moved from the ASSIST position. If the altitude hold switch is in the ALT HOLD position and the flight mode selector switch moved from ASSIST to AUTO, the altitude hold switch will revert to OFF. If the altitude hold feature is desired in the AUTO mode, the altitude hold switch may then be moved to the ALT HOLD position. If normal AUTO elevation steering is desired, the ALT HOLD switch should be set to OFF.

WARNING

> If AFCS altitude hold is engaged and the airplane is trimmed, in ASSIST or the flight mode selector switch is moved from the ASSIST position, the altitude hold feature will disengage. If this occurs while the pilot is preoccupied with the radar scope, an unscheduled loss of altitude could result in descent to ground or water level.

HEADING HOLD SWITCH

On some airplanes, a heading hold switch (figure 4-22) is located on the flight modes panel and has HDNG HOLD and OFF positions. With the flight mode selector switch in ASSIST position and the heading hold switch in HDNG HOLD position, airplane heading is maintained within ±1°. Bank angle is maintained if the HDNG HOLD position is selected when at a bank angle of more than 5°. With the flight mode selector switch in ASSIST position and the heading hold switch in OFF position, airplane heading hold is not assured within ±5° and bank angle may be varied within ±60°.

MANUAL MODE TRIGGER (MOMENTARY INTERRUPT TRIGGER)

A manual mode trigger (momentary interrupt trigger) is located on the control stick (figure 1-13). If the flight mode selector switch is in either assist or automatic mode, pressing the trigger will place the system in pitch damper mode. The system will remain in pitch damper mode while the trigger is held depressed. When the trigger is released, the system will return to the previously established mode, assist or automatic. The trigger interrupts power to assist mode components in the engage circuit but allows the flight mode selector switch to stay in assist or auto. (Power is maintained for pitch damper mode.)

NOTE Ⓑ

> Regardless of which cockpit has control of AFCS, the manual mode trigger will operate in either cockpit.

The manual mode trigger (Ⓑ front cockpit only) serves as a manual disconnect switch when the air refuel switch is ON.

EMERGENCY DIRECT MANUAL BUTTON (EMERGENCY DAMPER DISCONNECT BUTTON)

An emergency direct manual button (emergency damper disconnect button) is located on the control stick (figure 1-13). The automatic flight control system is automatically disengaged, including the damper modes, and the flight mode selector switch moves to the DIR MAN position when the button is depressed. The button interrupts dc power to the automatic flight control system engage circuitry.

NOTE Ⓑ

> Regardless of which cockpit has control of the AFCS, the EDM button will operate in either cockpit and will place the AFCS in direct manual mode.

FLIGHT MODE FAILURE WARNING LIGHT

The flight mode failure warning light (figure 1-36), located on the master warning light panel, illuminates and displays "Flight mode failure" whenever the selected flight mode is inoperative. The light may be extinguished by depressing the manual mode trigger. When the selected flight mode fails, the flight mode selector switch automatically "steps back" to the next operative flight mode, and the flight mode failure warning light illuminates to indicate that the initially selected flight mode is inoperative and the switch has "stepped back." Although there has been no flight mode failure, the light will illuminate when power is first applied to the airplane and should be extinguished by momentarily depressing the manual mode trigger. Power is supplied by the dc essential bus.

AFCS CONTROL TRANSFER BUTTON, MONITOR LIGHT AND INDICATOR

The AFCS control transfer button, monitor light, and indicator are located on the AFCS transfer panel (figure 4-9) on the forward and aft consoles. The buttons are placarded "AFCS & ILS AUTO NAV Transfer." The monitor light is enclosed in the switch housing. Transfer of control of the flight mode selector switch, the automatic mode selector switch, the instrument landing and approach equipment, and the automatic navigation equipment is affected by this switch; i.e., the cockpit with control would receive valid TACAN ILS information to the flight director whereas the other would not. Before control can be transferred, the forward and aft flight mode selector switches and automatic mode selector switches must be at the same setting. The indicator placarded "Will Transfer" will display "NO" if these switches are not at the same positions. If the switches are at the same positions, the indicator will display "YES" or "OK," and AFCS control can be transferred forward or aft by depressing the transfer button.

The monitor light in the transfer button will illuminate in the cockpit which has control. On some airplanes*, it is necessary to hold the flight mode selector switch in the selected position in the cockpit to which control is being transferred when the transfer button is actuated. When transfer is effected, the flight mode selector switch in the cockpit from which control is being transferred will revert to DIR MAN position, and the flight mode failure warning lights will illuminate. To extinguish the lights, it is necessary to momentarily depress the momentary interrupt trigger in both cockpits. On other airplanes** the above condition does not exist and transfer may be accomplished by actuating the transfer button when the will transfer indicator displays "YES," or "OK." Power is supplied from the MA-1 electrical power supply system.

AUTOMATIC FLIGHT CONTROL SYSTEM PREFLIGHT CHECK

After starting engine, the following checks may be performed prior to AFCS flights:

1. MA-1 power switch—RADAR STBY.
2. Flight mode selector switch—YAW then PITCH.
   Check dampers, note any transients.
3. Manual mode trigger—Depress and hold.
   Flight mode failure warning light should extinguish after the trigger is depressed.
4. Flight mode selector switch—ASSIST.
5. Manual mode trigger—Release.
   Check that no objectionable stick movement occurs when the trigger is released.
6. Longitudinal trim—Check.
   Check longitudinal trim by trimming NOSE UP and NOSE DOWN, checking that control stick follows trim button displacement. After trimming NOSE UP to obtain approximately 3 inches of stick displacement, depress the manual mode trigger; there should be little or no stick movement. Release manual mode trigger and trim NOSE DOWN to obtain approximately 3 inches of stick displacement and again depress manual mode trigger; there should be little or no stick displacement. Release manual mode trigger.
7. Lateral trim—Check.
8. Manual mode trigger—Depress, manual flight checked.
   Depress manual mode trigger and check that manual flight control is available, then release the trigger.
9. Pitch g limit test switch—(±) G: note that flight mode selector switch moves to YAW. Return flight mode selector switch to ASSIST.
10. Altitude hold check (if altitude hold switch is installed).
    a. Altitude hold switch—ALT HOLD.
    b. Elevon trim switch—NOSE UP.
       Altitude hold switch should revert to OFF. Release elevon trim switch.
    c. Altitude hold switch—ALT HOLD.
       Control stick should immediately center and remain stationary without oscillations or drift from center position.
    d. Elevon trim switch—NOSE DOWN.
       Altitude hold switch should revert to OFF. Release elevon trim switch.

*AF 57-2516 thru -2541.
**AF 57-2508 thru -2515, *-2542 & on.

e. Altitude hold switch—ALT HOLD.
Control stick should immediately center and remain stationary without oscillations or drift from center position.

f. Flight mode selector switch—PITCH DAMPER.
Altitude hold switch should revert to OFF. Return flight mode selector switch to ASSIST.

11. Heading hold check (if heading hold switch installed).

a. Heading hold switch—OFF.

b. Elevon trim button—Trim ailerons approximately 1/3 side stick movement.
Control stick should remain stationary without oscillations or drift toward the center stick position.

c. Heading hold switch—HDNG HOLD.
Control stick should immediately center and remain stationary without oscillations or drift from the center position.

12. Emergency direct manual button—Depress.
Depress the emergency direct manual button and check that the flight mode selector switch moves to DIR MAN.

13. Takeoff trim—Set.

OPERATION OF AUTOMATIC FLIGHT CONTROL SYSTEM

Engaging Procedure

Use the following procedure to engage AFCS:

1. MA-1 power switch—RADAR STBY or ON.
2. Flight mode selector switch—PITCH.
3. Trim for desired flight attitude.
4. Manual mode trigger—Depress.
5. Flight mode selector switch—ASSIST.
6. Manual mode trigger—Release.

AFCS is operating in the assist mode, maintaining pitch attitude and heading, or roll attitude depending on roll angle existing when the manual mode trigger was released. If a specific heading is desired instead of bank attitude, the wings should be within 5°of level flight. To make small corrections while in the assist mode, the elevon trim button is used as a trim control to feed in signals to vary the airplane attitude. Large corrections should be made by depressing the manual mode trigger to give the pilot manual control for faster, more positive corrections. For automatic steering, select the automatic mode desired, depress the manual mode trigger, place the flight mode selector switch in the AUTO position, and then release the manual mode trigger.

NOTE O

- On some airplanes*, due to possible intermittent malfunction of the flight mode selector switch and failure of the flight mode failure warning light to indicate switch position, a visual check of the switch should be made to ascertain that the switch is in the proper position after a change in position has been made. The mode switch may (1) step back to a mode lower than that selected, (2) "stick" and fail to step back when the manual mode trigger is depressed, or (3) step back as far as the DIR MAN position when the manual mode trigger is depressed.
- On some airplanes** the automatic mode selector switches in both cockpits must be in the same DL position. Do not move the automatic mode selector switch in the noncontrolling cockpit from a DL position to an ILS position while the automatic mode selector switch in the controlling cockpit is in a DL position. If this were done, data link information would be erased from the digital computer. This could result in a mission abort unless data link information were retransmitted.

Transfer Procedure B

To transfer AFCS control from one cockpit to the other, use the following procedure:

1. Flight mode selector switch—Same position in both cockpits.
2. Automatic mode selector switches—Same position in both cockpits.
3. Will transfer indicator—"YES" or "OK" (both cockpits).
4. Flight mode selector switches—Hold in place (both pilots) (some airplanes).

*AF 57-2516 thru -2526.
**AF 57-2516 thru -2564.

NOTE ◐

On some airplanes both flight mode selector switches must be held while the AFCS control transfer button is depressed. Otherwise, both flight mode selector switches will rotate to the DIR MAN position.

5. Control Stick—Maintain grip until AFCS transfer is complete (pilot in "transferred from" cockpit).
6. AFCS control transfer button—Depress (pilot in "transfer to" cockpit).
7. Manual mode trigger—Depress momentarily (both pilots).

NOTE ◐

- During AFCS control transfer in other than direct manual mode, the flight modes failure warning light will illuminate in both cockpits. To extinguish the light in both cockpits, the manual mode trigger is momentarily depressed in the cockpit taking control.
- During direct manual AFCS control transfer, the flight modes failure warning light will not illuminate.

Disengage Procedure

Momentary disengaging is available by depressing the manual mode trigger. If it is not desired to reengage pilot assist immediately, either of the following actions will disengage the system:

1. Flight mode selector switch—PITCH or YAW.
2. Emergency direct manual button—Depress (disengages pitch and yaw damper systems).

AUTOMATIC MODE SELECTOR SWITCH (CONVENTIONAL INSTRUMENT DISPLAY)

An automatic mode selector switch, placarded "Auto Modes," is located on the flight modes panel (figure 4-22). Switch positions are: AUTO NAV, DL MAX RNG, DL MIN TIME, and ILS. With the switch in AUTO NAV, the autonomous navigation system is operative, and if the flight mode selector switch is in AUTO, the automatic navigation system will supply steering signals to the automatic flight control system when the computer has valid TACAN or DR capabilities. The DL MAX RNG position is selected for close control or modified close control data link operation. If, by SAGE command, the dominant mode is CC, the selection of either MAX RNG or MIN TIME yields the same result: the guidance calculations are performed by SAGE. However, if the dominant mode is MCC, the position of the switch governs the profile and tactics commanded by the MA-1 in attacking the target. The tactics associated with the MAX RNG selection are the same as CC dependent upon switch position in MCC. MIN TIME produces cutoff tactics and MAX RNG produces stern. With the switch in ILS, the instrument landing and approach system will supply steering signals to the automatic flight control system if the flight mode selector switch is in AUTO position.

NOTE

- When the automatic mode selector switch is placed to ILS, the computer memory circuit is cleared of all data link and wind.
- During ILS approach continue to monitor the HSI course deviation indicator.
- ◐ If ILS is selected in either cockpit during data link operation, data link will not be displayed.

DISPLAY/AUTOMATIC MODE SELECTOR SWITCH (INTEGRATED INSTRUMENT DISPLAY)

A display/automatic mode selector switch, placarded "Disp/Auto Mode," is located on the flight modes panel (figure 4-22). Switch positions are: MAN NAV, AUTO NAV, DL MAX RNG, DL MIN TIME, ILS, and ILS APCH. With the switch at MAN NAV, autonomous navigation information cannot be utilized, and the command functions of the AMI, HSI, and AVVI must be set manually, if desired.

NOTE

When MAN NAV is selected on the display/automatic modes switch, the AUTO position cannot be selected on the flight mode selector switch.

With the switch in AUTO NAV, the autonomous navigation system is operative, and if the flight mode selector switch is in AUTO, the automatic navigation system will supply steering signals to the automatic flight control system when the computer has valid TACAN or DR capabilities. With the switch in ILS, the instrument landing and approach system will supply steering signals to the automatic flight control system if the flight mode selector switch is in AUTO position.

The DL MAX RNG position is selected for close control or modified close control data link operation. If, by SAGE command, the dominant mode is CC, the selection of either MAX RNG or MIN TIME yields the same result: the guidance calculators are performed by SAGE. However, if the dominant mode is MCC, the position of the switch governs the profile and tactic commanded by the MA-1 for the attack phase. The tactics associated with the MAX RNG selection are the same as CC dependent upon switch position in MCC. MIN TIME produces cutoff tactics and MAX RNG produces stern.

NOTE

- When the display/automatic mode selector switch is placed to ILS the computer memory circuit is cleared of all data link and wind.
- During ILS approach continue to monitor the HSI course deviation indicator.
- Ⓑ If ILS or ILS APCH is selected in either cockpit during data link operation, data link will not be displayed.

CAUTION

ILS localizer course and command altitude must not be set until after selection of ILS display mode.

With the switch in ILS APCH, the pitch steering bar of the ADI is operative and will be displayed.

ARMAMENT

NOTE

Refer to Supplement Flight Manual, T.O. 1F-106A-1-2, and Aircrew Special Weapon Delivery Manual, T.O. 1F-106A-29, for AIM missile, AIM missile description, armament limitations, weapon effects, jettison ballistics and kill probabilities. Refer to Section II for TACTICAL PROCEDURES.

Aircraft armament consists of four AIM missiles and on some Ⓐ airplanes, a gun system. All armament is contained in a missile bay in the bottom center portion of the fuselage. AIM missile launching provisions consist of four extendible launchers—two in the forward missile bay and two in the aft bay. The gun system occupies the same center aft missile bay location. High-pressure pneumatic system air is used for missile bay door opening for AIM missile operation and for AIM missile launcher extensions. Electrical signals control the sequence and relative positions of doors and launchers. Door operation is not required for gun firing. Secondary hydraulic system power is used for gun system operation. Armament electrical power is routed through the nose wheel well door-closed switch to prevent armament firing if the nose wheel well door is open.

ARMAMENT CONTROL PANEL

Refer to figures FO-1 and FO-2.

Arm-Safe Switch

A guarded arm-safe switch on the armament control panel (forward cockpit only in Ⓑ aircraft) has positions of ARM and SAFE. When the switch is in the guarded SAFE position, no power is supplied to the armament launching and firing circuits. With the switch in the SAFE position, practice attack runs may be made with all normal displays and indications from the MA-1 system. The ARM position allows power to be supplied to the firing circuits and should be used only when attack firing or armament salvo is desired. The arm-safe switch receives power from the dc essential bus.

Armament Selector Switch

NOTE

When switching from GUN to MISSILE MODES or vice versa, assure that the switch positively detents in the VIS IDENT position.

The rotary armament selector switch, located on the armament control panel (forward cockpit only in **O** aircraft), is used to select the desired armament for attack firing, to select armament salvo, or to select visual identification. Prior to changing the setting of the selector switch, the arm-safe switch should be in the SAFE position. A selector switch guard prevents entry into the GUN (some **O**) position unless the guard is depressed and rotated. The positive stop prevents entry into the GUN position from the SALVO position. Salvo position can be entered by clockwise rotation of the knob. The armament selector switch receives power from the dc essential and nonessential buses.

Armament Selection Indicator

The armament selection indicator, located on the armament control panel, is labeled SELECT. Indications of OK or NO appear in the window of the indicator to show whether or not the selected armament is available for firing. OK indicates that the armament selected by the armament selector switch is available, and that the intervalometer is reset (missile selection only). NO indicates that the selected armament is not available, that the intervalometer is not reset (missile selection only), or that no power is applied. When the armament selector switch is in VIS IDENT, the indicator is blank when the armament system is operating on MA-1 power and reads NO on aircraft power. In SALVO selection, the indicator reads NO when operating on aircraft or MA-1 power. When GUN is selected and a gun is installed, the indicator is blank.

Missile Bay Doors-Close Button

The missile bay doors-close button is located on the armament control panel (forward cockpit only in **O** aircraft). Actuation of this button retracts the missile launchers and closes the missile bay doors in event normal cleanup is not obtained because of an aborted attack or armament misfire.

WARNING

If emergency procedures are necessary for retraction, the missile shall not be retracted less than 75 seconds after full extension. A potential hazard of an in-bay explosion, resulting in severe aircraft damage and pilot danger, exists if missiles are retracted into the missile bay with the electrical-hydraulic power supply still operating.

The DOORS-OPEN light on the warning light panel illuminates when the above condition exists. The doors-close button is operative only when the nose wheel well door is closed and is independent of arm-safe switch or armament selector switch positions. To preclude possible door bounce during clean-up it is desirable to have the arm-safe switch in SAFE position and the armament selector switch in the VIS IDENT position prior to actuation of the doors-close button.

CAUTION

The doors-close button must be pressed and held until the DOORS-OPEN warning light extinguishes.

The doors-close button is powered by the dc essential bus.

AIRCRAFT ARMAMENT CONTROL MONITOR PANEL ⓑ

The armament control monitor panel (figure FO-2) is located in the ⓑ aft cockpit. This panel incorporates lights to provide the pilot in the aft cockpit with an indication of various armament functions performed in the front cockpit. Indicator lights are provided to show armament selector switch position and arm-safe switch position. The panel also includes an armament selection indicator.

ARMAMENT TRIGGER

The armament trigger, located on the forward side of the right-hand control stick grip (figure 1-13), provides for firing of the selected armament. The triggers in ⓑ aircraft are connected to require trigger depression in both forward and aft cockpits to effect firing when UHF control is in the aft cockpit. Pressing of only the forward trigger is required when UHF control is in the forward cockpit. The trigger is used for firing on all attacks. The trigger is also used for salvo (or jettison) firing. The trigger is spring-loaded to the full out or neutral position and has two detent positions. The two detents can be felt as the trigger is squeezed. During salvo operation only, pressing the trigger to the first detent opens the missile bay doors. Pressing the trigger to the second detent extends and launches the missiles. The trigger receives power from the dc essential bus during armament jettisoning and from the MA-1 power subsystem during missile attack firing. During gun system operation, depressing the trigger to the second detent provides dc essential power to initiate gun operation.

ARMAMENT RECYCLE BUTTON

The armament recycle button (figure FO-1 and FO-2) is located on the left console, (forward cockpit only in ⓑ aircraft). This switch provides inflight reset capability of the missile intervalometer and MA-1 bay select circuit. Actuation of the switch closes contacts to direct dc nonessential bus power to the missile intervalometer, causing it to reset and allowing additional cycling of the missile launchers within established limitations of the pneumatic system. This button has no function in the gun system. The armament recycle button operates when the armament selector switch is set to VIS IDENT only. The missile intervalometer should be reset by the ground crew prior to each mission. If this has not been done, the armament select indicator may indicate improperly. To insure that this does not happen during an attack mission, just prior to the first missile selection press and hold the armament recycle button for five seconds, then release. After the first attack pass, the armament recycle button must not be actuated again. To do so would defeat the logic of the bay select circuits on subsequent missile passes and could result in the selection of a bay which has been previously selected. Recycle if necessary to perform multiple WSEM attacks.

ARMAMENT MALFUNCTION WARNING LIGHTS

Missile Bay Door-Open Warning Light

The door-open warning light on the master warning light panel (figure 1-36) illuminates to display DOOR OPEN approximately 12 seconds after the missile bay doors are opened if the armament firing cycle is not completed and the doors do not close. In SALVO, the light illuminates if the armament trigger is released after firing before the doors close. It will then extinguish as soon as the doors are fully closed. The warning light indicates a door-open condition only if a door-open command signal is not present. The light is powered by the dc essential bus.

Missile Displaced Warning Light

The missile displaced warning light on the master warning light panel (figure 1-36) illuminates to display "MISSILE DISPLACED." This light illuminates any time a missile is displaced (not properly seated on a launcher) or a launcher is not up and locked with the doors closed. The light is powered by the dc essential bus.

CAUTION

Retracting the launchers following illumination of the missile displaced warning light may result in damage to the aircraft and/or missiles.

Misfire Warning Light

The misfire warning light on the master warning light panel (figure 1-36) illuminates to display "MISFIRE" following a firing signal which does not result in launching all selected armament. The light illuminates briefly during any AIM firing but extinguishes as soon as the armament is launched. The misfire warning light is powered by the dc essential bus.

GUN SYSTEM

A gun system (some aircraft) is installed in the missile bay and consists of a M61A1 20mm gun, an ammunition handling system, and an electrical control unit. The gun barrels extend below the normal contour of the closed missile bay doors and are enclosed in vented fairings. The gun components are contained in a housing in the missile bay and quick disconnects are provided on hoses and cables to facilitate removal and installation.

The gun, which has a rotating cluster of six barrels, fires electrically primed ammunition at a nominal rate of 4500 rounds per minute. It provides air-to-air and air-to-ground firepower capabilities. Secondary hydraulic system pressure supplies gun drive power and electrical power is supplied by the dc essential and ac essential buses. Gun firing is accomplished by placing the armament selector switch to GUN, placing the arm-safe switch to ARM, and depressing the armament trigger to the second detent. Missile bay doors and nose landing gear door must be closed to fire the gun.

The ammunition handling system consists of a storage drum, an ammunition conveyor mechanism, and a feed mechanism. The system has a storage capability of approximately 650 rounds. During loading, linked rounds are fed through the feed unit, stripped from the links, picked up by conveyor elements, and transported into the storage drum. During firing, the ammunition is routed through the storage drum, carried to the feed unit on the conveyor elements, and fed into the gun. The rounds are fired by an electrical contact. Empty cases and cleared rounds (duds) are returned to the ammunition storage drum for storage. A last-round switch stops gun operation prior to firing of the last round. Approximately 25 unfired rounds remain in the gun system after last-round switch actuation stops the gun.

Gun System Operation

1. Armament selector switch—GUN.
2. Armament selection indicator—Blank.
3. Arm-safe switch—ARM.
4. Armament trigger—Depress to second detent.

AIRCRAFT AND WEAPON CONTROL SYSTEM (MA-1)

NOTE

This manual covers two aircraft and weapon control systems, the MA-1 in the F-106A airplane and the AN/ASQ-25 in the F-106B airplane. The text distinguishes between the two configurations only where necessary and will refer to all switches, controls, etc., in both the F-106A and F-106B aircraft weapon and control system as the "MA-1."

Refer to Section VII for MA-1 SYSTEM MALFUNCTIONS. For additional information on the MA-1 system refer to Confidential Supplement, T.O. 1F-106A-1-2.

ATTITUDE HEADING REFERENCE GROUP (AHRG)

The attitude heading reference group provides the MA-1 system with the vertical and directional reference required for navigation and flight control of the airplane. The AHRG consists of four units: the displacement gyroscope assembly, the electronic control amplifier, the compass system controller, and the stable coordinate converter. The gyro can rotate 360° about the roll, pitch, and heading axis.

COMPUTER SUBSYSTEM

Operation of the MA-1 aircraft and weapon control interceptor system is based on use of a digital computer as a control element. The inflight function of the MA-1 digital computer is to solve the navigation and control problems which arise during a tactical mission. In solving problems, the computer follows a group of pre-recorded directions called a program. The total computer program consists of three separate programs: navigation, attack, and test. The navigation program furnishes command signals to fly the interceptor in the proper geometry for the navigation mode selected. To obtain proper command signals, one aspect of the navigation program is to compute the winds at interceptor altitude. Time to compute 95% of the winds is approximately 4 minutes. The attack program provides final attack positioning or armament timing. It functions with DROT, ATOT, IR full action switch, a manual pursuit selection, or VIS IDENT. The test program is entered by switch settings in the cockpit or the computer bay.

WARNING

If computer malfunction is suspected, monitor target range for accurate time-to-go.

In order to measure interceptor roll, pitch, and heading angle accurately, the vertical axis of the displacement gyro must be aligned with the local vertical and its heading must be established relative to computer grid north. Thereafter, the alignment is corrected by the computer or pilot for any change in the direction of the local vertical and in the orientation of navigational coordinate system due to earth rotation and the movement of the interceptor over the earth's surface. When there is an interceptor attitude change, the change is simultaneously measured and converted into a useable electrical signal and distributed to the MA-1 system. Information thus obtained is used in stabilizing the radar antenna during search; provides stabilized radar displays; provides roll, pitch, and heading signals for AFCS operation; and allows fire control computations to be made in reference to a stabilized base.

AUTO-NAV SYSTEM

NOTE

The "auto-nav" system refers to autonomous navigation. When fully automatic navigation is referenced, the term "automatic navigation" will be spelled out.

For auto-nav, the digital computer computes the course to fly to a preselected homing point. These homing points are stored in the digital computer and are selected manually. The digital computer determines a course on a maximum range basis and supplies steering signals to the tactical situation display, the command altitude indicator, the Mach indicator, and on some airplanes, to the HSI, AMI, and AVVI. The computer grid coordinate system is based on a "computer origin" point. The displacement gyro is the only source of aircraft heading in this grid system. The automatic modes switch must be in the AUTO NAV position for operation of the auto-nav equipment. Valid navigation begins upon reception of TACAN or when initial position is inserted. If the airplane is under automatic control, it is automatically flown on a prescribed course. The auto-nav system will continue to dead reckon after the TACAN annunciator displays "DR" or "OFF"; however, accuracy is degraded. The auto-nav equipment receives power from the MA-1 electrical power supply system.

NOTE

If the grid reference of the displacement gyro is not correctly aligned by the pilot, the computer cannot solve navigation programs correctly.

Auto-Nav Homing Point Selector Switch

An auto-nav homing point selector switch (figure 4-15) is located on the right console. The switch has 20 positions, corresponding to the number of homing point coordinates which may be stored in the digital computer. The MA-1 computer is programmed for as many as 20 homing points of which homing point T will always be the position of the selected TACAN station. The MA-1 computer positions the TSD target symbol over the selected homing point. The homing point selector switch receives power from the MA-1 electrical power supply system.

The following information is given for each homing point selection. Homing point "A" displays target marker circle and target elevation on MMST. Target Mach on command Mach marker and command Mach readout window will be displayed for approximately 10 seconds with DISP/AUTO MODE switch in MAX RNG or MIN TIME and with valid data link. Homing point "T" displays free air temperature in command altitude readout window (also the command altitude marker for integrated instruments) for temperatures below zero degree centigrade. Homing point "G" displays ground speed in knots in the command altitude readout window for 19 seconds. Thereafter desired altitude is displayed. The two least significant digits on the command altitude readout window are fixed at zero. If groundspeed is less than 700 knots, then readout is accurate to the nearest knot. However, a scaling change occurs at 700 knots such that groundspeeds greater than or equal to 700 knots are displayed with readouts accurate to the nearest ten knots.

EXAMPLE:

Actual Groundspeed	Readout
532.7 knots	53300
853.0 knots	08500

In homing point "U", the tactic selected is indicated on the command altitude readout window (also on the command altitude marker for integrated instruments) and on the scope NAV steering line for approximately 10 seconds with MAX RNG or MIN TIME selected on DISP/AUTO MODE switch. The following tactics and altitudes will be displayed:

50K-P (Pursuit)
45K-M (Manual) CC only
40K-CO (Cutoff)
35K-SB (Stern Before Offset)
30K-SA (Stern After Offset)
25K-NC (Non Commit)

NOTE

If none of the above homing points are selected, the range to the selected homing point is displayed in the target altitude window. Maximum displayed range is 700 nautical miles with accuracy to the nearest nautical mile.

The scope NAV steering line alternates vertically from the normal command level to the scope top with the horizontal position indicating tactic as shown in the table.

Tactic	Sim Hdg Error	Sim Ant AZ Angle	Strng Line Defl
SA (Stern After offset)	+30°	+53.5°	Full right
SB (Stern Before offset)	+15°	+26.75°	Half right
CO (Cutoff)	0	0	Center
M (Manual) CC only	−15°	−26.75°	Half left
P (Pursuit)	−30°	−53.5°	Full left

The scope NAV steering line alternates vertically from the normal command level to the scope bottom with horizontal position at 0° (center) to indicate a non-commit tactic.

The scope tactics display will also occur for approximately 10 seconds following a tactics change.

Auto-Nav Homing Point Profiles

Normal cruise for the interceptor in the AUTO-NAV mode is 0.92 Mach at 40,000 feet (0.88 Mach at 37,000 feet with tanks). Five AUTO-NAV homing point profiles are possible. Examples of these five possible situations and the interceptor response to each are as follows:

a. Normal profile—Interceptor is above or below normal cruise altitude but distance to homing point is far enough to permit subsonic climb or descent to normal cruise altitude and cruise for ten nautical miles or more.

b. Intermediate profile—Interceptor is below normal cruise altitude but so close to the homing point that ten nautical miles cruise after climbing to normal cruise altitude would be impossible. An "intermediate" cruise altitude which will permit ten nautical miles cruise will be computed.

c. Close-in profile—Interceptor, regardless of present altitude above or below homing point altitude, is so close to the homing point that no cruise altitude above homing point altitude would permit a ten nautical mile cruise: the homing point altitude would be immediately commanded. The climb or descent, as appropriate, to homing point altitude may still be in progress when homing point is reached.

d. Homing Point "T" Profile—Selecting homing point "T" assigns the selected TACAN station to become the homing point position. The target bug will be positioned at TSD center. Command altitude will be present interceptor altitude until AUTO AFCS is engaged at which time command altitude will be frozen at AUTO AFCS engagement altitude. Command Mach will be cruise Mach for the selected command altitude. Heading correction will cease 60 seconds prior to arrival over the TACAN station. AFCS drops to ASSIST upon arrival at the station. Command altitude will display outside air temperature.

   If a valid TACAN is selected, command heading will be that heading which will take the aircraft directly to or from the TACAN station on the selected bearing. It will not be dependent on computer derived winds. If a different selected bearing or TACAN station is required, momentary deselection of homing point "T" is necesary. Outbound steering is available and is determined when the angular difference between TACAN bearing and interceptor heading is greater than 90°. When AUTO AFCS is engaged, the interceptor will track Inbound/Outbound on the TACAN selected bearing to/from the station. (The CDI will continued to show displacement from the selected TACAN radial.)

   The AFCS drops to ASSIST 60 seconds after loss of TACAN bearing and/or range if a Manual TACAN is selected. If preset TACAN is selected and the interceptor is inbound to the station, the loss of valid TACAN will cause the aircraft to navigate to the station based on computer derived winds. AUTO AFCS will remain engaged. If outbound with Preset TACAN and loss of valid TACAN, interceptor heading will be displayed as command heading. AUTO AFCS will continue to be engaged.

   The operation of this program utilizes existing auto-navigation logic, and therefore, requires the AHRG be properly erected.

e. Homing Point R or S Profile—Homing point R or S position can be adjusted to any desired coordinates on the TSD map when AUTO NAV and homing point R or S are selected. Use the hand control (full action) to effect a "Not Search" within 5 seconds of selecting homing point R or S. The homing point may then be moved up or down by increasing or decreasing the range gate, and left or right with the radar azimuth angle hand control. If the target bug is moved beyond the selected map scale radius, the bug will return to center. If both homing points R and S need to be set, position one homing point to the desired location and then select and position the other while maintaining NOT SRCH. The coordinates of the target bug are stored in the selected homing point position (R or S) when one of the following occurs.

   (1) Return to "Search."
   (2) Deselect AUTO NAV.
   (3) Deselect present homing point (R or S).
   (4) DROT or ATOT is obtained.

MA-1 power must be standby or higher and the MA-1 power switch must be in "ON" position in order to set homing point R and S. The 2 nautical mile position of the range gate marker is the neutral position for up/down movement of the target bug regardless of scope range selection. Therefore, the 4 nautical mile scope range should be selected.

Subsequent repositioning of the bug will require momentary deselection of homing points R and S. Selection of this mode interrupts the normal tactical program which may affect A-A' cycling. Select VI to avoid this problem.

Pilot Assist may be selected during execution of this profile.

Operation of Auto-Nav Equipment

1. MA-1 power switch—Radar STBY or ON and power annunciator displaying "OK."
2. Without previous initial positioning check TACAN annunciator for "OK" or "DR" indication.
3. Automatic mode selector switch—AUTO NAV.
4. Auto-nav homing point selector switch—Set (as desired).
5. For automatic flight, flight mode selector switch—AUTO.

Cockpit Displays for Operation of Auto-Nav Equipment

Mode	Command Mach Window	Command Altitude Window	Target Altitude Window	Remarks
AUTO NAV	Computer Cmd Mach	Computer Cmd Mach (2), (3), (5)	Range to Selected Homing Point	See Notes 1 thru 9
MAX RNG/ MIN TIME	DL Command Mach (1)	DL Command Alt (2), (3), (5), (7)	DL Target Alt (6)	
ATTACK	No DROT: DL Cmd Mach DROT: Radar Target Mach	No DROT: DL Cmd Alt (8), (9) DROT: Radar Range Rate (5)	No DROT: DL Target Alt (6) DROT: Range Target Alt	
SNAP-SHOOT	0.4M if invalid DL message 2.2M if valid DL message	No DROT: 0 if invalid DL message 70,000 if valid DL message DROT: Range to Target in feet when within 8,000 feet	0	Homing points selection gives pippers representing the following wingspans: A-30', B-60', C-90', D-120', E-150', F-180', G-250'

(1) Homing point A selection will cause DL target mach to be displayed in the command mach window for 9.6 seconds in a DL or attack mode with no DROT.

(2) With homing point T selected, outside air temperature will be displayed.

(3) With homing point G selected, ground speed will be displayed for 19 seconds.

(4) Upon setting homing point U, tactics selection will be displayed for 9.6 seconds in DL mode.

(5) Range rate and ground speed readouts are scaled from 0-699 knots and 700-7000 knots. A display of 6500 in the appropriate window could represent either 65 or 6500 knots.

(6) When no DL target altitude values are received, target altitude window will display 22,200. A display of 33,300 will represent unknown target altitude.

(7) Zero will be displayed if navigation is not valid.

(8) With homing point T selected in angle ranging (missiles) or not angle ranging mode, outside air temperature will be displayed.

(9) In angle ranging mode, a command altitude 2500 feet above or below the target will be displayed.

DATA LINK

The cockpit data link equipment consists of the data link coverter-receiver control panel, computer mode annunciator and data link antenna switch.

Data Link Converter-Receiver Control Panel

The data link converter-receiver control panel, (figure 4-23) controls the receiver frequency and aircraft address used for TDDL. Functions of the controls on the data link converter-receiver control panel are discussed in the following paragraphs.

a. Channel Selection Controls. The channel selection controls, consisting of a thumbwheel selector drum and increase (INCR) and decrease (DECR) pushbuttons, are used to select one of 26 preset channels. The drum may be positioned quickly by the thumbwheel or in steps of one channel by the INCR or DECR pushbuttons until the desired channel number appears in the channel window. When the channel selection controls are positioned so that M appears in the channel window, the manual frequency controls may be used to manually select any one of a possible 1750 frequencies.

b. Manual Frequency Controls. The manual frequency controls are used in conjunction with the backup voice reception capability of the data link receiver. The channel selection controls must be set so that the channel window indicates M before the manual frequency controls are operative. At this time, windows above the manual frequency controls open and each manual frequency knob is rotated until the desired digit appears in the window above the knob. The voice backup capability is not available if the MA-1 power is off or if the MA-1 power switch is set to EMER.

c. Address Select Control. The address select control selects the desired aircraft address for data link. The control is rotated until the desired number appears in the window to the left of the knob. Capability is provided for 32 possible aircraft addresses.

d. Test Address/Display Off/Display On Control. The test address/display off/display on control determines the source of the aircraft address supplied to the data link converter. When this switch is set to DISPLAY OFF or DISPLAY ON, the time-division data link converter will accept only messages containing the aircraft address set up on the address select switch. When this switch is set to TEST ADDRESS, the data link converter will accept messages containing a predetermined test address.

e. Volume Control. The volume control permits adjustment of the audio level of data link voice signal in the headset. This control operates in conjunction with the volume control on the UHF control panel.

f. Squelch Switch. The squelch switch, when moved aft, disables the noise-limiting circuits in the data link voice receiver. The operation of the receiver may be checked by increasing the setting of the volume control and moving the squelch switch aft. If the receiver is operating, a noise will be heard in the headset. Normal operating position of the switch is forward.

Computer Mode Annunciator

The computer mode annunciator (figures FO-1 and FO-2) may display any one of three indications (DL, DR, or "barber pole") to show the currency of data link. DL is set in the annunciator when CC is primary. When entering the NAV mode following an attack mode, the computer mode annunciator will function as follows:

When MCC is primary, a DR is set if MCC messages have been received within 1 minute prior to switching from the attack mode to the NAV mode or if MCC messages have been received within the last minute of NAV. With MAX RNG or MIN TIME selected and a DR displayed, the target information displayed on all cockpit instruments will be from MCC. When messages are older than 1 minute, the barber pole is displayed and the data link target indications are dead-reckoned.

A barber pole is set if no MCC was received in attack until a new MCC is received in NAV. If a radar lock-on was achieved in the attack mode, a barber pole displayed, and MAX RNG or MIN TIME selected, the data link target indications are dead-reckoned from the last radar target on which the lock-on was achieved. Dead reckoning will continue for 44 minutes.

data link converter-receiver control panel

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Figure 4-23

NOTE

> When entering an attack mode a barber pole is displayed and commands are frozen until a close control message is received. Receipt of modified close control messages does not change the displays.

Data Link Antenna Switch

The data link antenna switch (figure 4-24) controls the directional capability of the data link antenna. The switch is located on the right console aft of the canopy switch. The data link antenna switch should

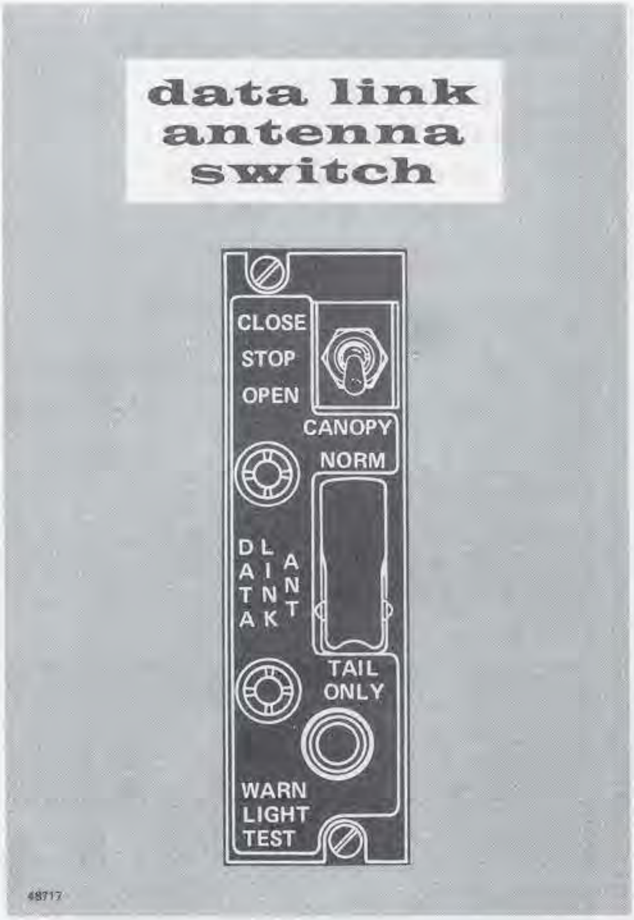


Figure 4-24

be set to the position which gives the best reception of data link during a particular phase of flight. Setting the switch to the TAIL ONLY position decreases the reception sensitivity of the data link receiver in the forward direction.

AIR REFUELING SYSTEM

The airplane is equipped with an air refueling system which permits airborne refueling of internal and external fuel tanks. The system uses the "boom and receptacle" refueling method. This method requires that the airplane be flown to a prescribed in-trail formation position and that the tanker boom be placed in the refueling receptacle for transfer of fuel. Fuel is supplied under pressure from the tanker to internal fuel tanks or to internal and external tanks as selected. Ground refueling transfer lines are used for air refueling. The refueling receptacle (figure 1-1) is located on the top of the fuselage aft of the cockpit. The receptacle area is enclosed by a door which is hinged on the forward end and opens downward at the aft end to expose the receptacle. The open door forms a slipway which guides the refueling boom into the receptacle. The receptacle area is lighted when the slipway door is open. The slipway door is normally actuated by secondary hydraulic system pressure. In event of secondary hydraulic system failure, high pressure pneumatic system pressure is supplied to the door actuator through a shuttle valve to provide emergency door opening. When the refueling boom nozzle is inserted into the receptacle, hydraulically actuated latches lock the nozzle in place. Upon completion of refueling, the boom latches are retracted and the nozzle is released. The latches may be released automatically by a pressure switch when the fuel tanks are full, by cockpit controls, or by a signal from the tanker. In event of secondary hydraulic system failure, there is no provision for emergency operation of the boom latches. However, fuel can be transferred by holding the boom nozzle firmly against the receptacle. The boom latches normally lock automatically when the boom nozzle is inserted. In event of electrical malfunction within the refueling system, a manual boom latching (MBL) feature is provided. When the air refueling system is activated, fuel system pressure valves for F and T tanks Ⓐ or F tank Ⓑ close allowing pressure in these tanks to relieve to 3 psi. This causes the respective FUEL VALVE CLOSED Ⓐ or F TANK PRESS Ⓑ (if fuel in F tank) warning lights to illuminate. Simultaneously external tank pressurization is shut off and external tanks are vented to ambient pressure. This allows all tanks to be refueled as required. Three air refueling status lights indicate the condition of the systems during air refueling. Fuel quantity during refueling of internal tanks may be monitored on the fuel quantity gage. External tanks quantity may be monitored by the external tank empty lights. When the lights extinguish, the tanks are full. After air refueling, the boom nozzle is released by automatic disconnect or by cockpit controls, the air refueling system is deactivated, and the fuel system is restored to normal operation.

NOTE

- Refer to T.O. 1-1C-1-17 for information on air refueling operations and procedures.
- On Ⓐ aircraft when refueling to other than full internal or full internal and external, the fuel load may not be symmetrical. In addition the F tank may feed out all of its fuel during the first feeding without experiencing a second F tank feeding subsequent to air refueling.

AIR REFUEL SWITCH

The guarded air refuel switch (figure 4-25) is located on the air refueling panel on the left console Ⓐ or right console Ⓑ (forward cockpit only.) The switch is placarded "Air Refuel" and has ON and OFF positions. Placing the switch to ON accomplishes the following: opens the slipway door; turns on the slipway lights; closes F and T tank Ⓐ or F tank Ⓑ pressurization valves; closes external tanks pressurization valves; and activates the function of the manual mode trigger as a boom nozzle manual disconnect switch. The F and T tank FUEL VALVE CLOSED Ⓐ or F TANK PRESS Ⓑ (if fuel in F tank) warning lights will illuminate with activation of their respective pressurization valves. When the receptacle door is fully open, the blue "READY" light on the status light display illuminates. Placing the air refuel switch to OFF returns the switch functions to their normal conditions and restores the fuel system to normal operation. Electrical power to the switch is supplied by the dc essential bus.

AIR REFUEL SELECT SWITCH

The guarded air refuel select switch (figure 4-25) is located on the air refueling panel on the left console Ⓐ or right console Ⓑ (forward cockpit only). The switch is labeled "Refuel Select" and has INT ONLY and ALL TANKS positions. Placing the switch to INT ONLY prior to air refueling closes the external tank refuel selector valve and results in refueling of the internal fuel tanks only. Placing the switch to ALL TANKS permits refueling of both internal and external fuel tanks. The switch receives power from the dc essential bus.

EMERGENCY SLIPWAY DOOR OPEN SWITCH

The emergency slipway door open switch (figure 4-25) is located on the air refueling panel on the left console Ⓐ or right console Ⓑ (forward cockpit only). The switch is placarded "Emerg Slipway Door Open" and has NORM and EMERG positions. The NORM position is used for all normal airborne refueling operations. This position allows opening of the slipway door by secondary hydraulic system pressure when the air refuel switch is placed to ON. The EMERG position is used to open the slipway door in event of secondary hydraulic system failure. Placing the switch to EMERG when the air refuel switch is ON routes high pressure pneumatic system air to a shuttle valve at the slipway door actuating cylinder. The shuttle valve, normally positioned for hydraulic pressure flow, allows high pressure pneumatic air to enter the door open side of the slipway door actuator, opening the door. When the switch is returned to NORM, pneumatic system pressure to the door is shut off and pneumatic air in the lines vents to ambient pressure. There is no provision for closing the slipway door pneumatically. The switch receives power from the dc essential bus.

RESET/MBL SWITCH

The reset/MBL switch (figure 4-25) is located above the throttle quadrant. On Ⓑ airplanes, the switch is in the forward cockpit only. The switch has a center NORM position and RESET and MBL positions. It is retained in the NORM position by a spring load from RESET and by a detent from MBL. In the NORM position, normal system operation and automatic boom latching are possible. In event system electrical malfunction disables the automatic boom latching capability, placing the switch to MBL activates the manual boom latching capability. This allows the boom latches to be retracted and extended by depressing and releasing the manual disconnect switch on the control stick grip. By this means, the boom nozzle can be manually latched and released. The RESET position is used to reset the system after any disconnect during refueling. Momentary actuation of the switch to RESET resets the air refueling system amplifier and prepares the system for another contact and additional refueling. The RESET position can also be used as an alternate method of releasing the boom latches when the manual disconnect switch fails to effect a release. When releasing the boom latches by this method, the switch must be held in the RESET position until the boom nozzle is removed from the receptacle. The reset/MBL switch receives power from the dc essential bus.

MANUAL DISCONNECT SWITCH

The manual mode trigger (figure 1-13) on the right-hand control stick grip (Ⓑ front cockpit only) serves as an air refueling manual disconnect switch when the air refuel switch is ON. The switch is a two-position switch. When the manual disconnect switch is depressed, the boom latches retract to release the boom from the receptacle. When the reset/MBL switch is in MBL, depressing the manual disconnect switch retracts the latches to effect a manual boom latch. In the MBL mode, the manual disconnect switch is depressed for boom nozzle insertion, then is released to lock the nozzle in place. After refueling is complete, the nozzle is released by depressing the manual disconnect switch. The switch receives power from the dc essential bus.

air refueling controls and indicators

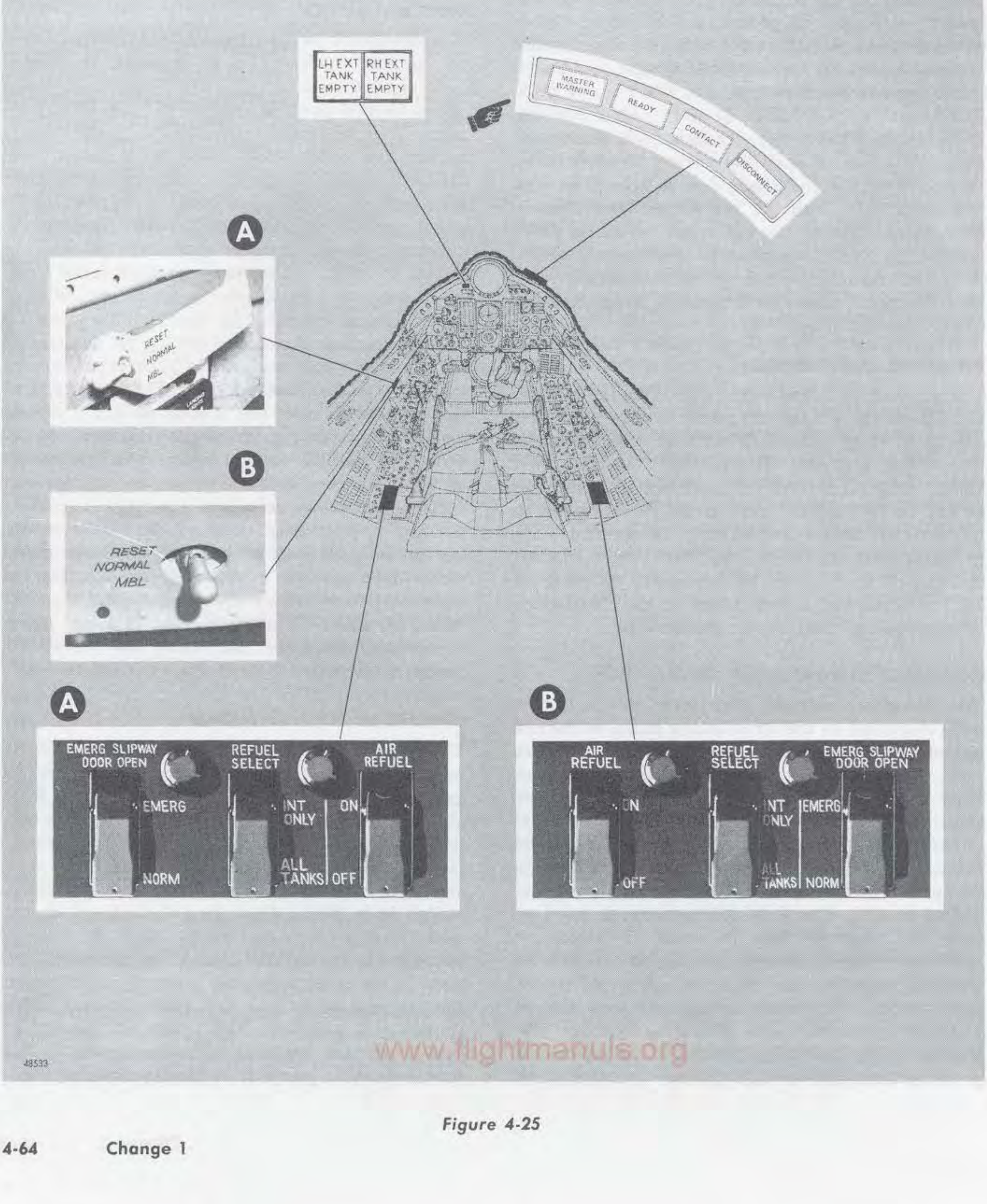


Figure 4-25

AIR REFUELING STATUS LIGHTS

Three status lights (figure 4-25) are located on a panel on the top right side of the glare shield. The lights are in the forward cockpit only on B airplanes. The lights are press-to-test type indicator lights and display the status during different phases of air refueling. Their functions are described in the following paragraphs.

Ready Light

The ready light on the status light panel illuminates blue to display a "READY" indication. The light illuminates when the air refuel switch is placed to ON and remains illuminated while the system is ready to accept a contact from the tanker. When the boom nozzle is inserted in the receptacle and the boom latches lock, the ready light goes off. The light will remain off until a new refueling sequence is initiated by turning the air refuel switch to ON or placing the reset/MBL switch to RESET. The ready light receives power from the dc essential bus.

Contact Light

The contact light on the status light panel illuminates green to display "CONTACT." The light illuminates when the boom nozzle is inserted into the receptacle. It extinguishes when the nozzle is removed from the receptacle. The contact light receives power from the dc essential bus.

Disconnect Light

The disconnect light on the status light panel illuminates amber to display a "DISCONNECT" indication. The light illuminates when the boom nozzle is removed from the receptacle. It will then remain on until the reset/MBL switch is placed to RESET or the air refuel switch is placed in OFF and the slipway door closes. If the slipway door remains open with the air refuel switch in OFF, the light will remain on. The disconnect light is powered by the dc essential bus.

MISCELLANEOUS EQUIPMENT

ANTI-G SUIT PROVISIONS

Engine bleed air, cooled by the cockpit air-conditioning primary heat exchanger, is used to pressurize the anti-g suit. A regulator maintains pressures of between 9 and 11 psi in the suit at high g loads. A valve in the regulator assembly automatically pressurizes the suit at g loads greater than 1-1/2 to 2 g. An anti-g suit button (figures FO-1 and FO-2), placarded "Push to Test," is used to manually pressurize the suit when desired. When the button is depressed, unregulated engine bleed air pressurizes the anti-g suit. When the button is released, the suit is depressurized. This feature of the regulator may be used during extended flights to prevent fatigue by creating a massaging effect on the body. Operation of the manual control button does not test the automatic feature of the regulator.

SPARE LAMPS

On some airplanes, spare lamps are located on the aft end of the left-hand console.

LUGGAGE RACK PROVISIONS

A luggage rack may be installed in the missile bay to provide a container for both luggage and clothing. The missile bay doors may be manually opened when electrical power is not available. The manual missile bay door control handle is located on the forward bulkhead of the left-hand main wheel well, and has OPEN and CLOSE positions. To open the doors, pull the control handle out, then rotate the handle to the right. To close the doors, rotate the handle to the left and push in. Pneumatic pressure is used to operate the doors. A safety pin with streamer must be installed whenever the handle is left in the OPEN position.

CAUTION

- Do not operate missile bay doors with manual missile bay door control handle unless airplane pneumatic pressure is above 2000 psi. Structural damage can occur during system operation if pneumatic pressure falls below 1000 psi.
- Inflight operation of the missile bay doors with the luggage rack installed is prohibited.

MAP AND DATA CASE

The map and data case (figures FO-1 and FO-2) is located aft of the right console.

INSTRUMENT FLIGHT TRAINING HOOD (B)

An instrument flight training hood is installed on the rear canopy of some airplanes. The hood may be manually positioned.

REAR VIEW MIRROR (A)

Three adjustable mirrors are mounted on the canopy frame to provide the pilot with rearward viewing capability.

AIRBORNE INSTRUMENTATION SUBSYSTEM (AIS) POD

Aircraft have been modified to carry the Airborne Instrumentation Subsystem (AIS) Pod (AN/ASQ-T-11/T-13/T17/T20/T21) on the right wing in place of the external fuel tank. The pod cannot be jettisoned and is not adaptable to the left wing. The AIS is part of the Air Combat Maneuvering Instrumentation (ACMI) system which allows accurate reconstruction and evaluation of air combat training engagements and simulated missile firing. The system is actuated by the right main landing gear up switch and requires no crewmember operation/monitoring.

SNAPSHOOT FIRE CONTROL SYSTEM

The snapshoot fire control system provides a heads-up gunsight display for the pilot to employ the F-106 in air-to-air gunnery. The system consists of the MA-1 computer, symbol electronics unit, attitude and rate sensors, optical display unit (ODU) and camera. Both the ODU and camera are mounted on the radar scope (figure 4-26) and the symbol electronics unit is mounted in the forward left radar rack. The MA-1 computer calculates the position of bullets at various ranges relative to the aircraft. This information is then displayed to the pilot through the symbol electronics unit, radar scope and ODU. The symbology is collimated to infinity and superimposed on the outside world view through the combining glass (HUD). The camera, dependent upon the mode of operation, records either the radar scope in the same way as the DSR camera, or the pilot's view of the gunsight symbology and outside world.

VIEWING MODES

Heads Down Mode. In the heads down viewing mode, the pilot only observes the radar symbology displayed on the MMST. He views this display by looking through the filter asembly on the gunsight.

Heads Up Mode. When the pilot looks at the combining glass assembly on the gunsight, he sees the outside world with the MMST display superimposed on it. In this viewing mode, the outside world passes directly through the combining glass (a beamsplitter) and, at the same time, the MMST display is reflected up to the combining glass and camera by the gunsight optics.

CONTROLS AND INDICATORS

The controls and indicators of the gunsight system are described in this section.

OPTICAL DISPLAY UNIT, CAMERA AND MA-1 SYSTEM

The optical display unit (ODU), camera, and MA-1 system controls and indicators are shown in figure 4-26.

optical display unit and camera

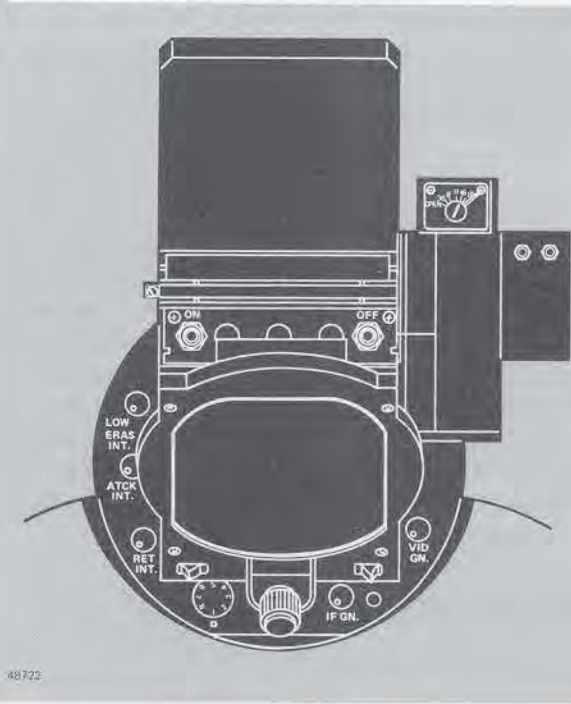


Figure 4-26

Optical Display Unit and Camera MA-1 System

Control Nomenclature	Control Setting	Effect
VID GN control	Fully clockwise	Video gain at maximum resulting in maximum brightness when writing and maximum darkness when stored.
	Fully counterclockwise	Video gain at minimum resulting in minimum brightness when writing and minimum darkness when stored. (Gain is so low that video will probably not be seen.)
IF GN control	Fully clockwise	Used with VID GN; targets displayed on scope are at maximum.
	Fully counterclockwise	Radar receiver is cut off.
DIMMER control	Fully clockwise	Total display at minimum brightness. Relative intensity of scope face, range scale lights, range gate lights, and mode lights is adjusted by this control. Red filter is operational at intermediate settings.
	Fully counterclockwise	Total display at maximum brightness.
Mode selector switch	1 (OFF)	Gunsight system is not activated. Mode of operation is determined by the MA-1 system and functions as if the gunsight system were not aboard.
	2 (RANGE)	When radar lock-on exists, two crosses, one at a fixed range of 1000 feet and the other at target range, appear on the HUD. If radar lock-on is lost, the gunsight system automatically returns to a no-range display.
	3 (NO RANGE)	Three crosses appear on the HUD at fixed ranges of 500, 1500, and 2500 feet.
	4 (DYNAMIC BORESIGHT)	Provides capability of compensating for an incorrect boresight during flight.
	5 (GROUND BORESIGHT)	Employed by maintenance personnel. Three crosses, forming a triangle, appear on the MMST. The cross at the apex of the triangle is displayed at the current boresight point.
	6 (SET BORESIGHT)	Enables the steering crosses (controlled by radar antenna position) to align the display optics to an external target.
	7 (REFERENCE)	Checks the alignment of the MMST display. Three crosses appear superimposed on the three bezel dots.

Optical Display Unit and Camera MA-1 System, Contd

Control Nomenclature	Control Setting	Effect
	8a (STANDBY RETICLE)	Bezel reticle is illuminated. Reticle markings can be used for sighting and firing on target when MA-1 system is inoperative.
	8b (DISPLAY CALIBRATION)	Enables the steering cross (controlled by radar antenna position) to electrically calibrate the MMST display.
RET INT control	Fully clockwise	Produces maximum reticle sidelight brightness.
	Fully counterclockwise	Produces minimum reticle sidelight brightness.
ATCK INT control	Fully clockwise	Attack gun displays are at a maximum intensity.
	Fully counterclockwise	Attack displays are not visible.

CAUTION

Excessive attack intensity will cause damage to the MMST.

NOTE

Attack gun display elements are as follows: artificial horizon, antenna elevation marker (Z-marker), dot, reference circle, time-to-go or range circle, IR range marker, TMC, firing bar, abort signal, fire signal, pullout signal, and gunsight symbology.

Control Nomenclature	Control Setting	Effect
LOW ERAS INT Control	Nominal	In selective erase, this control is adjusted so that noise is completely erased. This is determined by noting the area between erase and B-sweeps. In radar supersearch, the fade rate should be such that a target is being rewritten before it completely fades out. In radar hand control and track, the B-sweep should reach an equilibrium with adequate contrast between the noise and targets and the background.
	Clockwise	Maximum erase or fade; turns tube off due to protection circuit.
ON switch	Push	Activates a 35-second timing circuit that energizes the search, erase, and illumination functions of the radar display when the aircraft is on the ground. A second push of the switch is needed to activate the attack display, which remains on for three minutes, then turns off automatically. The ON switch is disabled when the canopy is closed.

Optical Display Unit and Camera MA-1 System, Contd

Control Nomenclature	Control Setting	Effect
OFF switch	Push	Deactivates the circuits energized by the ON switch. The OFF switch is disabled when the canopy is closed.
Push-to-Test button	Push (and hold)	Places camera in the cinemode (5 frames per second). This switch makes possible pilot check of camera operation.
f-stop Control	As required (16 for bright days and lower for overcast).	Series of diaphragm openings determining the amount of light entering the camera. Light conditions determine the proper f-stop setting.

Optical Display Unit and Camera MA-1 System, Contd

Control Nomenclature	Control Setting	Effect
PTF light (Power Test Failure)		Indicates power out of tolerance. On for 15 seconds or duration of failure.
RP light (Reduced Power)		Lights whenever the radar transmitter cycles to reduce power or power off.
VI WARN light		Lights with a DROT and (in order of priority): 1. In a VI, pursuit, or proportional mode accompanied by a digital range failure (steady light). 2. In a VI mode and radar range is 1500 feet or less (steady light). 3. In a VI mode with neither of the above conditions. Light flashes for approximately 15 seconds (11 computer frames) when the condition is entered.
Mode lights		Indicates the modes selected during the time the display is being photographed. The lights are numbered from 1 through 6 and indicate modes as follows: 1. Aircraft controlled by AFCS sub-system (Auto or Assist and not Manual Mode Trigger). 2. MAN IF 3. MISSILES ALL. 4. GATE or ALL chaff features elected. 5. Both "Armed" and "Confirm" signals present. 6. Armament trigger depressed.
Range Scale lights		The range scale light corresponding to the RANGE switch setting illuminates.
Range Rate lights		In attack, and 40 mile visual identification the 0, 200, 400, 800, and 1200 are illuminated. The lights correspond to the rate of closure indicated by the range rate gap in the time-to-go circle. In the 4- or 16-mile visual identification operation, the -33, 0, 50, 100, 200, and 300 lights are illuminated. The -33 light indicates an opening range rate; all other lights indicate a closing range rate.

OPERATIONS AND TECHNIQUES

This portion of the section pertains to gunsight system operation under normal conditions.

Armament Control Panel

Before the gunsight system can be placed into operation, the armament control panel switch must be set to GUN. Setting of this switch to this position, places the gunsight energizing voltage on the gunsight mode selector mode.

Auto-Navigation Homing Point Selector

In both the RANGE and NO RANGE modes, the size of the pippers is determined by the setting of the HOMING POINT SELECTOR switch. The displayed cross size (width) corresponds to span of the target aircraft in milliradians (mr) stadiametric ranging cues. The seven homing point positions for wing span selection are as follows:

Switch Position	Wing Span (feet)
A	30
B	60
C	90
D	120
E	150
F	180
All other positions	250

Selection of Gunsight Mode

There are eight positions on the gunsight mode selector switch, including the OFF position. The first two positions, 2 and 3 (Range and No Range) are gunsight system operating modes that provide the pilot with fire control symbology displays. Mode selector switch positions 4 through 7 provide appropriate boresight mechanization for ground and flight boresight verification and correction. Position 8 of the switch may be used for display calibration (Calibrate), or as an "Iron Sight" display (Standby Reticle). Figure 4-27 shows typical displays for the various modes described below.

Range Mode

In range mode, two crosses are displayed when the radar is locked on to a target; one at a fixed 1000-foot range, and the other at the target radar range. The cross that represents target radar range will flash if the simulated bullet can reach the target in 2 seconds or less. When this bullet time-of-flight is exceeded, the flashing action will stop. The exact radar range in feet (up to 8000) can be read in the target altitude window if AUTO NAV, MAX RNG, or MIN TIME is selected on the display/auto mode selector switch. If the radar range decreases to 1000 feet + (1.5 × range rate) or less, a range warning indication is displayed. The range warning display is a full size third reticle centered in the HUD. As soon as the range opens beyond 1000 feet + (1.5 × range rate), the third reticle disappears. Also, whenever the trigger is depressed with the arm-safe switch in SAFE, the 2500-foot pipper is set to full size and positioned off-centered on the radar scope. As soon as the trigger is released, the 2500-foot pipper disappears. In the event a range warning condition occurs when the trigger is depressed, the range warning display has a priority over a trigger depression display. Loss of a radar lock-on results in an automatic reversion to a "no range" display. The combination of long times-of-flight and high g levels will result in the cross saturating in lead angle. In this case, the cross will be replaced by a dot and will remain stationary at the field-of-view limit.

No Range Mode

In the no range mode, the 500, 1500, and 2500 feet range crosses are displayed on the MMST. These crosses do not have a time of flight cue associated with them. Reticle 3 also serves as a collision warning whenever a lockon exists and target range is less than or equal to 1000 feet + (1.5 × range rate). Under these circumstances, reticle 3 will flash between the size and position for 2500 feet and full size centered. If the trigger is depressed with the arm-safe switch in SAFE, the 2500-foot pipper expands to full size and retains its present position. As soon as the trigger is released, the 2500-foot pipper assumes its normal size as the reticle for 2500 feet. In the event a collision warning condition occurs when the trigger is depressed, the collision warning display has priority over a trigger depression display.

NOTE

Upon initiation of the range and no range modes, the three crosses appear one at a time as the simulated bullets reach their display ranges. The simulated bullet takes apporoximately 0.2 second to reach 500 feet, 0.6 second to reach 1500 feet, and 1.5 seconds to reach 2500 feet. Therefore, the full three crosses display will appear after a delay of approximately 1.5 seconds.

Dynamic Boresight Mode

This mode allows the pilot to compensate for errors in gunsight harmonization or gun boresight while in flight. The same display is presented as if the gunsight system were in the no range mode. The display can be moved with the hand control through antenna position feedback to the computer.

Ground Boresight

This mode is not a pilot function and will be used primarily by maintenance personnel.

Calibrate

Selection of this mode provides the display of a pointer (cross) that may be steered by the pilot. This is a dynamic mode, where the contents of the sacred cells in the computer are changed, thus changing the calibration of the display. Use of this mode by the pilot is covered in the preflight calibration procedures.

Reference

The reference mode is used to check the alignment of the MMST display. When the three crosses appear superimposed on the three bezel dots, the display is properly aligned. Use of this mode is covered in the preflight calibration procedures.

Standby Reticle

In this mode, the gunsight system is inoperative and the bezel reticle is illuminated. During this mode the pilot sees the reticle display when he uses heads up viewing. This is an "Iron-Sight" display that permits the pilot to visually sight and fire on a target when the range and no range displays are degraded or the MA-1 system fails.

PHOTOGRAPHIC RECORDER

The photographic recorder, mounted on the right side of the ODU (gunsight) consists of a full frame camera assembly and a replaceable magazine assembly. It contains a push-to-test button.

The camera records all displays presented during the mission, including the displays observed in both head-up and head-down viewing. The camera runs in the radar mode whenever the main landing gear is retracted and the armament is selected. When the gunsight system is activated (any position on the gunsight mode switch except position 1) and the armament trigger is pressed to the first or second detent, the camera records at 16 frames per second. In radar, and IR hand control and track, including IR expand, or when armament trigger is pressed to the first detent, the camera records at 5 frames per second. In radar and IR search and supersearch, including IR track and radar scan, the camera records one sweep per frame. When the push-to-test switch is pressed and the gunsight system is activated, the camera runs at 16 frames per second. If the gunsight system is not activated and the push-to-test switch is pressed, the camera runs at 5 frames per second. The camera take-up reel hub extends from the film housing and rotates to indicate actuation of the camera.

The magazine houses approximately 60 feet of core-wound 16-mm film and contains a mechanism to permit automatic processing of the film.

NOTE

> If usable head-down film is desired, the gunsight mode selector switch must be placed to 1, and the dust cover should be in place over the collimating lens.

PREFLIGHT CALIBRATION

Prerequisites to proper sight alignment are: B-sweep appears at 0° azimuth with ILS selected; load collision displays are properly calibrated; and TTG circle is round and properly sized.

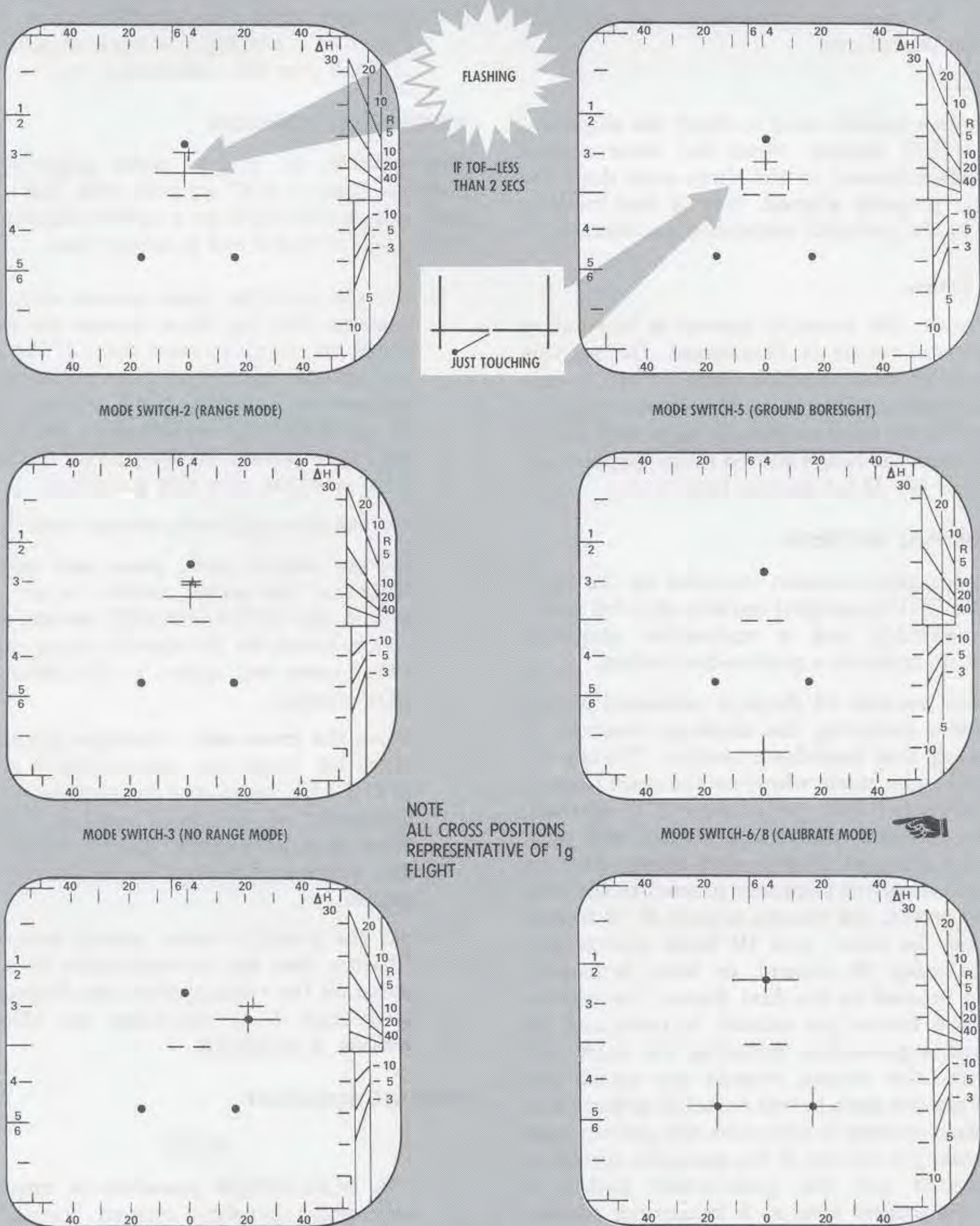
1. Set the gunsight mode selector switch to 7. Observe that the three crosses are superimposed on the three bezel dots. If the crosses are grossly misaligned (bear no resemblance to bezel dot configuration), calibration must be performed by maintenance personnel. If the three crosses are very close to the bezel dots, continue with this procedure.
2. Set the gunsight mode selector switch to 6.
3. On the control stick, press and release, in sequence, the action switch to the second detent, the AUTO SEARCH button, and the action switch to the second detent again. A 17-mil cross will appear in the center of the ODU display.
4. Move the cross until it is superimposed on a bezel dot. Move the cross vertically with the ANT ELEV wheel, and horizontally by lateral movement of the hand control. When the cross is superimposed on the desired bezel dot, press and release the AUTO SEARCH button.
5. Set the gunsight mode selector switch to 7. Observe that the selected cross is superimposed on the selected bezel dot. Repeat steps 2 through 5 to reposition the other two crosses, if necessary.

DYNAMIC BORESIGHT

NOTE

> This is an inflight procedure to correct only gross gunsight system boresight alignment errors since the expenditure of an already limited amount of ammunition is required.

gunsight modes displays



MODE SWITCH-2 (RANGE MODE)

MODE SWITCH-5 (GROUND BORESIGHT)

MODE SWITCH-3 (NO RANGE MODE)

NOTE
ALL CROSS POSITIONS REPRESENTATIVE OF 1g FLIGHT

MODE SWITCH-6/8 (CALIBRATE MODE)

MODE SWITCH-4 (DYNAMIC BORESIGHT MODE) AFTER ENABLE ACTION

MODE SWITCH-7 (REFERENCE MODE)

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Figure 4-27

1. Set the gunsight mode selector switch to 4 (Dynamic Boresight).
2. Press the AUTO SEARCH button.
3. Fly the aircraft straight and level.
   Observe that the 500-foot, 1500-foot, and 2500-foot crosses are displayed.
4. Fire a burst and note the position of the tracer line with respect to the position of the 500-foot cross. Freeze the display by pressing the action switch to the second detent and release.
5. Press, in sequence, the AUTO SEARCH button, action switch to the second detent, and the AUTO SEARCH button again.
   Observe that the 2500-foot cross becomes a dot and is superimposed on the 500-foot cross.
6. Press the action switch to the second detent and move the dot to the point on the display where the tracers passed the 500-foot range point (the point where the 500-foot cross should have been). Use the ANT ELEV wheel to move the dot vertically and the hand control to move the dot horizontally.
7. Press the AUTO SEARCH button.

NOTE

If the gunsight selector switch is set to 1 (OFF), the dynamic boresight correction will be lost.

8. Set the gunsight mode selector switch to any position except 1 (OFF).

operating limitations

Section V

48,058

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NOTE

This section includes airplane and engine limitations which must be observed during normal operation. The high performance of this airplane demands close adherence to these limitations.

INSTRUMENT MARKINGS

Careful attention must be given to the instrument markings (figure 5-1), because the limitations shown on these instuments and noted in the captions are not necessarily repeated in the text of this or any other section.

ENGINE LIMITATIONS

Normal engine limitations are shown in figure 5-1 and figure 5-2. Maximum thrust is the thrust obtained by placing the throttle fully forward and outboard for afterburner operation. Military thrust is the thrust obtained by placing the throt-the full forward and inboard (nonafterburning).

EGT SPREAD

The EGT spread limitation for takeoff is 120°. If the limitation is exceeded, abort and enter the reading in Form 781.

ENGINE OVERSPEED

The maximum permissible engine speed is 106.5% rpm. Any engine speed in excess of this limit must be noted on Form 781. The engine must be inspected for damage.

ENGINE PRESSURE RATIO

The military and maximum thrust checks are based on the takeoff thrust index marker being set according to the outside air temperature. When making the military thrust check during the Before Takeoff Engine Check, the gage pointer should be within the arc of the takeoff thrust index marker. Engine rpm should be stabilized. The maximum thrust check is made at the start of takeoff roll and is the same as the military thrust check. During takeoff roll, the gage reading will increase above that noted during the maximum thrust check.

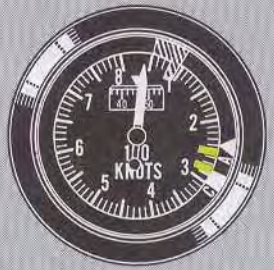
OIL PRESSURE

Normal oil pressure is 40 to 50 psi. Except at idle, oil pressures between 35 and 40 psi are undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle

instrument markings

BASED ON: JP-4 FUEL

NOTE
REFER TO AIRSPEED LIMITATIONS, THIS SECTION, FOR MAXIMUM ALLOWABLE AIRSPEEDS.

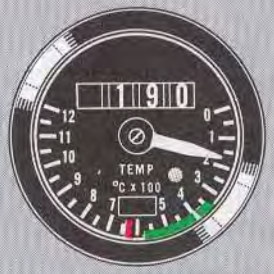


MACH INDICATOR

STRIPED POINTER INDICATES MACH NUMBERS CONSISTENT WITH MAXIMUM DESIGN AIRSPEED OR MAXIMUM STAGNATION TEMPERATURE, WHICHEVER OCCURS FIRST.

AIRSPEED — ANGLE OF ATTACK INDICATOR

- (Yellow) 285 KCAS MAXIMUM SPEED WITH LANDING GEAR EXTENDED.
- (Yellow) 250 KCAS MAXIMUM SPEED DURING EMERGENCY LANDING GEAR EXTENSION.



OIL QUANTITY

- (Green) NORMAL OPERATING RANGE
- (Yellow) CAUTION
- (Red) MINIMUM OPERATING RANGE

EXHAUST GAS TEMPERATURE

- (Green) 340°C TO 575°C CONTINUOUS OPERATION
- (Red) 635°C MAXIMUM FOR MILITARY THRUST, MAXIMUM THRUST, AND MAXIMUM ACCELERATION
- (Yellow) 400°C MAXIMUM FOR STARTING

OIL PRESSURE

- (Red) 35 PSI MINIMUM
- (Yellow) 35 PSI TO 40 PSI (CAUTION) ⚠1
- (Green) 40 PSI TO 50 PSI NORMAL OPERATION
- (Red) 50 PSI MAXIMUM ⚠2

HYDRAULIC PRESSURE GAGE

(PRIMARY AND SECONDARY SYSTEM GAGES IDENTICAL)

- (Red) 1000 PSI MINIMUM OPERATING PRESSURE
- (Yellow) 1000 PSI TO 2500 PSI (CAUTION) ⚠3
- (Green) 2500 PSI TO 3100 PSI CONTINUOUS OPERATING PRESSURE (NORMAL PRESSURES WITH NORMAL DEMANDS ON THE SYSTEM) ⚠4
- (Red) 3100 PSI MAXIMUM OPERATING PRESSURE

48090-18

Figure 5-1 (Sheet 1 of 2)

Figure 5-1 (Sheet 2 of 2)

setting. Oil pressures below normal should be entered on Form 781, and should be corrected before the next takeoff. Oil pressures below 35 psi are unsafe and require that a landing be made as soon as possible, using the minimum thrust required to sustain flight. Although 40 to 50 psi is the allowable pressure limit during all continuous or stabilized engine operation, a maximum of 80 psi is permitted during operation of short duration, such as for takeoff, go-around, or climb.

NOTE

The oil pressure gage needle may normally fluctuate as much as ±2.5 psi.

COOLING LIMITATIONS (GROUND OPERATIONS)

Starter Cooling

A minimum of 5 minutes waiting period is required before attempting a new start. A maximum of three pneumatic starts may be made in a 15 minute period. Cartridge and pneumatic starts may be interspersed with the total number of starts limited to three in a 15 minute period. However, a maximum of two cartridge starts in a 60 minute period must be adhered to.

Engine Cooling

If the ground operating limits (figure 5-2) are closely approached, five minutes operation at idle is required to allow the engine to cool before it can be shut down or before a schedule which will approach these limits can be repeated.

Electronic Equipment Cooling

Flight will not be conducted with the electronic warning light illuminated.

FUELS

Specified Fuel

The fuel recommended for normal operation is JP-4, MIL-T-5624 (NATO Symbol F-40). This fuel has been proved to operate satisfactorily under all conditions and contains an icing inhibitor to prevent fuel filter icing. Performance data is based on the use of JP-4 fuel.

Alternate Fuel

Alternate fuels are fuels approved for use when the specified fuel is not available and which may cause a reduction in engine performance and additional aircraft restrictions. Although alternate fuels will not cause permanent engine damage, their use may require an engine retrim to achieve rated engine performance. If the engine is not retrimmed both ground and air starts may be more difficult and higher EGT may be reached at lower thrust settings than when operating on JP-4.

CAUTION

> Engine operating limitations when using alternate fuels are the same as those established for JP-4. Care should be taken to insure that EGT and rpm limits are not exceeded when moving the throttle.

Alternate fuels have freezing points higher than JP-4 and may not contain icing inhibitors that retard the formation of ice at fuel temperatures below 32 degrees fahrenheit. Therefore, aircraft altitude is limited to that at which the outside air temperature is above the freeze point of the fuel or 32 degrees fahrenheit if water saturated fuel without icing inhibitor is used. When using alternate

engine operating limits

J75-P-17		MAXIMUM EXHAUST GAS TEMP (C)	TIME LIMITS	
			GROUND OPERATION	FLIGHT OPERATION
OPERATING CONDITIONS	MAXIMUM	635	5 MINUTES	15 MINUTES
	MAXIMUM ON ACCELERATION	635	———	———
	MILITARY	635	15 MINUTES ⚠1	30 MINUTES
	MAXIMUM CONTINUOUS (NON AFTERBURNER)	575	15 MINUTES ⚠1	CONTINUOUS
	IDLE	340	⚠1	———
	STARTING	400	———	———

NOTE
- IF TEMPERATURE LIMITS ARE EXCEEDED, MAKE ENTRY ON FORM 781 STATING DURATION AND PEAK TEMPERATURES.
- TIME LIMITATIONS ARE FOR OPERATING CONDITIONS (THROTTLE SETTINGS) REGARDLESS OF EGT.
- 635°C IS MAXIMUM FOR MILITARY THRUST, MAXIMUM THRUST, AND ACCELERATION.

⚠1 REFER TO COOLING LIMITATIONS, THIS SECTION.

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Figure 5-2

operating limitations

CONFIGURATION	ACCELERATION LIMITS	AIRSPEED LIMITS
LANDING GEAR EXTENDED AND DURING NORMAL EXTENSION OR RETRACTION	−1 TO 2.5g	285 KCAS DURING EMERGENCY EXTENSION, MAXIMUM ALLOWABLE AIRSPEED IS 250 KCAS. AFTER EXTENSION BY EMERGENCY SYSTEM, MAXIMUM AIRSPEED OF 285 KCAS APPLICABLE. TO PREVENT STRUCTURAL DAMAGE TO THE LANDING GEAR, AT LANDING GROSS WEIGHTS IN EXCESS OF 26,891 POUNDS ON (A) AIRPLANES OR 28,060 POUNDS ON (B) AIRPLANES, THE RATE-OF-SINK AT TOUCHDOWN IS LIMITED TO 300 FPM. AT LANDING GROSS WEIGHTS LESS THAN 26,891 ON (A) AIRPLANES OR 28,060 ON (B) AIRPLANES, THE RATE-OF-SINK AT TOUCHDOWN IS LIMITED TO 540 FPM.
DRAG CHUTE DEPLOYMENT	———	160 KCAS
CANOPY OPEN	———	(A) MAXIMUM TAXI SPEED IS 75 KCAS (B) MAXIMUM TAXI SPEED IS 60 KCAS (B) DO NOT TAXI WITH THE CANOPY OPEN HIGHER THAN APPROXIMATELY 12 INCHES.
RAIN REMOVAL SYSTEM	———	PROHIBITED DURING SUPERSONIC FLIGHT
RAM AIR TURBINE EXTENDED	−1 TO 3g	350 KCAS WHEN RAT IS ONLY SOURCE OF HYDRAULIC PRESSURE DO NOT FLY AT AIRSPEEDS BELOW 174 KCAS.
VARIABLE RAMP EMERGENCY RETRACTION	———	MACH 1.1 OR 500 KCAS WHICHEVER OCCURS FIRST AT ALTITUDES BELOW 25,000 FEET, EMERGENCY RAMP OPERATION IS PERMISSIBLE ONLY AT IDLE RPM.
TIRE LIMIT SPEED ON RUNWAY	———	217 KNOTS
ARMAMENT EQUIPMENT		
DOORS OPEN	−1 TO 3g (WITH OR WITHOUT ARMAMENT GEAR EXTENDED)	
ARMAMENT FIRING	———	ARMAMENT FIRING IS PERMISSIBLE WITH EXTERNAL TANKS INSTALLED WITHIN EXISTING EXTERNAL TANK LIMITATIONS.

48104-1A

Figure 5-3 (Sheet 1 of 3)

operating

CONFIGURATION	ACCELERATION LIMITS		AIRSPEED LIMITS
	SYMMETRICAL MANEUVERS	ROLLING PULLOUTS	
CLEAN			
(A) LESS THAN 7700 LB OF FUEL:			752 KCAS, MAXIMUM STAGNATION TEMP, OR MACH 2, WHICHEVER OCCURS FIRST NOTE A STRIPED POINTER ON THE MACH INDICATOR (ON AIRPLANES WITH THE CONVENTIONAL INSTRUMENT DISPLAY) OR A STRIPED MARKER ON THE AIRSPEED MACH INDICATOR (ON AIRPLANES WITH THE INTEGRATED INSTRUMENT SYSTEM) INDICATES MAXIMUM DESIGN AIRSPEED (752 KCAS) OR MAXIMUM STAGNATION TEMPERATURE (249°F), WHICHEVER OCCURS FIRST. IF THE STRIPED POINTER IS INOPERATIVE, THE MAXIMUM DESIGN SPEED WILL BE MACH 1.82 OR 670 KCAS, WHICHEVER OCCURS FIRST. THIS SPEED IS BASED ON AIR FORCE STANDARD HOT ATMOSPHERE.
MAX MANEUVER WARN LIGHT OUT	−3 TO 7g	0 TO 5g	
MAX MANEUVER WARN LIGHT ON	−2.3 TO 5g	0 TO 3.6g	
(A) MORE THAN 7700 LB OF FUEL	−2.4 TO 5g	0 TO 3.9g	
(B) LESS THAN 7300 LB OF FUEL:			
MAX MANEUVER WARN LIGHT OUT	−2.4 TO 6g	0 TO 4.3g	
MAX MANEUVER WARN LIGHT ON	−1.8 TO 4.5g	0 TO 3.3g	
(B) MORE THAN 7300 LB OF FUEL	−2.4 TO 5g	0 TO 3.9g	
WITH 360-GALLON EXTERNAL TANKS			
(A)(B) CONTAINING FUEL	−2.4 TO 5g	0 TO 3.9g	SAME AS CLEAN AIRPLANE LIMITS
	NOTE IF MAXIMUM MANEUVER LIGHT COMES ON WHILE TANKS CONTAIN FUEL, OBSERVE MAXIMUM MANEUVER LIGHT ON LIMITS FOR THE CLEAN AIRPLANE.		NOTE DO NOT JETTISON THE TANKS IN THE 0.95 TO 1.2 MACH NUMBER RANGE BELOW 25,000 FEET. TANK JETTISON IN THIS REGION WILL RESULT IN MOMENTARY NEGATIVE LOAD FACTORS APPROACHING OR EXCEEDING NEGATIVE LOAD FACTOR LIMITS.
(A)(B) EMPTY	SAME AS CLEAN AIRPLANE LIMITS		SAME AS CLEAN AIRPLANE LIMITS

48104-2

Figure 5-3 (Sheet 2 of 3)

fuel, particular care should be taken to assure that sump drainage provisions are strictly complied with to eliminate possible water contamination. The fuel weight differential plus the fuel quantity system and flow indication errors are not significant and may be disregarded. Approved alternate fuels are listed below in their preferred order of use:

Type Fuel	NATO Symbol	Freeze Point
JP-8 (MIL-T-83133)	F-34	−50°C (−58°F)
Commercial JET B	None	−49°C (−56°F)
JP-5 (MIL-T-5624)	F-44	−46°C (−51°F)
Commercial JET A-1	F-35	−47°C (−53°F)
Commercial JET A	None	−40°C (−40°F)

JP-8 Operating Characteristics

JP-8 is the preferred alternate fuel and when used, the following operating characteristics may be expected:

a. At ambient temperatures below −23°C (−8°F), 15 minutes of fuel control heating will be required for satisfactory engine start.

b. Lower than normal idle speeds can be expected at ambient temperatures below −18°C (0°F).

c. At ambient temperatures below −18°C (0°F), engine acceleration times will be significantly increased.

limitations

MANEUVERS	GENERAL MANEUVERING LIMITATIONS
WITH MAX MANEUVER WARNING LIGHT OUT, 360° ROLLS ARE PERMITTED FROM: (A) 0g TO 5g WITH NO RESTRICTIONS ON USE OF RUDDER OR AILERON (B) 0g TO 4.3g WITH NO RESTRICTIONS ON USE OF RUDDER OR AILERON WITH MAX MANEUVER WARNING LIGHT ON, 360° ROLLS ARE PERMITTED FROM: (A) 0g TO 3.6g WITH NO RESTRICTION ON USE OF RUDDER OR AILERON (B) 0g TO 3.3g WITH NO RESTRICTION ON USE OF RUDDER OR AILERON WITH THE YAW DAMPER AND TURN COORDINATOR OFF, AILERON DEFLECTION IS LIMITED TO 5° (APPROXIMATELY ⅓ STICK THROW). HOWEVER, FULL AILERON MAY BE USED FOR TAKEOFF AND LANDING AT AIRSPEEDS BELOW 285 KCAS.	(1) NEGATIVE g MANEUVERS ARE LIMITED TO 15 SECONDS MAXIMUM, OF WHICH ONLY 10 SECONDS MAY BE AT ZERO g. THIS LIMITATION IS NECESSARY TO PROVIDE ADEQUATE ENGINE LUBRICATION. (2) INTENTIONAL STALLS AND SPINS ARE PROHIBITED. (3) EXCESSIVE RUDDER INDUCED MANEUVERS (FISH TAIL) SHOULD BE AVOIDED (INTENT IS TO PERMIT THE USE OF UP TO 180 POUNDS PEDAL FORCE). HOWEVER, FULL RUDDER RAPIDLY APPLIED (FISH TAIL) MAY BE USED DURING TAKEOFF AND LANDING AT SPEEDS BELOW 285 KCAS. (4) DO NOT EXCEED THE DESIGN LIMIT ALTITUDE OF 65,000 FEET.
CLEAN AIRPLANE MANEUVERING LIMITS APPLY EXCEPT WITH TANKS CONTAINING FUEL MAXIMUM ROLL RATE IS 100° PER SECOND.	

48104-3

Figure 5-3 (Sheet 3 of 3)

Emergency Fuel

Aviation gasoline (MIL-G-5572) is the only approved emergency fuel and is limited to one-time ferry missions only. Use of emergency fuels causes undesirable lead deposits in the engine and may damage the fuel control and fuel pump because of its poor lubricating properties. The same general operating limitations and cautions apply during use of emergency fuels as during use of alternate fuels. Approved emergency fuels are listed below in their preferred order of use:

Type Fuel	NATO Symbol	Freeze Point
Grade 80/87	F-12	−60°C (−76°F)
Grade 100/130	F-18	−60°C (−76°F)
Grade 115/145	F-22	−60°C (−76°F)

NOTE

When aviation gasoline is used, three percent lubricating oil, specification MIL-L-22851 must be added to improve its lubricity characteristic.

Center of Gravity Control When Using Alternate Fuels

Since all alternate fuels except JET B are heavier than JP-4, special action is required to maintain the airplane center of gravity within limits. In the armament-out configuration, with or without external tanks, the Ⓐ airplane limits can be maintained by burning off 530 pounds of JP-5 or 425 pounds of JET A or JET A-1 prior to takeoff. In Ⓑ airplanes, armament-out configuration, the external tanks must not be filled with any alternate fuel other than JET B.

WARNING

Failure to observe the refueling and fuel burnoff instructions will cause the c.g. to exceed the aft limit. This can result in over-rotation during takeoff and possible loss of control during flight.

In the armament-in configuration, no special instructions are required for c.g. control and all alternate fuels may be used normally. In both airplanes, partial armament loads must be considered as the armament-out configuration.

AIRSPEED LIMITATIONS

NOTE

For information concerning AIRSPEED LIMITATIONS, see figure 5-3.

OTHER OPERATING LIMITATIONS

NOTE

For information concerning OTHER OPERATING LIMITATIONS, see figure 5-3.

MAXIMUM CABLE ENGAGEMENT GROUND SPEED

Figure 5-4 shows maximum cable engagement speed versus aircraft gross weight. The maximum speed is based on the limit imposed by the yield strength of the tailhook. Both the BAK-9 and BAK-12 have a greater arresting capability than the airplane tailhook.

MANEUVERS

NOTE

For information concerning MANEUVERS, see figure 5-3.

NOTE

- Symmetrical maneuver limits apply when the airplane bank angle is constant (no roll) during the period of accelerated flight.
- Rolling pullout limits apply when the airplane bank angle is changing during the period of accelerated flight.

ACCELERATION LIMITATIONS

See figure 5-5 for maneuvering flight limits plotted for a combat configuration with less than 7700 pounds of fuel remaining on Ⓐ airplanes or 7300 pounds of fuel remaining on Ⓑ airplanes. These charts represent the maneuvering flight limits for symmetrical maneuvers only. For rolling pullouts see figure 5-3. Maneuvering flight limit charts 1 and 2 contain essentially the same information in the areas of positive g acceleration, but chart 1 also contains negative g limits. Chart 1 is plotted against calibrated airspeed while chart 2 is plotted against Mach number. Chart 2 provides acceleration limits for any combination of altitude and Mach number. At the higher altitudes, maneuvering capability is determined by the elevator deflection limit (elevator against the mechanical stops). At lower altitudes in the high speed region, maneuvering capability is limited by the hydraulic power available for control surface deflection. This is referred to as the hinge moment limit. The stall limit, represented by the lines on the left side of chart 2, limits the maneuvering capability at relatively low speed. An amber light (maximum maneuver warning light) on the instrument panel illuminates to indicate speeds consistent with stagnation temperature of 174°F and represents the maximum speed for maximum maneuvers. In the event the amber light is inoperative, this speed will be considered to be Mach 1.0 below 10,000 feet and Mach 1.55 or 565 KIAS, whichever occurs first, above 10,000 feet. This speed is based on Air Force standard hot atmosphere.

On Ⓐ airplanes, for example, locate the intersection of Mach 0.8 and 40,000 feet. At this speed and altitude, the airplane will approach a stall at approximately 2.8 g. It will also be noted on chart 2 that a step variation in maneuvering capability

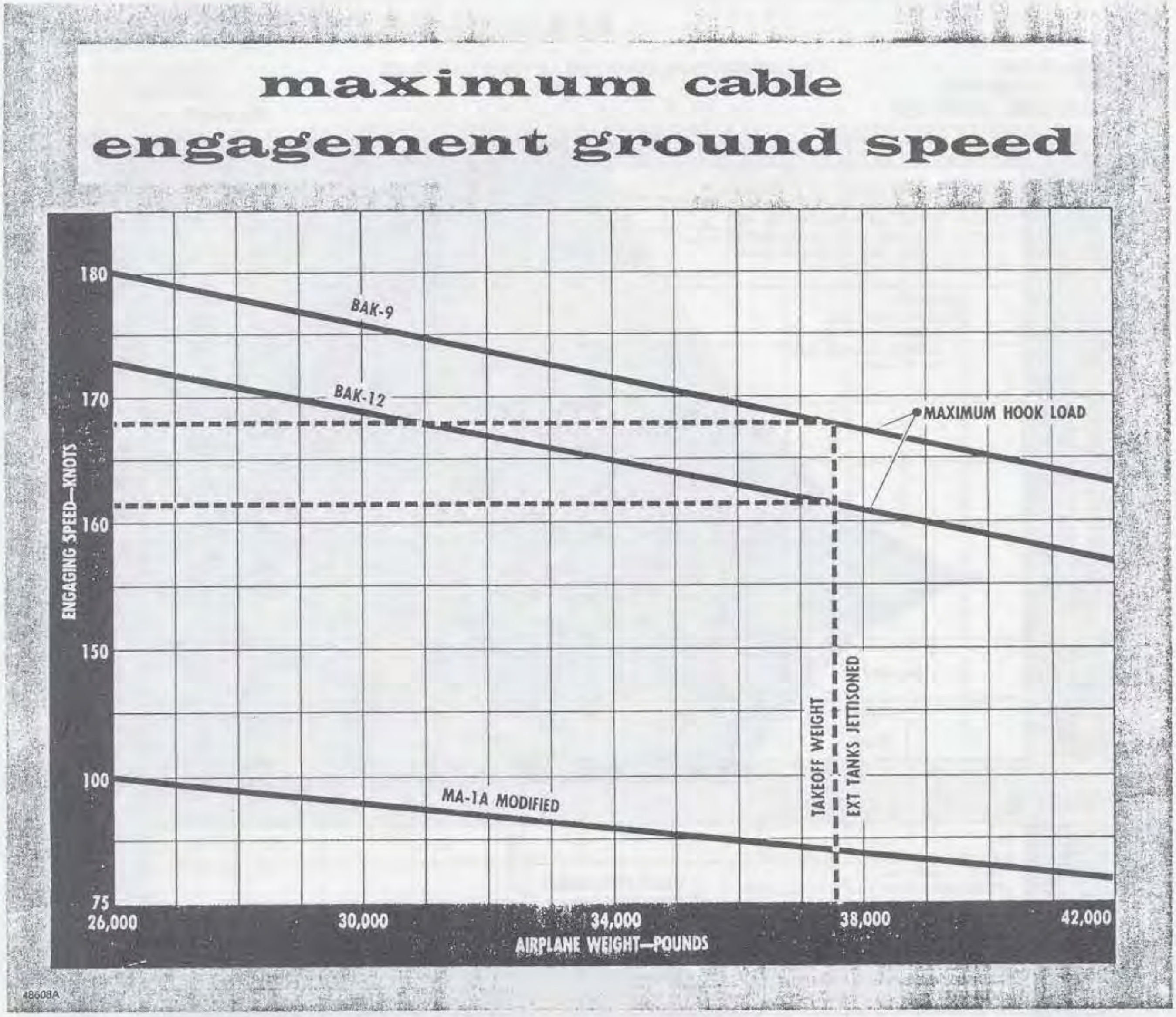

Figure 5-4

occurs above 10,000 feet and Mach 1.14. This is caused by the fuel transfer system. When the cg is moved aft, less elevator deflection is required to pull a given load factor. When operating in regions where elevator deflection is the limiting factor, moving the cg aft provides an increased maneuvering capability. On chart 1, the fuel transfer condition is represented by vertical portions of the various altitude curves. These vertical lines (marked FX) indicate the increased g capability provided by transferring fuel aft. The stall limits for various load factors, both positive and negative, are indicated near the left edge of the green area on chart 1. You will also note on chart 1 that many of the elevator deflection or hinge moment limits fall within the green area. When this occurs, the airplane cannot be overstressed. For an example, follow the flight enevelope for 45,000 feet altitude. The entire envelope falls within the green area. This means that the stall limit, the elevator

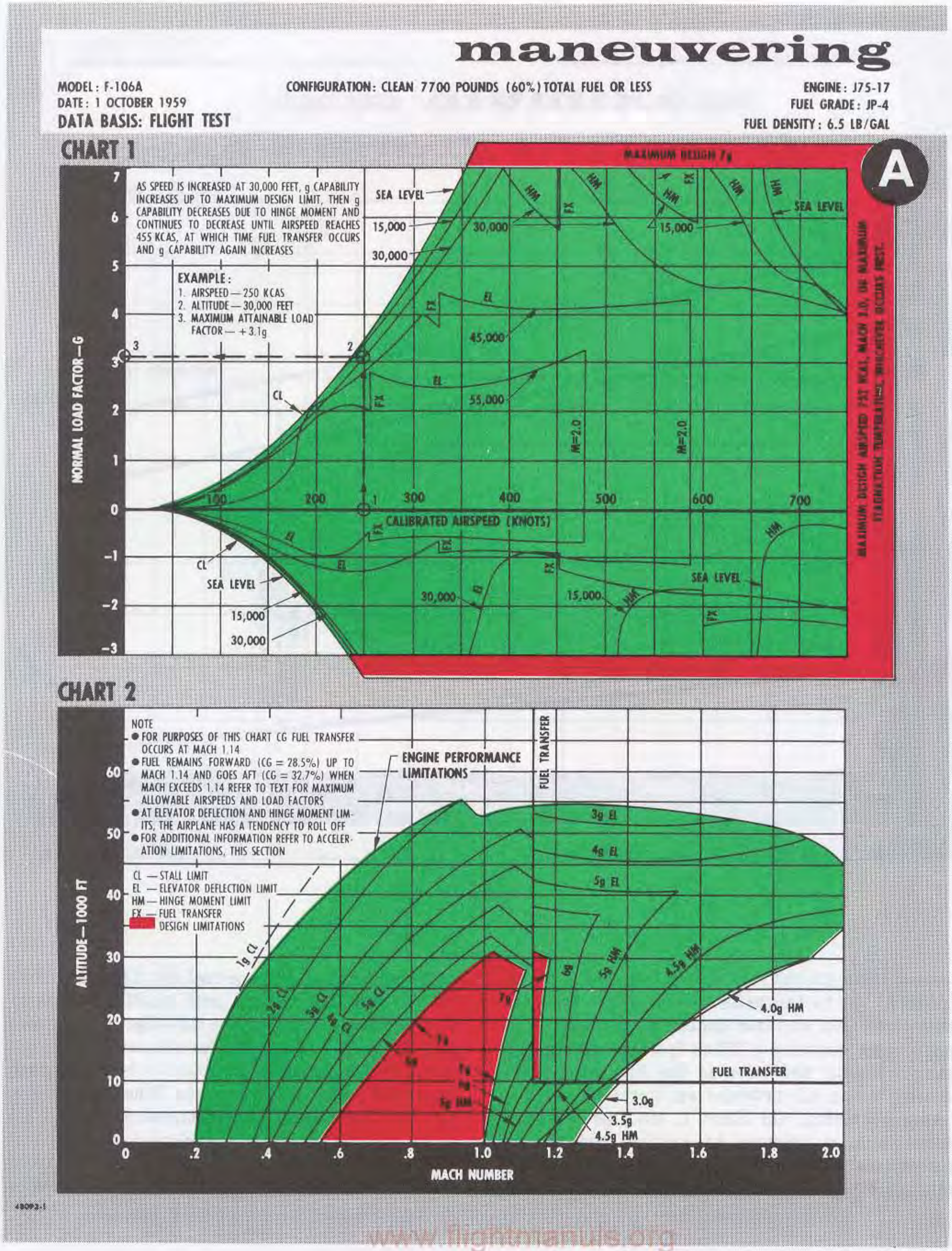

Figure 5-5 (Sheet 1 of 2)

flight limits

MODEL: F-106B
DATE: 1 OCTOBER 1959
DATA BASIS: FLIGHT TEST

CONFIGURATION: CLEAN 7300 POUNDS (60%) TOTAL FUEL OR LESS

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

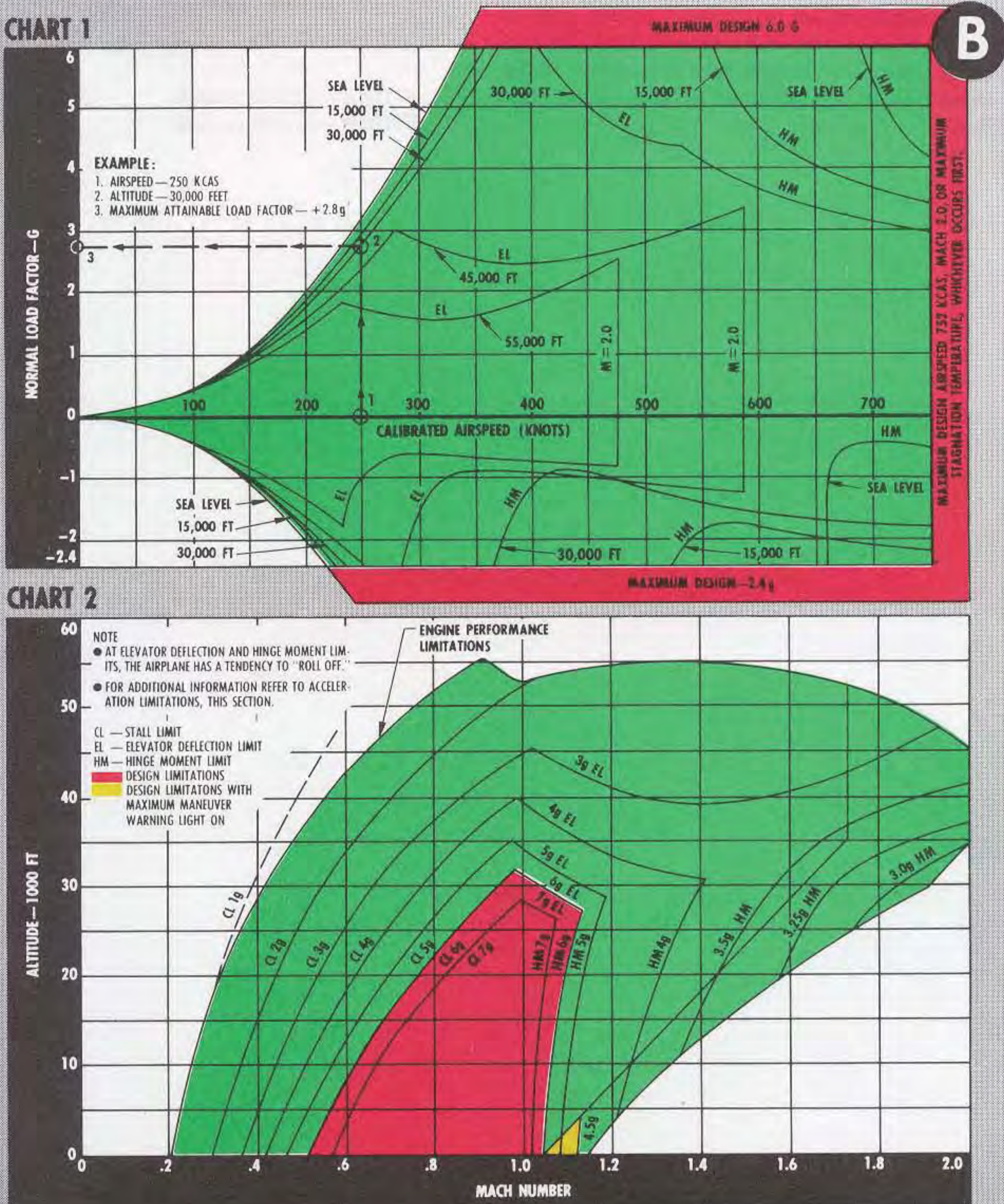

Figure 5-5 (Sheet 2 of 2)

deflection limit, or the hinge moment limit will be reached before the airplane structural limits are exceeded.

CENTER OF GRAVITY LIMITATIONS

CG limitations will not be exceeded during normal flight operation with full internal fuel, and/or external wing tanks or standard armament. Refer to Handbook of Weight and Balance Data, T.O. 1-1B-40.

WEIGHT LIMITATIONS

The design of the airplane precludes overloading. The maximum gross weight will not be exceeded even when standard armament and full external tanks are carried. Maximum gross weights are as follows:

F-106A—42,500 pounds
F-106B—43,500 pounds

flight characteristics

Section VI

48,059

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INTRODUCTION

The airplane has a conventional turbojet airplane response to change of thrust; however, the change of thrust in the operating range can be relatively large for a small throttle movement due to engine bleed valve operation. Fuel transfer maintains the center of gravity within allowable limits, depending on flight conditions, to provide optimum high-speed performance. The use of elevons requires no unusual flying techniques as stick movement for a desired maneuver is the same as it would be if conventional elevator and ailerons were employed. All flight control surfaces are hydraulically actuated to permit accurate control of the airplane at airspeeds which would otherwise impose such airloads that control surface movement would be impossible. An artificial feel system is provided to simulate stick forces felt in conventional type control systems. Control response is good at all speeds; however, a "snaking" motion appears in the transonic speed range. This snaking or oscillating motion is damped out by the yaw damper system. In addition to the yaw damper (which incorporates a turn coordination system) a pitch damper is installed to minimize pitch oscillations.

LEVEL FLIGHT CHARACTERISTICS

LOW SPEED

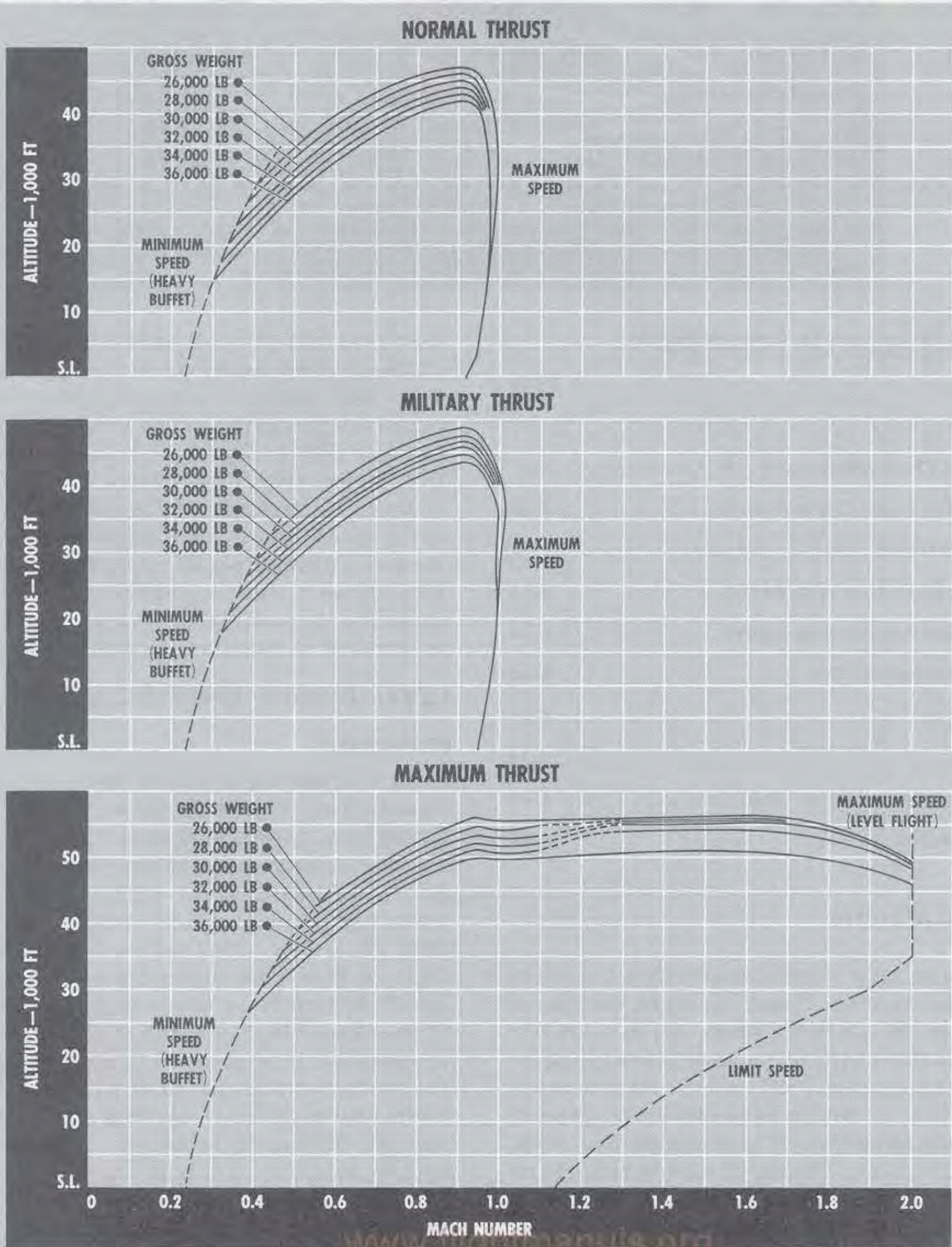
Control effectiveness at low speeds is good when operating at, or near, the recommended minimum speeds or at normal landing and approach speeds. Flight at airspeeds in the approach, landing, and go-around speed ranges is characterized by a relatively high angle of attack. Because of a high degree of control effectiveness during low-speed flight, it is possible to develop a critical angle of attack without being aware of it. A critical angle of attack may lead to excessive sink rate or result in operation in an area of directional instability. Once either of these conditions (high sink rate or directional instability) develops at low altitude, it may be impossible to recover with full thrust applied before contact with the ground. Refer to STALLS, this Section, for additional information. See figure 6-1 for minimum speed capabilities, and figure 6-2 for low-speed characteristics. Although the design of the airplane provides for

minimum and maximum

MODEL: F-106A
DATE: 1 SEPTEMBER 1961
DATA BASIS: FLIGHT TEST

CONFIGURATION: CLEAN
STANDARD ATMOSPHERE
1.0g LEVEL FLIGHT

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL



48101-1A

Figure 6-1 (Sheet 1 of 6)

speed capabilities

MODEL: F-106A
DATE: 21 FEBRUARY 1967
DATA BASIS: FLIGHT TEST

CONFIGURATION: TWO–360 GAL EXTERNAL TANKS
STANDARD ATMOSPHERE
1.0g LEVEL FLIGHT

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

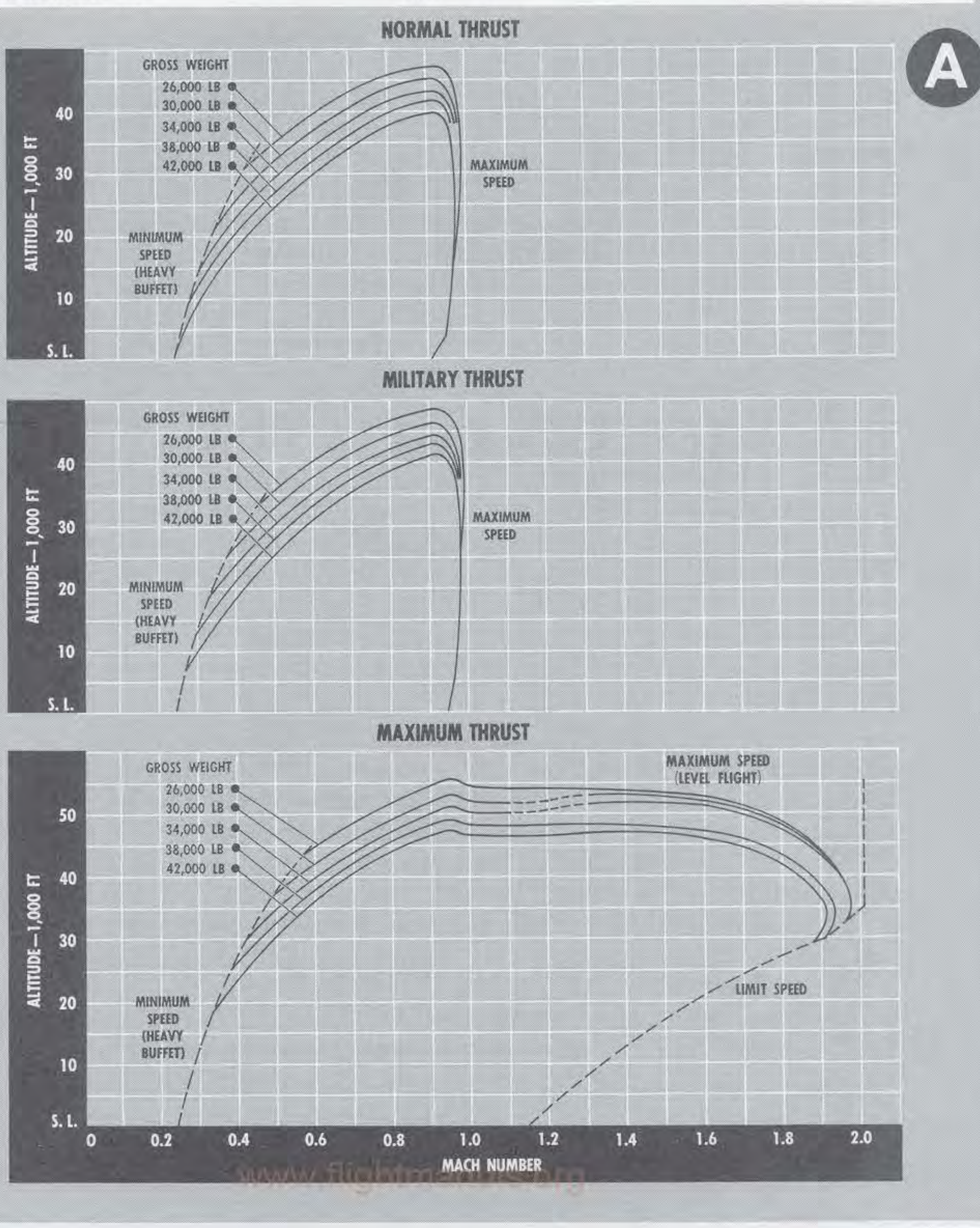


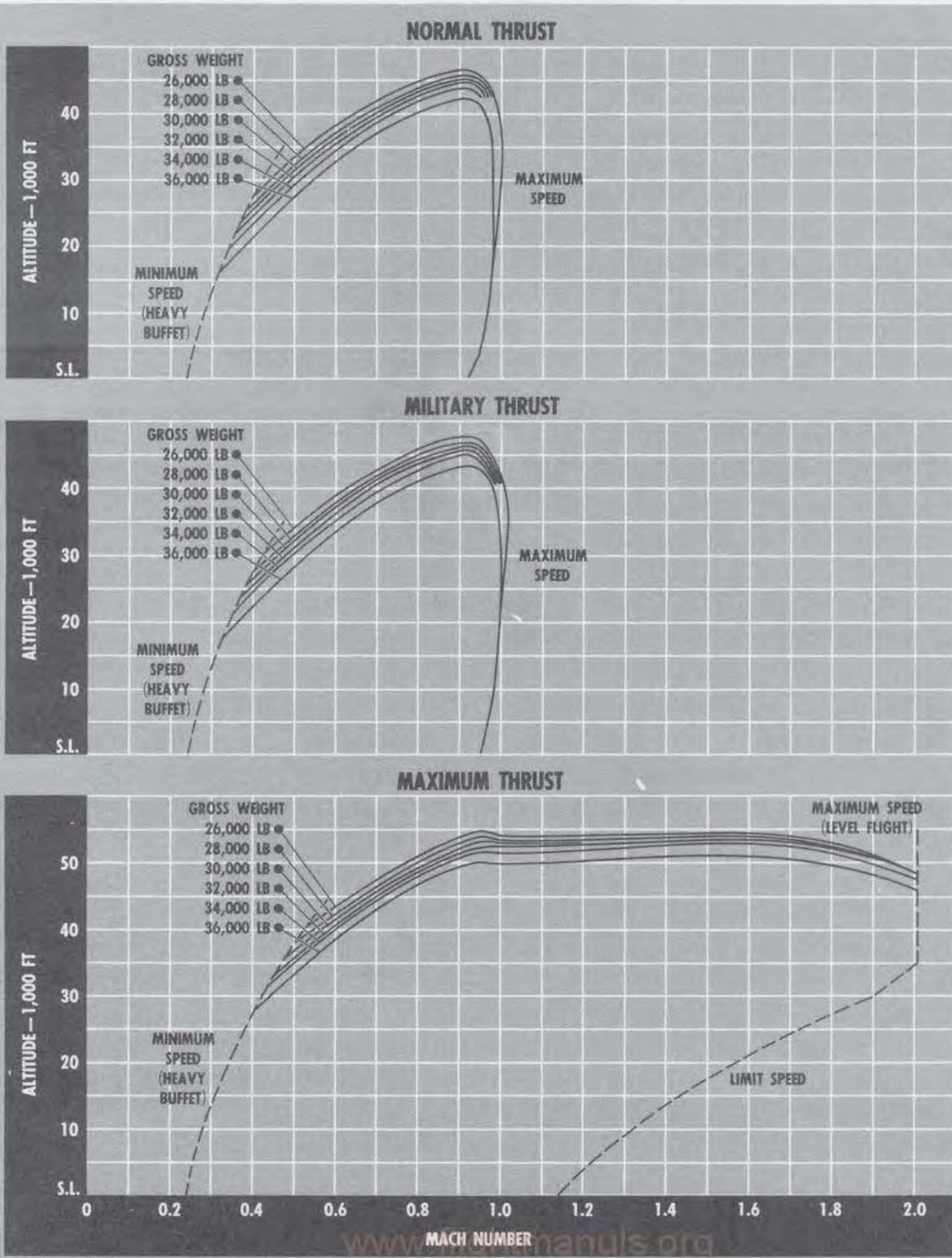
Figure 6-1 (Sheet 2 of 6)

minimum and maximum

MODEL: F-106B
DATE: 1 SEPTEMBER 1961
DATA BASIS: FLIGHT TEST

CONFIGURATION: CLEAN
STANDARD ATMOSPHERE
1.0g LEVEL FLIGHT

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL



48101-3

Figure 6-1 (Sheet 3 of 6)

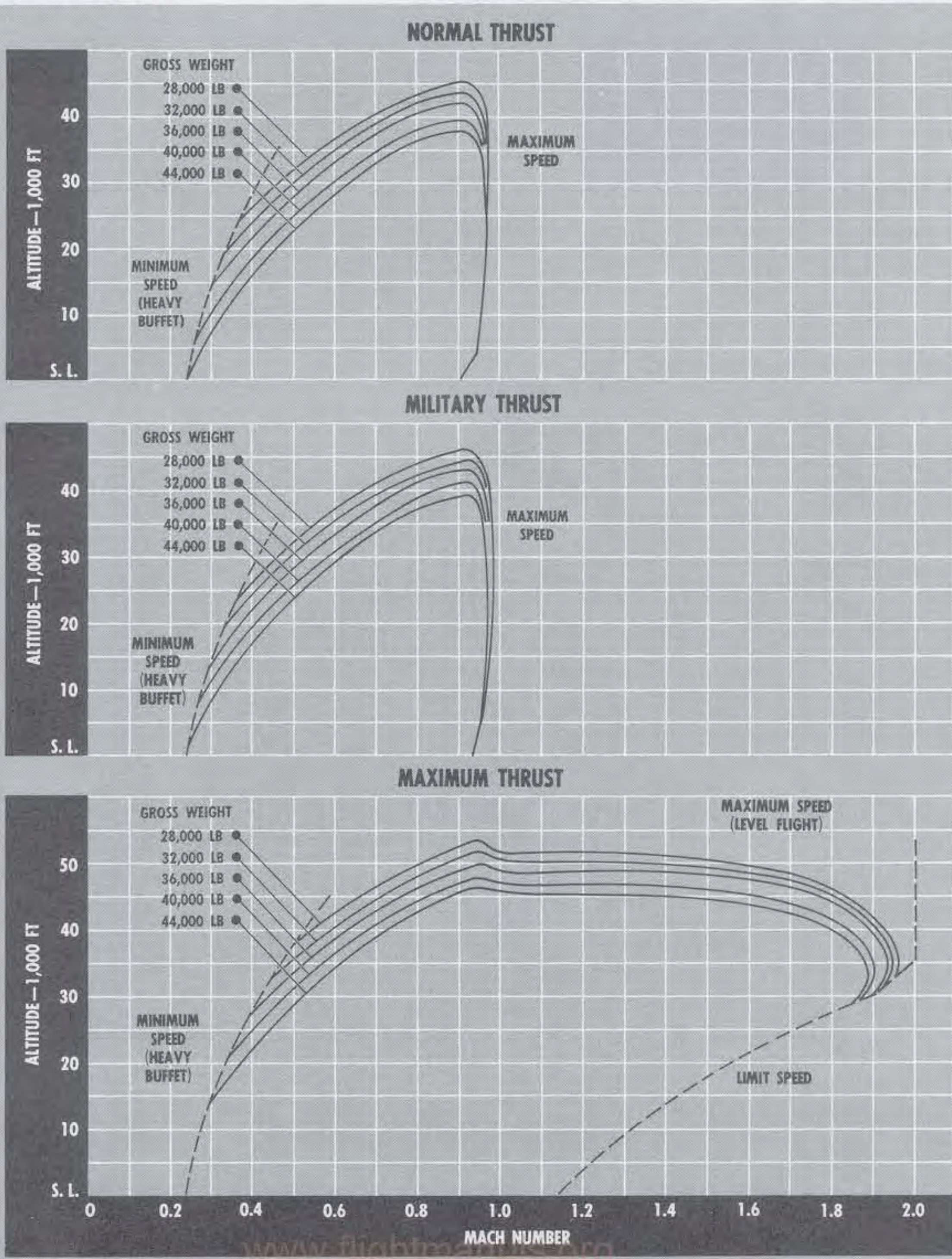
speed capabilities

MODEL: F-106B
DATE: 21 FEBRUARY 1967
DATA BASIS: FLIGHT TEST

CONFIGURATION: TWO—360 GAL EXTERNAL TANKS
STANDARD ATMOSPHERE
1.0g LEVEL FLIGHT

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

B



48101-4

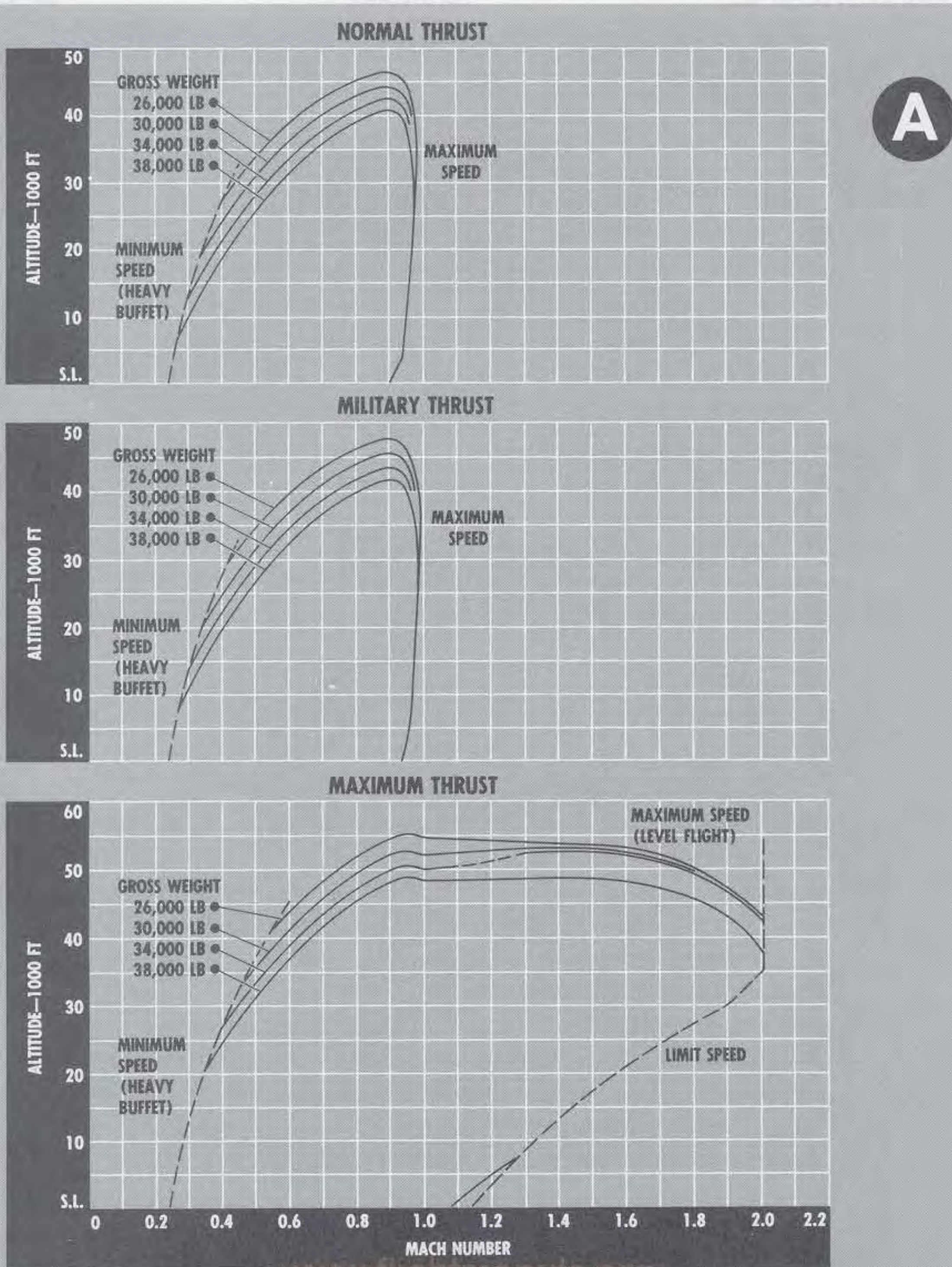
Figure 6-1 (Sheet 4 of 6)

minimum and maximum

MODEL: F-106A
DATE: 2 OCTOBER 1972
DATA BASE: ESTIMATED

CONFIGURATION: CLEAN WITH M61A1 GUN
STANDARD ATMOSPHERE
1.0g LEVEL FLIGHT

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL



48101-5

Figure 6-1 (Sheet 5 of 6)

speed capabilities

MODEL: F-106A
DATE: 2 OCTOBER 1972
DATA BASE: ESTIMATED

CONFIGURATION: M61A1 GUN AND TWO-360 GAL EXTERNAL TANKS
STANDARD ATMOSPHERE
1.0g LEVEL FLIGHT

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

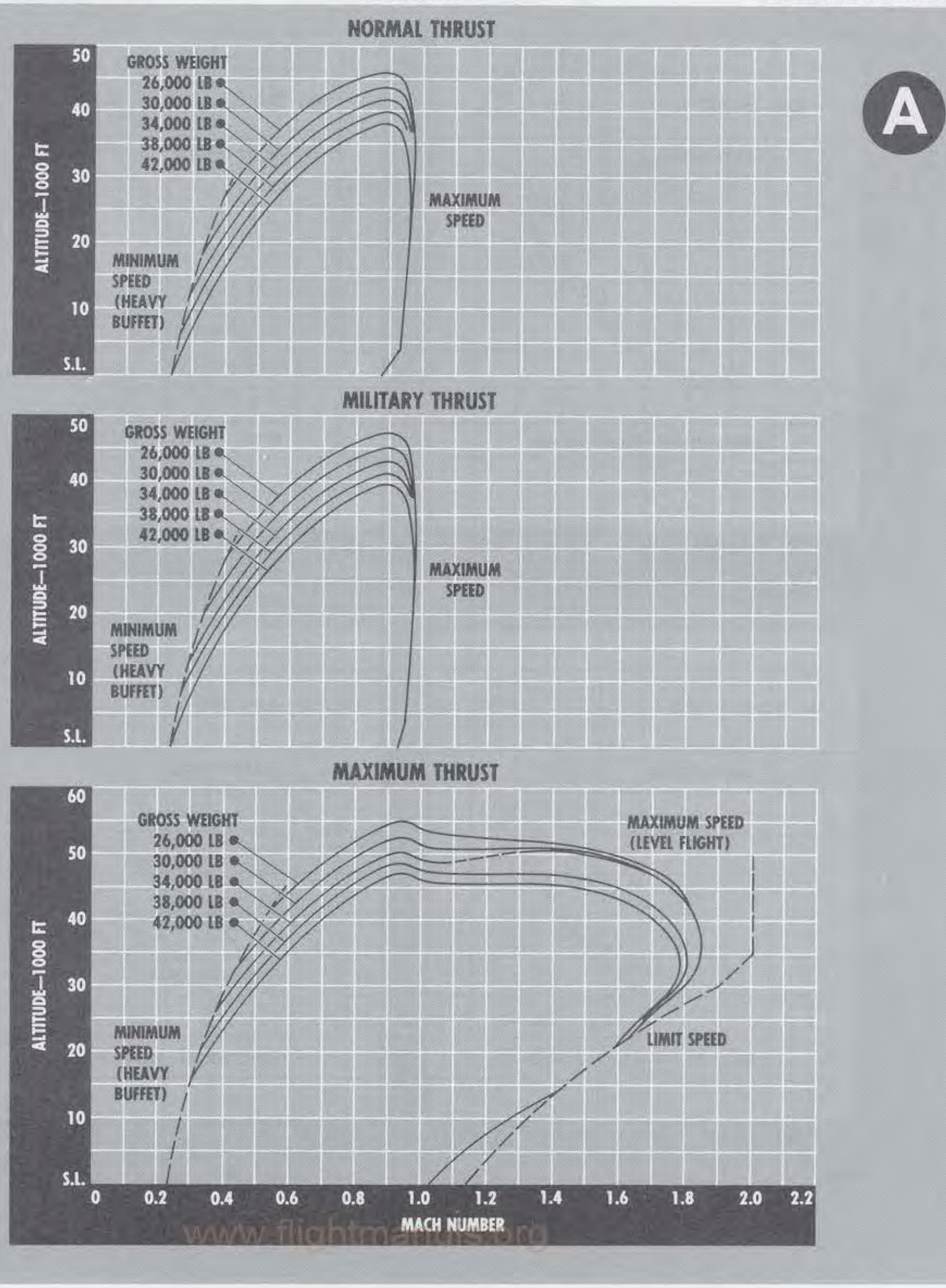


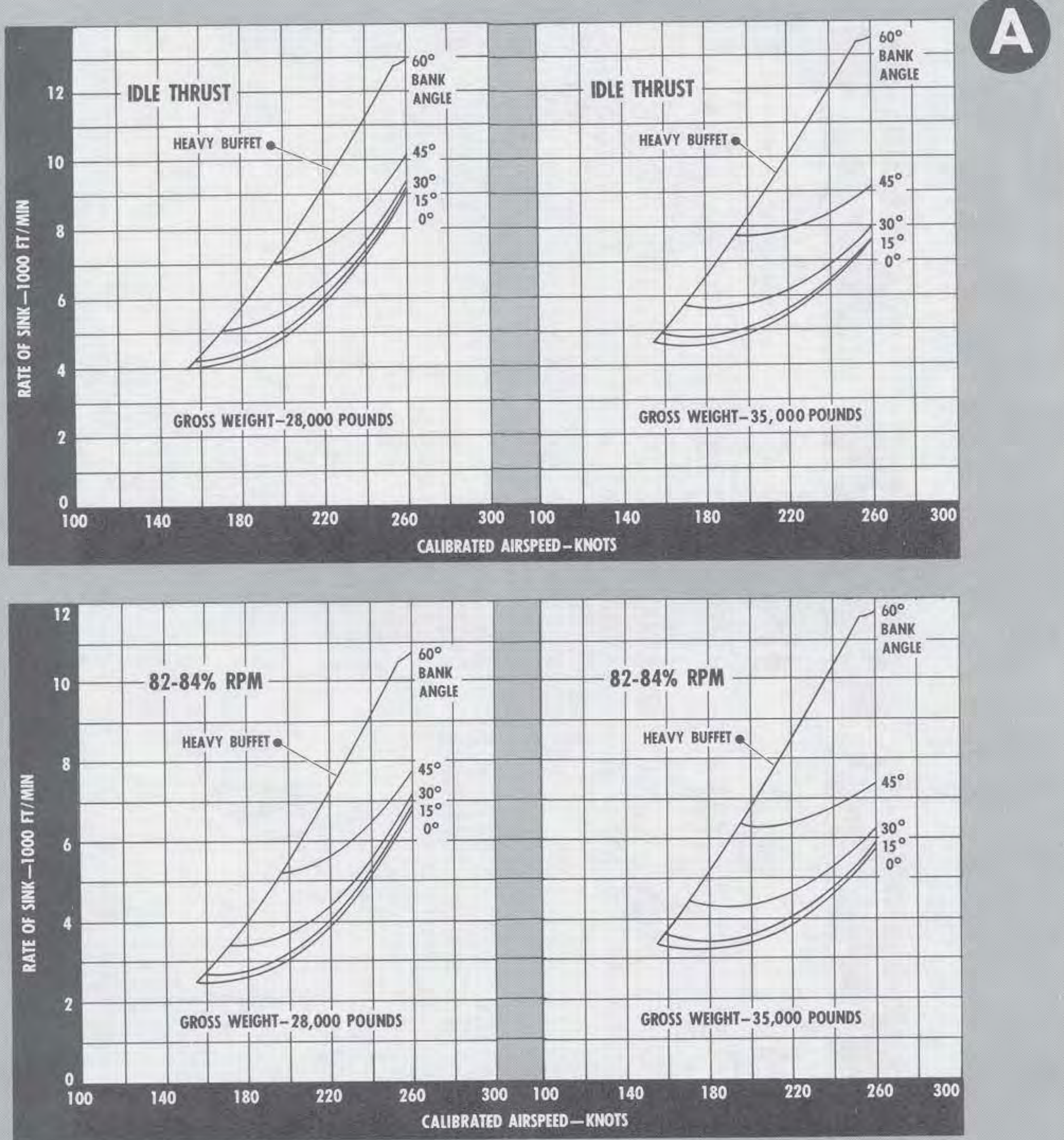
Figure 6-1 (Sheet 6 of 6)

low speed

MODEL F-106A
DATE: 1 SEPTEMBER 1961
DATA BASIS: FLIGHT TEST

CONFIGURATION: GEAR DOWN SPEED BRAKES OPEN • SEA LEVEL STANDARD ATMOSPHERE

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL



NOTE
INCREASE SINK RATES 10 FEET PER MINUTE FOR EACH DEGREE CENTIGRADE INCREASE FROM STANDARD AND 100 FEET PER MINUTE FOR EACH 1000 FEET OF ALTITUDE.

X8093-1

Figure 6-2 (Sheet 1 of 2)

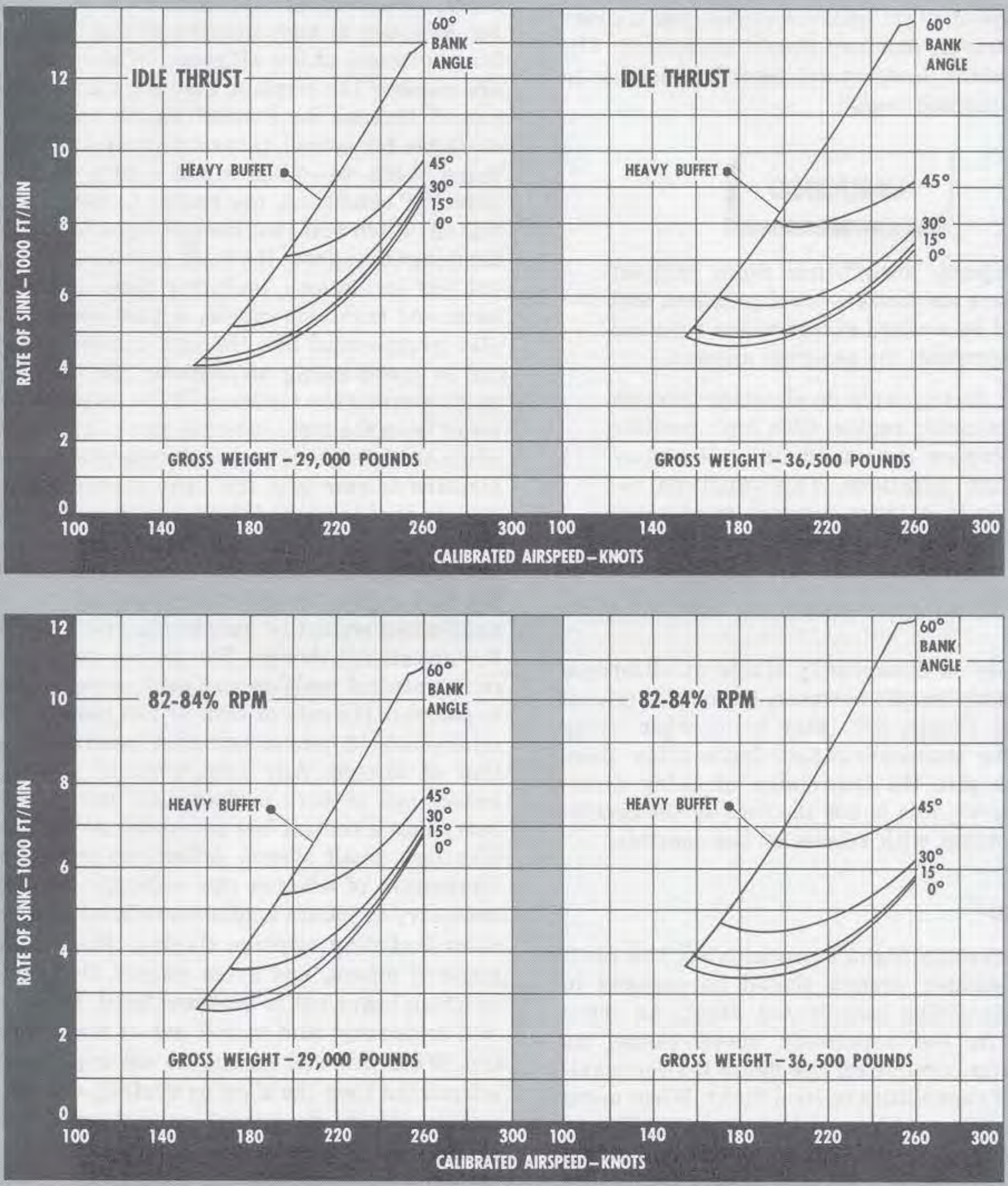
characteristics

MODEL F-106B
DATE: 1 SEPTEMBER 1961
DATA BASIS: FLIGHT TEST

CONFIGURATION: GEAR DOWN, SPEED BRAKES OPEN • SEA LEVEL STANDARD ATMOSPHERE

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

B



NOTE
INCREASE SINK RATES 10 FEET PER MINUTE FOR EACH DEGREE CENTIGRADE INCREASE FROM STANDARD AND 100 FEET PER MINUTE FOR EACH 1000 FEET OF ALTITUDE.

48,093-2

Figure 6-2 (Sheet 2 of 2)

good forward visibility during all normal flight, the wide range of the obtainable angle of attack (angle of attack in excess of about 20°) at low speed makes it possible to obstruct forward visibility along the flight path with the nose of the airplane.

MEDIUM SPEED

Medium speed flight characteristics are conventional; however, dampers should be utilized. The speed at which dampers are most beneficial is in the high subsonic region.

WARNING

- High-speed, low-altitude flight without dampers can cause control problems and should be avoided except where required to accomplish the assigned mission.
- Flight during rapid deceleration through the transonic region with high positive load factors can result in stall and/or post-stall gyrations. This condition results from a large increase in elevator effectiveness when decelerating through the transonic region (1.1 Mach to 0.9 Mach).

The airplane is dynamically stable at all speeds with the dampers off; however, lateral-directional oscillations (dutch roll) may occur when flying through the transonic range. Quite often these oscillations give the impression of being divergent; however, this is not the case as the oscillations will damp with release of the controls.

HIGH SPEED

When supersonic flight is anticipated, the pitch and yaw damper system should be engaged to aid in maintaining coordinated flight. As speed increases in the supersonic speed range, up elevator trim is required. See figure 6-1 for maximum speed capabilities in level flight. When using maximum thrust at low altitude, it is possible to exceed temporary or design speed limitations (refer to Section V). At high supersonic speeds the airplane may encounter stall-buzz. Refer to STALL-BUZZ, Section VII.

MANEUVERING FLIGHT CHARACTERISTICS

Stick forces per load factor (maneuvering stick forces) are very satisfactory throughout the speed range of the airplane. There is a tendency toward a slight increase in stick force per g at supersonic speed and as altitude increases. In supersonic flight, maneuvering capability is limited by elevator deflection at high altitudes and by the elevator hinge moment at low altitudes. When these limits are reached the airplane may have a tendency to roll-off because no further elevon movement is available for lateral (aileron) control. If the airplane starts to roll-off when approaching maximum "g" conditions, use rudder to counteract the roll-off. Pitch and yaw dampers provide adequate damping throughout the flight envelope and smooth out any oscillations, including those at high subsonic and transonic speeds. A turn coordinator is also incorporated into the yaw damper system to aid in coordinating maneuvers. The turn coordinator corrects the tendency of the airplane to yaw away from the turn (adverse yaw) at low speeds, while at high speeds it corrects the tendency of the airplane to yaw into the turn (favorable yaw). This is done in a scheduled manner so that during maneuvering the turn coordinator applies rudder in the proper direction to minimize side slip. During high angle of attack maneuvers, smooth rudder application should be used as the primary control for directional change. The aileron must be held in the neutral position and back pressure applied to generate the rate of turn or roll required. Back trim should be used to minimize inadvertent addition of aileron. Any application of aileron will reduce roll or turn performance and may cause entry into a control loss condition. At high angles of attack small aileron deflections produce large increments of adverse yaw although the amount necessary to induce a spin depends on many variables including airplane rigging, Mach number, angle of attack, and gross weight. During turns in which heavy buffet is encountered, the airplane will ordinarily tend to roll out of turn, over the top. When this roll occurs, do not oppose it with aileron but keep the ailerons neutral, relax g load, and maintain directional control with rudder. Maneuvering characteristics with external tanks installed are essentially the same as the clean airplane. Roll rates for both rudder and aileron rolls are reduced slightly below that obtained with the clean airplane. It will be noticed that there is a slight increased pitch up tendency when decelerating through the transonic range (Mach 1.1 to 0.9). During high load factor maneuvers through the transonic range, this increased pitch up tendency should be anticipated and back stick pressure should be reduced to prevent exceeding positive load factor limits. There is also a slight increase in rudder sensitivity during low airspeed (below 200 KCAS) maneuvers. Flight with a single external tank aboard requires no additional restrictions. However, there is insufficient lateral trim available at supersonic speeds and the pilot must hold some lateral stick force. Supersonic roll performance away from the single tank is seriously degraded and should be considered prior to engaging air combat maneuvers.

STALLS, POST-STALL GYRATIONS, AND SPINS

NOTE

Refer to Section III for control loss procedures.

For the purpose of this discussion, the term "stall" is defined as that condition wherein control is lost about any airplane axis. Airframe buffet is the first warning of a potential stall whether from straight and level flight or an accelerated turn. Buffet onset occurs at about 10° angle of attack and at an airspeed dependent upon weight and load factor as shown in Section V of the Flight Manual. The buffet intensity increases as the angle of attack is allowed to increase by either decreasing airspeed or increasing load factor. As angle of attack approaches 18°, the buffet intensity starts to decrease and deterioration of the lateral directional stability begins to occur coupled with lateral directional oscillations. Just prior to the stall, loss of aileron and rudder effectiveness occurs with a tendency for the airplane to roll out of a turn. The complete stall is characterized by a sudden increase in angle of attack above 28°.

In wings-level stall approaches, airframe buffet is first encountered at 170 to 175 KCAS. Buffet intensity increases with decreasing airspeed and reaches a maximum at 145 to 150 KCAS. The intensity then decreases with decreasing airspeed until, in most cases, it has dissipated at around 130 KCAS. Lateral directional instability is encountered at about 115 KCAS and usually persists until the stall. Aileron control ineffectiveness followed by a loss of rudder effectiveness occurs about 0 to 10 KCAS above the stall. At the stall (approximately 105 KCAS), angle of attack increases abruptly. Neutral aileron at the stall causes the airplane to wallow, lose altitude, and turn slowly in the direction of rudder application. Angles of attack will vary from approximately 50° to 70° with a sink rate of 10,000 to 15,000 fpm.

In accelerated entry stalls using wind up turns of from 1.5 to 2.5 g, airframe buffet is first encountered about 90 to 100 KCAS above the stall and increases with decreasing airspeed. About 10 to 15 KCAS before the stall, short period lateral-directional oscillations will occur which last until the stall. Just before the stall is reached, the airplane has a tendency to roll out of the turn. The complete stall is again characterized by an abrupt increase in angle of attack accompanied by a sudden roll off away from the direction of turn caused by adverse yaw.

Adverse yaw results from a combination of aileron application and rolling motion and occurs in a direction opposite the roll (i.e., when attempting to correct for a right-wing-low condition while flying near a stall, moving the stick to the left for a left-hand rolling motion will cause the nose to yaw to the right). At extreme angles of attack, adverse yaw can be severe enough to result in a spin or post-stall gyrations. During critical phases of flight (such as immediately before touchdown and during go-around), if approaching a stall or a suspected critical angle of attack, it is especially important to use rudder as the primary control for lateral and directional corrections. This action precludes the addition of adverse yaw into an already unsafe flight condition.

WARNING

Intentional stalls are prohibited due to the possibility of encountering post-stall gyrations.

Abrupt elevator inputs should be avoided while maneuvering at low airspeeds. A large elevator input will cause a rapid pitch change that will in turn reduce the amount of stall buffet warning. The onset of the stall buffet warning changes with changing airspeed but the range is approximately

10° angle of attack wide. For example, while maneuvering at 30,000 feet altitude and 220 KCAS with little or no buffet at 10° angle of attack and 8° up elevator, a rapid increase to 20° up elevator will increase the angle of attack to the full stalled condition in less than one second. The angle of attack increases through the 10° stall buffet range in less than 1/2 second giving little buffet warning of the approach to the stall. The airplane can fly into the area of buffet decrease, lateral control oscillations or even loss of control (if aileron is deflected) before corrective action can be initiated.

WARNING

Avoid large abrupt elevator inputs when maneuvering at low airspeed due to the possibility of encountering post-stall gyrations or spin without buffet warning.

Any control input at airspeeds below 200 KCAS should be gradual and no more than that required to achieve maximum performance. Avoid complete reliance on heavy buffet as an indication of approach to a stall. The amplitude and frequency of buffet varies with airspeed; therefore, buffet at high airspeeds is much more obvious than the heaviest buffet attainable at low airspeeds. At low airspeeds, any increase in angle of attack above moderate buffet will decrease buffet intensity and lead to lateral control oscillations and loss of control.

Unlike lateral control oscillations which are a form of stall warning, the post-stall gyration is defined as a violent, erratic oscillatory motion of the airplane which occurs when the complete stall is reached with a sideslip angle of at least 10°. During this maneuver, control surface deflections have no apparent effect upon airplane motion and the airplane will oscillate rapidly in roll, pitch, and yaw. The predominant oscillation will generally be in the yaw axis. These oscillations can be of noticeably long periods and span up to ±60° heading changes. The pilot must use extreme caution not to misinterpret this long period yaw oscillation as entry into spin since premature inputs of anti-spin controls can induce the post-stalled aircraft into a spin. It is not until the control surfaces are neutralized and the airplane is unloaded that the airplane will begin to recover.

Entry into post-stall gyration will most probably occur during turns with a high angle of attack where buffet is encountered and pressed to the point that the airplane begins to roll out of the turn. Application of more aileron into the turn at this point will cause sufficient adverse yaw to force the airplane to rapidly roll away from the turn and into a post-stall gyration or spin.

If a post-stall gyration is entered, neutralizing the aileron and unloading the airplane is the only way to recover. Failure to apply the proper recovery controls may allow the airplane to enter a spin. Any attempt by the pilot to initiate corrective control would be much too late and would only tend to aggravate the condition. There are large changes in pitch, bank, and heading. However, the heading oscillates, unlike the unidirectional rotation characteristics of the spin. When accompanied by high yaw rates, the lateral oscillations could very well give the pilot the first impression of a spin. If spin recovery aileron were applied under these conditions, the airplane would be forced into a spin in the direction opposite to the applied aileron. Application of stick forward of neutral may cause the airplane to go into an inverted spin; however, the rudder will be effective and the airplane may be rolled upright with the rudder.

WARNING

If a post-stall gyration is encountered below **10,000** feet above the terrain — **EJECT.**

During the spin testing program, control losses were induced from wings-level, unaccelerated flight and from 2g to 2.6g turns. With these types of departure entries, the aircraft will spin only against the ailerons, i.e., right-wing-down aileron produces a left spin and vice versa. If pro-spin controls are added at the stall (rudder with, ailerons against, and up elevator), an abrupt pitch-up occurs followed by a turn and pitch-down motion, developing into the spin.

The F-106 has two distinct spin modes, the normal or oscillatory mode and the flat spin mode. There is no clear evidence to indicate what causes the aircraft to enter one mode versus the other; however, they are distinctly different and the pilot should be able to recognize them.

The normal or oscillatory spin is characterized by oscillations about the pitch and roll axis. Pitch may oscillate from +15° to −60°. Although the rate of yaw will vary, the nose will move laterally through 360° without reversal. Yaw (spin) rates of 4 to 10 rpm are common. Because the roll may reverse against the lateral rotation, the spin direction may be masked. The direction of spin rotation should be determined using the turn needle, outside references, or calls from other aircraft. Because of the possibility of disorientation and confusion, the turn needle should be considered the most reliabile indicator. During a spin, the airspeed will be less than 100 KCAS and the altitude loss per turn will vary from 2,000 to 5,000 feet with an average vertical velocity of 20,000 fpm. Like the post-stall gyration, the normal spin is an unstable maneuver. With sufficient altitude, the aircraft will recover to normal flight even if the controls are neutral. It will recover more quickly if proper recovery procedures are used.

From the pilot's viewpoint the major difference be tween the two spin modes is that little or no oscillation in pitch or roll will be present in the flat spin. The aircraft's nose will be 10° to 30° below the horizon and rotating laterally through 360° without reversal. The yaw (spin) rate will be steady to slightly increasing from 10 to 18 rpm. Altitude loss per turn will be 1500 to 2000 feet with a vertical velocity of 15,000 to 30,000 fpm. Unlike the post-stall gyration of normal spin, the flat spin is a stable mode of flight. With neutral controls the aircraft will continue to spin. It is important, therefore, that the pilot recognize the flat spin quickly and apply the correct recovery controls in order to maximize the possibility of recovery.

WARNING

- Intentional spins are prohibited due to excessive loss of altitude and the possibility of not being able to effect a recovery.
- During flat spins with high rotation rates (approximately 10 rpm or greater), transverse forces from centrifugal acceleration of the aircraft may jeopardize a successful ejection. The pilot may be forced forward and unable to assume the proper body position or raise the seat hand grips high enough to initiate the ejection sequence. In order to egress the aircraft by recommended 10,000 ft AGL the pilot should plan to eject with sufficient altitude to cope with any difficulties which the acceleration forces might cause.
- During extremely high angle of attack maneuvering, directional control should be maintained with rudder alone. Any aileron input will probably force the airplane into a spin or post-stall gyration. During a full stall with aileron neutral, the airplane will turn slowly in the direction of rudder application.

During deceleration through the transonic speed range, the level flight trim change is moderate. However, if this deceleration occurs while in a hard turn or dive pullout, the large amount of up elevator necessary to turn at supersonic speeds must be reduced through the transonic range or the airplane will rapidly "dig in." Elevator effectiveness about triples; and if deceleration is rapid enough, the increased angle of attack will force the airplane into a fully stalled condition. Therefore, be prepared for this "dig in" effect and relax back stick pressure to maintain optimum turn performance.

Recovery from buffet or lateral instability is accomplished by relaxing back stick pressure and smoothly flying the airplane out of the pre-stall indication. Increasing the angle of attack beyond lateral control oscillations is not recommended under any circumstances due to the probability of encountering post-stall gyration and spin.

FLIGHT CHARACTERISTICS WITH AFT CG

The handling characteristics of this airplane with aft cg obtained by the fuel transfer system are excellent in the supersonic region. (Refer to CG FUEL TRANSFER SYSTEM, Section I.) The fuel transfer signal is applied by the air data computer at approximately Mach 1.2. After application of the transfer signal, some delay may occur, dependent upon which tanks are pressurized and the available air pressure.

NOTE

Forward transfer will also occur when descending through approximately 13,000 feet.

If deceleration is extremely rapid, as might be the case when thrust is reduced to idle at Mach 1.2, the engine bleed air pressure will be insufficient to pump the transferred fuel forward before the airplane is subsonic. Stick forces will lighten when flying subsonic with most of the transferred fuel remaining aft; i.e. there is a tendency to decrease longitudinal stability and, with maximum aft cg in the subsonic region, a tendency toward neutral longitudinal stability. The situation is compounded during load factor maneuvers at idle rpm initiated near the transfer Mach region. The airplane can decelerate from Mach 1.2 to 0.95 in ten seconds or less during these latter maneuvers and fuel transfer time will exceed 20 seconds.

The net result of flying subsonic with an aft cg is (1) a possibility of overshooting the intended load factor and (2) if in the region of maximum g capability, a possibility of going beyond design limits. The above can be more pronounced due to the inherent transonic trim change. It is therefore recommended:

1. Load factor maneuvers should be avoided in the fuel transfer Mach range when flying with an aft cg.
2. Do not reduce engine thrust to idle until sufficient time has elapsed to insure completion of forward fuel transfer (approximately 20 seconds).

ARTIFICIAL FEEL SYSTEM INOPERATIVE

Internal failure of the elevator feel force regulator normally directs unregulated ram air into the elevator feel-force cylinder which will produce higher stick forces but the airplane remains controllable at restricted speeds. Clogging of the small intake will normally cause the rudder pedal forces to be low, being about the same as the pedal forces encountered on the ground. The abnormally low rudder pedal forces will require caution when operating at high indicated airspeeds to prevent overcontrolling, but will probably appear normal during approach and landing. However, it is possible for the intake to clog at such a time as to trap high "q" pressure, resulting in high rudder pedal forces for approach and landing. Elevator stick forces will be normal or low in most cases of "q" intake clogging. With the small intake clogged, elevator stick force will be normal below 0.88 Mach, and high above that range. With both "q" intakes clogged, elevator stick force will be low, with the extreme low force being the same as that experienced while on the ground. The low elevator stick force will feel approximately normal during approach and landing.

FLIGHT WITH DAMPERS OFF

This airplane can be safely flown throughout the speed envelope with the pitch and yaw dampers off. The airplane is dynamically stable at all speeds; however, lateral-direction oscillations (dutch roll) may occur when flying through the transonic and lower supersonic speed range. Quite often these oscillations give the impression of being divergent; however, this is not the case as the oscillations will damp with release of controls.

WARNING

High-speed, low-altitude flight without dampers can cause control problems and should be avoided except where required to accomplish the assigned mission.

NOTE

A light, relaxed grip on the stick is much less likely to produce induced oscillations that a firm, rigid grip.

SPEED BRAKES

The hydraulically operated speed brakes may be used to slow the airplane at all speeds. When the speed brakes are extended, a slight nose-up tendency occurs. When the speed brakes are retracted a nose-down tendency occurs.

DIVES

The airplane is capable of attaining high airspeeds and/or indicated Mach numbers during dives at steep angles. The Dive Recovery Chart (figure 6-3)

dive recovery chart

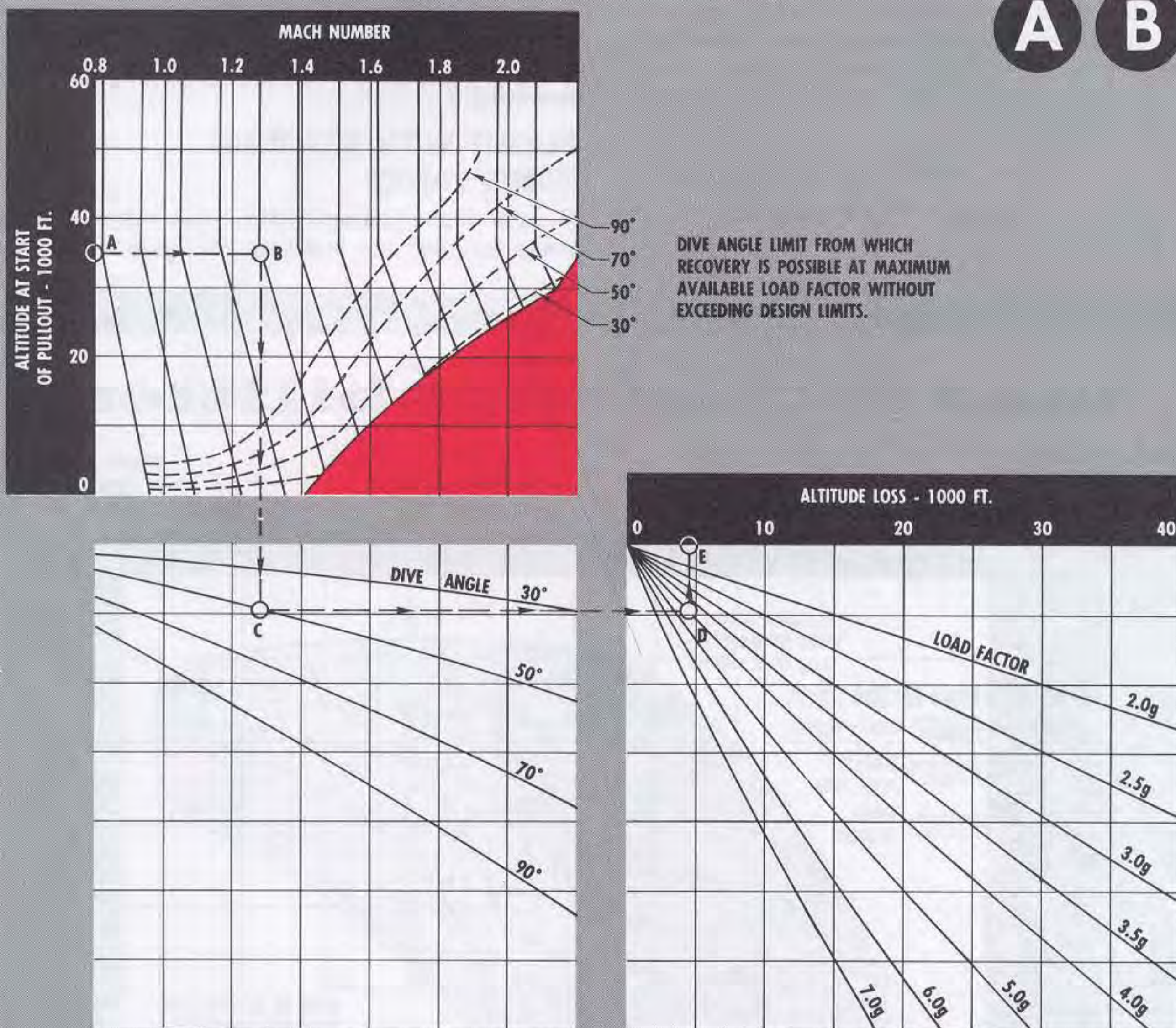
CONFIGURATION: CLEAN
STANDARD ATMOSPHERE
IDLE THRUST

MODEL: F-106 A/B
DATE: 21 JUNE 1968
DATA BASIS: FLIGHT TEST

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

BOTH HYDRAULIC SYSTEMS OPERATING

A B



EXAMPLE:

- A - ALTITUDE AT START OF RECOVERY (35,000 FEET)
- B - MACH NO. AT START OF RECOVERY (1.28)
- C - DIVE ANGLE AT START OF RECOVERY (50°)
- D - LOAD FACTOR DURING RECOVERY (4.0g)
- E - ALTITUDE LOSS (4500 FEET)

NOTE:

- REFER TO SECTION V FOR OPERATING LIMITATIONS.
- FOR LOAD FACTOR COMPATIBILITY, REFER TO FIGURE 6-4.
- FOR RECOMMENDED MAXIMUM DIVE ANGLES, REFER TO FIGURE 6-5.

48102

Figure 6-3

demonstrates altitude lost during these conditions. To achieve the results predicted, it is necesary to have both hydraulic systems operating, speed brakes out, idle thrust, and to have entered the pullout altitude with the g-load already established. Failure of one hydraulic system reduces the airplane's dive recovery performance, but adequate control remains to perform normal dive recovery and rolling maneuvers. The g-load which can be attained at a given altitude and Mach number during the pullout without exceeding heavy buffet, maximum elevator deflection, or hinge moment limits is shown in the Load Factor Capability Chart (figure 6-4). This chart is based on a representative airplane gross weight and center of gravity location.

NOTE

Refer to Section V for operating limitations.

The Recommended Maximum Dive Angles Charts (figure 6-5) indicate ground clearance at a constant Mach and maximum g pullout for various altitudes, airspeeds, and dive angles. The curves indicate the recommended maximum dive angles to insure ground clearance without exceeding the design limit of the airplane. The Altitude Lost in Maximum Available Load Factor Recovery charts (figure 6-6) show altitude lost after entering an altitude with established maximum available load factor, Mach number, and dive angle. Charts are shown for idle, full military, and maximum thrust settings. To achieve the results predicted, it is necessary to have both hydraulic systems operating.

FLIGHT WITH EXTERNAL WING TANKS

General flight characteristics with external wing tanks installed are basically the same as for the

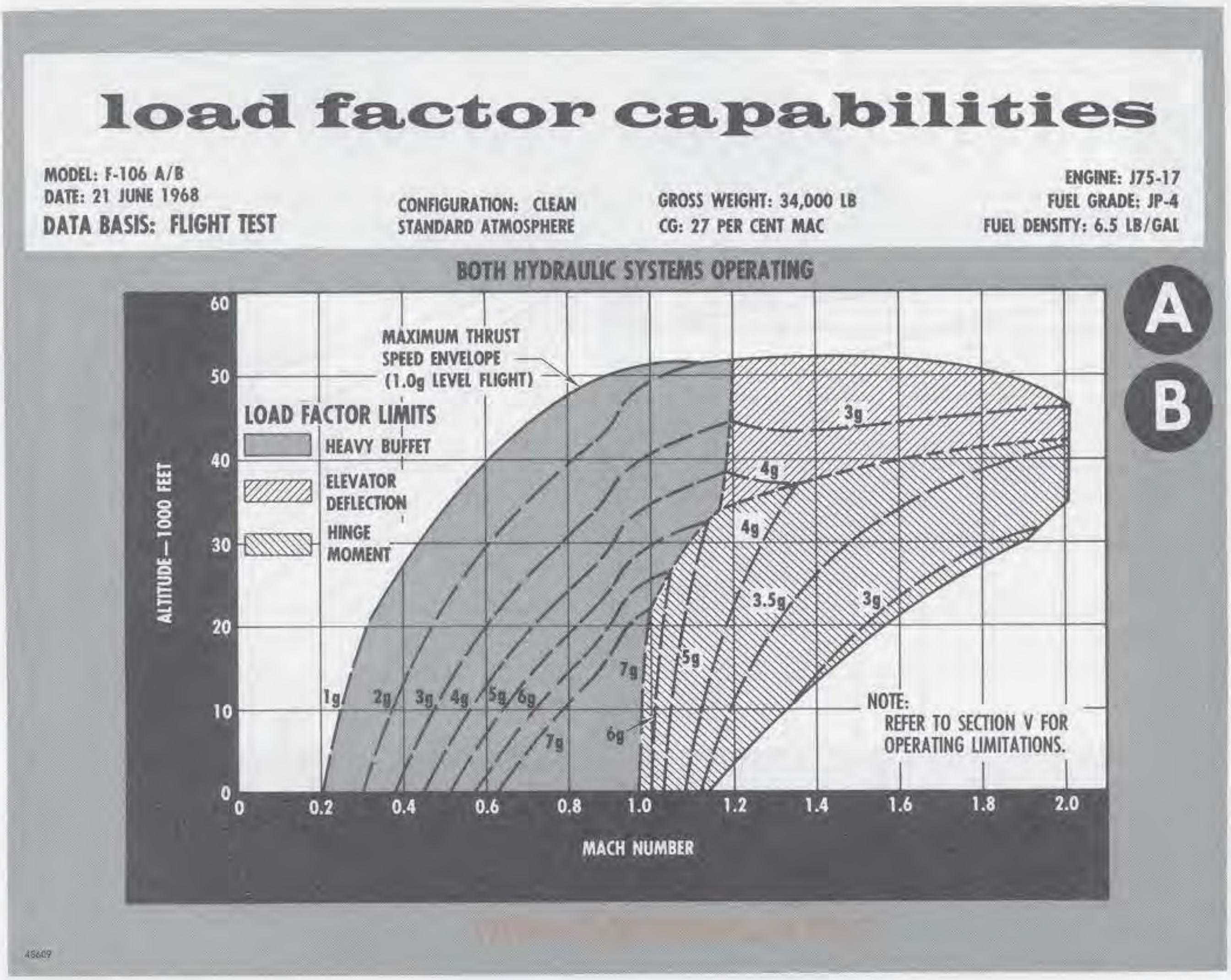


Figure 6-4

clean airplane. There is a notable difference in elevator required for level flight during low-altitude, transonic and supersonic operation. This difference is attributed to a large positive pitching moment (nose-up tendency) caused by the external tanks in this area of flight. In the transonic and low supersonic speed ranges (approximately Mach 0.95 to 1.2) below approximately 10,000 feet altitude, large forward stick displacement is required to maintain level flight. At altitudes below 7,000 feet, insufficient down elevator is available to maintain level flight.

Flight tests of external tank jettisoning have shown that the tanks separate cleanly without striking the airplane structure when jettisoned in a level flight attitude at a constant airspeed. If only one tank separates from the airplane at any fuel load, the resulting roll can be easily controlled with aileron and rudder. Tanks will clear the airplane when jettisoned in a climb, dive, or accelerated flight if they are either full or empty. However, if tanks are partially full and are jettisoned in a climb, dive, or accelerated flight, they will probably strike the airplane. This results from fuel collecting in one end of the tank causing an undesirable tank rotation upon release. Therefore, partially full tanks should be jettisoned in level flight after airspeed has been stabilized for 10 to 15 seconds when time and conditions permit. Full or empty tanks may be jettisoned at any speed without appreciable change in aircraft attitude except in the transonic and low supersonic speed range (0.95 to 1.2 Mach number) below 25,000 feet. Tank jettison in this region will result in momentary negative load factors approaching or exceeding negative load factor limits. The maximum load factor of this post jettison oscillation occurs at 0.6 to 0.9 seconds after ejection forces are felt. The resultant oscillations are self-dampening in three to four cycles and an attempt to lead or correct this initial tendency could result in violent pilot induced oscillations. Therefore, do not jettison the tanks in the 0.95 to 1.2 Mach number range below 25,000 feet.

ENGINE VIBRATION

The engine has a vibration characteristic that is considered to be normal and does not jeopardize the structural integrity of the airplane. Engine vibration in subsonic and nonafterburner flight is more noticeable than at supersonic speed. Use of afterburner dampens out or reduces normal engine vibration. Coincident with engine vibration, a noise which can be described as a "moan" or low frequency oscillation, may be experienced. The noise is a normal condition and should cause no concern to the pilot.

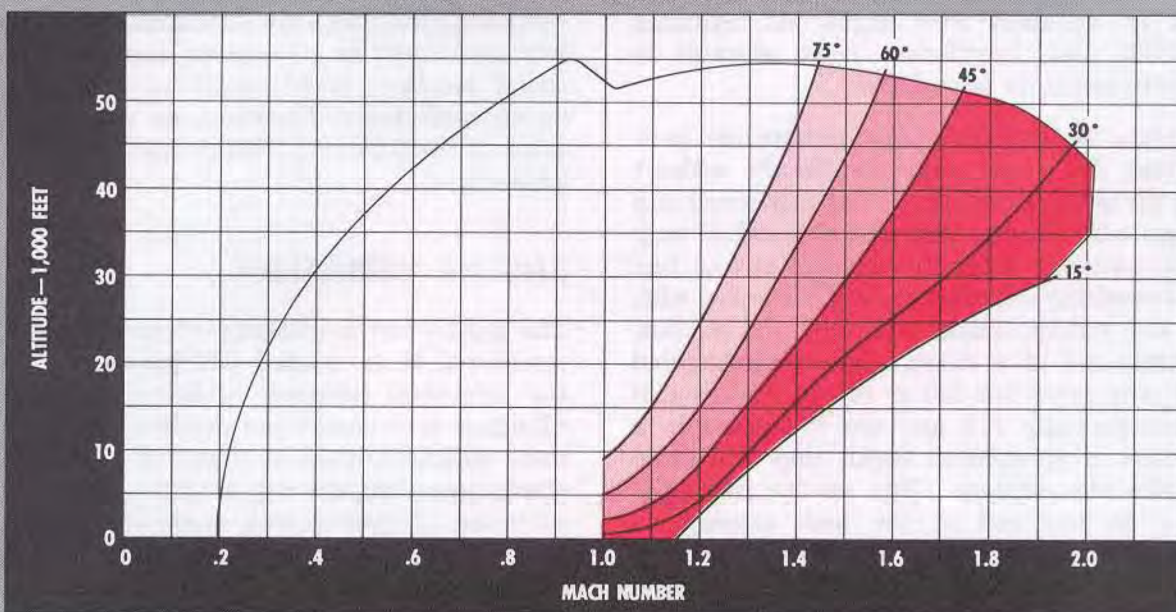
recommended maximum

MODEL: F-106A
DATE: 1 SEPTEMBER 1961
DATA BASIS: FLIGHT TEST

GROSS WEIGHT 29,776 LBS
STANDARD ATMOSPHERE

ENGINE: J-75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

SINGLE HYDRAULIC SYSTEM OPERATING NO FUEL TRANSFER (C.G. 26%)



BOTH HYDRAULIC SYSTEMS OPERATING NO FUEL TRANSFER (C.G. 26%)

EXAMPLE

- AT 35,000 FEET AND 1.5 MACH NUMBER WITH A FORWARD C.G. (26% MAC) AND WITH ONLY A SINGLE HYDRAULIC SYSTEM OPERATING, A DIVE ANGLE SHOULD BE NO GREATER THAN 50°.
- THE PULLOUT LOAD FACTOR IS BASED UPON THE AVERAGE MAXIMUM AVAILABLE (DUE TO HINGE MOMENT LIMITING) BETWEEN INITIATION-ALTITUDE AND FINAL ALTITUDE.

48,174-1

Figure 6-5 (Sheet 1 of 3)

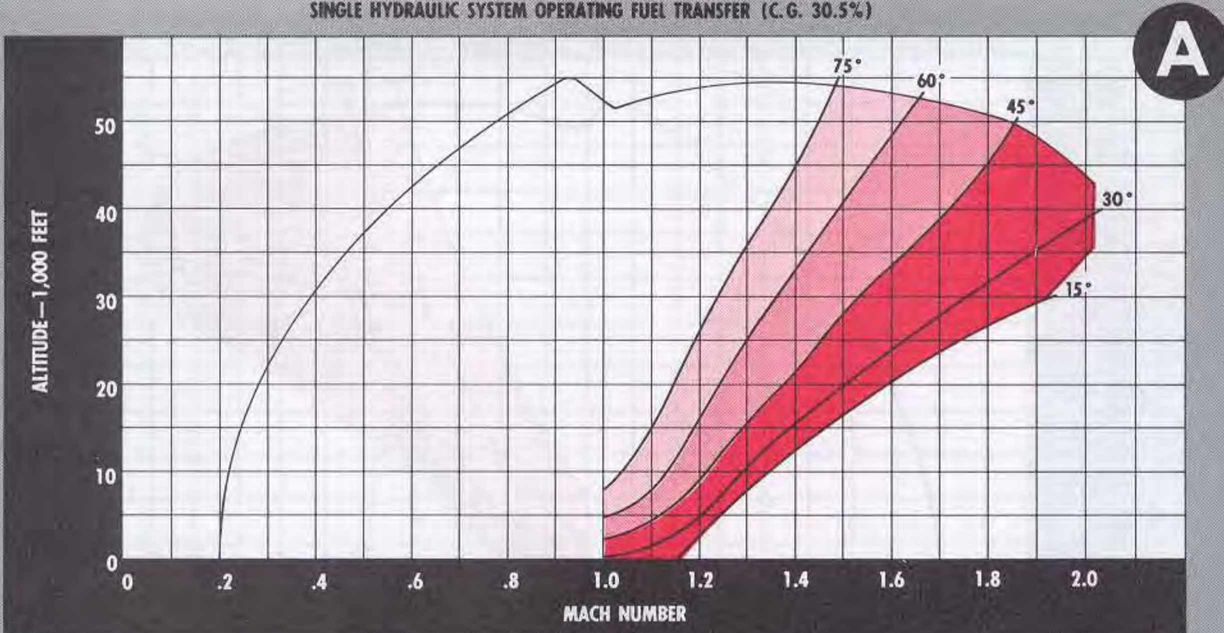
dive angles

MODEL: F-106A
DATE: 1 SEPTEMBER 1961
DATA BASIS: FLIGHT TEST

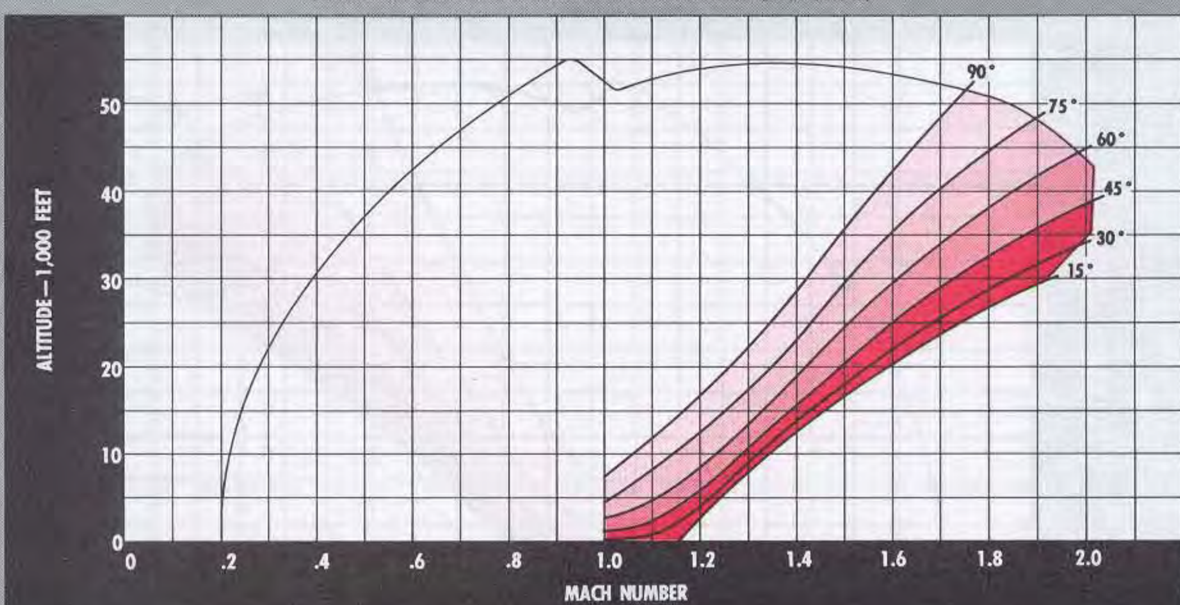
GROSS WEIGHT 29,776 LBS
STANDARD ATMOSPHERE

ENGINE: J75-17
FUEL GRADE JP-4
FUEL DENSITY: 6.5 LB/GAL

SINGLE HYDRAULIC SYSTEM OPERATING FUEL TRANSFER (C.G. 30.5%)



BOTH HYDRAULIC SYSTEMS OPERATING FUEL TRANSFER (C.G. 30.5%)



NOTE
- THESE CURVES INDICATE THE RECOMMENDED MAXIMUM DIVE ANGLE TO INSURE AGAINST EXCEEDING V_L, OR BELOW M = 1.15, TO ASSURE GROUND CLEARANCE
- DURING THE RECOVERY. THEY ARE CONSERVATIVE IN THAT A CONSTANT MACH NUMBER RECOVERY IS ASSUMED.

48374-2

Figure 6-5 (Sheet 2 of 3)

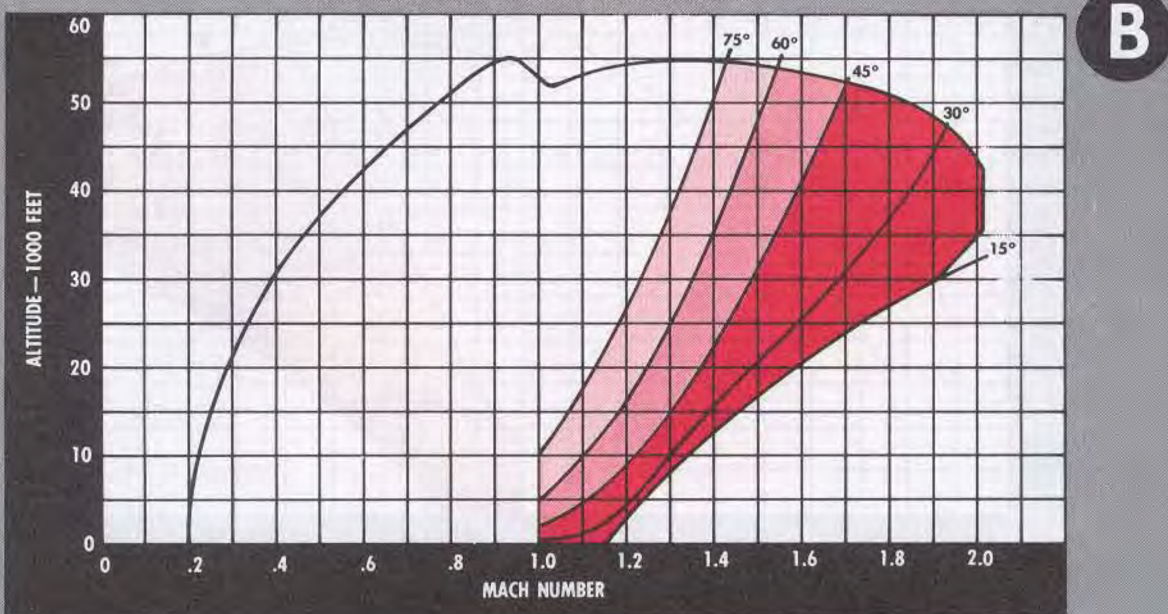
recommended maximum dive angles

MODEL: F-106B
DATE: 1 SEPTEMBER 1961
DATA BASIS: FLIGHT TEST

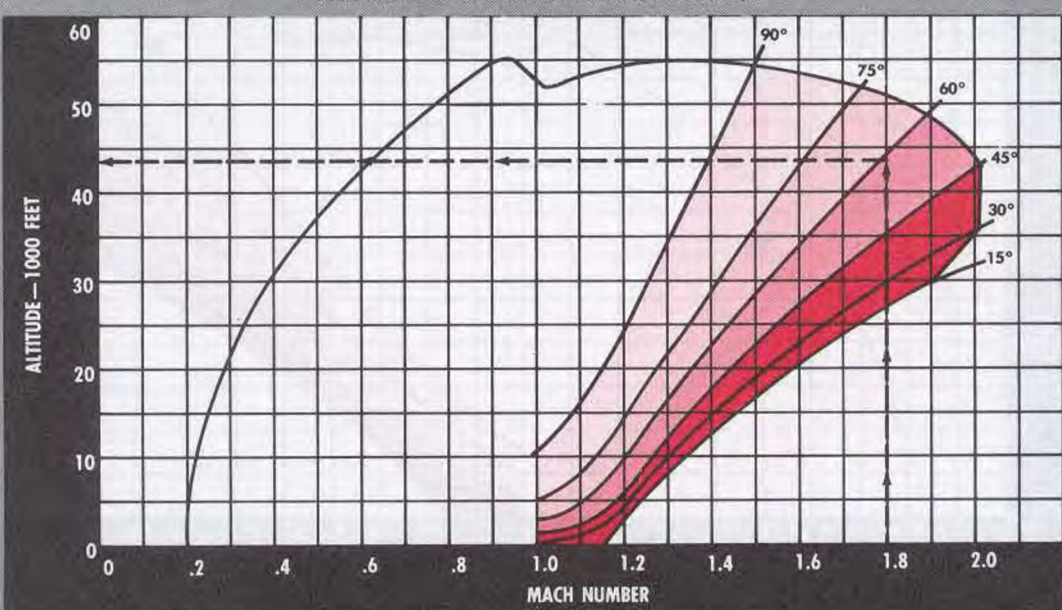
GROSS WEIGHT 31,576 LBS
STANDARD ATMOSPHERE

ENGINE: J-75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

SINGLE HYDRAULIC SYSTEM OPERATING (C.G. 26.8%)



BOTH HYDRAULIC SYSTEMS OPERATING (C.G. 26.8%)



EXAMPLE:
- AT 43,000 AND 1.8 MACH NUMBER AND BOTH HYDRAULIC SYSTEMS OPERATING, A DIVE ANGLE SHOULD BE NO GREATER THAN 60°.
- THE PULLOUT LOAD FACTOR IS BASED UPON THE AVERAGE MAXIMUM AVAILABLE (DUE TO HINGE MOMENT LIMITING) BETWEEN STARTING ALTITUDE AND FINAL ALTITUDE.
- THESE CURVES INDICATE THE RECOMMENDED MAXIMUM DIVE ANGLE TO INSURE AGAINST EXCEEDING V_L, OR BELOW M = 1.15 TO ASSURE GROUND CLEARANCE.
- DURING THE RECOVERY, THEY ARE CONSERVATIVE IN THAT A CONSTANT MACH NUMBER RECOVERY IS ASSUMED.

48174-3

Figure 6-5 (Sheet 3 of 3)

altitude lost in maximum available load factor dive recovery

MODEL: F-106 A/B
DATE: 21 JUNE 1968
DATA BASIS: FLIGHT TEST

IDLE THRUST

CONFIGURATION: CLEAN
STANDARD ATMOSPHERE

GROSS WEIGHT: 34,000 LB
CG: 27 PER CENT MAC

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

BOTH HYDRAULIC SYSTEMS OPERATING

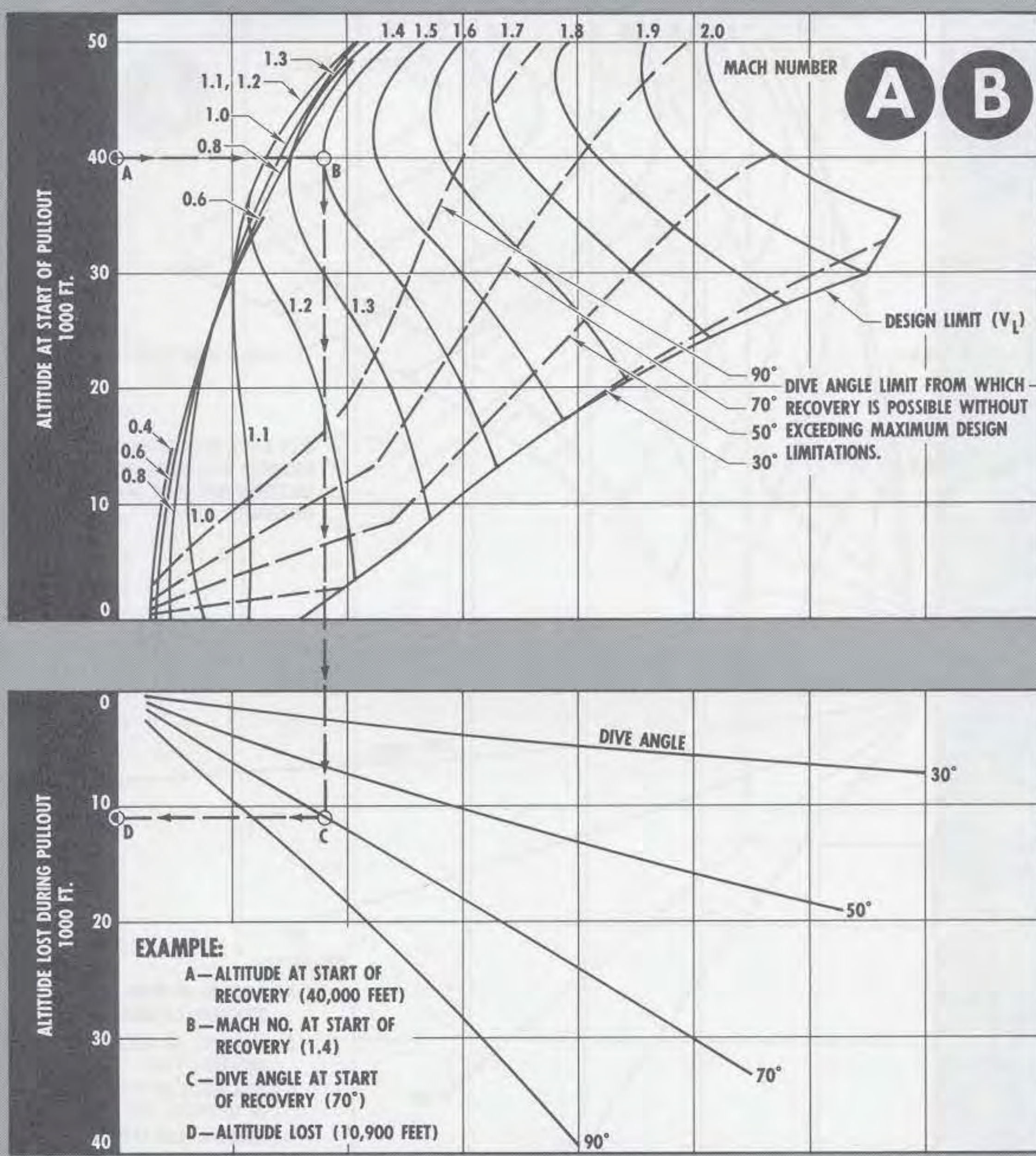


Figure 6-6 (Sheet 1 of 3)

altitude lost in maximum available load factor dive recovery

MODEL: F-106 A/B
DATE: 21 JUNE 1968
DATA BASIS: FLIGHT TEST

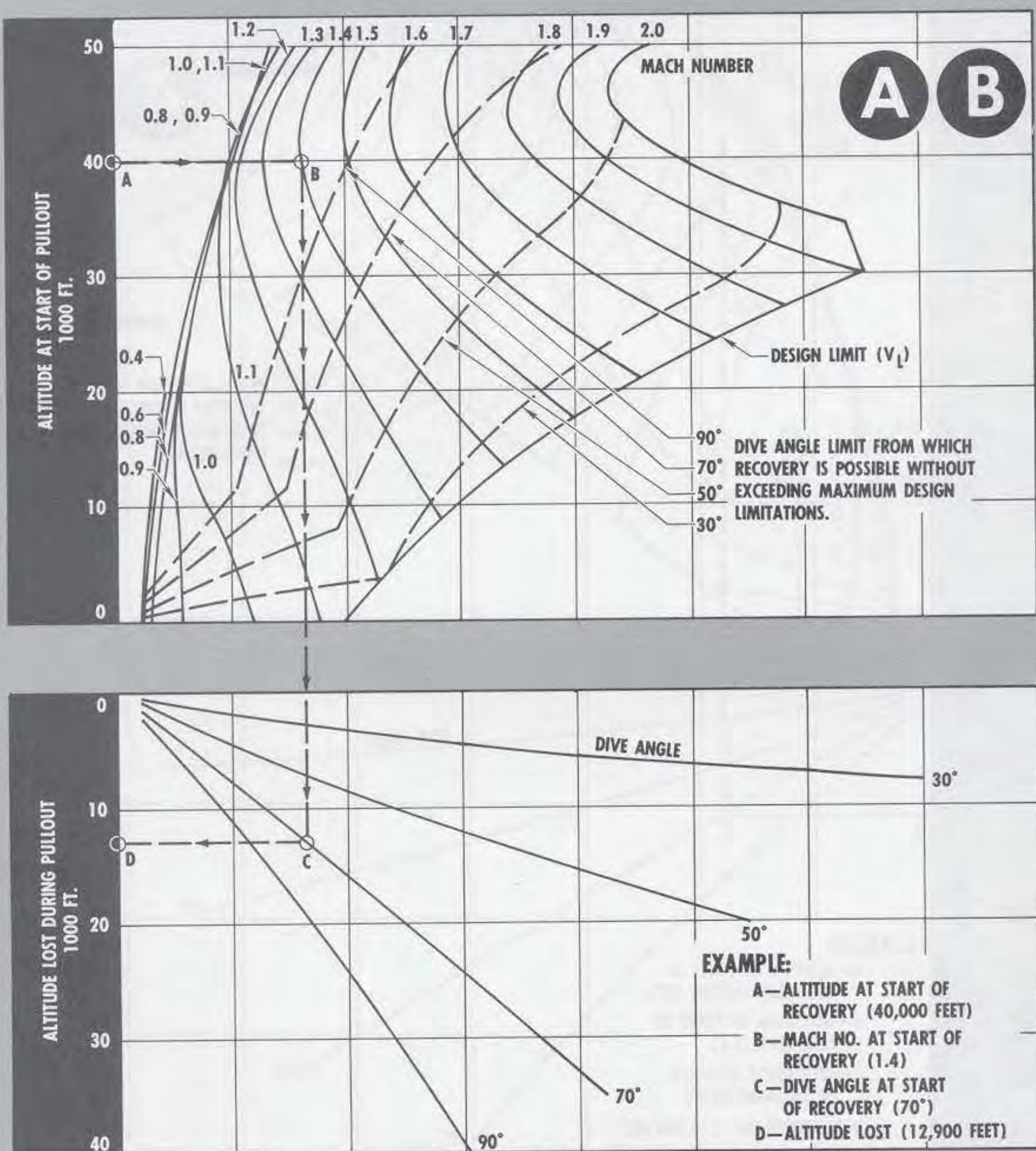
MILITARY THRUST

CONFIGURATION: CLEAN
STANDARD ATMOSPHERE

GROSS WEIGHT: 34,000 LB
CG: 27 PER CENT MAC

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

BOTH HYDRAULIC SYSTEMS OPERATING



48103-2

Figure 6-6 (Sheet 2 of 3)

altitude lost in maximum available load factor dive recovery

MAXIMUM THRUST

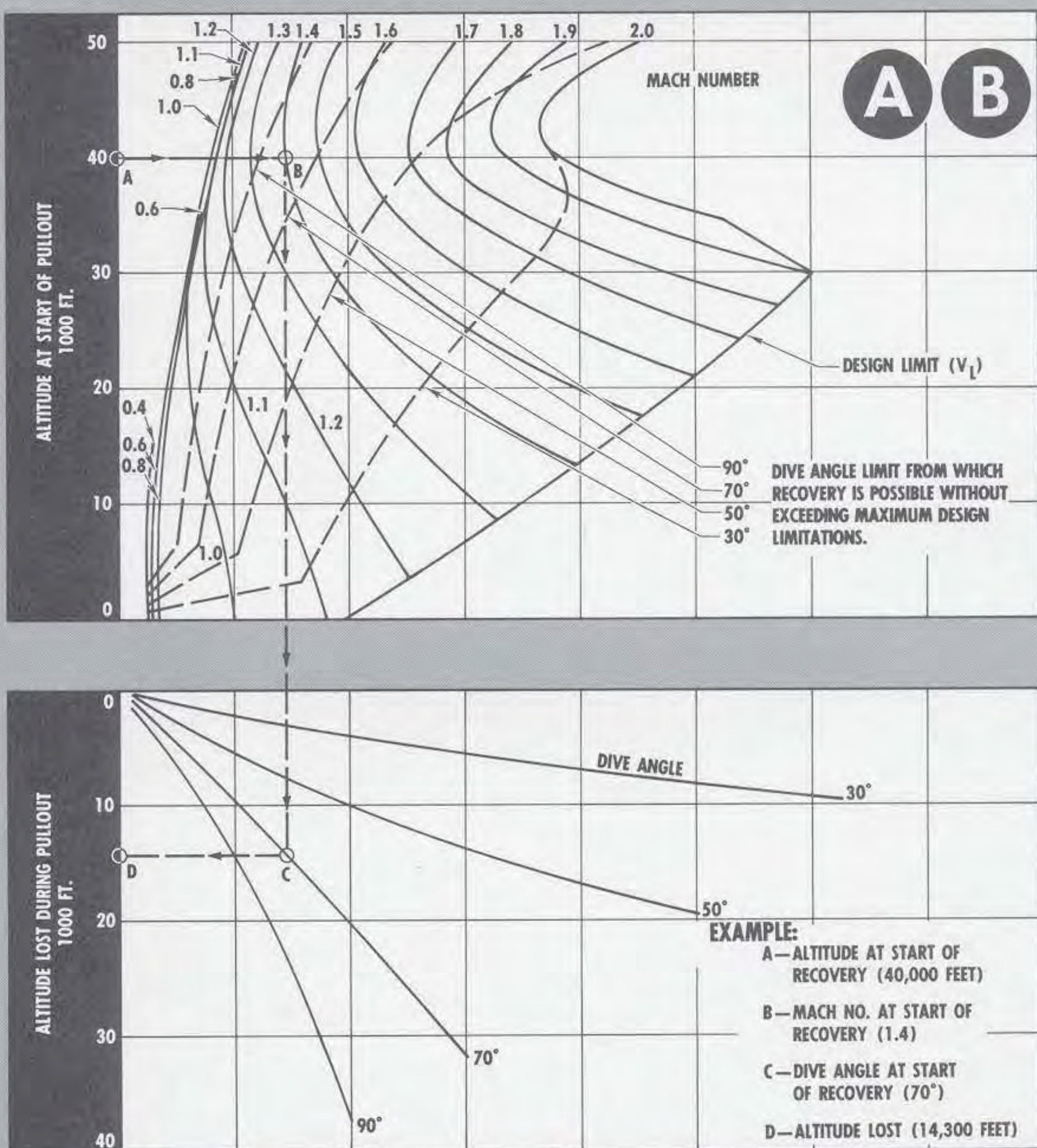
MODEL: F-106 A/B
DATE: 21 JUNE 1968
DATA BASIS: FLIGHT TEST

CONFIGURATION: CLEAN
STANDARD ATMOSPHERE

GROSS WEIGHT: 34,000 LB
CG: 27 PER CENT MAC

ENGINE: J75-17
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

BOTH HYDRAULIC SYSTEMS OPERATING



48103-3

Figure 6-6 (Sheet 3 of 3)

systems operation Section VII

48060

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SMOKE FROM TAILPIPE AFTER SHUTDOWN

Normally the pressurizing and dump valve in the fuel control system will prevent the accumulation of fuel in the engine after shutdown. However, if for any reason fuel or oil should collect in the turbine housing during or immediately after shutdown, residual heat will vaporize the liquid and create a potential hazard. The situation is indicated by smoke or vapor exiting from the tailpipe. The engine should be cleared by using the EXCESSIVE EGT OR FIRE IN TAILPIPE procedure, Section III. All personnel should remain clear of the tailpipe for several minutes after engine shutdown and at all times when smoke or vapor is issuing from the nozzle.

USE OF WHEEL BRAKES

To minimize brake wear, the following precautions shall be observed insofar as practicable:

1. Take full advantage of the length of the runway, utilizing aerodynamic braking to help stop the airplane.

2. Do not apply brakes immediately after touchdown or at any time when there is considerable lift on the wings, to prevent skidding the tires. Heavy brake pressure will lock the wheels more easily if applied immediately after touchdown than if the same pressure is applied after the full weight of the airplane is on the tires. A wheel once locked in this manner immediately after touchdown will not become unlocked as load increases, as long as brake pressure is maintained. Brakes can stop the wheel from turning, but stopping the airplane is dependent on the frictional force between the tires and the runway. As the load on the tires increases, the frictional force increases, giving better braking action. During a skid, the frictional force is reduced, thus requiring more distance to stop.

3. If maximum braking is required after touchdown on a dry surface, lift should first be decreased as much as possible by dropping the nose before applying brakes. With the nose wheel on the ground, the wings provide negative lift which forces the wheels down against the runway. This procedure

will improve braking action by increasing the frictional force between the tires and the runway.

4. For minimum length landing rolls, a single, smooth application of the brakes with constantly increasing pedal pressure will result in optimum braking.
5. A minimum of 15 minutes should elapse between landings where the landing gear remains extended in the slipstream, and a minimum of 30 minutes between landings where the landing gear has been retracted, to allow sufficient time for cooling between brake applications. Additional time should be allowed for cooling if brakes are used for steering or cross-wind taxiing operation, or if a series of landings is performed.
6. At the first indication of brake malfunction, or if brakes are suspected to be in an overheated condition after excessive use, the airplane should be maneuvered off the active runway and stopped. The airplane should not be taxied into a crowded parking area. Overheated wheels and brakes shall be cooled before the airplane is subsequently towed or taxied. Peak temperatures occur in the wheel and brake assembly from 5 to 15 minutes after a maximum braking operation. In extreme cases, heat buildup can cause the wheel and tire to fail with explosive force or be destroyed by fire if proper cooling is not effected. Taxiing at low speeds to obtain air cooling of overheated brakes will not reduce temperatures adequately and can actually cause additional heat buildup.
7. The brakes should not be dragged when taxiing, and should be used as little as possible for turning the airplane on the ground.

COMPRESSOR STALL

A breakdown of compressor airflow is known as a compressor stall. Stalls may be encountered at any speed. Compressor stalls may occur as individual loud reports or as a series of loud reports in rapid order. Compressor stalls are accompanied by airframe vibration and in some cases, emission of vapor from the engine air intake duct.

NOTE

The engine can sustain numerous rapid order type compressor stalls without engine damage.

Compressor stalls may be recognized by loss of thrust reflected through engine instruments, rapid reduction or fluctuation of engine pressure ratio at a constant throttle position, or failure of rpm to increase during acceleration. A compressor stall may be accompanied by a rise in exhaust gas temperature. The possibility of encountering compressor stall is increased during high-altitude operation as the thinner air does not conform as easily to smooth airflow through the compressor section as does the heavier air at low altitude. This results in a more easily disturbed compressor airflow pattern. If a compressor stall is experienced, it should be noted on Form 781. Refer to STALL-BUZZ CORRECTIVE PROCEDURE, this Section.

STALL-BUZZ

The term "stall-buzz" refers to engine compressor stall combined with inlet duct pressure fluctuations which may occur at speeds greater than Mach 1.25. The engine compressor stalls are characterized by a series of loud metallic banging noises. The inlet duct pressure fluctuations result in a low pitched, rumbling, buzzing sound which is heard between individual compressor stall surges. Although loud and startling, this phenomenon (stall-buzz) does not jeopardize the structural integrity of the airplane as demonstrated by flight tests under all conditions of stall-buzz. Along with the loud noise, airplane yaw will occur because of asymmetric duct pressure distribution (i.e., one duct swallowing a shock wave while the other duct is rejecting a shock wave). The steady yaw angle may reach two or three degrees and can induce a low roll rate. Lateral load factors associated with the yaw condition will tend to move the pilot to an awkward position in the cockpit. Flight tests have shown that a small amount of aileron opposing the roll will counteract both the roll and yaw. The yawing motion creates no structural problem. At speeds above approximately Mach 1.25, stall-buzz can be caused by rapid or improper throttle movement, variable ramp malfunction (resulting from secondary hydraulic system failure, air data computer failure, ac or dc nonessential power failure, ramp controller or actuator failure), and fuel control malfunction. Stall-buzz is most commonly encountered when shutting down afterburner near limit speed at high altitude. It can also be encountered when throttling excessively in afterburner or during afterburner relight.

THROTTLE MANAGEMENT TO AVOID STALL-BUZZ

1. Below Mach 1.25, no restriction on throttle movement.
2. Between Mach 1.25 and 1.7, no restriction on throttle movement in the afterburner range. Use slow throttle movement when retarding throttle aft of the minimum afterburner detent.
3. Between Mach 1.7 and limit speed, use slow throttle movement between maximum and minimum afterburner.

NOTE

As altitude, Mach number, and angle of attack limits are approached, stall-buzz is increasingly likely to occur.

STALL-BUZZ CORRECTIVE PROCEDURE

1. When in afterburner, shut down afterburner.
2. When coming out of afterburner, maintain present throttle setting.
3. When maneuvering, reduce load factor and accomplish either step 1 or 2 above, as applicable.

NOTE

- If stall-buzz is caused by rapid or improper throttle movement, the stall-buzz will tend to subside within 2 to 5 seconds and before appreciable deceleration occurs.
- If stall-buzz is caused by variable ramp malfunction or by fuel control malfunction, stall-buzz will tend to continue until the airplane has decelerated to approximately Mach 1.3, which may require up to 10 to 12 seconds.
- Afterburner relight should never be attempted until stall-buzz subsides and the engine stabilizes.
- If stall-buzz is experienced in flight, it should be noted on Form 781.

CAUSES OF VARIABLE RAMP FAILURE

System failures which can affect variable ramp operation are: (1) secondary hydraulic systems; (2) air data computer; (3) loss of ac or dc nonessential power; and (4) failure of the variable ramp components, such as the screw actuator. The most immediate indications of variable ramp failure, as caused by any one of the above, are compressor stall with associated inlet duct pressure fluctuations (stall-buzz), possible yaw, and loss of acceleration. Refer to STALL-BUZZ CORRECTIVE PROCEDURE, this Section.

SECONDARY HYDRAULIC SYSTEM FAILURE

Failure of the secondary hydraulic system will cause the ramps to remain in the position which exists at the time of failure. Fuel should be monitored to determine the range capabilities. Retract the ramps in accordance with VARIABLE RAMP FAILURE procedures, Section III.

VARIABLE RAMP CONTROLLER UNIT FAILURE

Faulty variable ramp controller output signals may cause premature extension, a fixed position, or premature retraction of the ramps. If the ramps fail at an angle greater than the position required to maintain the scheduled inlet duct Mach, the airflow through the engine inlet ducts will become supercritical. This supercritical or highspeed airflow results in low performance (i.e., change of acceleration rate, decrease of engine pressure ratio, and possible compressor stall if allowed to continue), and may prevent the airplane from accelerating. Noise created by the turbulent airflow through the intake will normally accompany a supercritical intake condition. If the ramps are at an angle less than required, stall-buzz will result above approximately Mach 1.5. In either case, monitor fuel flow for range considerations and retract the ramps in accordance with VARIABLE RAMP FAILURE procedures, Section III, if necessary.

AIR DATA COMPUTER FAILURE

Failure of the air data computer above Mach 1.25 will cause variable ramps to schedule improperly, resulting in stall-buzz, or a high duct Mach number and a resultant loss of performance at high speeds. Air data computer failure may be indicated by an "OFF" flag appearing in either the Mach indicator or the airspeed-Mach indicator or illumination of "CADC FAIL" warning light. Unless the ramps are retracted in accordance with VARIABLE RAMP FAILURE procedures, Section III, the ramps will continue attempting to schedule at subsonic speeds where the ramps would normally be retracted. With this type of failure, sufficient thrust will be available to accomplish a safe go-around, even though the variable ramps are maintaining the highest programmed inlet duct Mach.

RAMP MECHANISM FAILURE

If any part of the ramp mechanism fails while the ramps are extended, use of the emergency system may not retract either or both ramps. The variramp warning light will remain on at speeds below Mach 1.20. Care should be exercised during the landing phase because power available decreases as airspeed (ram effect) decreases. Airspeed should remain above 200 KCAS until starting flare.

NOTE

Should a failure of the crossover flex drive shaft occur, the left ramp may be extended without variable ramp warning light indication.

CG TRANSFER SYSTEM FAILURE (A)

The cg transfer system should be monitored for proper operation by checking fuel quantity in the fuselage tank. If F tank fuel fails to transfer aft during supersonic flight above 13,500 feet, place the cg control switch in the FWD position to prevent inadvertent aft transfer of the fuel, and to ensure proper sequencing of fuel. If the fuel quantity-low warning lights illuminate too soon with fuel transferred aft, place the cg control switch in the FWD position and slow to a subsonic speed. If the low-level warning lights do not extinguish within one minute, only the fuel in the No. 3 tanks will be available. Land as soon as practical.

INTEGRATED FLIGHT INSTRUMENT SYSTEM—MODE SWITCHING AND RESULTANT DISPLAYS

The instrument displays presented by the integrated flight instrument system depend upon settings of various cockpit switches. The primary determinant of the operating mode is the display/automatic mode selector switch. Dependent upon the setting of this switch, the instruments will display navigation, data link, or ILS indications and commands.

NOTE

Switching of the flight mode selector switch from one position to another will not affect the basic display as presented thru the display/automatic mode selector switch.

Supporting the display/automatic mode selector switch in distribution of signals to the various instrument functions are the heading selector switch and the bearing selector switch. Figure 7-1

airspeed-mach indicator and altitude-vertical velocity indicator presentations

		DISP/AUTO MODE SELECTOR SWITCH			
		MAN NAV	AUTO NAV	DL MAX RNG OR DL MIN TIME	ILS OR ILS APCH
AIRSPEED-MACH INDICATOR	COMMAND MACH	MANUALLY SET	INDICATES COMMAND MACH FOR CLIMB, CRUISE, OR DESCENT SCHEDULES	COMMAND MACH FROM DATA LINK STATION OR DIGITAL COMPUTER	NOT USED
AIRSPEED-MACH INDICATOR	COMMAND AIRSPEED	SET MANUALLY FOR DESIRED PURPOSE (OR SIDE DETENT) SO COMMAND AIRSPEED MARKER SLAVES TO LUBBER LINE AND CAS READS IN AIRSPEED READOUT WINDOW.			
ALTITUDE-VERTICAL VELOCITY INDICATOR (AVVI)	COMMAND ALTITUDE	MANUALLY SET	COMMAND ALTITUDE FOR CLIMB, CRUISE, OR DESCENT SCHEDULE	COMMAND ALTITUDE FROM DATA LINK STATION OR DIGITAL COMPUTER	MANUALLY SET
ALTITUDE-VERTICAL VELOCITY INDICATOR (AVVI)	TARGET ALTITUDE	HOMING POINT/ TARGET ALTITUDE	HOMING POINT/ TARGET ALTITUDE	TARGET ALTITUDE	NOT USED

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Figure 7-1

shows the AMI and AVVI presentation as affected by the positions of the display/automatic mode selector switch. Figure 7-2 shows the ADI presentation as affected by the automatic mode selector switch and the heading selector switch. Figure 7-3 shows the HSI presentation as affected by the positions of the display/automatic mode selector switch, heading selector switch, and the bearing selector switch.

- If the display/automatic mode selector switch is moved from any one major mode (NAV, DL, or ILS) to another major mode, both the heading selector switch and the bearing selector switch will revert to NORMAL and NORM respectively. These switches will not revert if merely switching within the major mode; i.e., MAN NAV TO AUTO NAV (or vice versa), except that when switching from ILS to ILS APCH (or vice versa) the heading selector switch will revert to NORMAL. It is always possible to again select the MANUAL position if desired.
- Whenever the display/automatic mode selector switch is set to an ILS mode, the computer memory circuit is cleared of all data link information.
- During MCC data link navigation, any repositioning of the disp/auto mode selector switch causes the computer to reselect the appropriate tactics and profile for the current intercept conditions.

Once the various switching features are established, as described in the previous paragraph and in figures 7-1, 7-2, and 7-3, the integrated flight instrument system can be applied to actual mission functions. The basic modes which can be selected are navigation (TACAN), data link, ILS and ADF. All other modes, such as takeoff, climb-out, penetration, and GCA, can be considered as submodes of the basic modes listed above. Figure 7-4 shows MA-1 system climb and cruise schedules for auto-nav mode. The basic modes, including ADF, are presented in the following paragraphs.

NAVIGATION MODE

In the navigation mode, inputs to the integrated flight instruments are determined by settings of the display/automatic mode selector switch, the heading selector switch, and the bearing selector switch.

Manual Navigation

In the manual navigation mode, the HSI is the primary reference instrument. All of the command indicators are visible on the cockpit instruments and can be set to any desired positions, since command signals are not present.

NOTE

Whenever the display/automatic mode selector switch is placed to the MAN NAV position, it is not possible to select AUTO on the flight mode selector switch.

1. MA-1 power switch—RADAR STBY or ON.
2. Flight mode selector switch—As desired.
3. Display/automatic mode selector switch—MAN NAV.
4. Heading selector switch—As desired.

NOTE

The ADI bank steering bar is removed from the display unless the heading selector switch is placed to MANUAL. The bar will then give steering corrections to headings selected by the heading selector knob.

5. Heading marker—Set, if desired.
6. Course arrow—Set to desired TACAN radial.
7. Bearing selector switch—NORM or TACAN.
8. TSD scale selector switch—As desired.
9. TSD mode selector switch—MAN.
10. TSD command heading pointer—As desired.
11. TACAN channel selector—Set to desired channel.

The following will be displayed:

NOTE

- AMI—No automatic command functions will be displayed.
- AVVI—Target altitude or homing point altitude.

attitude director indicator presentations

	DISP/AUTO MODE SELECTOR SWITCH							
	MAN NAV	AUTO NAV		DL MAX RNG OR DL MIN TIME		ILS OR ILS APCH		
	HEADING SELECTOR SWITCH*				HEADING SELECTOR SWITCH*		HEADING SELECTOR SWITCH*	
	MAN	NORMAL	MAN	NORMAL	MAN	NORMAL	MAN	NORMAL
BANK STEERING BAR***	FLYING SELECTED HEADING	OUT OF VIEW	** FLYING SELECTED HEADING	** COMMAND HEADING	** FLYING SELECTED HEADING	** COMMAND HEADING	FLYING SELECTED HEADING	LOCALIZER COURSE
PITCH STEERING BAR***	OUT OF VIEW EXCEPT WHEN DISP/AUTO MODE SELECTOR SWITCH IS IN ILS APCH (OR IN ILS AFTER REACHING GLIDE SLOPE WHEN MAKING AN AUTOMATIC APPROACH), AND HEADING SELECTOR SWITCH IS IN NORMAL.							
ILS GLIDE SLOPE INDICATOR	OUT OF VIEW						INDICATES POSITION RELATIVE TO GLIDE SLOPE	
ILS LOCALIZER OFF-FLAG	OUT OF VIEW						IF OUT OF VIEW, INDICATES VALID LOCALIZER RECEIVER INFORMATION	
GLIDE SLOPE WARNING FLAG	OUT OF VIEW						IF OUT OF VIEW, INDICATES VALID GLIDE SLOPE RECEIVER INFORMATION	
POWER OFF WARNING FLAG	OUT OF VIEW							

* IF THE FLIGHT MODE SELECTOR SWITCH IS PLACED TO AUTO, THE HEADING SELECTOR SWITCH WILL REVERT TO NORMAL.

** IF THE FLIGHT MODE SELECTOR SWITCH IS PLACED TO AUTO, THE BANK STEERING BAR WILL DISAPPEAR.

*** ADI PITCH STEERING AND BANK STEERING BARS ARE ON AC NONESSENTIAL BUS (SOME AIRPLANES) OR THE ATG BUS (OTHER AIRPLANES).

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Figure 7-2

ADI

Bank steering bar—Operative if heading selector switch is in MANUAL.

HSI

a. Bearing pointer—Points to TACAN station bearing.

b. "To-From" indicator—Indicates that selected TACAN course will take airplane to or from TACAN station.

c. Range indicator—Distance to TACAN station.

d. Illumination of left-hand "NAV-MAN" lights and right-hand "TAC" light.

e. Course deviation indicator—Angular deviation from selected TACAN course.

TSD

a. Interceptor symbol will display airplane position.

b. Heading cursor—Airplane heading.

horizontal situation indicator presentations

BEARING SELECTOR SWITCH			DISP/AUTO MODE SELECTOR SWITCH							
			MAN NAV		AUTO NAV		DL MAX RNG OR DL MIN TIME		ILS OR ILS APCH	
			HEADING SELECTOR SWITCH*				HEADING SELECTOR SWITCH*		HEADING SELECTOR SWITCH*	
			MAN	NORMAL	MAN	NORMAL	MAN	NORMAL	MAN	NORMAL
HSI FUNCTION LIGHTS	NORM	LH	NAV MAN		NAV MAN	NAV	DL MAN	DL	ILS MAN	ILS
		RH	TAC				TGT		NONE	
	TAC	LH	NAV MAN		NAV MAN	NAV	DL MAN	DL	ILS MAN	ILS
		RH	TAC							
	ADF	LH	NAV MAN		NAV MAN	NAV	DL MAN	DL	ILS MAN	ILS
		RH	UHF OR DL							
HEADING MARKER			MANUALLY SET		MAN SET	COM HEADING	MANUALLY SET	COMMAND HEADING	MANUALLY SET	SERVOS TO AIRPLANE HEADING
BEARING POINTER	NORM		TO SELECTED TACAN STATION				BEARING TO TARGET		SERVOS TO AIRPLANE HEADING	
	TAC		TO SELECTED TACAN STATION							
	ADF		TO UHF OR DL ADF SOURCE							
COURSE READOUT WINDOW			MANUALLY SET FOR COURSE TO SELECTED TACAN STATION				TARGET HEADING **		MANUALLY SET TO INBOUND LOCALIZER HEADING	
COURSE DEVIATION BAR			ANGULAR DEVIATION FROM SELECTED TACAN COURSE				LATERAL DISTANCE FROM INTERCEPTOR TO TARGET TRACK **		DEVIATION FROM LOCALIZER	
TO-FROM ARROW			TO-FROM TACAN STATION				TARGET DIRECTION **		OUT OF VIEW	
DISTANCE READOUT	NORM		DISTANCE TO TACAN STATION				DISTANCE TO TARGET **		MASKED	
	TAC		DISTANCE TO TACAN STATION							
	ADF		MASKED							

**DISPLAYED IF MCC IS VALID IN NAV, WITH A LOCK-ON IN ATTACK, OR IN NAV FOLLOWING AN ATTACK WITH A LOCKON.

*IF THE FLIGHT MODE SELECTOR SWITCH IS PLACED TO AUTO, THE HEADING SELECTOR SWITCH WILL REVERT TO NORMAL.

48206A

Figure 7-3

ma-1 climb and cruise schedules-auto nav

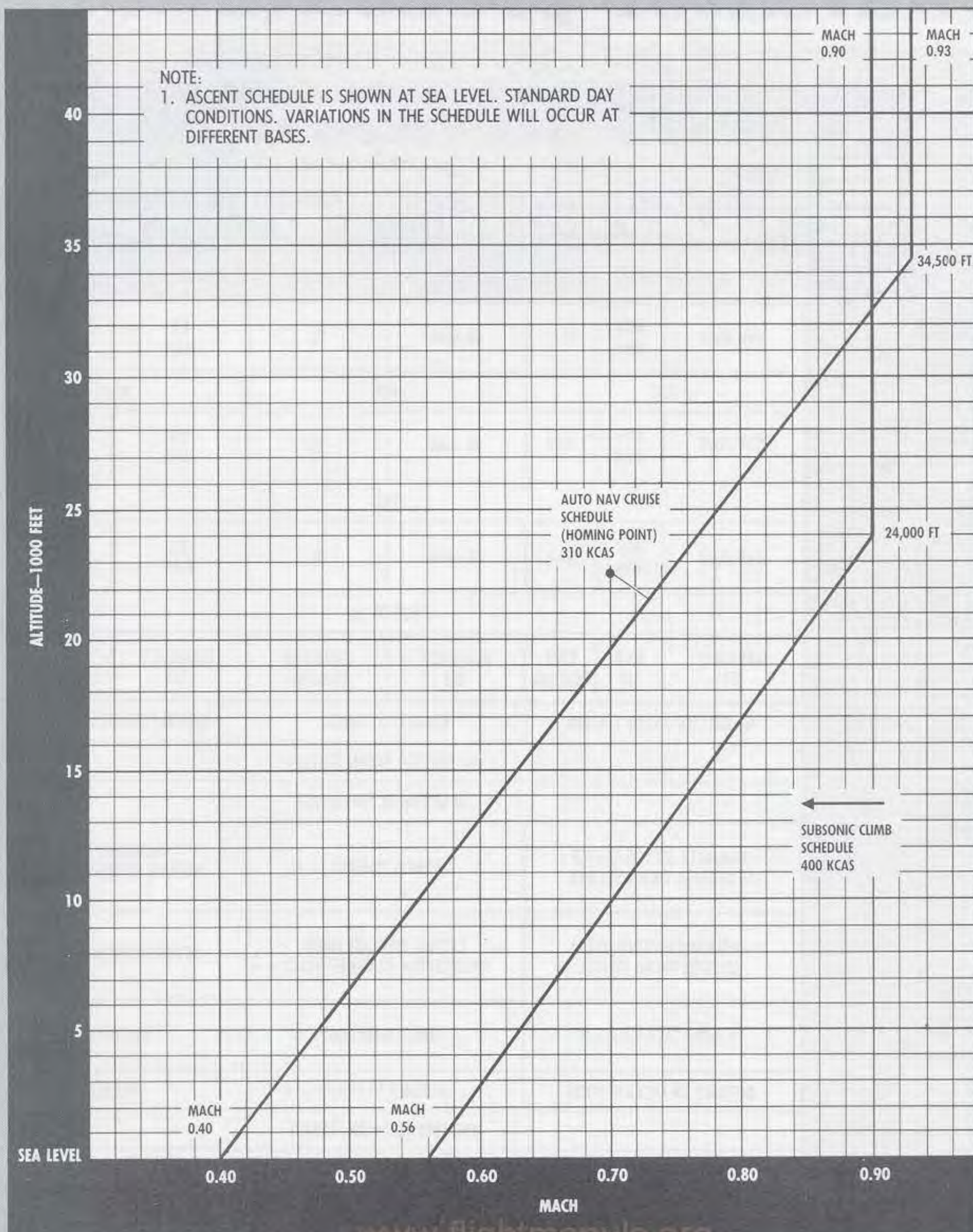

Figure 7-4

Auto Nav

1. MA-1 power switch—RADAR STBY or ON.
2. Flight mode selector switch—As desired.
3. Display/automatic mode selector switch—AUTO NAV.
4. Heading selector switch—NORMAL.
5. Course selector knob—Desired course.
6. Bearing selector switch—NORM.
7. TSD scale selector switch—As desired.
8. TSD mode selector switch—AUTO.
9. TACAN channel—As desired.
10. Homing point selector switch—As desired.

The following will be displayed:

RADAR SCOPE

a. Time-to-go circle—Represents time-to-go to homing point.
b. Steering line—Indicates steering to homing point.

AMI

a. Command Mach positioned automatically.
b. Command airspeed marker—As desired.

ADI

a. Bank steering bar—Indicates steering to homing point.

AVVI

a. Command altitude marker–Command altitude or groundspeed for 19 seconds after homing point G is selected.
b. Target altitude–Horizontal range to selected homing point. Maximum displayable range is 700 nautical miles.

HSI

a. Mode indicator light–"NAV."
b. Bearing pointer indicator light–"TAC."
c. Heading marker–Command heading to homing point.
d. Bearing pointer–Bearing to TACAN station.
e. Range indicator–Distance to TACAN station.
f. Course arrow and course deviation indicator–Angular deviation from selected TACAN course.
g. "To-From" indicator—Indicates that selected TACAN course will take airplane to or from TACAN station.

TSD

a. TACAN annunciator—"OK."
b. Interceptor symbol and heading—Geographical position & heading.
c. Target symbol—Located over homing point on proper heading.
d. Command heading pointer—Command heading.

By following the above indications the airplane will be directed to the desired homing point.

DATA LINK MODE

Data link is the primary source of interceptor command and navigation information from the SAGE ground environment. There are two modes of control in data link navigation: close control and modified close control.

Close Control

The primary mode of data link control is close control. In this mode the SAGE computer performs the calculations required. The data link commands are then automatically sent from the SAGE transmitter site to the aircraft. The equipment aboard the aircraft checks the information for validity and proper address, then sends it to the MA-1 computer, which in turn sends command to the AFCS and to cockpit displays. When the pilot sets in the grid reference correction prior to takeoff, he compensates for variation as well as the convergence angle at the takeoff base. When an interceptor using close control is paired with a target, modified close contact (MCC) messages also are normally sent. The role of the MCC information in this case is to provide the pilot with extensive target information in the form of cockpit displays and to act as a backup in the event of a loss of data link reception.

Modified Close Control

When the dominant mode of control is MCC, SAGE sends target information. The MA-1 computer uses this information to calculate the tactics required and sends the necessary speed, altitude and heading commands to the cockpit displays and to the AFCS. Two types of MCC messages can be transmitted by SAGE: MCC-Region Origin (MCC TACAN) and MCC-Interceptor (MCC-NO TACAN). In MCC-Region Origin, target X and Y position is referenced with respect to the SAGE division origin. In MCC-Interceptor, target x and y position is referenced with respect to the interceptor. The automatically selected MCC mode is MCC-Region Origin. The MCC-Interceptor mode must be requested by the pilot. When the mode of control is CC, the MCC backup messages are normally MCC-Interceptor.

When the interceptor receives a CC message for CAP/RTB, MCC information will not be displayed.

ILS MODES

NOTE

Refer to Section IX for ILS procedures.

The ILS mode can be flown in an automatic or manual flight mode.

NOTE

- If the automatic feature is engaged, bank angle is limited to 30° until glide-slope interception; after interception, bank angle is limited to 15°.
- If the glide-slope signals should fail, the AFCS will revert to ASSIST and any subsequent AUTO selection will revert to ASSIST.
- During the automatic approach it is not necessary to place the display/automatic mode selector switch to ILS APCH upon interception of the glide-slope. Switching is automatic within the system and the switch will remain in the ILS position. The glide-slope indicator will display glide-slope deviation throughout this mode. The bank steering bar is not utilized for an automatic approach.

When flying the ILS mode for a manual localizer intercept and approach, the ADI pitch steering bar is initially out of view. The display/automatic mode selector switch must be placed to ILS APCH to activate the pitch steering bar. The ILS APCH mode should not be selected until stabilized on localizer.

1. MA-1 power switch—WARM, RADAR STBY, ON, or RADIO SILENCE.
2. ILS channel selector switch—Set to desired channel.
3. ILS volume control knob—Identify station and adjust.
4. Localizer warning flag—Not visible.

NOTE

- Appearance of the localizer warning flag in the ADI indicates that localizer information is invalid on both the ADI and the HSI.
- Disappearance of the localizer warning flag in the ADI indicates only that the localizer receiver is receiving a valid signal. In order for valid ILS localizer information to be displayed in the cockpit, continue with the following procedures:

5. Display/automatic mode selector switch—ILS.

NOTE

If ILS APCH position is selected on the display/automatic mode switch when flying a manual ILS approach, bank steering signals will be limited to 15°. If selected prior to being established on the localizer it may result in inability to stabilize on the localizer.

6. Course selector knob—Set to published localizer course (also valid for back-course ILS approach).

   Set the published localizer course in the course selector window of the HSI. The course deviation indicator will then present correct magnitude and direction of deviation from the selected ILS course, and the bank steering bar on the ADI will present accurate steering information.

WARNING

ADI and HSI steering information will be erroneous unless proper ILS localizer course is set into the course selector window. The course selector window should be checked after selecting ILS to ensure the selected ILS final course remains in the window. It is possible for the reading to shift from the selected value.

7. Flight mode selector switch—As desired.
8. Heading selector switch—NORMAL.
9. Bearing selector switch—NORM or TAC.
10. TSD scale selector switch—As desired.
11. TSD mode selector switch—As desired.
12. AVVI barometric pressure knob—Set.
13. Command altitude slewing switch—Place marker as desired.
14. Command airspeed slewing switch—As desired.

The following will be displayed:

ADI

a. Glide-slope indicator—Deflected to top of scale.

b. Pitch steering bar—Out of view.

c. Bank steering bar—Indicates steering required to intercept and follow localizer.

WARNING

It is possible that a malfunction of the ADI might be determined only by checking it with the turn-and-slip indicator and the AVVI. Also, cross-check with artificial horizon on radar scope.

HSI

a. Mode indicator light—"ILS."

b. Command heading marker—Slaved to airplane heading.

c. Bearing pointer—Slaved to airplane heading or pointing to TACAN station.

d. Course deviation indicator—Angular deviation from selected heading, or from localizer course.

NOTE

The HSI "To-From" indicator will be out of view and the range indicator will be masked unless the bearing selector switch is in TAC.

15. Display/automatic mode selector switch—In manual flight, switch to ILS APCH when established on the localizer course (CDI centered).

The following will be displayed:

ADI

a. Glide-slope indicator—Centered.

b. Pitch steering bar—Centered.

c. Bank steering bar—Centered.

HSI (Unchanged).

WARNING

When attempting to intercept the outbound course of an ILS after a missed approach, if the airplane heading is not within 90° of the previous inbound course, the bank steering bar will indicate that the "on course" is on the opposite side of the airplane from the actual "on course" position. Therefore, monitor and use the HSI course deviation indicator as the HSI presents the true situation.

CAUTION

If the approach is automatic, when the runway is in clear view or when published minimums are reached, take over manually be depressing the emergency direct manual (EDM) button.

AUTOMATIC DIRECTION FINDING (ADF)

The ADF feature can be used to determine a bearing to a ground or airborne transmitter in the event that TACAN is jammed or if such operation is directed otherwise. UHF signals can be received from a ground or airborne source, through the communications receiver, when the bearing selector switch is placed to the UHF-ADF position. If the bearing selector switch is placed to DL-ADF, the signals are received through the data link receiver. When the ADF antenna is at the null position, the correct bearing of the transmitting station is displayed through the HSI bearing indicator (airplanes with integrated flight instrument system), and the TSD command heading pointer (airplanes with conventional instrument display).

NOTE

For the most accurate DF steering information, the airplane should be in a straight and level flight attitude.

UHF—ADF

1. Flight mode selector switch—As desired.
2. Display/automatic mode selector switch—As desired.
3. Heading selector switch—NORMAL.
4. Bearing selector switch—UHF-ADF.
5. UHF channel selector—Set to desired channel.

The following will be displayed:

HSI

a. Mode indicator light(s)—Correspond to display/automatic mode selector switch setting.

b. Bearing pointer indicator light—"UHF."

c. Bearing pointer—Points to transmitting station (ground or airborne).

TSD

a. Interceptor heading cursor—Indicates magnetic heading of interceptor.

DL—ADF

1. Flight mode selector switch—As desired.
2. Display/automatic mode selector switch—As desired.
3. Heading selector switch—NORMAL.
4. Bearing selector switch—DL-ADF.

4a. MA-1 power—WARM or above.

5. Data link channel selector—Set to desired channel.

The following will be displayed:

HSI

a. Mode indicator light(s)—Correspond to display/automatic mode selector switch setting.

b. Right light—"DL."

c. Bearing pointer—Points to transmitting ground station.

TSD (Same as UHF-ADF).

MA-1 SYSTEM MALFUNCTIONS

The pilot has a definite responsibility for helping to keep equipment malfunctions to a minimum and for completing a mission when malfunctions occur. All too often a system will not show a malfunction on the ground in the same way that it does in the air; sometimes the malfunction will appear only when the aircraft is airborne. The pilot is the only one with the system while airborne; the pilot is the only one to see it malfunction; the pilot is the only one who can describe the malfunction and the circumstances under which it happened.

The following is devoted to a discussion of some of the failures that may be encountered. In most cases, there are specific things to look for to tell the ground crew.

POWER

WARNING

Never change the position of the MA-1 power switch unless the arm-safe switch is in SAFE and the armament selector is in VIS IDENT. Failure to observe this warning may result in irreversible damage to the armament and sets up the possibility of an accidental firing.

MA-1 Power Failure

A transient overvoltage or undervoltage will cause the MA-1 system to revert from an on condition to either a warm or off condition. If the transient is of less than 0.5 second, the system will revert to a warm condition. If the transient condition persists after reverting to warm, the system will revert to off. In either case, the scope range scale light will go out. To determine which has happened, observe the TSD for illumination. The TSD will be illuminated if the system is in a warm condition. If system is in an off condition the TSD light will be out. If the system had reverted to the warm condition, set the MA-1 power switch to WARM and the range scale light will come on. The MA-1 power switch should then be set to ON and the system will time in to an on condition (as indicated by the radar scope becoming operational) in approximately 30 seconds. If the range scale light does not come on when the MA-1 power switch was set to WARM, the system was in an off condition. This condition can result from either a transient of greater than 0.5 second duration or a fault in one of the subsystems. Set the MA-1 power switch to EMER, then to RADAR STBY. If the system times in properly, (as indicated by the TSD becoming operational) set the MA-1 power switch to ON. Should the system time in properly in RADAR STBY and then remain in an on condition when the MA-1 power switch is set to ON, continue with the mission. If the system fails to remain in a standby condition, set the MA-1 power switch to EMER, then to WARM. If the system will not maintain an on condition, but will stay in either a standby or warm condition, the MA-1 system has full navigation and communication capabilities, provided that the fault causing power failure does not lie in these subsystems.

If it is impossible to maintain the system in either a warm, standby, on, or radio silence condition, set the MA-1 power switch to EMER. Setting the MA-1 power switch to EMER provides additional cooling for the communications equipment. When debriefed, the pilot should tell the ground crew:

a. The circumstances under which power failed — cycling armament, pulling positive or negative g, switching functions, transmitting on UHF, etc.

b. Whether power was recycled, the results of recycling, and also the time required for system to dump (5 or 50 seconds).

c. Whether there was any scope flickering or fluctuations on any indicators prior to the power loss.

Automatic Power Supply Test

The computer provides automatic monitoring of power system voltage and noise levels. A power test failure is indicated by lighting of the PTF lamps on the radar scope which will appear on the photographic recorder film. The lamp should stay on for 15 seconds or the duration of the failure whichever is greater.

RADAR

During the search portion of a mission, there are various display malfunctions that may occur. These malfunctions may vary from distortion of a single display to complete loss of all displays. The following paragraphs detail these malfunctions and give any corrective action that may be possible.

Transmitter Malfunctions

The quality of the system radar scope display is dependent on proper operation of several subsystems. MA-1 power regulates receiver-transmitter operation, and the cooling and pressurizing function must be operating properly in order to have an optimum display. Radar scope presentations less than optimum frequency occur particularly at high altitudes and after prolonged operation at low altitude under conditions of high ambient temperature. If such a condition occurs as a result of the MA-1 transmitter switching to reduced power, the RP light on the radar scope will light. Under these conditions the following steps should be taken:

a. Recycle the MA-1 power switch through RADAR STBY.

b. If the condition persists, observe whether normal video is restored during descent and report the occurrence to MA-1 maintenance personnel.

It can be determined if the transmitting circuits are malfunctioning by switching to RADAR STBY. To assist maintenance, note if RP light is on prior to standby. In this position, the synchronizer is connected directly to the range trace generator. If the synchronizer, range trace generator, and the indicator are working, the B-sweep should appear; then it is known that the trouble is in the transmitter. If the transmitter has failed because of a temporary overload, normal operation can be restored by setting the MA-1 power switch to RADAR STBY for several seconds then back to ON.

Receiver Malfunction

The pilot may notice that the video is intermittent or that there is no video at all. That is, the B-sweep appears to be satisfactory and is searching, but targets are intermittent or no target appears at all.

In the case where targets are intermittent, the AFC is not tuning consistently to the transmitter frequency. As a result, targets appear during the short period when the receiver and the transmitter are at the proper frequency. It may help to select a different tuning rate. If this procedure does not remedy the malfunction, it is impossible to complete a radar attack. The pilot must then rely on IR or visual contact to complete an attack. If the pilot notices that the video is intermittent as it crosses the scope, the trouble is in the transmitter or AFC functions. Turning the power switch to RADAR STBY and then back to ON may remedy the situation in some cases. If operating in the NORM tune rate mode and CADJ, select another tune rate. The radar receiver power supply has a crowbar protection circuit that may shut down the receiver during initial MA-1 time-in. If no video appears after initial time-in or if the video disappears, turning the power switch to WARM then back to ON may remedy the situation.

Radar Display

Part of Display Distorted or Missing. The seriousness of the malfunction when part of the display is distorted or missing depends on which part of the display is affected. The artificial horizon may be distorted, half missing, or completely missing, without greatly affecting system operation. It is more serious if the time-to-go-to-offset circle or the steering dot are distorted or missing. During the first 25 seconds of post fire (not MAN PUR), if search is selected an abnormal radar display may be expected, wherein the steering dot and reference circle may be missing or erratic.

If the artificial horizon should disappear or become distorted to where it is unusable, the pilot can refer to the ADI and obtain approximately the same information. If the antenna elevation marker should become unusable, the pilot can approximate the antenna's position by noting the AMT ELEV control position. Distortion or loss of the reference circle should not prevent the pilot from completing his mission. The B-sweep, RGM, and target displays may be distorted without seriously affecting system operation. Distortion of the RGM or target displays may require some additional manipulating in order to achieve lockon.

Whenever the steering dot and/or time-to-go-to-offset circle become unusable due to distortion or loss, the pilot should ensure that the AFCS is engaged (flight mode switch to AUTO). If only the time-to-go-to-offset circle is unusable, the pilot can still determine when he has reached offset by observing when the target elevation marker becomes operational. The pilot may also be able to obtain voice control from the ground to replace the information lost as a result of one or both of the above displays failing.

Erase Malfunctions. The types of malfunctions of the erase function which should be noted and relayed to maintenance personnel during post flight are as follows:

a. The erase sweep lead on the B-sweep is too large, too small, or nonsymmetrical. It is critical that the erase sweep not be too close to the B-sweep for it could degrade detection.

b. The erase sweep is too short, doesn't cover the search raster or becomes a dot.

c. The raster covered in raster erase does not include the entire tube.

All of the above are malfunctions or misadjustments and should be easy to duplicate on the ground.

Search Display Shrinkage. This search malfunc- is characterized by the B-sweep covering less than its normal area on the scope. The antenna is still covering its normal search area, but the scope display is compressed. This condition may be alleviated by selecting a different position of the AZ SCAN switch or by engaging the manual search or supersearch submodes. If the situation cannot be corrected but lockon can be acquired, a normal attack can be accomplished.

Stationary B-Sweep. Loss of pressurization in the radar waveguide assembly will cause the radar transmitter to be disabled. If this occurs, the B-sweep will be stationary at the center of the scope; no target will be displayed but the B-sweep can be moved in manual search. The only way to alleviate the problem is to descend to a lower altitude.

Antenna Servo Disabled. A failure of the antenna servo is characterized by the appearance of bands across the entire display. These are caused by the antenna failing to sweep across the search area while the B-sweep continues to move. Thus, a target return from the stationary antenna is spread across the face of the scope by the moving B-sweep. If this has happened, the radar cannot be used. Before aborting a radar attack, however, make sure that the bands are not caused by clutter. Elevate the antenna to see if an aerial target can be obtained, or depress the antenna to get a different ground clutter return. If the bands remain, the antenna drive is disabled and a successful radar attack cannot be accomplished.

Artificial Horizon Drift. This can be a serious malfunction during the search phase of a mission because it is usually an indication of AHRG drift. The radar search scan uses the same horizontal references as the artificial horizon. When the AHRG drifts, the search pattern drifts in a similar manner. If the drift is excessive, the search pattern will not cover the entire region in which the targets are expected.

WARNING

When the radar artificial horizon is obviously drifting, not just aligning itself after an abrupt maneuver, do not use AFCS. The AFCS uses the same vertical references as the artificial horizon that appears on the scope.

Disappearance of B-Sweep off One Side of Scope. If the B-sweep disappears off one side of the scope, obtaining lockon becomes impossible. Since the cause of this malfunction is usually due to shorting as a result of excessive moisture in one of the coaxial cables feeding the deflection circuitry, there is nothing the pilot can do to regain the B-sweep. He may try IR, however since the deflection circuits for RADAR and IR are common, the chances are that IR will also be missing its sweep. If this is true, the pilot will have to rely on visual contact to complete an attack. A selection of ILS or BORS may return the B-sweep to a centered position on the scope.

Radar Lockon

There are various malfunctions that may occur to lockon circuitry. The following paragraphs give the indications that result from these malfunctions and any corrective action that may be possible.

NOTE

If the system will not automatically range track a target, it is possible to productively fire the radar missiles in a pursuit mode by manually positioning and holding the radar range gate on the target until missile impact.

Low Lockon Sensitivity. When this malfunction occurs, difficulty will be experienced in locking on to targets when they are clearly visible. Also, lockon may break easily. However, a successful radar attack may still be made. Try locking on by placing the range gate just under the target, releasing the action switch, and letting the target fly into the range gate. As long as the radar stays locked on, the system has full capability. After returning to base, report the difficulty in locking on to clearly visible targets.

Apparent Loss of Lockon. On rare occasions, the attack display will disappear temporarily but the system will remain locked on. When the attack display disappears, check to see if the B-sweep and range gate stay on the target. If they do, the system is still locked on. The attack display will probably reappear as the interceptor closes on the target. If the target echo and range gate or B-sweep definitely separate, lockon has been lost and must be regained. If the attack display disappeared temporarily but the system remained locked on, the technician should be informed of this and also whether the target was weak.

Loss of Target in Hand Control. It is possible that the target may disappear when the action switch is pressed to the second detent. When this happens, the source of trouble will usually be in the PFN (Pulse Forming Network). It may help to set the RANGE switch to 40SP, set the power switch to RDR STBY and then to ON. If this procedure does not correct the malfunction, it is impossible to complete a radar attack. The pilot must then rely on IR or MTWS to complete an attack.

Lockon Transfer to Altitude Line. Lockon transfer to the altitude line is possible while tracking targets near a strong altitude line. This condition is more pronounced in low overtake situations where range rate is not adequate to allow the range gate to pass through the altitude line prior to transfer of lockon.

Extrapolated Target. If radar lock-on is lost for any radar-dominant mode, the target position will be extrapolated based on last known target altitude and velocity vectors and will be updated according to interceptor maneuvers. The target position will be displayed on all normal data link target displays. The target marker circle and antenna elevation marker will indicate target position on the radar scope in VI and lead collision. If an ABORT or FIRE signal should occur, the "A" or "X" will reappear on the scope. If ATOT occurs following a DROT in lead collision, the normal extrapolated lead collision display will appear on the scope.

Part of Attack Display Distorted or Missing. Distortion of the artificial horizon, reference circle, Z-marker, or range rate gap can take place without seriously affecting system operation. It is more serious if the time-to-go-to-fire circle and/or the steering dot and reference circle are distorted or missing. If these symbols are lost, system performance is degraded but firing is still possible. Radar attacks can be flown in AUTO with full attack capability with complete loss of attack displays. If necessary, the target range can be obtained from the B-sweep. If AUTO is not available, the attack can be completed by centering the B-sweep in azimuth and the elevation marker in elevation.

NOTE

If the digital range function within the computer subsystem becomes unreliable, the VI WARN lamp will flash in the pursuit, proportional steering, VI, and lead collision modes. In the lead collision mode, this condition is also indicated by a time-to-go circle fixed at one-half size. This condition may occur at any time ROT and DROT are present and will continue for the duration of the unreliable digital range function.

WARNING

The pullout signal may not appear when the armament is fired, and collision warning may not be available.

Erratic Motion of Steering Dot. This attack malfunction is characterized by erratic motion of the steering dot. In a sensitive display, the dot is moving somewhat erratically but by steering to center the average position of the dot, a successful attack can be made. With a very "hot" dot, the dot is moving so erratically that the excursions are far out of the steering circle, and a successful radar attack cannot be accomplished. CADJ may be effective in damping a hot dot.

IR

IR Search Display

The IR search display is subject to a variety of malfunctions that result in loss or distortion of the display. The following paragraphs enumerate these malfunctions and give any corrective action that may be possible.

Search Pattern Drift. The IR seeker head uses the AHRG as a horizontal reference during search. If the AHRG drifts, the search pattern will also drift. Visually checking the rear of the seeker head may reveal search pattern malfunctions. An AHRG drift does not affect the C-scan display since it is scope oriented. This drift could result in a search pattern which does not cover the area intended.

Part of Search Display Distorted. Because of the mechanical construction of the IR seeker head, it is necessary that the azimuth and elevation drive motors operate differentially during search. A fault in the interconnecting circuitry could cause the search pattern to be rotated to some degree about the longitudinal axis of the aircraft and the scope search display to be similarly rotated. If not present to an excessive degree, this fault would not seriously degrade system ability to detect a target.

No Apparent IR Targets. The IR search trace as displayed on the scope will normally exhibit small deflections due to clutter and system noise. A very smooth trace is an indication of a malfunction in the IR subsystem or an improperly adjusted IR THRESHOLD VIDEO control. If the search trace shows no deflections, set the IR THRESHOLD VIDEO control to its extreme clockwise position. The appearance of IR targets on the trace is indicative of a properly operating system. The control should then be adjusted so that the trace deflections are barely visible. If the adjustment of the control was ineffective, engage the manual search mode by pressing the action switch to the second detent and, using the left hand control and the ANT ELEV control, seek a target such as a cloud, the sun, ground reflections, or if possible another interceptor. If a target indication can be seen on the scope, the system may function properly. Should the above methods fail to produce a deflection of the scope trace, there may be a fault in the cooling system for the IR detector cell.

Complete loss of the search pattern or the expanded sweep may be due to a fault in the display circuitry. If this is the case, it is still possible to accomplish lockon by use of the aural tone. To determine if the IR receiver is functioning properly, press the action switch to the second detent to engage the manual search mode. Try to find a target such as a cloud, ground reflections or if possible another interceptor. If the aural tone is heard while manually sweeping across the target, the IR receiver is operational. A sharp increase in frequency of the aural tone will indicate the detection of a target. Depress the action switch to the first detent to engage the supersearch submode immediately upon hearing the target. In this mode the seeker head is scanning in azimuth a total of 33 degrees centered on a line determined by the lateral position of the left hand control. To achieve lockon, it will be necessary to hunt for the target in azimuth only. As soon as the aural tone is heard, carefully adjust the ANT ELEV control for a tone of the highest pitch possible. When this has been accomplished, depress the action switch to the second detent, adjust the left hand control laterally for maximum deflection and release the action switch. A relatively constant aural tone and the appearance of the attack displays will indicate lockon.

IR Lockon

There are various malfunctions that may occur to that circuitry directly concerned with lockon. The following paragraphs detail these malfunctions and give any corrective action that may be possible.

Lockon Difficulties. The pilot may experience difficulty in locking onto an IR target due to the IR reference generators being out of calibration or to an erroneous drive signal in the seeker head stabilization circuitry.

If IR lockon cannot be accomplished after spotlighting a target and releasing the action switch, there is usually nothing the pilot can do to remedy the difficulty. However, the pilot should make serval observations to assist the maintenance technicians in rectifying the malfunction. If lighting conditions permit, observe the movement of the seeker head when the action switch is released. If the seeker head jumps in a particular direction, inform the ground crew of that fact. If adequate illumination of the seeker head is not available, the pilot may be able to tell the nature of the difficulty from scope indications.

When the action switch is released, RDR SLVD selected, observe the expanded C-scan. If the C-scan jumps in elevation, it is an indication that the seeker head is doing the same thing. If the system locks on momentarily, but an erroneous azimuth drive signal exists, the point source display peaks will move closer together and then disappear. If an erroneous elevation drive signal exists, one peak grows shorter and disappears.

Transfer of Lockon. If the target being tracked passes between a source of infrared radiation and the interceptor, the seeker head may transfer lockon to the unwanted target. The unwanted target could be the sun, a sunlit cloud, or in the case of low-altitude missions, reflections from water or from terrain. During track, the closing rate will normally cause the pitch of the aural tone to steadily increase. If lockon should transfer to an unwanted target, there will be a change in aural tone and possibly an excursion of the steering dot. Such a transfer might be determined by an examination of the expanded sweep. Press the RDR IR/EXP switch and compare the trace with that obtained at original lockon. If it is determined that transfer of lockon has occurred, return the system to search and lock on to the proper target. It may sometimes be necessary to change altitude so that the unwanted target will no longer be in a direct line with the interceptor and the desired target. Transfer of lockon can also result in loss of lockon. During low-altitude missions over water, the seeker head may lock on to a reflection from a wave or white cap. The wave then disappears or is quickly passed by and lockon is lost. A similar situation can exist over terrain, particularly over desert terrain. The seeker head transfers lockon to a new heat source. As soon as the interceptor has passed the false target, lockon is lost. In both instances, it will be necessary to return to search and once again lock on to the desired target. Transfer of lockon is not a malfunction of the IR subsystem, but is described here since it may result in loss of lockon which could be misinterpreted as a fault in the system.

No Radar Target in RDR SLVD Submode. This malfunction can result from antenna-seeker head misalignment. Switch to RDR SCAN and observe whether or not a radar target appears. If a target does not appear, the fault may be due to a vertical antenna-seeker head misalignment. To determine this, the system would have to be returned to search and the antenna moved in elevation by rotating the ANT ELEV control.

There are also certain transmitter problems that could cause this malfunction. The problem may be an overload within the transmitter. It may be possible to cure this problem by setting the power switch to RDR STBY and back to ON. This means setting the armament selector switch to VIS IDENT which would break IR lockon. If none of the above actions remedy the situation, there is little that the pilot can do except make any observations that may assist the maintenance personnel in locating the fault.

IR Attack Displays Distorted or Missing. It may be possible to determine the validity of an IR target even though the ability to recall the expanded C-display is lost. If radar is functioning and manages to burn through any jamming that is present, the pilot can, by observing the radar display, compare its range and elevation with where he believes the IR target to be. If the comparison is favorable he can assume that the IR target is valid. If the range and FIR markers should become inoperative or missing, the pilot will have to try and obtain his ranging information from the radar subsystem. If this is possible, armament can be launched when the target passes the firing bar. If radar is completely jammed or inoperative, angle ranging can be used to determine when to launch armament. If the steering dot becomes inoperative or missing, the mission can still be completed by setting the system to RDR SLVD and using the B-sweep to determine azimuth position and the expanded C-scan to determine elevation relative to the target. When any or all of the above malfunctions occur, there is little corrective action that the pilot can take except to make those observations that he feels will assist the maintenance personnel in locating the fault.

X-BAND RECEIVER

The X-BAND receiver is designed to replace the PARAMP and other unsupportable receiver components in the MA-1 Radar. The new hardware consists of a new receiver and a new waveguide. Key receiver components include a low-noise X-band FET amplifier, and solid-state IF and video amplifiers. A different TR limiter device is employed, and the old mixer assembly with its low-reliability crystals has been eliminated.

The new receiver operation is basically the same as the old receiver in terms of input and output functions. The radar system also retains the same transmitter tuning bands, rates, and control logic. With the NORM tune selection, the new receiver yields high sensitivity equal to or better than the old PARAMP. The primary difference is that with SNIFF, FAST MIN, and FAST MAX tune selections, the new receiver maintains essentially the same high level of sensitivity during operation over the entire MA-1 radar frequency band.

Anomalies. Due to the increased sensitivity of the new receiver, there are readily noticeable differences from the old system. First, the displayed video on the MMST will be darker and appear more cluttered than the old system. However, the higher sensitivity, which causes the "Dark Scope," will also cause contact ranges to increase both in Long Pulse and Short Pulse operations.

Second, during Short Pulse operation in SEARCH, HAND-CONTROL, and/or TRACK, "second-time-around-returns" will appear on the scope when the radar antenna position is near-horizontal in elevation. These "ghosts" are caused by reflections from strong, long-range ground clutter, which are actually received and displayed after transmission of the next radar pulse. Such returns thus appear to be derived from targets/clutter at relatively short ranges, which are incorrect and ambiguous. The jittered PRF of the radar causes the phenomena to be displayed at somewhat different ranges on a pulse-to-pulse basis. However, this factor only tends to smear the clutter in range, decreasing but not eliminating the intensity of the second-time-around display.

Operating Procedures

1. **Scope Tuning** — Increased returns, darker video, and second-time-around-returns mean different techniques will be needed to tune the scope.
   a. **IF/Video Gain** — With the new receiver, the gains need to be adjusted at all altitudes, as is presently done at low level.
   b. **Second-Time-Around-Returns** — Second-time-around-returns are a natural phenomenon of the X-band receiver and as such are a "confidence" feature indicating the system is working at full sensitivity. The returns should not be removed by reducing IF gain — this only reduces contact range on the target. Instead, by selection of a faster tune rate (i.e., FMIN or FMAX) the returns will disappear while contact ranges will not be affected. This is because the receiver works at full sensitivity regardless of radar tune selections.
2. **Lock-on Techniques**
   a. It will become readily apparent when first using the system that locking-on to a target in the front is more difficult than with the old receiver. The fly-through technique should work properly if the cockpit nose/tail switch is set to NOSE. This selection is consistent with the pilot's decision to gate the target from closer range, independent of the attack geometry. Once DROT is achieved, the system is very resistant to break-lock.
   b. Radar lock-on should not be attempted at short range with the radar mode switch in the MAN IF position. With the IF gain potentiometer set for maximum gain, the possibility of side-lobe lockon is increased. It is basically incorrect procedure to have the MAN IF switch position selected except when the target appears to be employing a certain type of ECM.
3. **Sidelobe Lockon Prevention**
   a. To accomplish a lockon in the stern, the IF gain must be reduced to remove side lobes. If not, it is possible to lockon to side lobes and still receive what appears to be the normal steering information. The only indication of this, is that the antenna angles are erroneous. For example, the B-sweep might appear 10° or more left, while actual target position is 10° or more right of the nose. Moreover, if the fighter is co-altitude with the target, the antenna angle could be showing up to 30° down. The danger of this happening is especially prevalent when attempting to lockon in radar BORS.

b. Prevention of side-lobe lockon and side-lobe transfer can be accomplished by the following techniques.

(1) Select radar mode switch NORM (automatic gain control) prior to lockon.

(2) Adjust IF gain to remove side lobes prior to lockon.

(3) Observe proper operation of automatic gain.

(4) If MAN IF is dictated, gain must be manually controlled (reduced) during the intercept.

c. Insidious side-lobe transfer, following a good lockon, can occur when MAN IF is selected and the gain is not reduced during the intercept. It can also occur when automatic gain control is not functioning properly.

4. **Short-Pulse Christmas Tree** — The christmas tree in short pulse is far more pronouced with the new receiver. Reducing IF gain, or moving the target out of that area is the only way to avoid the phenomenon.

5. **Low Level** — Selecting FMIN or FMAX will remove a lot of the clutter while contact ranges will be greatly improved.

6. **ECCM** — Overall, there are not noticeable differences between the old and new receiver. Switchology and techniques remain exactly the same as the old system when encountering the ECM.

SECTION VIII—CREW DUTIES

Not Applicable to this Airplane

all weather operation

Section IX

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NOTE

Except for some repetition necessary for emphasis, clarity, or continuity of thought, this section contains only those procedures that differ or are in addition to the normal operating instructions covered in Section II and Section IV.

INSTRUMENT FLIGHT PROCEDURES

For instrument approach purposes, this aircraft is classified as Category E.

These procedures and techniques pertain primarily to instrument flight conditions and are in addition to normal procedures. Fuel requirements for completion of instrument penetration, approach, and possible diversion to an alternate are much greater than for VFR flight and must be included in preflight planning.

INSTRUMENT TAKEOFF

Complete the normal TAXI and BEFORE TAKEOFF checks as prescribed in Section II, and check pitot heat ON. After aligning the airplane visually with runway centerline, check heading indicator and magnetic compass against runway heading. Set attitude indicator at 5° nose-down with thrust at IDLE. This setting will provide a more accurate indication as it will tend to offset the pitch error resulting from takeoff acceleration.

CAUTION

To insure that nose wheel steering is engaged for takeoff, the steering should be used to line up and should not be disengaged until the rudder becomes effective on the takeoff roll.

Instrument takeoffs may be made at either military or maximum thrust.

NOTE

Afterburner is recommended to shorten the takeoff roll in conditions of low visibility.

Maintain directional control with nose wheel steering, then disengage steering when rudder becomes effective.

NOTE

Nose wheel steering may be used throughout the takeoff roll; however, directional control becomes increasingly sensitive above 75 KCAS.

The heading indicator is primarily for directional control but reference should be made to runway centerline and runway lights if possible. At 140 KCAS apply back pressure and rotate the airplane to a 10° nose-up attitude on the attitude indicator. Airplane will fly off the ground with the pitch change. Raise landing gear when a positive climb indication is noted on both the altimeter and vertical velocity indicator. Maintain a positive climb indication until the climb schedule is reached.

INSTRUMENT CLIMB

An instrument climb is accomplished in the same manner as a VFR climb by maintaining a positive climb indication until intercepting the climb schedule.

NOTE

During an instrument climb in afterburner, do not exceed a 30° nose-up indication on the attitude indicator to preclude a low airspeed, high angle of attack condition.

HOLDING

Holding procedures are based on airspace requirements, ease of handling, and fuel consumption and are found in FLIP II. Approximate thrust requirements to maintain 250 KCAS for holding altitudes are presented below. An increase of 1 to 2% rpm is necessary to maintain 250 KCAS during turns at 30,000 feet and 40,000 feet. A 30° angle of bank is used.

ALTITUDE FEET	KCAS	RPM %	FUEL FLOW LB/HR
20,000	250	85	2800
30,000	250	87	2800
40,000	250	89	2800

DESCENT

The optimum configuration for descents in instrument flight conditions is speed brakes extended, 275 KCAS and 85% rpm.

NOTE

Idle power descents may be accomplished; however, compressor stalls may occur and compressor bleed air may be insufficient for anti-icing.

Radar Recovery

Radar recovery can be accomplished with a minimum amount of time and fuel required. When a PAR or ILS approach is required, the descent from the inbound cruising altitude should be started at a sufficient distance to permit a straight-in approach at the recommended airspeed. A distance of three to four miles should be allowed for deceleration and changing to approach configuration before reaching the final approach fix.

Jet Penetration

Typical penerations are shown in figures 9-1 and 9-2. At the initial approach fix, reduce thrust to 85% rpm, lower the nose to approximately 10° nose-down indication and establish 275 KCAS. Extend speed brake when reaching 275 KCAS. Start penetration turn as published and maintain 30° bank angle. Begin level-off 1000 feet above minimum altitude. Maintain 250 KCAS (82-84% rpm) inbound.

INSTRUMENT APPROACHES

Do not decrease airspeed below 200 KCAS until turn onto final approach is completed. Use speed brakes to change altitude and for descent to minimum altitude. Recommended final approach airspeeds are for 2000 pounds fuel remaining.

TACAN

Establish final approach airspeed with gear extended prior to final approach fix. Thrust required for level flight is approximately 88% rpm. Upon reaching the final approach fix, extend speed brakes and descend to minimum altitude.

PAR

Maintain 250 KCAS on downwind and 225 to 250 KCAS on base and dogleg. Thrust required is approximately 83% rpm. Extend landing gear on base, dogleg or final as required. After turn onto final approach, establish final approach airspeed with gear extended. As glide-path is intercepted, extend speed brakes and establish desired rate of descent. See figure 9-3 for airspeeds, configurations, and thrust settings.

TACAN—Circling Approach

With recommended base leg airspeed and landing gear extended, proceed from the TACAN final approach fix and/or designated point to begin a letdown to the circling approach altitude. Use speed brakes as required to insure reaching the circling approach altitude prior to the missed approach point. If speed brakes are extended for descent, close them prior to initiating the circling maneuver. Maintain recommended base leg airspeed (landing gear down and speed brakes closed) during maneuvering in the circling approach until descent from the circling approach altitude for landing or missed approach is initiated. When this descent is initiated, open the speed brakes and reduce airspeed to final approach airspeed. See figure 9-4 for one type of circling approach.

NOTE

AFM-51-37 depicts various methods to maneuver for circling approaches.

ILS

Refer to typical ASR-PAR pattern, figure 9-3, for airspeed, configuration and thrust setting. Fly outbound for a sufficient length of time so that final approach configuration can be established prior to intercepting glide-slope.

Missed Approach

Advance throttle to military thrust position, retract speed brakes, and establish a 10° nose-up indication on the attitude indicator. When a definite climb is indicated on the altimeter and vertical velocity indicator, retract landing gear. Execute missed approach procedure. If another approach is to be executed, reduce power to maintain 250 KCAS as missed approach altitude is reached.

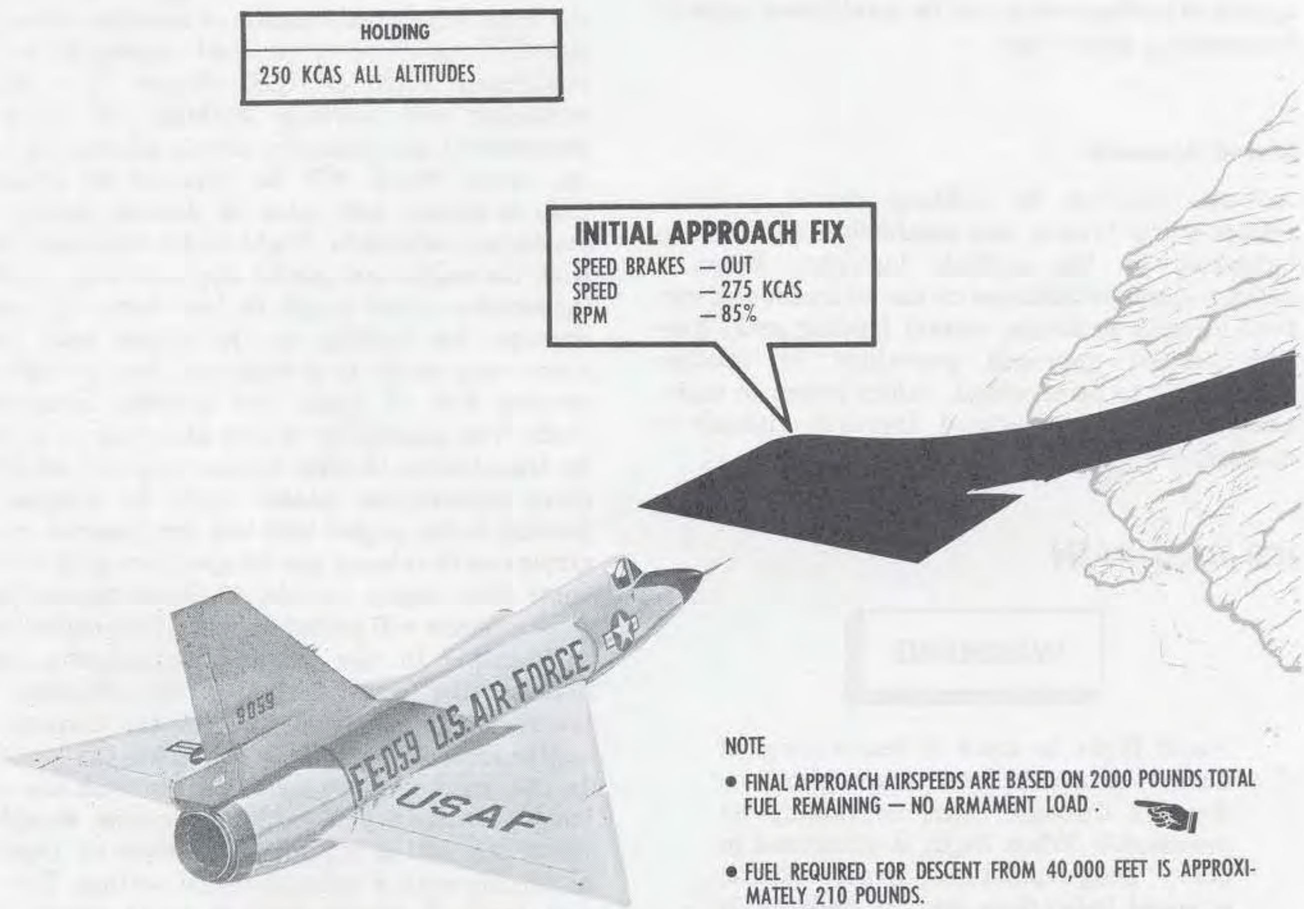
ICE AND RAIN

WARNING

Avoid flight in areas of heavy icing. If unable to avoid these areas, climb or descend through them as rapidly as practicable. When flight is conducted in heavy icing conditions, expect erratic airspeed indications and ice build-up in engine inlets and on the canopy. Place the surface and engine anti-ice switch in the MAN ON position.

When the anti-icing systems are in operation, the airplane may be flown safely under icing conditions. No wing or vertical stabilizer surface anti-icing systems are required as there is sufficient thrust available to overcome the increased drag from surface ice buildups. Surface icing will reduce range as increased thrust is required to maintain desired flying speed. The stability and control of the airplane will not be noticeably affected with surface ice buildups. The most probable free air icing temperatures vary from −4°C (+25°F) at sea level to −24°C (−12°F) at 20,000 feet. Above 20,000 feet, due to the inability of the air to contain moisture, the amount of icing is negligible. The mission of the airplane is so designed that most phases of a typical mission will be performed at altitudes above icing levels. The phase most susceptible to ice and most critical to operation is the instrument approach. If icing conditions are known to exist at instrument approach altitudes, the most expeditious means of recovery (normally the GCI penetration to final approach with a straight-in PAR or ILS) should be used to minimize the surface buildup. If icing is encountered unexpectedly and is allowed to build up, more thrust will be required to maintain desired speeds and rates of descent during the instrument approach. Flight under icing conditions with the engine and intake duct anti-icing systems inoperative could result in two forms of engine damage. Ice buildup on the engine inlet guide vanes may result in a restricted flow of inlet air, causing loss of thrust and possible compressor stalls. The possibility of this occurring is reduced by the absence of inlet screens and the relatively clean unrestricted intake. Light to medium ice buildup in the engine inlet will not cause an appreciable rise in exhaust gas temperature as it does on some other engine models, so thrust loss and compressor stalls will probably be the first engine icing indications. In the event of compressor stalls depress the ignition button to alleviate the possibility of a flameout. Place the surface and engine anti-icing switch in the MAN ON position. In the event of inlet ice formation with the anti-icing system inoperative, the airplane should be flown out of the icing area as soon as possible, preferably with a reduced thrust setting. The second form of engine damage could result from intake duct ice breaking loose and being drawn into the compressor section of the engine, resulting in compressor section failure. Because of the possible damage that may result due to engine ice, the anti-icing system should be operable and the surface and engine anti-icing switch in the automatic position at all times when flight under icing conditions is anticipated.

typical penetration (straight in)



NOTE

- FINAL APPROACH AIRSPEEDS ARE BASED ON 2000 POUNDS TOTAL FUEL REMAINING — NO ARMAMENT LOAD.
- FUEL REQUIRED FOR DESCENT FROM 40,000 FEET IS APPROXIMATELY 210 POUNDS.
- REFER TO "TERMINAL FLIGHT INFORMATION (HIGH ALTITUDE)-JET" FOR PUBLISHED PENETRATION.
- IF WEATHER IS TOO LOW FOR TACAN APPROACH, REQUEST PAR, ILS, OR PROCEED TO ALTERNATE WHILE STILL AT ALTITUDE.

48182-1A

Figure 9-1 (Sheet 1 of 2)

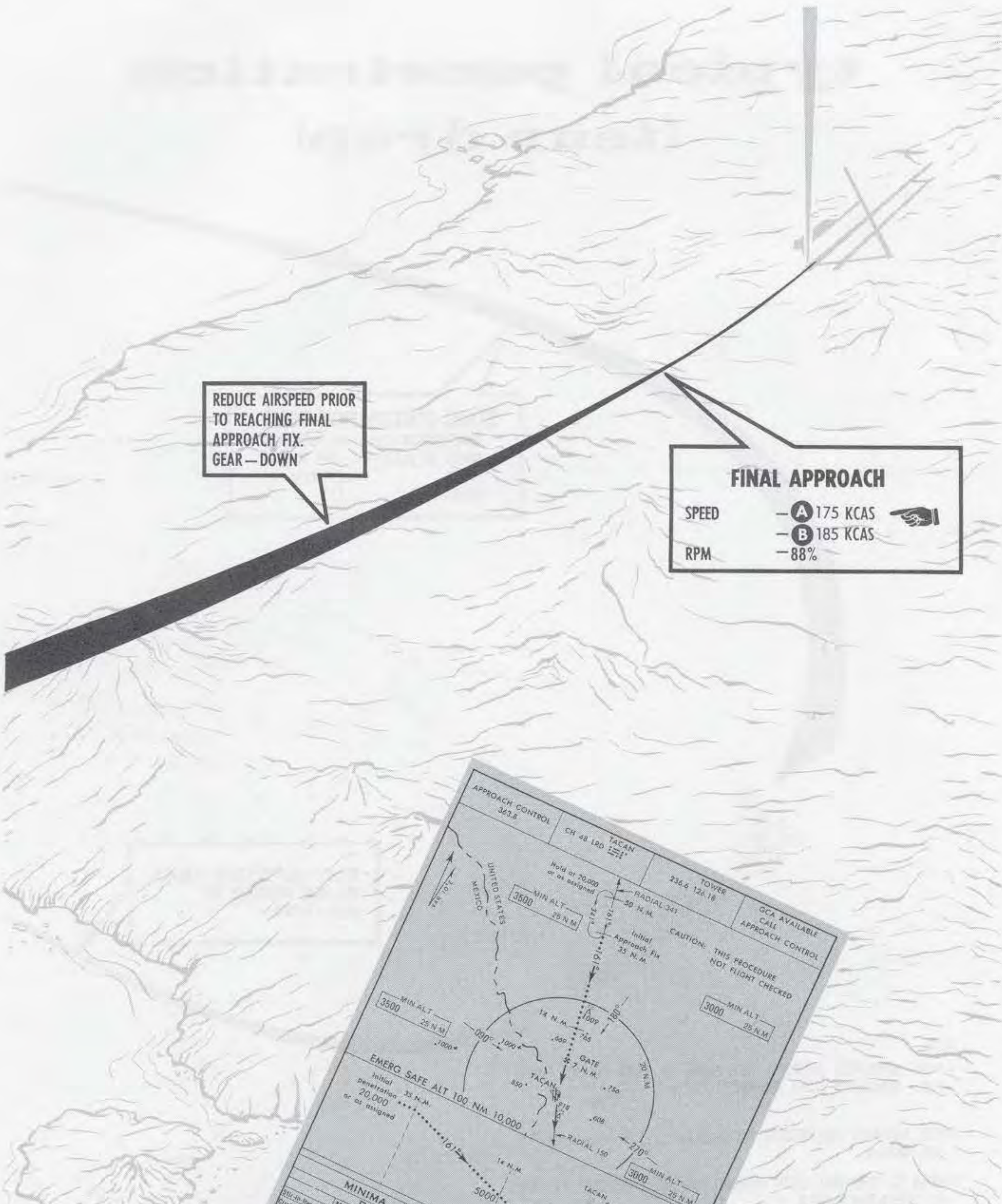
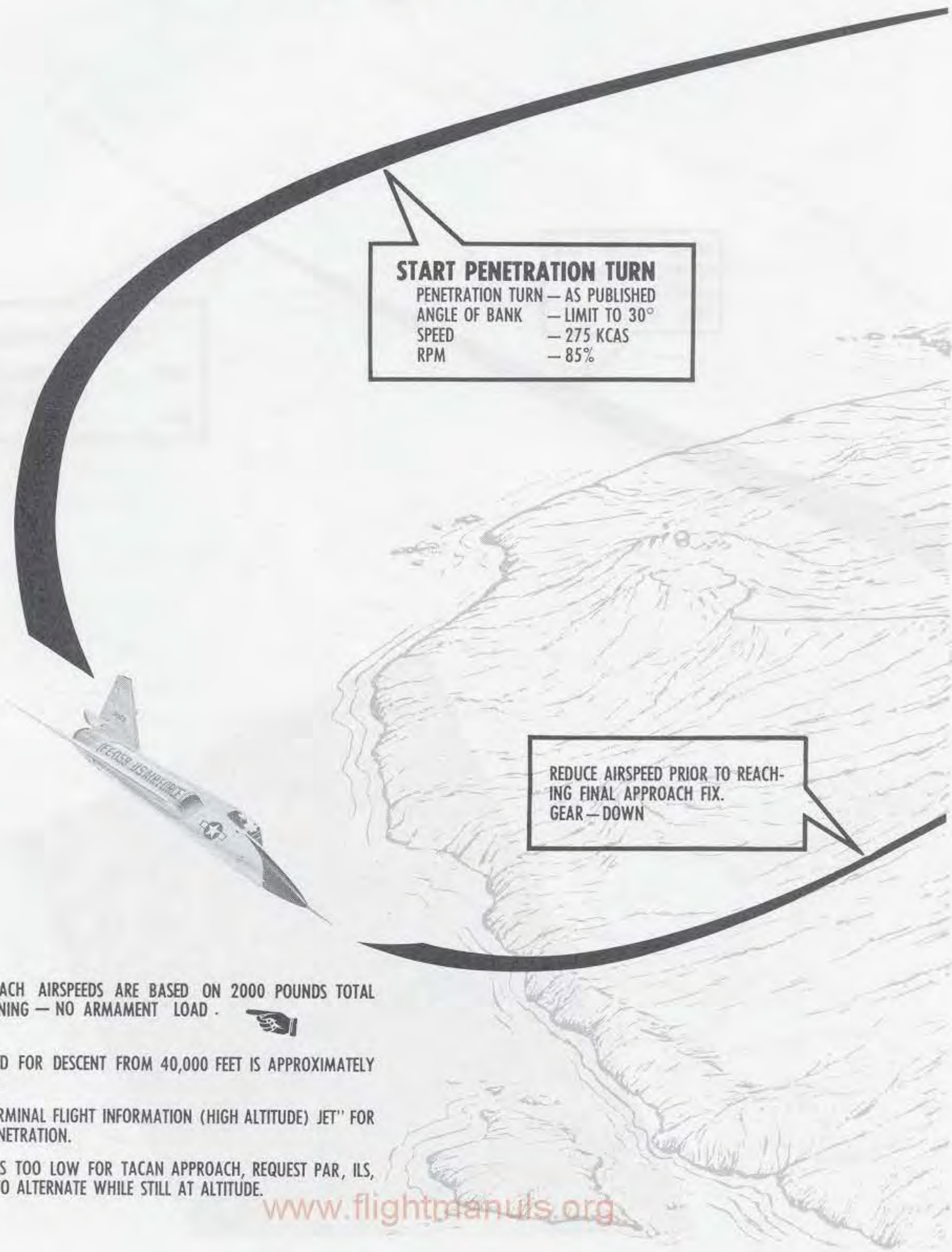


Figure 9-1 (Sheet 2 of 2)

typical penetration (tear drop)



NOTE

- FINAL APPROACH AIRSPEEDS ARE BASED ON 2000 POUNDS TOTAL FUEL REMAINING — NO ARMAMENT LOAD.
- FUEL REQUIRED FOR DESCENT FROM 40,000 FEET IS APPROXIMATELY 210 POUNDS.
- REFER TO "TERMINAL FLIGHT INFORMATION (HIGH ALTITUDE) JET" FOR PUBLISHED PENETRATION.
- IF WEATHER IS TOO LOW FOR TACAN APPROACH, REQUEST PAR, ILS, OR PROCEED TO ALTERNATE WHILE STILL AT ALTITUDE.

48181-1B

Figure 9-2 (Sheet 1 of 2)

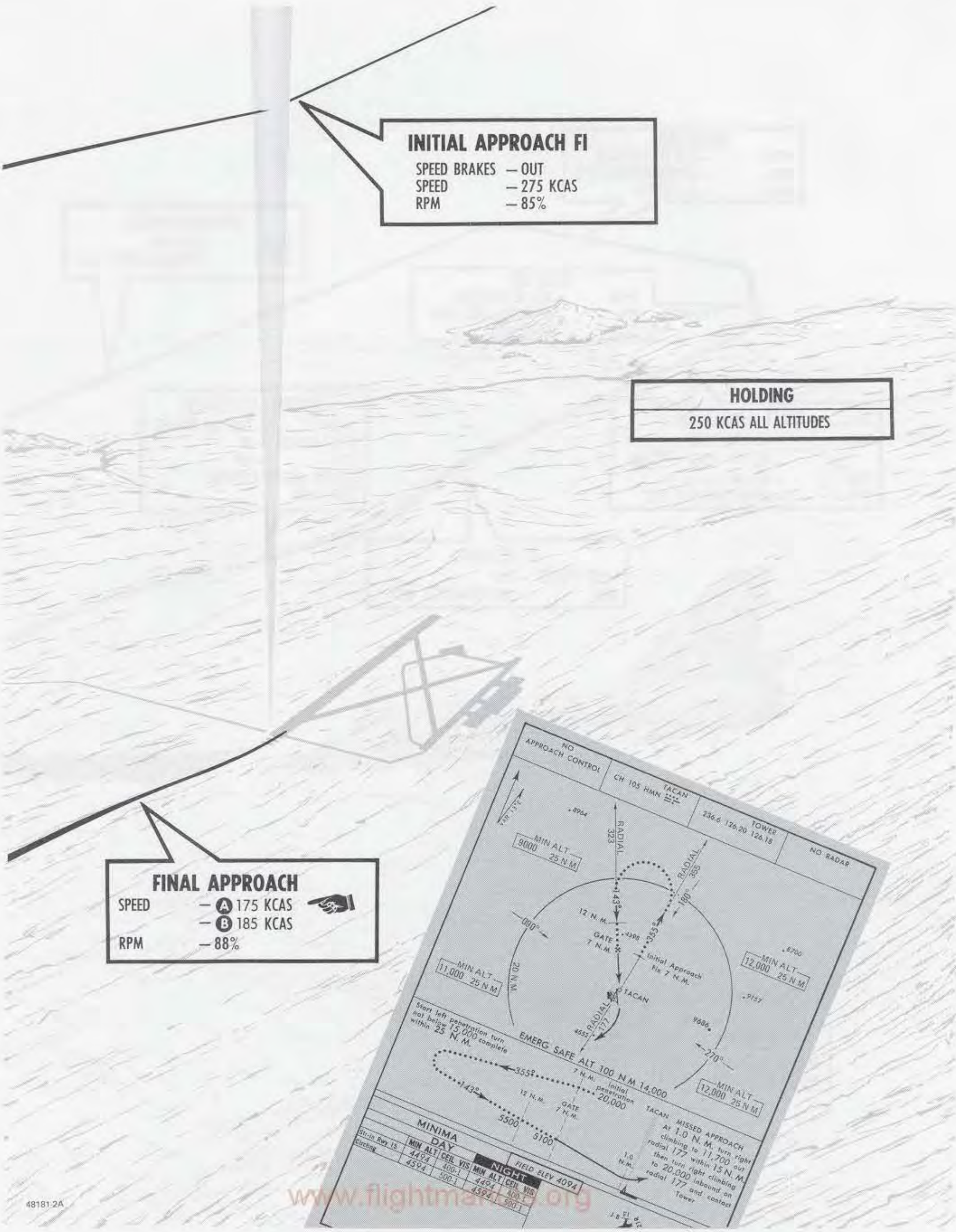
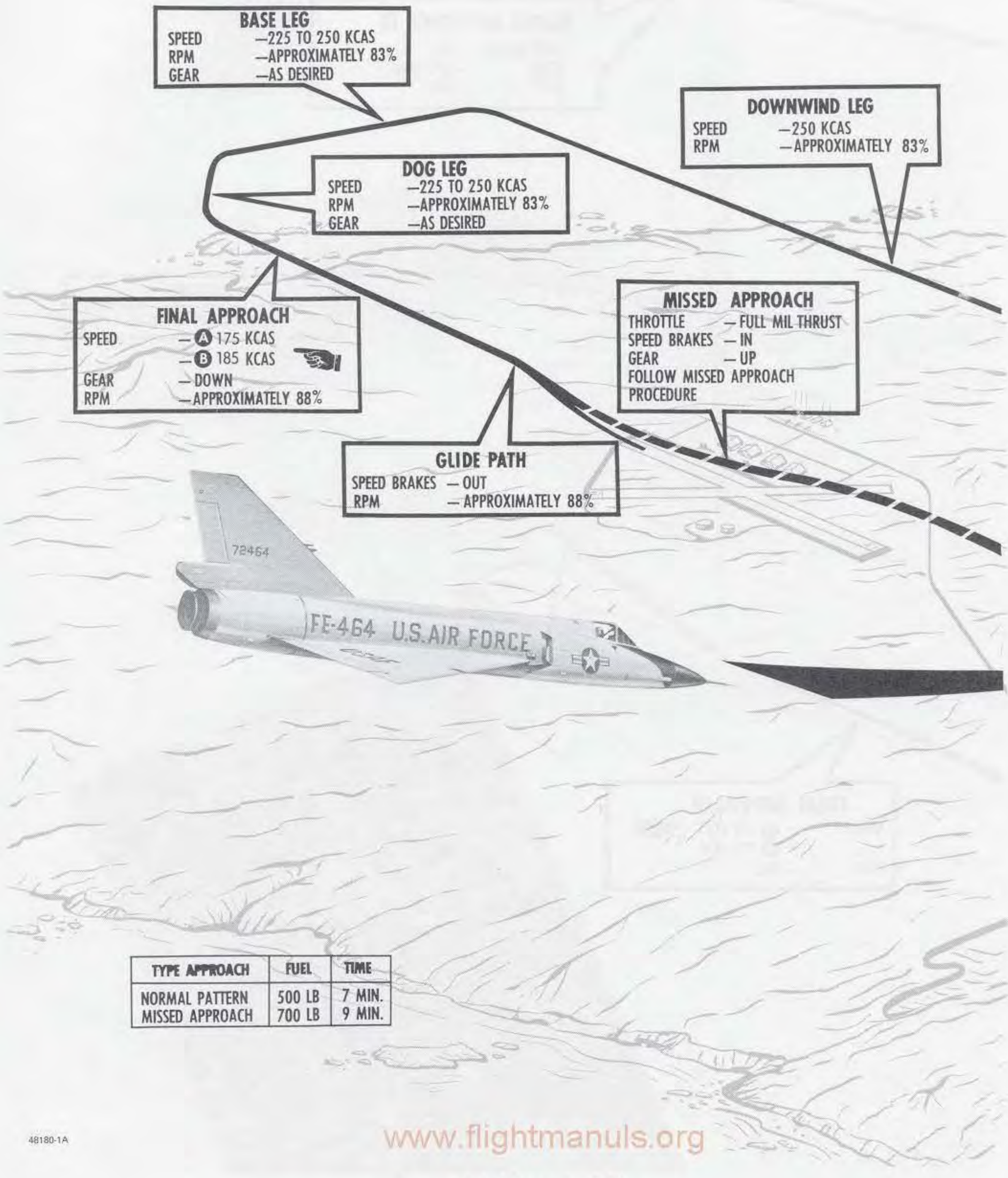


Figure 9-2 (Sheet 2 of 2)



TYPE APPROACH	FUEL	TIME
NORMAL PATTERN	500 LB	7 MIN.
MISSED APPROACH	700 LB	9 MIN.

48180-1A

Figure 9-3 (Sheet 1 of 2)

asr and par pattern
(typical)

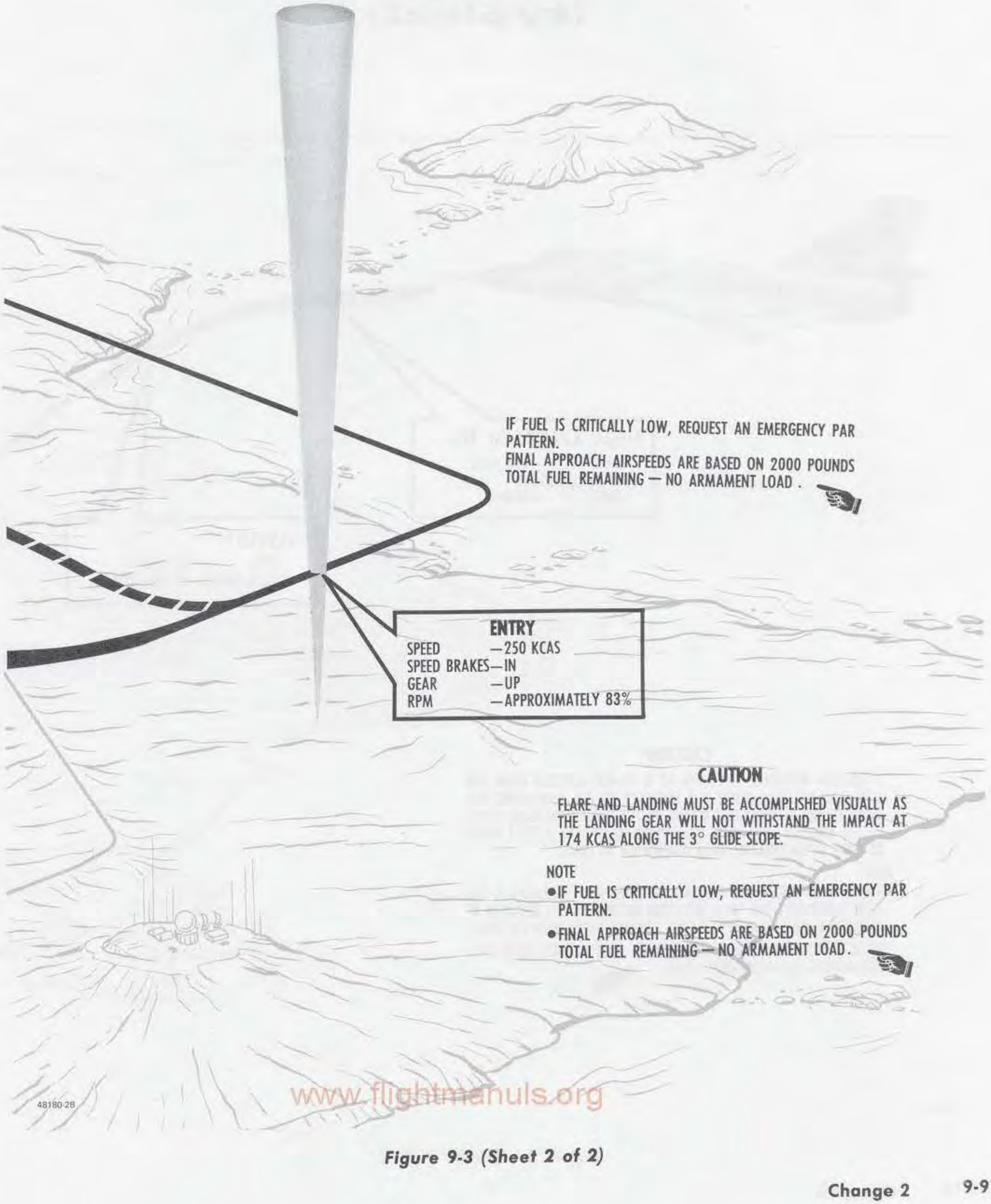
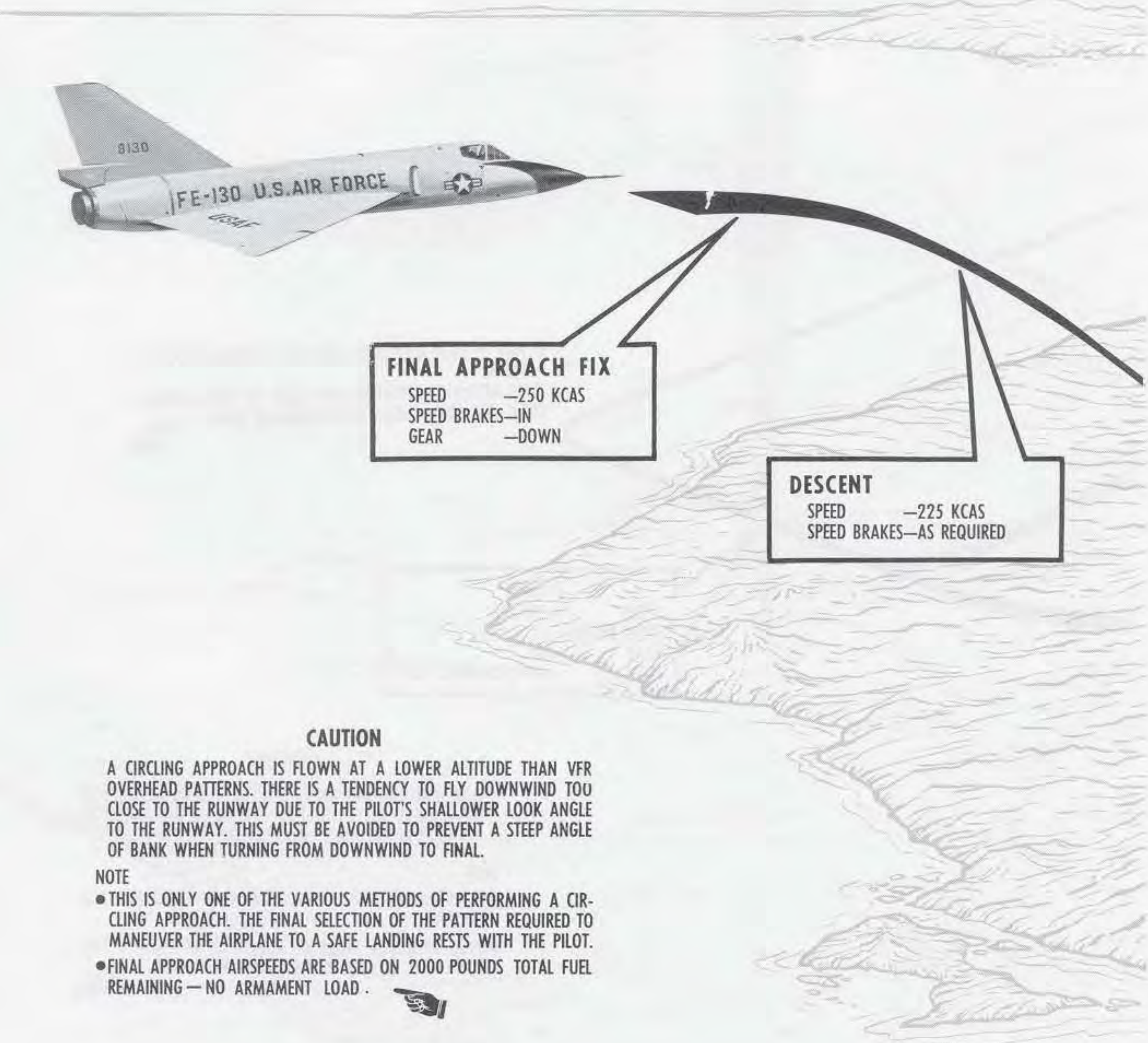


Figure 9-3 (Sheet 2 of 2)

circling approach
(typical)



CAUTION

A CIRCLING APPROACH IS FLOWN AT A LOWER ALTITUDE THAN VFR OVERHEAD PATTERNS. THERE IS A TENDENCY TO FLY DOWNWIND TOO CLOSE TO THE RUNWAY DUE TO THE PILOT'S SHALLOWER LOOK ANGLE TO THE RUNWAY. THIS MUST BE AVOIDED TO PREVENT A STEEP ANGLE OF BANK WHEN TURNING FROM DOWNWIND TO FINAL.

NOTE

- THIS IS ONLY ONE OF THE VARIOUS METHODS OF PERFORMING A CIRCLING APPROACH. THE FINAL SELECTION OF THE PATTERN REQUIRED TO MANEUVER THE AIRPLANE TO A SAFE LANDING RESTS WITH THE PILOT.
- FINAL APPROACH AIRSPEEDS ARE BASED ON 2000 POUNDS TOTAL FUEL REMAINING — NO ARMAMENT LOAD.

48603-1A

Figure 9-4 (Sheet 1 of 2)

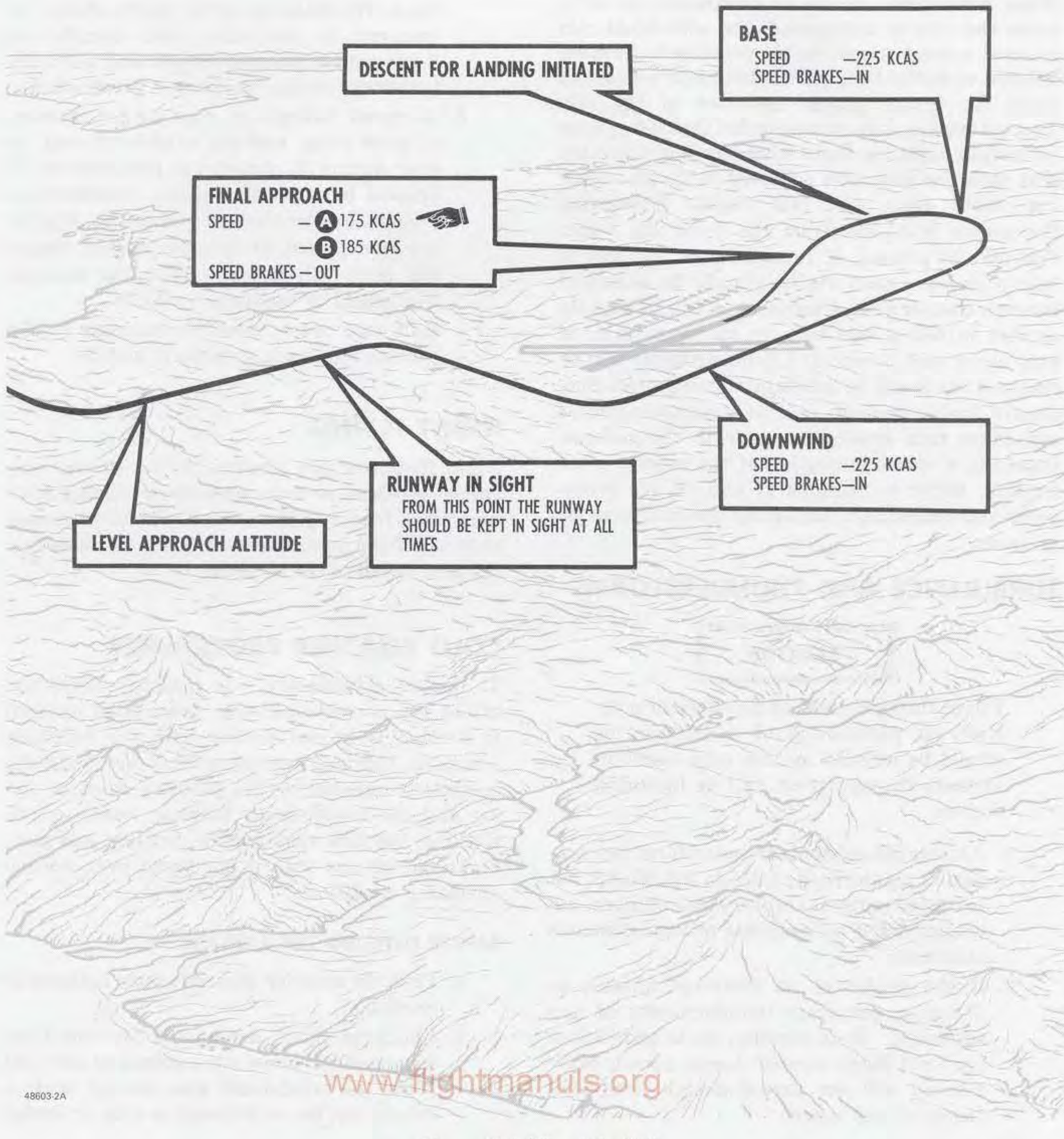


Figure 9-4 (Sheet 2 of 2)

NOTE

Engine operation below approximately 85% rpm may not supply sufficient heat to keep the engine compressor inlet guide vanes clear of ice under severe icing conditions. When descending in icing conditions, thrust should be increased to provide sufficient heat.

When instrument takeoffs 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-hand windshield panel. To insure proper operation of the rain removal system, it is recommended that the system be energized prior to flight whenever it is suspected that moisture may have collected in the rain clearing ducts since the last flight. Energizing the system will blow from the ducts any water that may be present. If reported rain intensity is heavy or less, good vision should be obtained through cleared area. 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. Successive flights through rain at supersonic speeds can cause rain erosion to occur to the radome, requiring a visual inspection of the radome after landing. Refer to Sections II and IV for procedures and operation of anti-icing and rain removal systems.

TURBULENCE AND THUNDERSTORMS

CAUTION

Flight through areas of thunderstorm activity or penetration of thunderstorms should be avoided as this may result in aircraft damage from hail or lightning strikes.

1. Accomplish subsonic thunderstorm penetration at an airspeed of 275 to 325 KCAS, not to exceed optimum cruise Mach number, unless profile of an intercept mission demands otherwise.
2. If the profile of an intercept mission so demands, penetrate thunderstorms at any supersonic Mach number, up to and including limit Mach number. Large g-loads experienced will not exceed design limit load factor at any speed.
3. Engine performance and airplane control are satisfactory during both subsonic and supersonic thunderstorm penetrations.
4. Be prepared for large roll and pitch rates during a turbulence penetration at any flight speed. The largest disturbances will be in roll.
5. Airplane reaction to turbulence varies between subsonic and supersonic penetrations. The majority of the pilot's efforts are required in combating roll disturbances during subsonic penetrations and pitch disturbances during supersonic penetrations.
6. Airspeed indications may be lost because of pitot icing, and the windshield may ice over during thunderstorm penetrations. If descent immediately follows thunderstorm penetration, windshield and canopy fogging can be expected. If extreme fogging occurs, the pilot will have to wipe the canopy/windshield to maintain visibility.
7. Hail can cause extensive damage to the radome and leading edges of airfoils.

NIGHT FLYING

Night flights in this airplane do not present any special problems or techniques except during landing. When lowering the nose, it will be necessary to switch from landing to taxi lights to illuminate the area ahead of the airplane.

COLD WEATHER PROCEDURES

To insure satisfactory cold weather operation, utilize the normal operating procedures outlined in Section II in conjunction with the following additions. It should be expected that due to adverse conditions imposed by the presence of snow and ice and the requirement to wear heavy Arctic clothing, the time required for preflight and postflight inspections will be increased over normal operating conditions.

BEFORE ENTERING THE AIRPLANE

1. Perform exterior inspections as outlined in Section II.
2. Check the entire airplane for freedom from snow and ice. Loose snow should be removed from the windshield and canopy with a broom, but do not attempt to chip or scrape

ice since it can be successfully removed by the windshield and canopy anti-icing and defog system once power is applied to the airplane.

WARNING

Due to increased drag with accumulated snow and ice, takeoff distances and climb-out performance can be seriously affected. The roughness and distribution of the ice and snow could vary stall speeds and characteristics to an extremely dangerous degree. Loss of an engine shortly after takeoff is a serious enough problem without the added, and avoidable, hazard of snow and ice on the wings. In view of the unpredictable and unsafe effects of such a practice, the ice and snow must be removed before flight is attempted.

3. Check angle of attack vane for freedom of movement.
4. Insure that the drag chute compartment is free from ice and/or moisture which might restrict deployment of chute.

ON ENTERING AIRPLANE

1. Make a normal cockpit check for switch and circuit breaker positions as outlined in Section II.
2. As soon as power is available, turn on windshield anti-icing, anti-fog and canopy anti-fog switches.

BEFORE STARTING ENGINE

1. Make normal checks as outlined in Section II.
2. Actuate brake pedals until normal brake pressure is available.

STARTING ENGINE

1. Use normal starting procedures as outlined in Section II. When a battery start is anticipated below freezing temperatures, ascertain that the battery has been preheated.
2. If airplane has been cold soaked to a temperature of −35°C (−31°F), operate the engine at idle rpm for at least two minutes to preclude damage to oil and hydraulic systems.
3. If temperature is between +32°F and −32°F, operate engine at idle rpm for at least one minute.
4. If the oil pressure-low warning light remains illuminated after start, the engine should be operated at idle until the light extinguishes. Advancing the throttle above idle shortly after the light extinguishes may cause the light to again illuminate. Operation of the engine at idle for approximately two minutes after the light extinguishes will allow advancing the throttle to maximum thrust without light illumination. Electrical power supply system check should be delayed until after the light extinguishes to minimize the load on the accessory drive shaft.

WARMUP AND GROUND CHECKS

Special attention should be paid to operational checks on all ice protection and defogging equipment. Refer to Section IV for anti-icing systems operation.

1. Keep wheel chocks in place until ready to taxi.
2. Slowly cycle elevon controls several times and actuate speed brakes. Have the crew chief check for leaks.
3. Check all instruments, radar, communication and navigation equipment, etc., for proper operation.
4. Set cabin temperature control knob for a comfortable level in AUTOMATIC.

NOTE

- At low temperatures, cockpit heat will be inadequate at idle rpm even with cockpit temperature control knob set to MANUAL HOT.
- If cold wind blast in the face is annoying, place cockpit air selector handle to direct airflow out of aft vertical outlets.

TAXIING INSTRUCTIONS

WARNING

Make sure all instruments have warmed up sufficiently to insure proper operation. Check for sluggish instruments during taxiing.

1. At all temperatures, excess thrust is available at idle rpm, and at lower temperatures this condition is further intensified, resulting in dangerously high taxi speeds unless controlled by brakes or the idle thrust control system.

NOTE

If bottoming of a landing gear strut occurs during taxiing, stop airplane and notify ground crew.

2. Taxi at slow speed when taxiing over rough, snow-packed surfaces.
3. Increase spacing when taxiing behind other aircraft or in vicinity of parked aircraft, and allow more room than on a cleared surface to bring the airplane to a stop.
4. After cold soaking, an increase of rpm up to 80% may be necessary to start taxiing. This is due to flat spots on the tires, stiff grease, etc. Once rolling, idle rpm is more than sufficient.
5. Successful taxiing can be accomplished in snow 6 inches deep with only a slight increase in thrust.
6. For all normal taxiing, nose wheel steering will be adequate. If minimum radius turns are required, disengage nose wheel steering and use rapid brake applications on the inboard wheel, being careful not to slide the tire. Approximately 75% rpm will be required. This will result in a pivot turn.

CAUTION

If nose wheel steering is inoperative and the airplane is stopped on ice or slippery packed snow, it will be difficult to make a minimum radius turn without first obtaining some forward motion.

BEFORE TAKEOFF

If other airplanes are in takeoff position, taking the runway behind them should be avoided if possible. Flying debris in the form of ice, snow, or ice fog from other jet engines can considerably reduce visibility prior to takeoff or during takeoff roll.

1. Make normal before takeoff check as outlined in Section II.
2. If one wheel starts to slip on engine runup, release brakes and make normal takeoff or retard throttle and stop the airplane.

WARNING

Under conditions of high relative humidity, excess moisture through the air-conditioning system could cause fog condensation so dense that the instrument panel is not visible. In event this occurs, place the cabin air switch to RAM.

TAKEOFF

1. During low temperature operation, engine performance is considerably improved over normal temperature operation. Because of this improved performance, takeoff roll will be reduced and initial climb attitude will be steeper than normal. Oil pressure may reach 80 psi for a short duration on takeoff and transient yaw may be experienced at speeds low as 50 KCAS. Afterburner takeoffs may produce an uncomfortably steep initial climb angle which is disconcerting when operating in adverse weather. Unless there is an operational requirement for an afterburner climb, a military climb is recommended when operating in cold weather.
2. Nose wheel steering is somewhat sensitive and overcontrolling is possible at higher speeds. Disengage nose wheel steering at 75 KCAS if not needed to counteract transient yaw.
3. Due to the increased acceleration, double check for complete gear-up indication before exceeding gear speed limit.

LANDING

1. Use normal landing technique as outlined in Section II.
2. When operating at temperatures below −10°F be prepared for landing in ice fog. This phenomenon is characterized by good visibility straight down; however, the visibility will be zero at any angle off the vertical. Depth of the ice fog will usually be

less than 100 feet. When this condition exists and no alternate is available, ascertain that the approach and runway lights are at full intensity. Use normal PAR procedures and once in the fog reduce rate of descent to 300 to 400 fpm and hold that attitude until touchdown. Approach and runway lights should be visible on both sides.

3. Plan each landing with the possibility of a drag chute failure in mind.
4. If strong cross winds are encountered on landing, use normal cross-wind landing technique and be prepared to jettison the drag chute if airplane direction cannot be controlled by nose wheel steering and brakes.

CAUTION

When landing on runways that have patches of dry surface, increased vigilance will be required to avoid tire skidding or locking the wheel, which could result in tire blowout.

WARNING

When the pilot wears arctic combination of flight clothes, the stick travel is restricted.

DESERT AND HOT WEATHER PROCEDURES

In general, hot weather and desert procedures differ from normal procedures mainly in that added 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 parts and systems (engine, fuel system, pitot static system, etc.). All filters should be checked more frequently than under normal conditions. Units incorporating plastic or rubber parts should be protected as much as possible from wind-blown sand and excessive temperatures. Tires should be checked frequently for signs of blistering, etc.

BEFORE ENTERING THE AIRPLANE

Check exposed portions of the shock strut pistons for dust and sand, and have them cleared if necessary. Check intake ducts for accumulations of dust or sand. Make sure crew chief has had all filters cleaned and that the airplane has been thoroughly inspected for fuel or hydraulic leaks caused by the swelling of packing or expanding of fittings. Inspect area behind the airplane to make sure sand and dust will not be blown onto personnel or equipment during starting operations. Check inflation of shock struts and tires, which may have become overinflated from the heat.

ON ENTERING THE AIRPLANE

Check the cockpit for excessive accumulation of dust or sand. Check instruments and controls for moisture from high humidity, and ground heat them if necessary to dry them. Complete as much of preflight cockpit check as possible before starting the engine to avoid prolonged ground running.

BEFORE TAKEOFF

The air-conditioning system should be turned ON before takeoff. If, under humid climatic conditions, fog forms in the cockpit, adjust the cabin temperature control knob toward HOT until the fog disappears.

TAKEOFF

WARNING

Excessive moisture condensation may occur through the cabin pressurization system. This condensation may become so dense when operating under conditions of high dew point temperature that it may be impossible to read the instrument panel presentation. In the event this occurs, place the cabin air selector switch to RAM.

CAUTION

It is imperative that takeoff be made at recommended speeds. Refer to the Appendix for takoff distances required at varying gross weights, temperatures and field elevations. When outside air temperature is high, more than usual takeoff distance will be required to obtain takeoff speed.

DESCENT

Check that the windshield anti-ice and canopy anti-fog system is on at least 4 minutes before any rapid descent from altitude to prevent fogging and frosting of the windshield and canopy.

APPROACH

Maintain the recommended indicated airspeeds for approach and touchdown. Because of high outside air temperatures, the true airspeed will be higher than normal, and longer landing roll will result.

LANDING

Avoid heavy braking during the landing roll. Small increments of braking with the drag chute deployed will stop the airplane in a reasonably short distance without excessive tire wear. Heavy braking may cause brake grabbing and tire failure.

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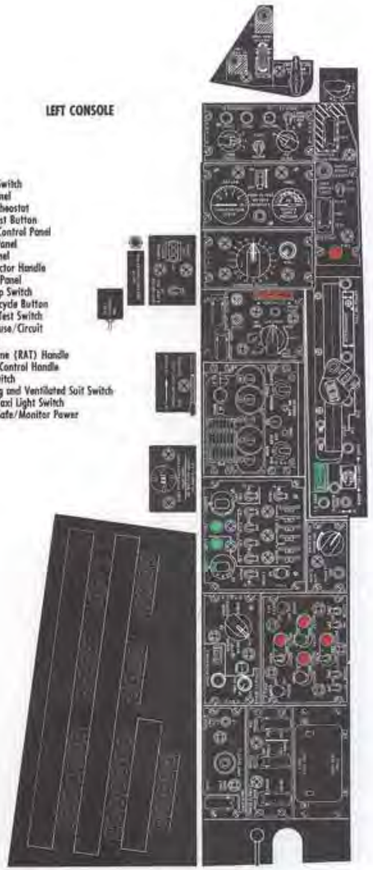
F-106A cockpit -typical

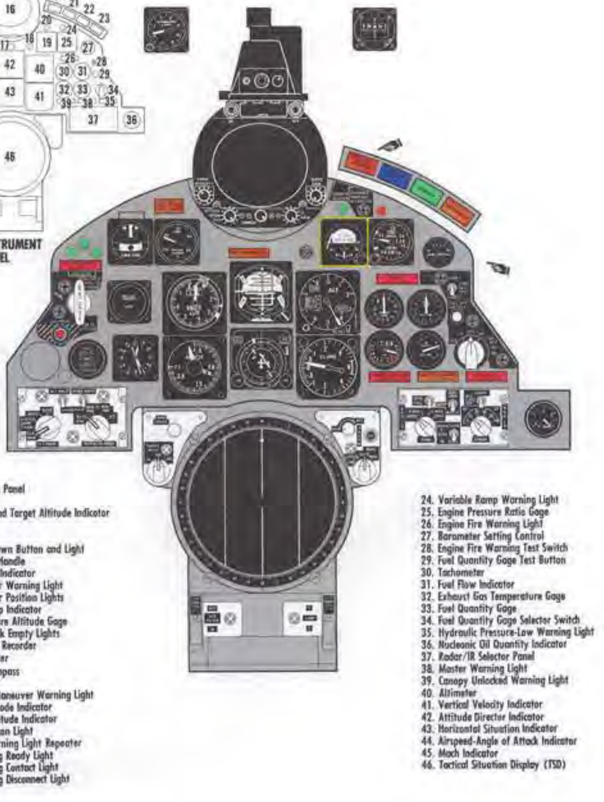
CONVENTIONAL INSTRUMENT DISPLAY

LEFT CONSOLE



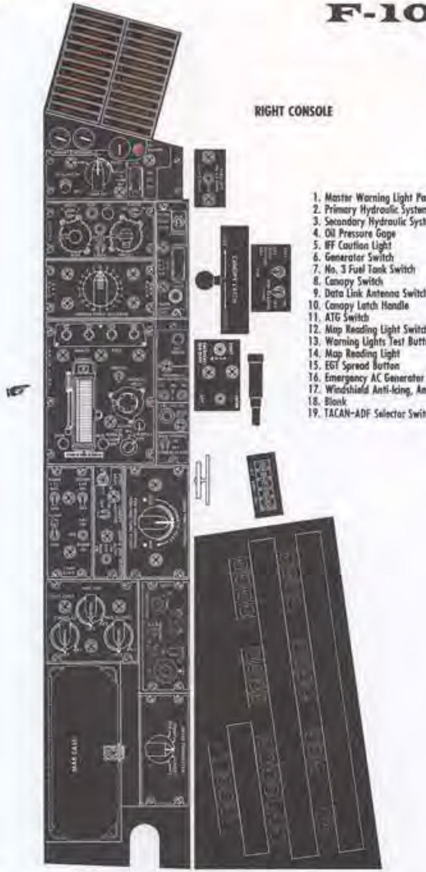
1. Landing Gear Emergency Up Button
2. Landing Gear Handle
3. External Wing Tanks Release Button
4. Landing Gear Emergency Extension Handle
5. Altitude Band Switch
6. Master Electrical Power Switch
7. Landing Gear Audio Warning Cutoff Button
8. Idle Thrust Control Switch
9. CG Control Switch
10. CG Transfer Test Failure Light
11. Radar/IR Control Panel
12. Oxygen Control Panel
13. ILS Channel Selector Panel
14. Armament Control Panel
15. Throttle Quadrant
16. Throttle
17. UHF Control Panel
18. Takeoff Trim Light
19. Fuel Control Switch
20. Rudder Trim Switch
21. IFF Control Panel
22. Mask Defog Rheostat
23. Anti-G Suit Test Button
24. MA-1 Power Control Panel
25. Fuel Control Panel
26. MA-1 Test Panel
27. Cabin Air Selector Handle
28. Air Refueling Panel
29. Variable Ramp Switch
30. Armament Recycle Button
31. Pitch G Limit Test Switch
32. Cockpit Left Fuse/Circuit Breaker Panel
33. Ram Air Turbine (RAT) Handle
34. Pressure Suit Control Handle
35. Reset/MBL Switch
36. Cockpit No-Fog and Ventilated Suit Switch
37. Landing and Taxi Light Switch
38. AIR-2A Arm/Safe/Monitor Power

INSTRUMENT PANEL



1. Flight Modes Panel
2. Clock
3. Command and Target Altitude Indicator
4. Blank
5. Blank
6. Tail Hook Down Button and Light
7. Drag Chute Handle
8. UHF Remote Indicator
9. Landing Gear Warning Light
10. Landing Gear Position Lights
11. Turn-and-Slip Indicator
12. Cabin Pressure Altitude Gage
13. External Tank Empty Lights
14. Radar Scope Recorder
14A. Accelerometer
15. Standby Compass
16. Radar Scope
17. Maximum Maneuver Warning Light
18. Computer Mode Indicator
19. Standby Attitude Indicator
20. Marker Beacon Light
20A. Master Warning Light Repeater
21. Air Refueling Ready Light
22. Air Refueling Contact Light
23. Air Refueling Disconnect Light
24. Variable Ramp Warning Light
25. Engine Pressure Ratio Gage
26. Engine Fire Warning Light
27. Barometer Setting Control
28. Engine Fire Warning Test Switch
29. Fuel Quantity Gage Test Button
30. Tachometer
31. Fuel Flow Indicator
32. Exhaust Gas Temperature Gage
33. Fuel Quantity Gage
34. Fuel Quantity Gage Selector Switch
35. Hydraulic Pressure-Low Warning Light
36. Nucleonic Oil Quantity Indicator
37. Radar/IR Selector Panel
38. Master Warning Light
39. Canopy Unlocked Warning Light
40. Altimeter
41. Vertical Velocity Indicator
42. Attitude Director Indicator
43. Horizontal Situation Indicator
44. Airspeed-Angle of Attack Indicator
45. Mach Indicator
46. Tactical Situation Display (TSD)

RIGHT CONSOLE



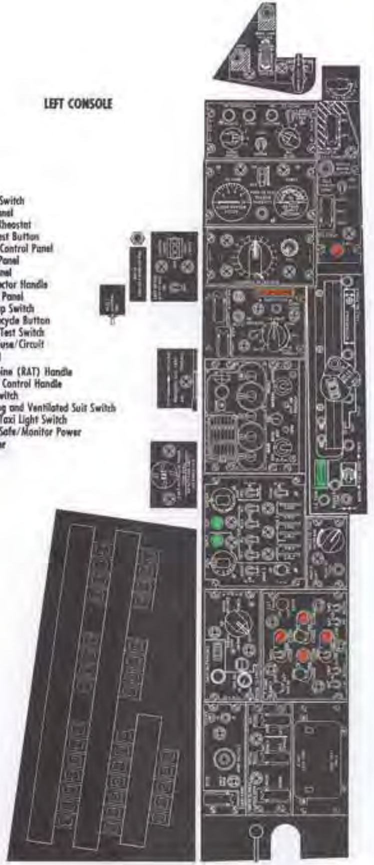
1. Master Warning Light Panel
2. Primary Hydraulic System Pressure Gage
3. Secondary Hydraulic System Pressure Gage
4. Oil Pressure Gage
5. IFF Caution Light
6. Generator Switch
7. No. 3 Fuel Tank Switch
8. Canopy Switch
9. Data Link Antenna Switch
10. Canopy Latch Handle
11. ATG Switch
12. Map Reading Light Switch
13. Warning Lights Test Button
14. Map Reading Light
15. EGT Spread Button
16. Emergency AC Generator Switch
17. Windshield Anti-Icing, Antifog Switches
18. Blank
19. TACAN-ADF Selector Switch
20. Engine Anti-Ice Warning Test Button
21. Rain Removal Switch
21A. Altitude Warning Selector
22. Ejection Seat Ground Safety Pin Stowage
23. Cabin Temperature Control Knob
24. Pitot Heat Switch
25. Canopy Antifog Switch
26. Surface and Engine Anti-Icing Switch
27. Compass System Controller
28. Cockpit Right Fuse/Circuit Breaker Panel
29. MATTS Switch
30. Map and Data Case
31. Lighting Control Powerstats
32. Lighting Control Panel
33. Data Link Control Panel
34. Auto-Navigation Homing Point Selector
35. TACAN Control Panel
36. Refrigeration Unit Switch
37. Cabin Air Selector Switch

Figure FO-1 (Sheet 1 of 2)

F-106A cockpit -typical

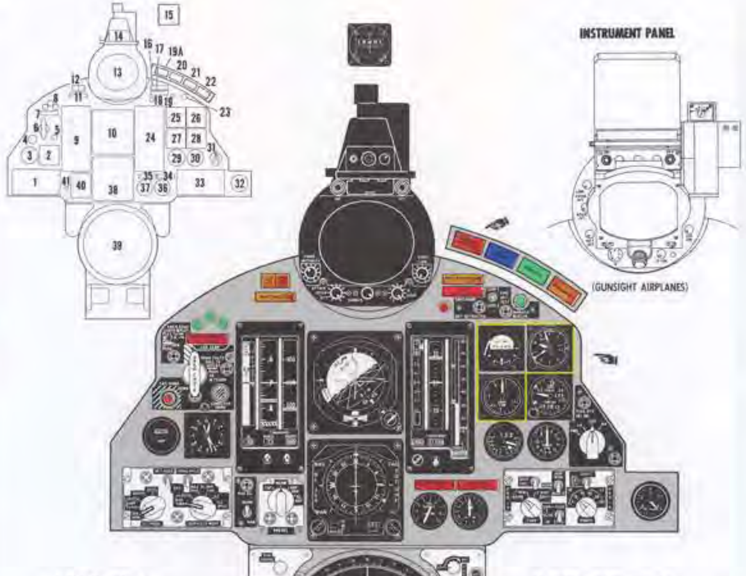
INTEGRATED FLIGHT INSTRUMENT SYSTEM

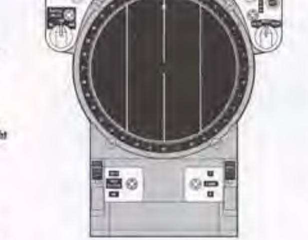
LEFT CONSOLE



1. Landing Gear Emergency Up Button
2. Landing Gear Handle
3. External Wing Tanks Release Button
4. Landing Gear Emergency Extension Handle
5. Altitude Band Switch
6. Master Electrical Power Switch
7. Landing Gear Audio Warning Cutoff Button
8. Idle Thrust Control Switch
9. CG Control Switch
10. CG Transfer Test Failure Light
11. Radar/IR Control Panel
12. Oxygen Control Panel
13. ILS Channel Selector Panel
14. Armament Control Panel
15. Throttle Quadrant
16. Throttle
17. UHF Control Panel
18. Takeoff Trim Light
19. Fuel Control Switch
20. Rudder Trim Switch
21. IFF Control Panel
22. Mask Defog Rheostat
23. Anti-G Suit Test Button
24. MA-1 Power Control Panel
25. Fuel Control Panel
26. MA-1 Test Panel
27. Cabin Air Selector Handle
28. Air Refueling Panel
29. Variable Ramp Switch
30. Armament Recycle Button
31. Pitch G Limit Test Switch
32. Cockpit Left Fuse/Circuit Breaker Panel
33. Ram Air Turbine (RAT) Handle
34. Pressure Suit Control Handle
35. Reset/MBL Switch
36. Cockpit No-Fog and Ventilated Suit Switch
37. Landing and Taxi Light Switch
38. AIR-2A Arm/Safe/Monitor Power Circuit Breaker

INSTRUMENT PANEL

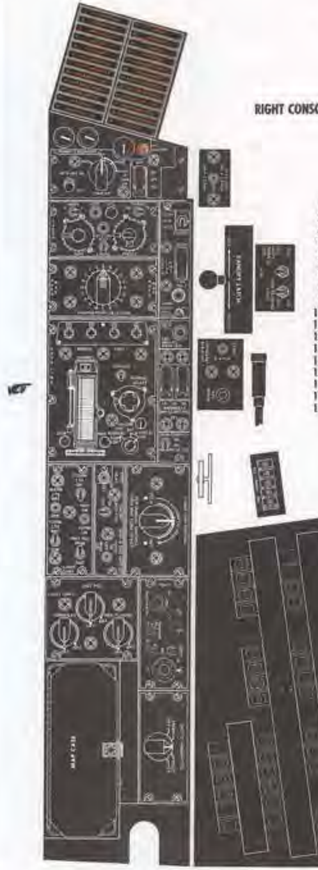




(GUNSIGHT AIRPLANES)

1. Flight Modes Panel
2. Clock
3. UHF Remote Indicator
4. Tail Hook Down Button and Light
5. Computer Mode Indicator
6. Drag Chute Handle
7. Landing Gear Warning Light
8. Landing Gear Position Lights
9. Airspeed-Mach Indicator (AMI)
10. Attitude Director Indicator (ADI)
11. Maximum Maneuver Warning Light
12. External Tank Empty Lights
13. Radar Scope
14. Radar Scope Recorder
15. Standby Compass
16. Master Warning Light
17. Engine Fire Warning Light
18. Variable Ramp Warning Light
19. Engine Fire Warning Test Switch
19A. Master Warning Light Repeater
20. Air Refueling Ready Light
21. Air Refueling Contact Light
22. Air Refueling Disconnect Light
23. Marker Beacon Light
24. Altitude-Vertical Velocity Indicator (AVVI)
25. Standby Attitude Indicator
26. Standby Altimeter
27. Standby Airspeed Indicator
28. Engine Pressure Ratio Gage
29. Exhaust Gas Temperature Gage
30. Tachometer
31. Fuel Quantity Gage Selector Switch
32. Nucleonic Oil Quantity Indicator
33. Radar/IR Selector Panel
34. Hydraulic Pressure-Low Warning Light
35. Canopy Unlocked Warning Light
36. Fuel Flow Indicator
37. Fuel Quantity Gage
38. Horizontal Situation Indicator (HSI)
39. Tactical Situation Display (TSD)
40. Bearing Selector Switch
41. Heading Selector Switch

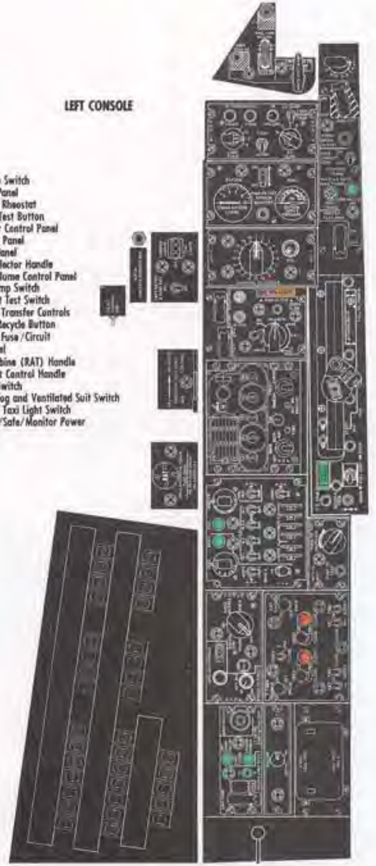
RIGHT CONSOLE



1. Master Warning Light Panel
2. Primary Hydraulic System Pressure Gage
3. Secondary Hydraulic System Pressure Gage
4. Oil Pressure Gage
5. IFF Caution Light
6. Generator Switch
7. No. 3 Fuel Tank Switch
8. Canopy Switch
9. Data Link Antenna Switch
10. Canopy Latch Handle
11. ATG Switch
12. Map Reading Light Switch
13. Warning Lights Test Button
14. Map Reading Light
15. Engine Anti-Ice Warning Test Button
16. Emergency AC Generator Switch
17. Windshield Anti-Icing, Antifog Switches
18. EGT Spread Button
19. Rain Removal Switch
19A. Altitude Warning Selector
20. Ejection Seat Ground Safety Pin Stowage
21. Cabin Temperature Control Knob
22. Pitot Heat Switch
23. Canopy Antifog Switch
24. Surface and Engine Anti-Icing Switch
25. Compass System Controller
26. Cockpit Right Fuse/Circuit Breaker Panel
27. MATTS Switch
28. Map and Data Case
29. Lighting Control Powerstats
30. Lighting Control Panel
31. Data Link Control Panel
32. Auto-Navigation Homing Point Selector
33. TACAN Control Panel
34. Refrigeration Unit Switch
35. Cabin Air Selector Switch

F-106B cockpit
-typical-forward
CONVENTIONAL INSTRUMENT DISPLAY

LEFT CONSOLE

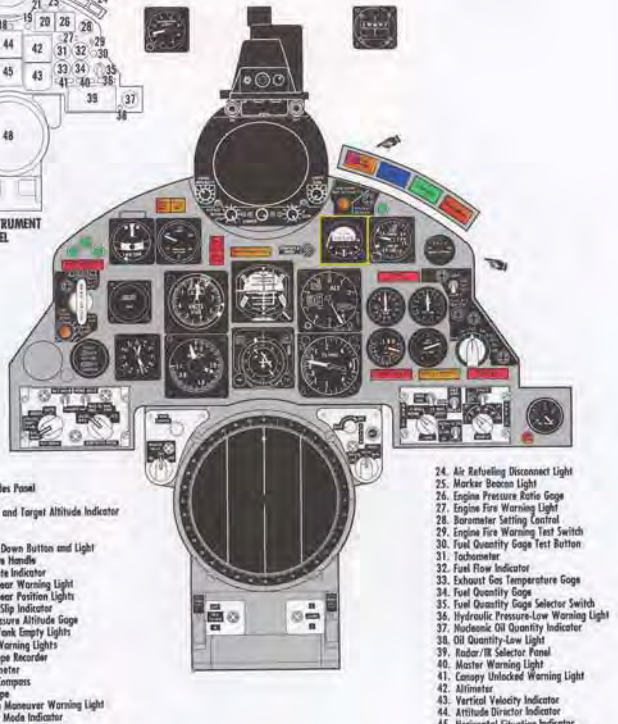


1. Landing Gear Emergency Up Button
2. Landing Gear Handle
3. External Wing Tanks Release Button
4. Landing Gear Emergency Extension Handle
5. Altitude Band Switch
6. Bailout Switch
7. Landing Gear Audio Warning Cutoff Button
8. Idle Thrust Control Switch
9. AFCS Transfer Controls
10. Master Electrical Power Switch
11. Radar/IR Control Panel
12. Oxygen Control Panel
13. ILS Channel Selector Panel
14. Armament Control Panel
15. Throttle Quadrant
16. Throttle
17. UHF Control Panel
18. Takeoff Trim Light
19. Fuel Control Switch
20. Rudder Trim Switch
21. IFF Control Panel
22. Mask Defog Rheostat
23. Anti-G Suit Test Button
24. MA-1 Power Control Panel
25. Fuel Control Panel
26. MA-1 Test Panel
27. Cabin Air Selector Handle
28. Intercom Volume Control Panel
29. Variable Ramp Switch
30. Pitch G Limit Test Switch
31. UHF/TACAN Transfer Controls
32. Armament Recycle Button
33. Cockpit Left Fuse/Circuit Breaker Panel
34. Ram Air Turbine (RAT) Handle
35. Pressure Suit Control Handle
36. Reset/MBL Switch
37. Cockpit No-Fog and Ventilated Suit Switch
38. Landing and Taxi Light Switch
39. AIR-2A Arm/Safe/Monitor Power

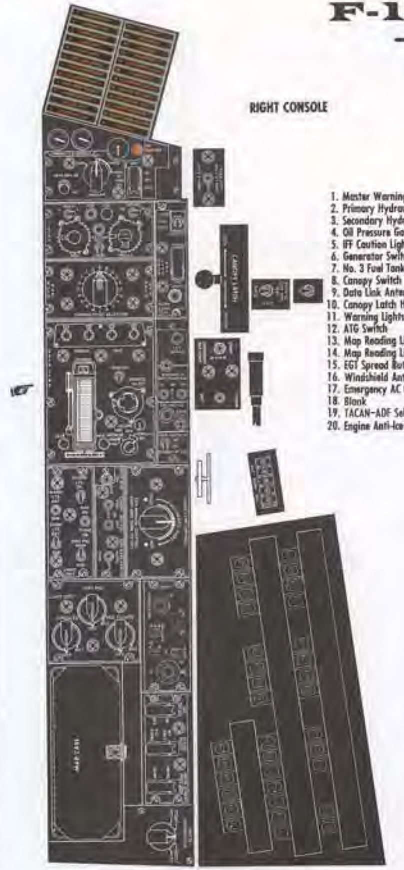
INSTRUMENT PANEL

1. Flight Modes Panel
2. Clock
3. Command and Target Altitude Indicator
4. Blank
5. Blank
6. Tail Hook Down Button and Light
7. Drag Chute Handle
8. UHF Remote Indicator
9. Landing Gear Warning Light
10. Landing Gear Position Lights
11. Turn-and-Slip Indicator
12. Cabin Pressure Altitude Gage
13. External Tank Empty Lights
14. Bailout Warning Lights
15. Radar Scope Recorder
15A. Accelerometer
16. Standby Compass
17. Radar Scope
18. Maximum Maneuver Warning Light
19. Computer Mode Indicator
20. Standby Attitude Indicator
21. Variable Ramp Warning Light
21A. Master Warning Light Repeater
22. Air Refueling Ready Light
23. Air Refueling Contact Light
24. Air Refueling Disconnect Light
25. Marker Beacon Light
26. Engine Pressure Ratio Gage
27. Engine Fire Warning Light
28. Barometer Setting Control
29. Engine Fire Warning Test Switch
30. Fuel Quantity Gage Test Button
31. Tachometer
32. Fuel Flow Indicator
33. Exhaust Gas Temperature Gage
34. Fuel Quantity Gage
35. Fuel Quantity Gage Selector Switch
36. Hydraulic Pressure-Low Warning Light
37. Nucleonic Oil Quantity Indicator
38. Oil Quantity-Low Light
39. Radar/IR Selector Panel
40. Master Warning Light
41. Canopy Unlocked Warning Light
42. Altimeter
43. Vertical Velocity Indicator
44. Attitude Director Indicator
45. Horizontal Situation Indicator
46. Airspeed-Angle of Attack Indicator
47. Mach Indicator
48. Tactical Situation Display (TSD)

RIGHT CONSOLE



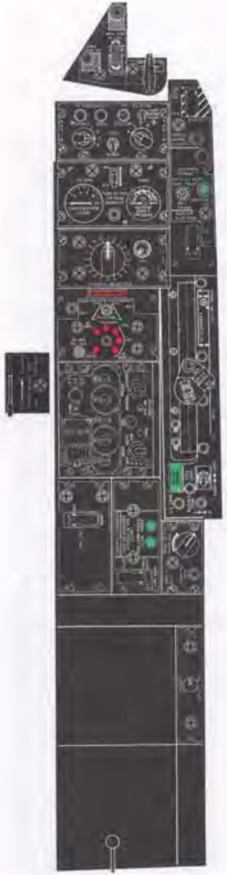
1. Master Warning Light Panel
2. Primary Hydraulic System Pressure Gage
3. Secondary Hydraulic System Pressure Gage
4. Oil Pressure Gage
5. IFF Caution Light
6. Generator Switch
7. No. 3 Fuel Tank Switch
8. Canopy Switch
9. Data Link Antenna Switch
10. Canopy Latch Handle
11. Warning Lights Test Button
12. ATG Switch
13. Map Reading Light Switch
14. Map Reading Light
15. EGT Spread Button
16. Windshield Anti-Icing, Antifog Switches
17. Emergency AC Generator Switch
18. Blank
19. TACAN-ADF Selector Switch
20. Engine Anti-Ice Warning Test Button
21. Rain Removal Switch
21A. Altitude Warning Selector
22. Ejection Seat Ground Safety Pin Stowage
23. Cabin Temperature Control Knob
24. Compass System Controller
25. Air Refueling Panel
26. Cockpit Right Fuse/Circuit Breaker Panel
27. MATTS Switch
28. Map and Data Case
29. Lighting Control Powerstats
30. Surface and Engine Anti-Icing Switch
31. Lighting Control Panel
32. Canopy Antifog Switches
33. Pitot Heat Switch
34. Data Link Control Panel
35. Auto-Navigation Homing Point Selector
36. TACAN Control Panel
37. Refrigeration Unit Switch
38. Cabin Air Selector Switch

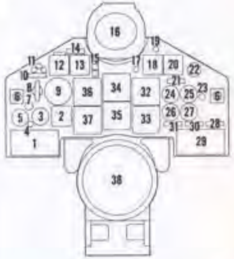


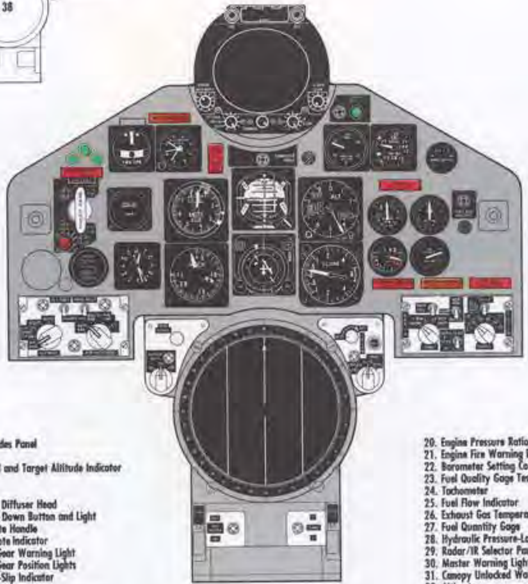
F-106B cockpit
-typical-aft
CONVENTIONAL INSTRUMENT DISPLAY

LEFT CONSOLE

1. Landing Gear Emergency Up Button
2. Landing Gear Handle
3. External Wing Tanks Release Button
4. Landing Gear Emergency Extension Handle
5. Bailout Switch
6. Radar/IR Control Panel
7. Landing Gear Audio Warning Cutoff Button
8. Oxygen Control Panel
9. AFCS Transfer Controls
10. ILS Channel Selector Panel
11. Master Electrical Power Switch
12. Armament Control Monitor Panel
13. Throttle Quadrant
14. Throttle
15. UHF Control Panel
16. Takeoff Trim Light
17. Fuel Control Switch
18. Rudder Trim Switch
19. UHF/TACAN Transfer Controls
20. Mask Defog Rheostat
21. Variable Ramp Switch
22. Anti-G Suit Test Button
23. Intercom Volume Control Panel
24. Cabin Air Selector Handle
25. Fuel Shutoff Switch
26. Pressure Suit Control Handle



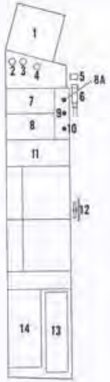




1. Flight Modes Panel
2. Clock
3. Command and Target Altitude Indicator
4. Blank
5. Blank
6. Cabin Air Diffuser Head
7. Tail Hook Down Button and Light
8. Drag Chute Handle
9. UHF Remote Indicator
10. Landing Gear Warning Light
11. Landing Gear Position Lights
12. Turn-and-Slip Indicator
13. Accelerometer
14. Maximum Maneuver Warning Light
15. Bailout Warning Lights
16. Radar Scope
17. Computer Mode Indicator
18. Cabin Pressure Altitude Gage
19. Marker Beacon Light
20. Engine Pressure Ratio Gage
21. Engine Fire Warning Light
22. Barometer Setting Control
23. Fuel Quality Gage Test Button
24. Tachometer
25. Fuel Flow Indicator
26. Exhaust Gas Temperature Gage
27. Fuel Quantity Gage
28. Hydraulic Pressure-Low Warning Light
29. Radar/IR Selector Panel
30. Master Warning Light
31. Canopy Unlocked Warning Light
32. Altimeter
33. Vertical Velocity Indicator
34. Attitude Director Indicator
35. Horizontal Situation Indicator
36. Airspeed-Angle of Attack Indicator
37. Mach Indicator
38. Tactical Situation Display (TSD)

RIGHT CONSOLE

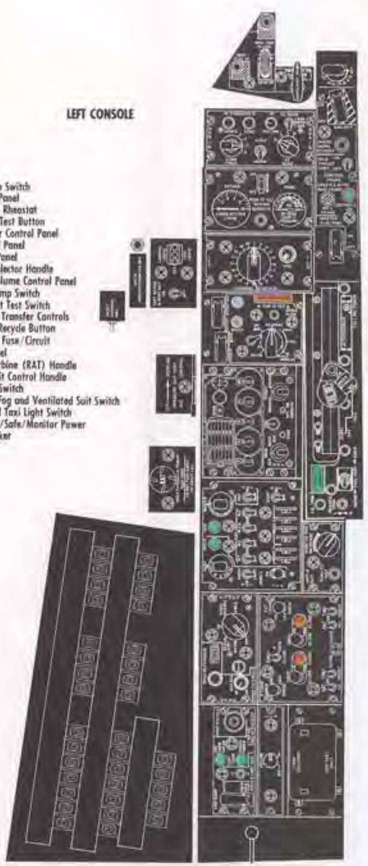
1. Master Warning Light Panel
2. Primary Hydraulic System Pressure Gage
3. Secondary Hydraulic System Pressure Gage
4. Oil Pressure Gage
5. Map Reading Light Switch
6. Map Reading Light
7. TACAN Control Panel
8. Auto-Navigation Homing Point Selector
8A. Emergency Canopy Open Switch
9. Warning Lights Dimmer Switch
10. Warning Lights Test Button
11. Lighting Control Powerstats
12. Ejection Seat Ground Safety Pin Stowage
13. Cockpit Right Fuse/Circuit Breaker Panel
14. Map and Data Case



F-106B cockpit
-typical-forward

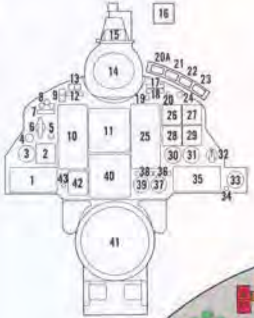
INTEGRATED FLIGHT INSTRUMENT SYSTEM

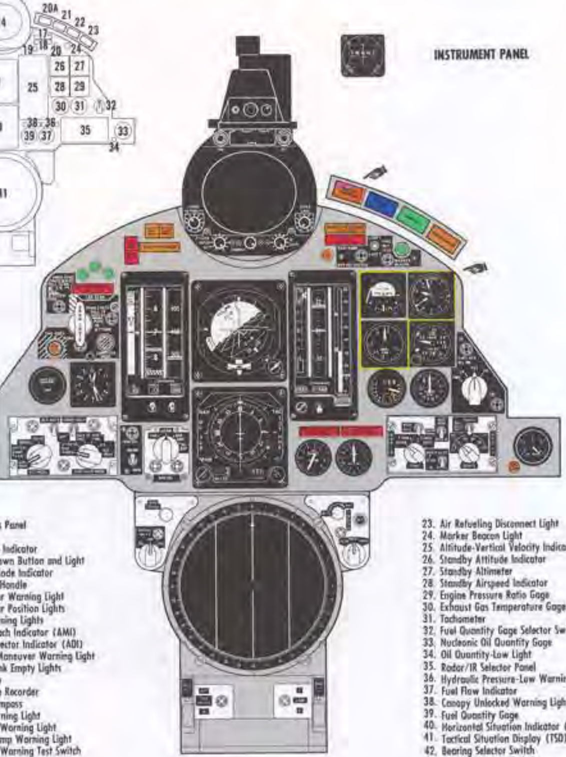
LEFT CONSOLE



1. Landing Gear Emergency Up Button
2. Landing Gear Handle
3. External Wing Tanks Release Button
4. Landing Gear Emergency Extension Handle
5. Altitude Band Switch
6. Bailout Switch
7. Landing Gear Audio Warning Cutoff Button
8. Idle Thrust Control Switch
9. AFCS Transfer Controls
10. Master Electrical Power Switch
11. Radar/IR Control Panel
12. Oxygen Control Panel
13. RS Channel Selector Panel
14. Armament Control Panel
15. Throttle Quadrant
16. Throttle
17. UHF Control Panel
18. Takeoff Trim Light
19. Fuel Control Switch
20. Rudder Trim Switch
21. IFF Control Panel
22. Mask Defog Rheostat
23. Anti-G Suit Test Button
24. MA-1 Power Control Panel
25. Fuel Control Panel
26. MA-1 Test Panel
27. Cabin Air Selector Handle
28. Intercom Volume Control Panel
29. Variable Ramp Switch
30. Pitch G Limit Test Switch
31. UHF/TACAN Transfer Controls
32. Armament Recycle Button
33. Cockpit Left Fuse/Circuit Breaker Panel
34. Ram Air Turbine (RAT) Handle
35. Pressure Suit Control Handle
36. Reset/MBL Switch
37. Cockpit No-Fog and Ventilated Suit Switch
38. Landing and Taxi Light Switch
39. AIR-2A Arm/Safe/Monitor Power Circuit Breaker

INSTRUMENT PANEL



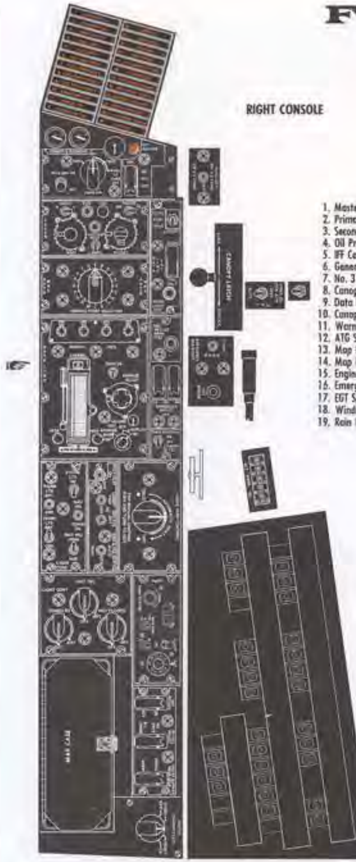


1. Flight Modes Panel
2. Clock
3. UHF Remote Indicator
4. Tail Hook Down Button and Light
5. Computer Mode Indicator
6. Drag Chute Handle
7. Landing Gear Warning Light
8. Landing Gear Position Lights
9. Bailout Warning Lights
10. Airspeed-Mach Indicator (AMI)
11. Attitude Director Indicator (ADI)
12. Maximum Maneuver Warning Light
13. External Tank Empty Lights
14. Radar Scope
15. Radar Scope Recorder
16. Standby Compass
17. Master Warning Light
18. Engine Fire Warning Light
19. Variable Ramp Warning Light
20. Engine Fire Warning Test Switch

20A. Master Warning Light Repeater

21. Air Refueling Ready Light
22. Air Refueling Contact Light
23. Air Refueling Disconnect Light
24. Marker Beacon Light
25. Altitude-Vertical Velocity Indicator (AVVI)
26. Standby Attitude Indicator
27. Standby Altimeter
28. Standby Airspeed Indicator
29. Engine Pressure Ratio Gage
30. Exhaust Gas Temperature Gage
31. Tachometer
32. Fuel Quantity Gage Selector Switch
33. Nucleonic Oil Quantity Gage
34. Oil Quantity-Low Light
35. Radar/IR Selector Panel
36. Hydraulic Pressure-Low Warning Light
37. Fuel Flow Indicator
38. Canopy Unlocked Warning Light
39. Fuel Quantity Gage
40. Horizontal Situation Indicator (HSI)
41. Tactical Situation Display (TSD)
42. Bearing Selector Switch
43. Heading Selector Switch

RIGHT CONSOLE



1. Master Warning Light Panel
2. Primary Hydraulic System Pressure Gage
3. Secondary Hydraulic System Pressure Gage
4. Oil Pressure Gage
5. IFF Caution Light
6. Generator Switch
7. No. 3 Fuel Tank Switch
8. Canopy Switch
9. Data Link Antenna Switch
10. Canopy Latch Handle
11. Warning Lights Test Button
12. ATG Switch
13. Map Reading Light Switch
14. Map Reading Light
15. Engine Anti-Ice Warning Test Button
16. Emergency AC Generator Switch
17. EGT Spread Button
18. Windshield Anti-Icing, Antifog Switches
19. Rain Removal Switch

19A. Altitude Warning Selector

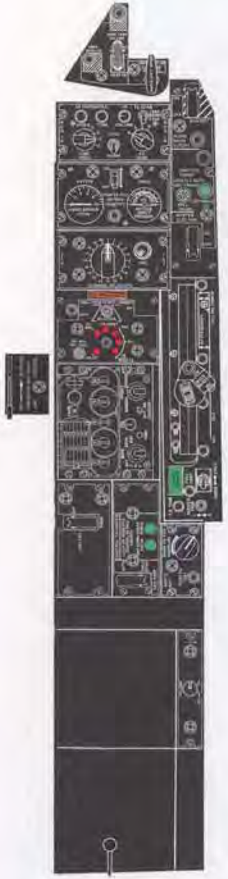
20. Ejection Seat Ground Safety Pin Stowage
21. Cabin Temperature Control Knob
22. Compass System Controller
23. Cockpit Right Fuse/Circuit Breaker Panel
24. Air Refueling Panel
25. MATTS Switch
26. Map and Data Case
27. Lighting Control Powerstats
28. Surface and Engine Anti-Icing Switch
29. Canopy Antifog Switches
30. Pitot Heat Switch
31. Lighting Control Panel
32. Data Link Control Panel
33. Auto-Navigation Homing Point Selector
34. TACAN Control Panel
35. Refrigeration Unit Switch
36. Cabin Air Selector Switch

F-106B cockpit
-typical-aft

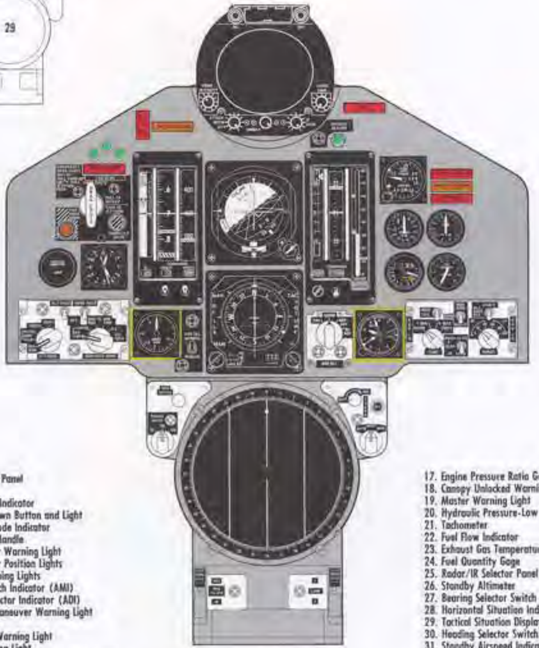
INTEGRATED FLIGHT INSTRUMENT SYSTEM

LEFT CONSOLE

1. Landing Gear Emergency Up Button
2. Landing Gear Handle
3. External Wing Tanks Release Button
4. Landing Gear Emergency Extension Handle
5. Bailout Switch
6. Radar/IR Control Panel
7. Landing Gear Audio Warning Cutoff Button
8. Oxygen Control Panel
9. AFCS Transfer Controls
10. ILS Channel Selector Panel
11. Master Electrical Power Switch
12. Armament Control Monitor Panel
13. Throttle Quadrant
14. Throttle
15. UHF Control Panel
16. Takeoff Trim Light
17. Fuel Control Switch
18. Rudder Trim Switch
19. UHF/TACAN Transfer Controls
20. Mask Defog Rheostat
21. Variable Ramp Switch
22. Anti-G Suit Test Button
23. Intercom Volume Control Panel
24. Cabin Air Selector Handle
25. Fuel Shutoff Switch
26. Pressure Suit Control Handle

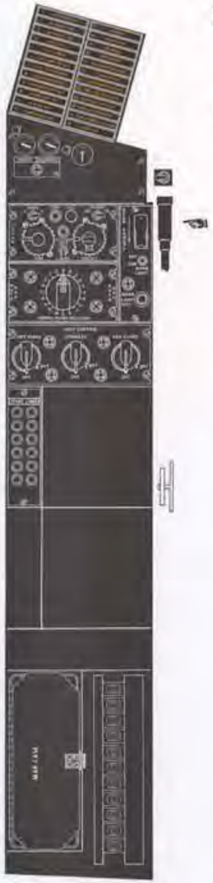


INSTRUMENT PANEL



1. Flight Modes Panel
2. Clock
3. UHF Remote Indicator
4. Tail Hook Down Button and Light
5. Computer Mode Indicator
6. Drag Chute Handle
7. Landing Gear Warning Light
8. Landing Gear Position Lights
9. Bailout Warning Lights
10. Airspeed-Mach Indicator (AMI)
11. Attitude Director Indicator (ADI)
12. Maximum Maneuver Warning Light
13. Radar Scope
14. Engine Fire Warning Light
15. Marker Beacon Light
16. Altitude-Vertical Velocity Indicator (AVVI)
17. Engine Pressure Ratio Gage
18. Canopy Unlocked Warning Light
19. Master Warning Light
20. Hydraulic Pressure-Low Warning Light
21. Tachometer
22. Fuel Flow Indicator
23. Exhaust Gas Temperature Gage
24. Fuel Quantity Gage
25. Radar/IR Selector Panel
26. Standby Altimeter
27. Bearing Selector Switch
28. Horizontal Situation Indicator (HSI)
29. Tactical Situation Display (TSD)
30. Heading Selector Switch
31. Standby Airspeed Indicator

RIGHT CONSOLE



1. Master Warning Light Panel
2. Primary Hydraulic System Pressure Gage
3. Secondary Hydraulic System Pressure Gage
4. Oil Pressure Gage
5. Map Reading Light Switch
6. Map Reading Light
7. TACAN Control Panel
8. Auto-Navigation Homing Point Selector
8A. Emergency Canopy Open Switch
9. Warning Lights Dimmer Switch
10. Warning Lights Test Button
11. Lighting Control Powerstats
12. Ejection Seat Ground Safety Pin Stowage
13. Cockpit Right Fuse/Circuit Breaker Panel
14. Map and Data Case

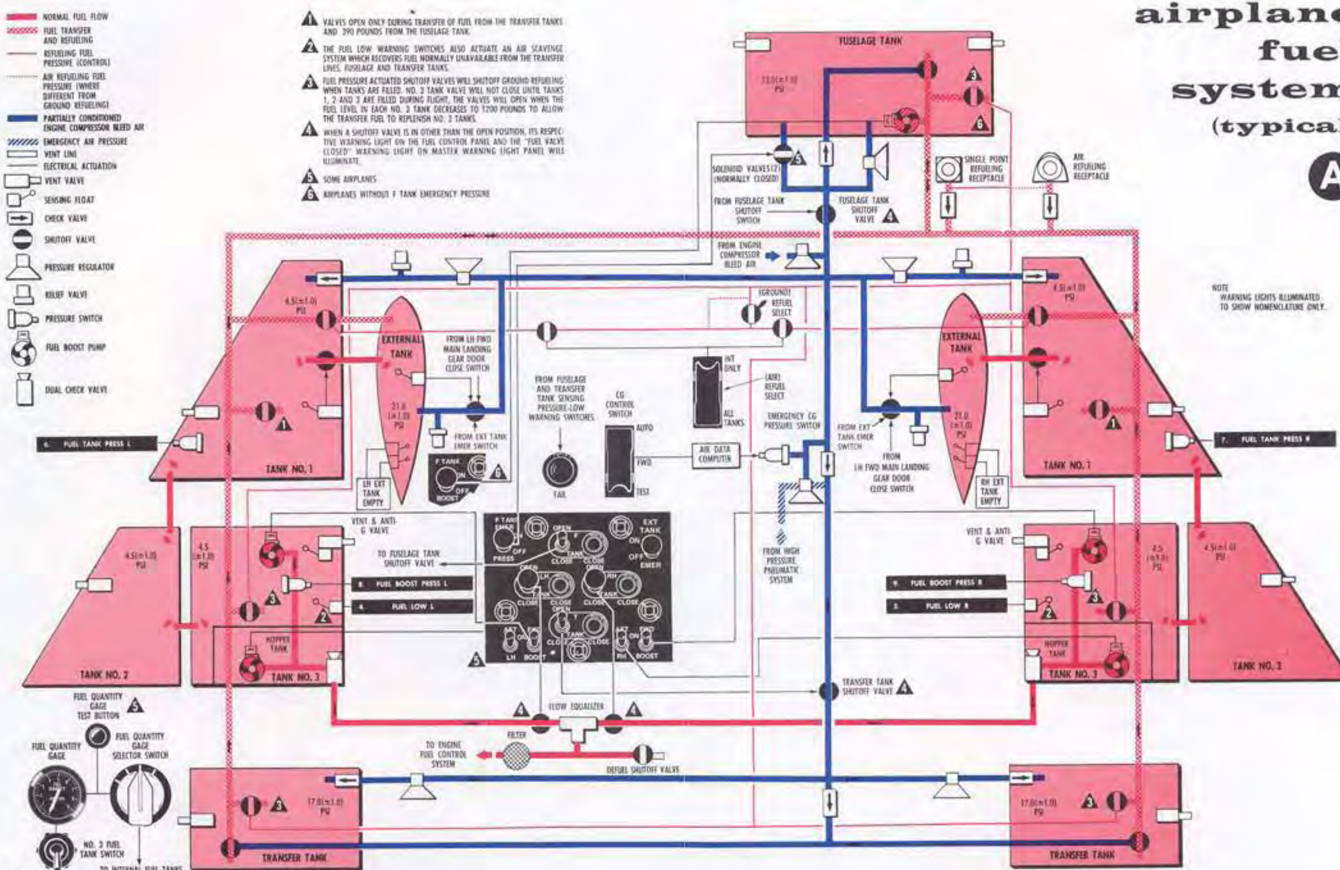
Figure FO-2 (Sheet 4 of 4)

airplane fuel system (typical)

A

1. VALVES OPEN ONLY DURING TRANSFER OF FUEL FROM THE TRANSFER TANKS AND 390 POUNDS FROM THE FUSELAGE TANK.
2. THE FUEL LOW WARNING SWITCHES ALSO ACTUATE AN AIR SCAVENGE SYSTEM WHICH RECOVERS FUEL NORMALLY UNAVAILABLE FROM THE TRANSFER LINES, FUSELAGE AND TRANSFER TANKS.
3. FUEL PRESSURE ACTUATED SHUTOFF VALVES WILL SHUTOFF GROUND REFUELING WHEN TANKS ARE FILLED. NO. 3 TANK VALVE WILL NOT CLOSE UNTIL TANKS 1, 2 AND 3 ARE FILLED DURING FLIGHT. THE VALVES WILL OPEN WHEN THE FUEL LEVEL IN EACH NO. 3 TANK DECREASES TO 1700 POUNDS TO ALLOW THE TRANSFER FUEL TO REPLENISH NO. 3 TANKS.
4. WHEN A SHUTOFF VALVE IS IN OTHER THAN THE OPEN POSITION, ITS RESPECTIVE WARNING LIGHT ON THE FUEL CONTROL PANEL AND THE "FUEL VALVE CLOSED" WARNING LIGHT ON MASTER WARNING LIGHT PANEL WILL ILLUMINATE.
5. SOME AIRPLANES
6. AIRPLANES WITHOUT F TANK EMERGENCY PRESSURE

NOTE
WARNING LIGHTS ILLUMINATED TO SHOW NOMENCLATURE ONLY.



airplane fuel system (typical)

B

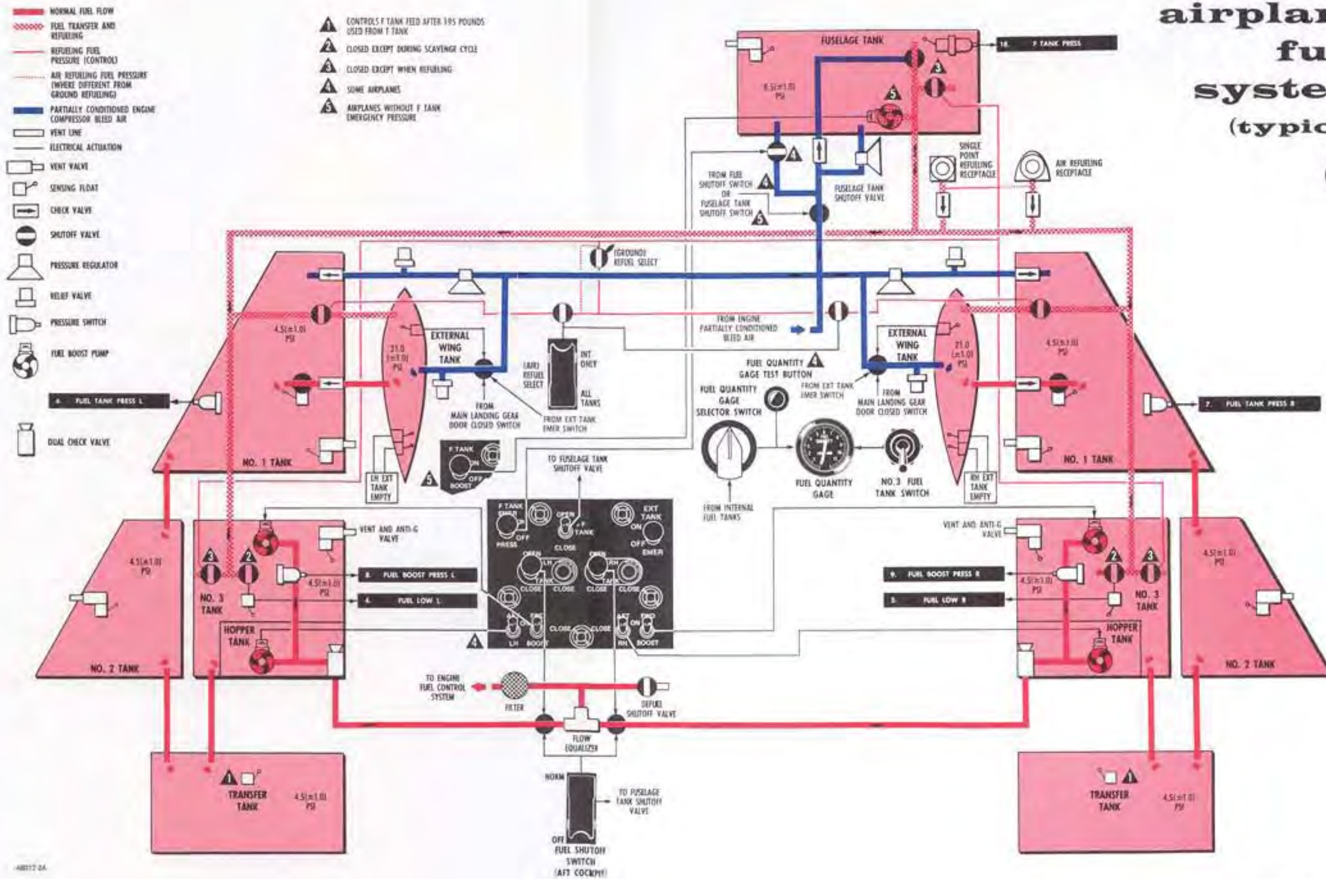


Figure FO-3 (Sheet 2 of 2)

electrical power supply system

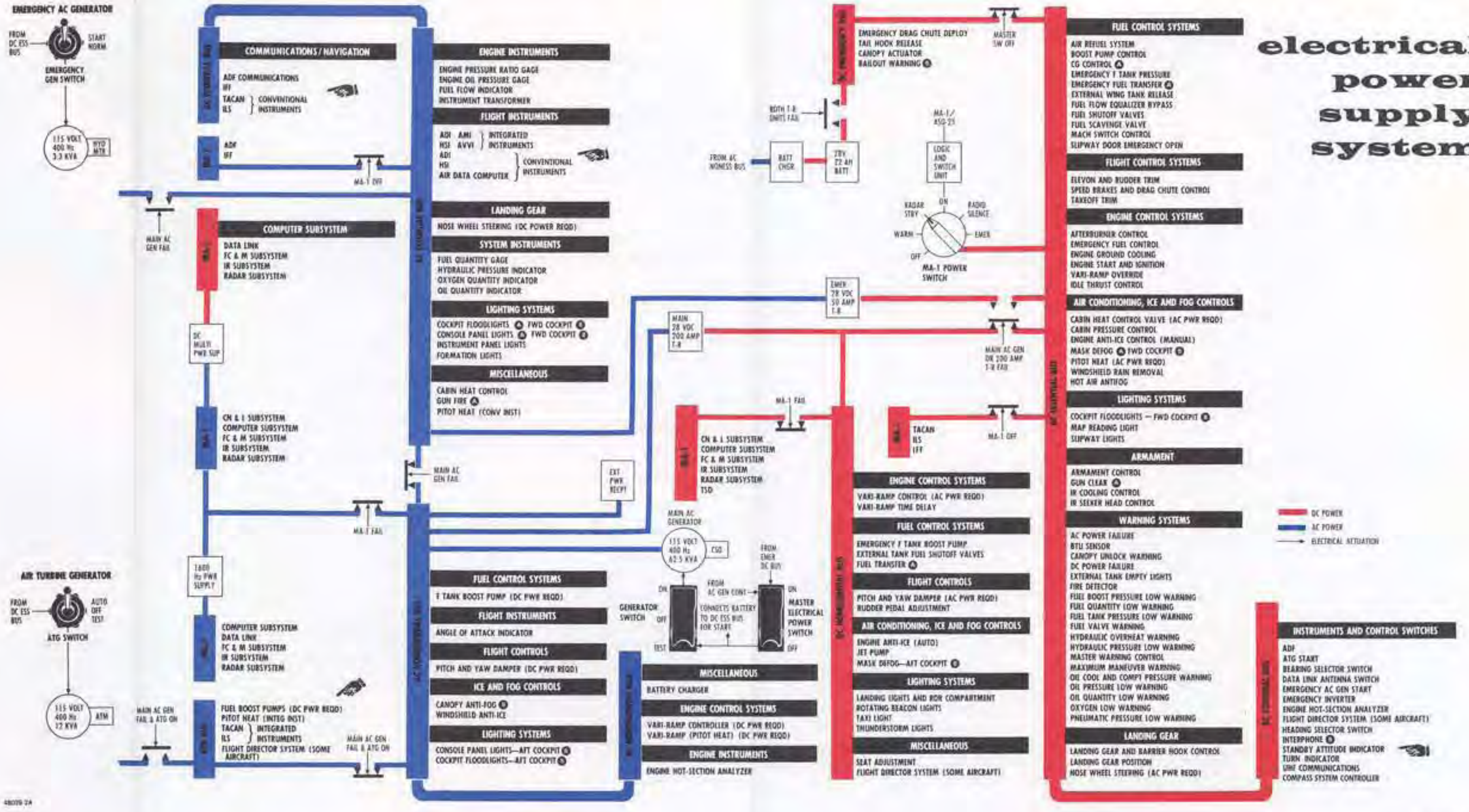
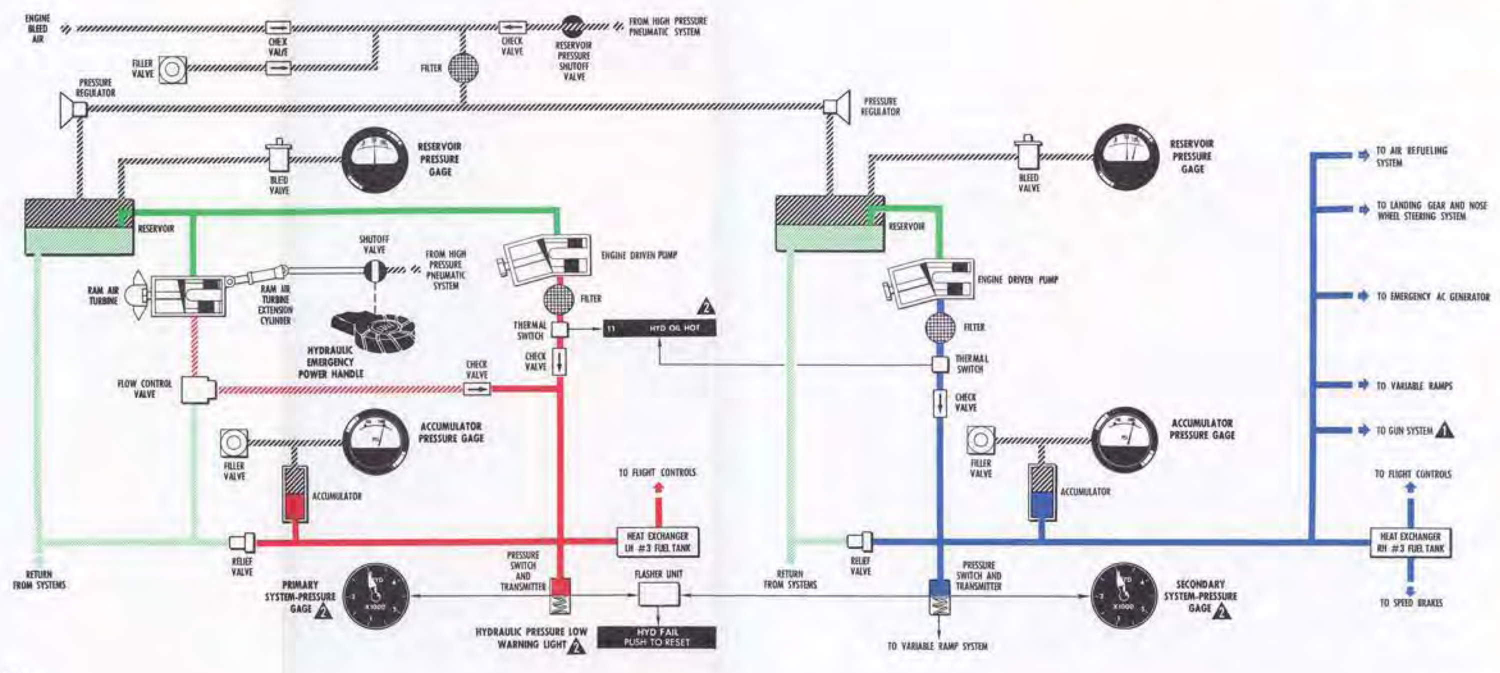


Figure FO-4

hydraulic power supply system

- HYDRAULIC SYSTEM SUPPLY
- PRIMARY SYSTEM PRESSURE
- SECONDARY SYSTEM PRESSURE
- HYDRAULIC SYSTEM RETURN
- EMERGENCY PRESSURE
- AIR PRESSURE
- STATIC AIR
- ELECTRICAL ACTUATION
- MECHANICAL ACTUATION
- 1 SOME AIRPLANES
- 2 B DUAL CONTROLS AND INDICATORS NOT SHOWN



indicator and warning lights description

LIGHT	CAUSE	CORRECTIVE ACTION	REMARKS
(B) UHF - Comm Tacan	UHF communication and Tacan control is in cockpit in which light is illuminated.	None	Control automatically transfers to forward cockpit when MA-1 power switch is in EMER position.
(B) Radar Power	Radar control is in cockpit in which light is illuminated.	None	Control automatically transfers to forward cockpit when MA-1 power switch is in EMER position.
Fuel Shutoff	Respective shutoff valve in some position other than fully open.	Follow prescribed emergency procedure.	None
(A) CG Fuel Transfer Test Failure	Low pressurization in the transfer and fuselage tanks.	Follow emergency procedures for Fuselage Tank Pressurization Failure.	None
(B) AFCS - ILS-Auto Nav Trans	AFCS and ILS control is in cockpit in which light is illuminated.	None	Before control can be transferred, flight and auto mode switch settings must be the same in both cockpits.
Tailhook Down	Tailhook uplatch in extended position releasing the tailhook.	Information only.	Illumination inflight indicates that the tailhook is extended and precautions should be observed to avoid inadvertant barrier engagement during landing.
LH EXT TANK EMPTY / RH EXT TANK EMPTY	External tanks empty as indicated by the low-level float switches.	Information only.	The light will remain on until the high-level float switches indicate the tanks are full. It may illuminate during negative-g maneuvers.
MAX MANEUVER	Stagnation temperature limit exceeded.	Observe reduced maximum allowable load factors.	None
Variable Ramp Not Retracted	Failure of the ramps to fully retract at speeds below Mach 1.2.	Follow prescribed emergency procedure.	The warning light is activated by a switch in the right ramp. The light will extinguish when the ramps are fully retracted.
FIRE	Fire detection system has sensed a local hot spot (flashing light) or fire (steady light when both loops are energized).	Follow prescribed emergency procedure.	This system is deactivated when the master electrical power switch is in OFF position.
CANOPY UNLKD	Both canopy latches not fully engaged.	Follow prescribed emergency procedure if airborne.	The light dimming feature has been deactivated.
MASTER WARNING PUSH TO RESET	Illuminates when any of the warning light panel lights and other warning lights illuminate.	Extinguish by depressing the light.	The individual warning light will remain illuminated until the cause for illumination is corrected.
MASTER WARNING	Illuminates when any of the warning light panel lights and other warning lights illuminate. (Repeats above light.)	Extinguish by depressing Master Warning Light (above).	Do not press to extinguish.

LIGHT	CAUSE	CORRECTIVE ACTION	REMARKS
HYD FAIL	Light flashes when primary or secondary hydraulic system pressure falls below approximately 1000 psi. Pressure loss in both systems causes steady illumination.	Follow prescribed emergency procedure.	The light may be extinguished by a pressure rise above 1,000 psi or by depressing the light if it is flashing.
1. AC POWER FAIL	Failure of ac generator.	Follow prescribed emergency procedure.	ATG and emergency ac generator should provide ac power automatically to ATG and ac essential buses.
2. DC POWER FAIL	Momentary flash – loss of 200A TR output. Steady light – loss of both 200A & 50A TR output.	Follow prescribed emergency procedure.	DC nonessential bus power will not be available. If light is on steady, battery will be depleted in approximately 15 minutes.
3. EMER FUEL ON	Fuel control switch in EMER position.	Information only.	Before engine start, the light is illuminated with fuel control switch in either position.
4. FUEL LOW L / 5. FUEL LOW R	Illuminates when usable fuel in each No. 3 tank reaches approximately 570 pounds.	Follow prescribed emergency procedure and observe flight restrictions when operating with low fuel quantity.	None
6. FUEL TANK PRESS L / 7. FUEL TANK PRESS R	Left or right No. 1 tank pressurization low.	Follow prescribed emergency procedure.	Normal fuel transfer into the No. 3 tanks cannot be expected.
8. FUEL BOOST PRESS L / 9. FUEL BOOST PRESS R	Left or right tank outlet pressure low.	Follow prescribed emergency procedure.	None
10. ENGINE ANTI-ICE	Automatic or manual engine anti-icing system, as selected – inoperative.	When flying in heavy icing conditions, select MAN ON; otherwise select AUTO ON.	Light may illuminate during reduced airflow in intake duct or if in AUTO ON and probe heater is on for more than 25 seconds.
11. HYD OIL HOT	Hydraulic fluid in either system reaches excessive temp. Light can be an indication of pending flight control oscillations or pressure loss.	Follow prescribed emergency procedure.	There is no positive means for determining which system has overheated.
12. CABIN PRESS LOW	Cabin pressure altitude above approximately 44,000 feet and emergency cabin pressurization system operating.	Follow prescribed emergency procedure.	Maximum recommended cabin altitude with MBU-3/P or MBU-5/P oxygen mask is 25,000 feet.
13. MISFIRE	A firing signal does not launch selected armament.	Follow prescribed emergency procedure.	Light illuminates briefly during any firing.
14. DOOR OPEN	Illuminates approximately 12 seconds after missile bay doors are opened if armament firing cycle is not completed and the doors do not close.	Follow prescribed emergency procedure. Monitor fuel for range considerations.	May also illuminate if armament trigger is released after firing but before doors close.

LIGHT	CAUSE	CORRECTIVE ACTION	REMARKS
15. OIL PRESS	Oil pressure below 37 ± 2 psi.	Follow prescribed emergency procedure.	None
16. PNEU PRESS	Pressure in the two main air storage flasks below approximately 1700 psi.	Follow prescribed emergency procedure.	None
17. ENG COMPT O. PRESS	Engine accessory compartment pressure limit exceeded.	Follow prescribed emergency procedure.	Once illuminated, the light will remain on for the rest of the flight.
(B) 18. F TANK PRESS	Fuselage tank pressure low.	Follow prescribed emergency procedure for either F tank emergency boost pump or F tank emergency pressure system airplanes.	(B) only. This warning system not installed in (A) aircraft.
(A) 18. OIL QUAN LOW (B) OIL LOW	Usable oil quantity in the tank below approximately one-fourth.	Follow prescribed emergency procedure.	(B) Front cockpit only.
19. ELECTRONIC COOLING	Cooling air in the electronic compartment is insufficient for sustained equipment operation.	Follow procedure prescribed for illumination of electronic cooling light, ground or air operation.	Electronic cooling light is inoperative with MA-1 switch in OFF or EMER position.
20. FUEL VALVE CLOSED	Any one of fuel shutoff valves in a position other than fully open.	Follow prescribed emergency procedure.	On (B) airplanes the fuel valve fail light will not illuminate when the F tank shutoff switch is in CLOSE position.
21. OXYGEN LOW LEVEL	Liquid oxygen quantity below 1 liter.	Follow prescribed emergency procedure.	None
22. MISSILE DISPLACED	Missile not properly seated on launcher or launcher not up & locked with doors closed.	Follow prescribed emergency procedure.	May be accompanied by the misfire and door-open warning lights.
23. FLIGHT MODE FAILURE	Selected flight mode inoperative.	None. Selector switch automatically steps back to an operative mode or direct manual.	Light will illuminate when power first applied to the airplane and is extinguished by depressing MMT.
24. CADC FAIL	Failure of the Mach module, altitude module, or airspeed module within the CADC.	Follow prescribed emergency procedure and refer to standby airspeed indicator and altimeter.	All AMI and AVVI indications must be considered unreliable.

48700A

Figure FO-6